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## QUICK FACTS

### The School

The Naval Postgraduate School is America's national security research university. It provides education and research programs that are relevant to the needs and interests of the Navy, Department of Defense, other military services and federal agencies.

### The Campus

Located in Monterey, California, on the Pacific Ocean, 120 miles south of San Francisco, the Naval Postgraduate School campus covers 627 acres of land. The site, home to NPS since 1951, houses state-of-the-art laboratories, numerous academic buildings, a library, government housing and impressive recreational facilities.

### The Students

As of 2006, nearly 1,800 students attend the Naval Postgraduate School in residence and another 850 are enrolled in off-campus degree or certificate programs. The student body consists of officers from all branches of the U.S. uniformed services, officers and civilians from approximately 60 other countries and civilian employees of both the federal government and state and local governments. A limited number of defense contractors and enlisted personnel are also enrolled. Selection for graduate education at NPS is based upon outstanding professional performance, promotion potential, and a strong academic background.

### The Faculty

Drawn from a broad array of educational institutions, the faculty represent a prestigious collection of scholars, the majority of whom are civilians. Faculty interaction with students is high and every class is taught directly by a faculty member. All tenure and tenure-track faculty hold a doctoral degree. Other faculty are credentialed experts in their fields of study.

### The Degrees

The Naval Postgraduate School confers the following advanced degrees: Master of Arts Degree, Master of Business Administration, Master of Science Degree, Engineer Degree, Doctor of Philosophy, and Doctor of Engineering.

For more information on admission, contact:

Admissions Office  
Code 01C3  
Naval Postgraduate School  
1 University Circle, He-022  
Monterey, CA 93943

Telephone: (831) 656-3093 / DSN 756-3093  
e-mail: [grad-ed@nps.edu](mailto:grad-ed@nps.edu)

### Printed catalogs:

For a printed catalog, send a request to the address above and include a check or money order for \$10 per catalog to cover shipping and handling. Make payable to U.S. Treasurer.

The online edition of the School's catalog is at:  
<http://www.nps.edu/admissions/catalog>

## DISTINGUISHED ALUMNI AND FACULTY ROSTER

### Distinguished U.S. Military Alumni

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers have attained flag or general officer rank and were on the active duty list as of December 2005:

LTG Keith B. Alexander, USA  
 BG Steven M. Anderson, USA  
 RDML Mark W. Balmert, USN  
 RDML Raymond E. Berube, USN  
 RADM Linda J. Bird, USN  
 BG Nolen V. Bivens, USA  
 RDML John T. Blake, USN  
 RADM Stanley D. Bozin, USN  
 RDML Brian G. Brannman, USN  
 RADM Richard E. Brooks, USN  
 RADM Annette E. Brown, USN  
 RDML Michael A. Brown, USN  
 RADM Nancy E. Brown, USN  
 RDML Gregory R. Bryant, USN  
 RDML John D. Butler, USN  
 MG William B. Caldwell IV, USA  
 RDML (Sel) Nevin P. Carr, Jr., USN  
 VADM Albert T. Church III, USN  
 RDML Robert J. Cox, USN  
 RADM (Sel) Peter H. Daly, USN  
 RDML Dan W. Davenport, USN  
 Brig Gen Paul A. Dettmer, USAF  
 RADM John K. Donnelly, USN  
 RDML Patrick W. Dunne, USN  
 RADM Dennis M. Dwyer, USN  
 RDML Mark E. Ferguson III, USN  
 RDML Timothy V. Flynn III, USN  
 RDML Mark I. Fox, USN  
 RDML William D. French, USN  
 RDML Michael S. Frick, USN  
 RDML Jan C. Gaudio, USN  
 RDML John W. Goodwin, USN  
 RDML William E. Gortney, USN  
 Gen Michael W. Hagee, USMC  
 BG David D. Halverson, USA  
 BG Frank G. Helmick, USA  
 RADM Charles X. Hamilton Jr., USN  
 RDML Cecil E. Haney, USN  
 RDML (Sel) Michael D. Hardee, USN  
 RDML Mark D. Harnitchek, USN  
 RADM Timothy L. Heely, USN  
 RDML Elizabeth A. Hight, USN  
 BG Jeffrey C. Horne, USA  
 RADM Richard R. Houck, USCG  
 RDML Richard W. Hunt, USN  
 MG Kenneth W. Hunzeker, USA  
 VADM Lowell E. Jacoby, USN  
 RADM Carlton B. Jewett, USN  
 VADM Harvey E. Johnson, Jr., USCG

MG Jason K. Kamiya, USA  
 RADM John M. Kelly, USN  
 RADM Curtis A. Kemp, USN  
 BG Michael J. Lally III, USA  
 RDML William E. Landay, USN  
 RDML Michael A. Lefever, USN  
 RADM Anthony W. Lengerich, USN  
 RDML Charles M. Lili, USN  
 VADM Keith W. Lippert, USN  
 Brig Gen Thomas J. Loftus, USAF  
 RDML Archer M. Macy, Jr., USN  
 RADM Joseph Maguire, USN  
 BG Francis G. Mahon, USA  
 RDML Michael K. Mahon, USN  
 RADM Michael G. Mathis, USN  
 RDML Gerard M. Mauer Jr., USN  
 VADM Justin D. Mccathy, USN  
 RDML Timothy J. Mcgee, USN  
 RDML William H. Mcraven, USN  
 RDML (Sel) Davis J. Mercer, USN  
 ADM Michael G. Mullen, USN  
 VADM Eric T. Olson, USN  
 BG Mark E. O'Neill, USA  
 BG Patrick J. O'Reilly, USA  
 RADM Kathleen K. Paige, USN  
 RDML John J. Prendergast III, USN  
 RDML Donald Quinn, USN  
 RDML Kevin M. Quinn, USN  
 RDML William D. Rodriguez, USN  
 RADM Michael S. Roesner, USN  
 VADM Ronald A. Route, USN  
 LTG Ricardo S. Sanchez, USA  
 RADM Kenneth D. Slaght, USN  
 MG Edgar E. Stanton, III, USA  
 RDML James W. Stevenson Jr., USN  
 BG Randolph P Strong, USA  
 VADM Stanley R. Szemborski, USN  
 BG William J. Troy, USA  
 MG Thomas R. Turner II, USA  
 ADM Henry G. Ulrich III, USN  
 MG John M. Urias, USA  
 MG Michael A. Vane, USA  
 RADM David J. Venlet, USN  
 RDML Michael C. Vitale, USN  
 RDML Richard J. Wallace, USN  
 GEN William S. Wallace, USA  
 BG Louis W. Weber, USA  
 RADM Anthony L. Winns, USN

## Distinguished International Alumni

Akgul, Aziz, Mr.,  
*Senior Advisor to Prime Minister, Turkey*

Amundsen, Espen, MGEN,  
*Chief of Norwegian Joint Staff, Norway*

Bechir, Mahamoud, Mr.,  
*Ambassador to the United States, Chad*

Bogunov, Sergiy, COL (Ret),  
*Advisor to Deputy Minister of Defense, Ukraine*

Gjoni, Ilir, Mr.,  
*Member of Parliament, Albania*

Lui, Pao Chuen, Mr.,  
*Chief Defense Scientist, Minister of Defense, Singapore*

Mollo, Solly, GEN,  
*Commandant, Military Academy, South Africa*

Murumets, Jan, Mr.,  
*Principal Advisor to CHOD, Estonia*

Ndiaye, Modiene, Mr.,  
*Director of National Lottery, Senegal*

Shkedy, Elyezer, GEN,  
*Chief of Staff, Israeli Air Force, Israel*

Srimuang, Chamlong, Mr.,  
*Former Gov of Bangkok, Current Advisor to PM, Thailand*

## Distinguished Professors

"Distinguished Professor" is an honorary title conferred upon certain faculty members in recognition of meritorious scholarly accomplishments and sustained, significant contributions to the educational mission of the Naval Postgraduate School. Their research or scholarly contributions while at the Naval Postgraduate School have had a significant impact on their fields of expertise.

Agrawal, Brij  
*Mechanical and Astronautical Engineering*

Brown, Gerald  
*Operations Research*

Bruneau, Thomas  
*National Security Affairs*

Chang, Chih Pei  
*Meteorology*

Colson, William  
*Physics*

Elsberry, Russell  
*Meteorology*

Gaver, Donald  
*Operations Research*

Healey, Anthony  
*Mechanical and Astronautical Engineering*

McNelley, Terry  
*Mechanical and Astronautical Engineering*

Netzer, David  
*Mechanical and Astronautical Engineering*

Owen, Guillermo  
*Mathematics*

Renard, Robert  
*Meteorology*

Schrady, Dave  
*Operations Research*

Shin, Young  
*Mechanical and Astronautical Engineering*

Thorton, Edward  
*Oceanography*

## Distinguished Professors Emeriti

Ball, Robert  
*Mechanical and Astronautical Engineering*

Crittenden, Eugene  
*Physics*

Fuhs, Allen  
*Mechanical and Astronautical Engineering*

Giet, George  
*Electrical and Computer Engineering*

Haderlie, Eugene  
*Oceanography*

Haltiner, George  
*Meteorology*

Kinney, Gilbert  
*Physics*

Lewis, Peter  
*Operations Research*

Marshall, Kneale  
*Operations Research*

Marto, Paul  
*Mechanical and Astronautical Engineering*

Platzer, Max  
*Mechanical and Astronautical Engineering*

Powers, John  
*Electrical and Computer Engineering*

Sarpkaya, Turgut  
*Mechanical and Astronautical Engineering*

Sheingold, Abraham  
*Electrical and Computer Engineering*

Washburn, Alan  
*Operations Research*

Wozencraft, Jack  
*Electrical and Computer Engineering*

## THE NAVAL POSTGRADUATE SCHOOL

### The School

To meet its advanced educational requirements, the Navy has a unique academic institution at the Naval Postgraduate School (NPS) with specially tailored academic programs and a distinctive organization tying academic disciplines to naval and joint war fighting applications.

The student body consists of officers from all branches of the U.S. uniformed services, officers and civilians from approximately 60 other countries and civilian employees of both the federal government and state and local governments. A limited number of defense contractors and enlisted personnel are also enrolled. Selection for graduate education at NPS is based upon outstanding professional performance, promotion potential, and a strong academic background. Students receive graduate degrees as a result of successful completion of programs designed primarily to prepare them for future career assignments. Degrees are awarded on the basis of the same high academic standards that prevail at other accredited institutions.

As an academic institution, NPS emphasizes study and research programs that are relevant to the Navy's interests, as well as the interests of other branches of the Department of Defense (DoD). The programs are designed to accommodate the unique requirements of the military, defense department and other federal agencies, including requirements for Defense Acquisition Certification.

### Mission

Provide relevant and unique advanced education and research programs in order to increase the combat effectiveness of U.S. and Allied armed forces and enhance the security of the United States.

### Vision

- Be the world leader in naval, defense, and national security-related graduate education and supporting research.
- Prepare the intellectual leaders for tomorrow's national security forces.

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs; to be responsive to technological change and innovation in the Navy, defense, and national security environments; to

prepare students to introduce and employ future technologies; and to work with other agencies and nations to ensure global security.

### Accreditation

The Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges (WASC) accredits the Naval Postgraduate School. In addition to regional accreditation, the Graduate School of Engineering and Applied Science's Electrical, Mechanical and Astronautical Engineering degree programs are accredited by the Accreditation Board for Engineering and Technology (ABET). The Graduate School of Business and Public Policy programs are accredited by the Association to Advance Collegiate Schools of Business (AACSB). The Master of Business Administration program is accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

### Degrees Conferred

Meeting the highest academic standards, the curricula are tailored to address defense and national security requirements and are developed within the framework of classical academic degrees.

#### Master of Arts

- Security Studies
- National Security Affairs

#### Master of Science

- Applied Physics
- Applied Science
- Astronautical Engineering<sup>1</sup>
- Computer Science
- Contract Management
- Defense Analysis
- Electrical Engineering<sup>1</sup>
- Engineering Acoustics
- Engineering Science
- Human Systems Integration
- Information Systems and Operations
- Information Technology Management
- Leadership and Human Resource Development Management
- Management
- Materials Science and Engineering
- Mechanical Engineering<sup>1</sup>



- Meteorology
- Meteorology and Physical Oceanography
- Modeling Virtual Environments and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Software Engineering
- Space Systems Operations
- Systems Engineering
- Systems Technology

### Master of Business Administration

- Master of Business Administration
- Executive Master of Business Administration

### Engineer

(Typically requires one year of study beyond the master's degree)

- Astronautical Engineering\*
- Electrical Engineering
- Mechanical Engineering

### Doctor of Philosophy

- Astronautical Engineering
- Applied Mathematics
- Applied Physics
- Computer Science
- Electrical Engineering\*
- Engineering Acoustics
- Material Science and Engineering
- Mechanical Engineering\*
- Meteorology
- Modeling, Virtual Environments and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Software Engineering

### Doctor of Engineering

- Astronautical Engineering
- Engineering Acoustics
- Mechanical Engineering

\*Apart from institutional accreditation, the Graduate School of Engineering and Applied Science's Electrical, Mechanical and Astronautical Engineering degree programs are accredited by the Engineering Accreditation Committee of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700

## Board of Advisors

The Board of Advisors is composed of distinguished professionals, including highly qualified civilian educators, prominent citizens from business, the professions and other vocations, and active and retired military officers. The purpose of the Board is to assist the President and advise the Secretary of the Navy concerning graduate education. In fulfilling this objective, the Board assesses the effectiveness with which the Naval Postgraduate School is accomplishing its mission and evaluates its future plans. Board Members shall be appointed on an annual basis by the Secretary of Defense, and shall serve terms of four years. Following their initial four-year tour, Board Members may, at the discretion of the President, Naval Postgraduate School, be considered for additional terms on the Board.

The Board meets semi-annually, at least once at the Naval Postgraduate School, and submits a report of its recommendations to the Secretary of the Navy via the President of NPS, the Commandant of the Marine Corps and Chief of Naval Operations.

### Federal:

*Federal members serve by virtue of their position.*

Jamie Barnett, RADM	Deputy, Training Integration, Naval Education & Training Command
Bill Landay, RADM	Chief, Office of Naval Research
Michael Dunn, LTG	President, National Defense University
David H. Huntoon, Jr., MG	Commandant, Army War College
Stephen R. Lorenz, Lt Gen	Commander, Air University
Keith Stalder, MajGen	Commanding General, Training & Education Command, Marine Corps Combat Development Command

### Non-Federal:

Walter Anderson	Chairman & CEO, Parade Publications Private Consultant
Stanley R. Arthur, ADM, USN (Ret.)	Private Consultant
Lyle G. Bien, VADM, USN (Ret.)	Private Consultant
Honorable Jack Borsting, Ph.D.	Professor and Dean Emeritus, University of Southern California
Elisabeth Pate-Cornell, Ph.D.	Professor and Chair, Stanford University
Honorable Robert Fossum, Ph.D.	Senior Research Scientist, University of Texas at Austin
David E. Frost, VADM, USN (Ret.)	President, Frost & Associates

Lee Gunn, VADM, USN (Ret.)	President, Institute for Public Research, CNA Corp
T. Joseph Lopez, ADM, USN (Ret.)	President, Information Manufacturing Corp
Honorable Sean O'Keefe	Chancellor, Louisiana State University
Graham B. Spanier, Ph.D.	President, Penn State University
Honorable G. Kim Wincup	Vice President, SAIC (Science Applications International Corp)

## Administration

The President of the Naval Postgraduate School is a flag officer of the line of the Navy. In addition to serving as the institution's president, the President is the academic coordinator for all graduate education programs in the Navy. The President administers fully-funded graduate educational programs at the Naval Postgraduate School, other service graduate schools and civilian universities.

## Leadership

### President

Richard H. Wells, Ph.D.  
RDML, USN

### Provost & Academic Dean (Acting)

Leonard A. Ferrari, Ph.D.  
Professor of Electrical and Computer Engineering

### Chief Of Staff

David Smarsh, Ph.D.  
Col, USAF

## Academic Staff

### Associate Provost and Dean of Research

Leonard A. Ferrari, Ph.D.

### Associate Provost for Academic Affairs

Julie Filizetti, Ed.D.

### Associate Provost for Institutional Development & Director for Center for Homeland Defense and Security

Paul Stockton, Ph.D.

### Dean of Graduate School of Engineering and Applied Science

James L. Kays, Ph.D., BG, USA (Ret.)

### Dean of Graduate School of Business and Public Policy

Robert N. Beck

### Dean of Graduate School of Operational and Information Sciences

Peter Purdue, Ph.D.

### Dean of School of International Graduate Studies

Robert L. Ord, III, LTG, USA (Ret.)

## Administrative Staff

### Associate Provost for Strategic Planning

George W. Conner, CAPT, USN (Ret.)

### Associate Provost for Library and Information Resources

Eleanor Urlinger

### Dean of Students & Acting Director of Institutional Advancement

C. J. Herron, CAPT, USN

### Chief Financial Officer & Comptroller

Megan Reilly

### Executive Director of Information Resources & Chief Information Officer

Christine M. Cermak, Ph.D.

### Executive Director of Facilities and Space

Peter Dausen, COL, USA (Ret.)

### Executive Director of Defense Resource Management Institute

Charles J. LaCivita, Ph.D.

### Executive Director for Strategic Development

Nancy Ann Budden

### Director of Academic Planning

Gilbert T. Howard, Ph.D.

### Director of Academic Administration and Registrar

P. Michael Andersen

### Director of the Office of Continuous Learning

Thomas R. Hazard, Maj, USMC (Ret.)

### Director of Programs

Paula Jordanek, CAPT, USN

### Director of Center for Civil-Military Relations

Richard Hoffman, LTC, USA (Ret.)

### Director of International Programs

Herbert G. Roser, Col, USMC (Ret.)

**Director of Intelligence Research**

Robert L. Simeral, CAPT, USN (Ret.)

**Director of Instructional Technology**

Tracy Hammond

**Director of Institutional Research**

R. Frances Horvath, Ph.D.

**Chief Technology Officer**

Thomas E. Halwachs, CDR, USN (Ret.)

**Director of Center for Executive Education**

Ronald E. Franklin

**Academic Organization**

The Naval Postgraduate School has four graduate schools as well as several research and education institutes and centers. Academic departments and faculty are organized within four schools. Institutes and centers provide groups of faculty an additional structure for collaborative and inter-disciplinary teaching and research activities. The Naval Postgraduate School also has a number of inter-disciplinary committees and groups that oversee and advise education programs.

**Graduate School of Business and Public Policy**

Organizations and Management Academic Area  
 Acquisition Management Academic Area  
 Financial Management Academic Area  
 Logistics Management Academic Area  
 Manpower and Economics Academic Area  
 Enterprise and Information Management Academic Area

**Graduate School of Engineering and Applied Science**

Electrical and Computer Engineering Department  
 Physics Department  
 Applied Mathematics Department  
 Oceanography Department  
 Meteorology Department  
 Mechanical and Astronautical Engineering Department  
 Space Systems Academic Group  
 Systems Engineering Department

**Graduate School of Operational and Information Sciences**

Computer Science Department

Information Sciences Department  
 Operations Research Department  
 Defense Analysis Department

**School for International Graduates Studies**

National Security Affairs Department  
 International Graduate Programs Office  
 Defense Resources Management Institute  
 Center for Civil-Military Relations  
 Center for Homeland Defense and Security  
 Center for Contemporary Conflict

**Research Institutes**

In addition to the Schools, the Naval Postgraduate School has research centers and interdisciplinary institutes that combine education and research.

**Cebrowski Institute for Innovation and Information Superiority**

[www.nps.edu/cebrowski](http://www.nps.edu/cebrowski)

In a world dominated by distributed communication networks, the Cebrowski Institute for Innovation and Information Superiority facilitates cross-discipline studies in how information processes and technologies can strengthen national security. Main areas of concentration are hastily formed networks, network centric operations, world wide consortium for the grid (W2COG), mobile devices and communications, information operations, counterterrorism and irregular warfare, information assurance, information security, and the skills of innovation. The Institute operates as a federation of research centers and projects serving a community of students and faculty.

**Wayne E. Meyer Institute of Systems Engineering**

[www.nps.edu/research/meyer](http://www.nps.edu/research/meyer)

The Meyer Institute of Systems Engineering conducts a program of education and research dedicated to the education of officers of all services as well as international students. The educational program is an 18-month interdisciplinary curriculum consisting of combat systems technology, systems analysis, joint professional education, systems engineering, and a capstone systems engineering project. Successful completion of the program awards an MS in Systems Engineering and Analysis and completes JPME phase I requirements.

The capstone projects are characterized by high priority Naval, joint, or national interest with participation by students from across the NPS campus

and advisors from sponsoring agencies. Current projects address Maritime Domain Security, Joint Battle Management, and Future Naval Surface Combatant Characteristics.

Research programs conducted by the Meyer Institute respond to requests by military sponsors. Current programs include research in Maritime Domain Awareness and technology leading to future ship tactical ballistic missile defense system capabilities.

## **MOVES Institute**

[www.nps.navy.mil/moves](http://www.nps.navy.mil/moves)

The Modeling, Virtual Environments and Simulation (MOVES) Academic Program of the Naval Postgraduate School provides the MS and Ph.D. student both fundamental and specialized courses in modeling and simulation and the application of quantitative analyses to human systems and simulation technology.

The MS program is a two-year, eight-quarter program whose core covers the fundamentals of computer science, human systems, and data analysis. These topics include object-oriented programming, artificial intelligence, computer communications and networks, computer graphics, virtual worlds and simulation systems, probability, statistics, stochastic modeling, data analysis, human-performance evaluation and human-behavior modeling.

Specialization by the MS student is accomplished by completing course blocks providing depth in a selected area. There are eight blocks available of which the student must select three. These include combat modeling, visual simulation, agents and cognitive modeling, training systems and human factors, optimization, and acquisition.

Once the MOVES core courses have been taken and while the specialization courses are underway, the final step in the MS degree is the completion of a written thesis. This thesis is usually conducted on a research problem specified by a MOVES faculty thesis advisor.

MOVES has a program leading to the degree Doctor of Philosophy. Areas of focus are networked virtual environments, adaptable software agents, human factors in virtual environments, physically based modeling for virtual environments, modeling human and organizational behavior, discrete-event systems modeling, data and model visualization, and combat modeling.

## **Center for Executive Education**

[www.cee.nps.navy.mil](http://www.cee.nps.navy.mil)

The Center for Executive Education is exclusively dedicated to enhancing the knowledge and understanding of leaders within the Department of Navy and Department of Defense and those who are in partnership with the leaders who will be making critical decisions affecting the nation's readiness in this complex and rapidly changing environment. Tailored courses in executive education for leaders and their staffs are available and may be delivered on campus or at the requesting command's location. CEE spaces are also available for executive symposiums and off-site conferences. Please contact the CEE by calling (831) 656-3334 or visiting our Web site.

## **International Graduate Programs Office**

The International Graduate Programs Office is responsible for the cultural, social and academic integration of the international community. The office is charged with interacting with outside agencies, military and civilian to accomplish the goals of the Security Assistance Training Program (SATP) and the Informational Program (IP). Additionally, it is responsible for the International Sponsor Program and acts as the Command Sponsor to the International Executive Committee.

Since 1954, over 4350 International officers and government sponsored civilians from 89 countries have graduated from NPS. Many have gone on to achieve positions of prominence within their military services, governments, and private industry. The International Program at NPS serves as an integral link in establishing the long-term military-to-military relationships between our U.S. and international officers. The International Graduate Programs Office sponsors the following courses:

### **IT1500 Informational Program Seminar for International Officers (4 - 0)**

Provides international students with an awareness and functional understanding of internationally recognized human rights and the American democratic way of life. Areas of emphasis introduced during the seminar include civil-military relations, human rights, relationships in a democratic society, and a comparative look at the U.S. free enterprise system.

### **IT1600 Communication Skills for International Officers (3 - 0)**

Provides the opportunity to enhance English speaking and listening skills by taking part in organized oral exercises, group discussions, and instructional briefings on a variety of subjects. The course addresses pronunciation by incorporating language software programs to improve speaking. Building reading and writing skills is part of the course but not the main focus.

**IT1700 Academic Writing for International Officers (2 - 0)**

Structured to prepare students for the task of writing in the academic style of American universities. The course provides techniques for organization, writing, revising, and editing papers required for the diverse curricula at NPS. Strategies for writing a thesis or research paper are covered.

**The point of contact for requests to the International Graduate Programs office is:**

Gary Roser, Col, USMC (Ret.)  
Assistant Dean of the School of International  
Graduate Studies  
Commercial: (831) 656-2186

DSN 756-2186

Fax: (831) 656-3064

Website: [www.nps.edu/Adminsrv/IGPO/index.html](http://www.nps.edu/Adminsrv/IGPO/index.html)

**Library**

The Dudley Knox Library was recognized in 2005 as the "Federal Library of the Year" for 2004 in the large library category. This award, sponsored by the Library of Congress, recognized the Dudley Knox Library as a "national leader in the delivery of government and defense information" and for initiatives such as Virtual Reference delivery and its involvement in the creation and development of the Homeland Security Digital Library. As a university library, it is expected to meet standards established by the School's principal accrediting body, the Western Association of Schools and Colleges (WASC), as well as standards set for programs in applied science, computing, engineering and technology by ABET. This library is unique within the community of academic libraries in that it is dedicated to supporting research and graduate level education and providing for the special requirements of the Naval Postgraduate School's mission both on-campus and within the larger defense community. In addition to its open-literature graduate level collections in the disciplines of science, engineering, international studies and national security, and business and public policy, the Library houses a collection of classified (Secret/Confidential) research materials.

Today's university libraries have a three-fold mission. They are gateways to information. They provide physical places for study, research and learning to improve information literacy skills. They house personnel providing a wide range of services, from acquiring and circulating books, journals, and reports to providing research assistance and training in accessing the ever increasing variety of information available to students, faculty, and researchers.

**Access and Library Materials**

Through its Web page, the Library provides direct patron access to an increasing array of scholarly information in electronic formats. It provides access to a wide range of online databases, electronic books and journals, and to digital files of NPS theses. The initial point of access to these resources is <http://www.nps.edu/Library/index.aspx>. Library staff members actively identify and provide links to many electronic publications and journals, especially those pertinent to the military and national defense. Off-campus access to these resources is available 24 hours a day, seven days a week through the Library's proxy server <http://library.nps.navy.mil/home/proxyabout.htm>.

BOSUN (the Library's online catalog) is also Web accessible and provides information on the Library's holdings as well as links to online versions of reports and publications. Through BOSUN, users can remotely renew the materials they have checked out, place holds or make book purchase suggestions. BOSUN is also the primary entry into the Library's digital archive. A principal component of the Digital Archives is a collection of digitized NPS theses, reports and government documents.

Presently, the Library's physical holdings number approximately 600,000 volumes, 1,500,000 volumes in microform and 836 current journal subscriptions in approximately 100,000 square feet of space. The Library has a map collection in support of the School's curriculum. The Christopher Buckley, Jr. collection of books on Naval and maritime history includes both fiction and non-fiction material. The Library is a selective depository for government documents and information distributed through the Federal Depository Program. It also has a Restricted Resources and Services area housing classified documents.

The Library is organized into service groups responsible for acquiring and processing research and instructional materials and providing user support in the identification of scholarly resources to support courses, thesis requirements and research. The Information Services group provides research assistance, user instruction, interlibrary loan, document delivery, online searching, circulation and telephone paging services and also designs customized Web pages and guides to support assigned subject areas. The Library Systems Office provides hardware and software support, maintenance, planning and evaluation for both administrative and instructional computer systems within the Library. The Technical Services group purchases, catalogs, and enters materials into the Library's online catalog and maintains the accuracy of its databases.

A staff of 35 librarians and library support personnel identify and process materials for the collection, maintain the Library's Web pages and assist members of the campus community, distributed learning students and the public to find information resources useful for their work. The Library contains photocopy facilities, individual study carrels and group study rooms. It provides research assistance and workstations to access the Internet and the Library's electronic resources.

### **Library Organization**

The Library is a member of the Monterey Bay Cooperative (MOBAC) Library System which hosts the MOBAC regional library catalog and provides expedited interlibrary loan among its members. The Library also participates in the Consortium of Naval Libraries and the National Research Library Alliance. It utilizes the Online Computer Library Center (OCLC) interlibrary loan program, which facilitates the borrowing of materials. It is a member of the Military Education Coordinating Council, whose linked catalog project (MERLN), provides access to the catalogs of other DoD institutions delivering joint military education.

### **Information Technology and Communication Services**

The ITACS (Information Technology and Communication Services) organization incorporates all communication services, telephone support, and network support into the core computing functions that have been provided by the Naval Postgraduate School since 1953. <http://www.nps.edu/Technology>

### **Accounts**

All faculty, students, staff, and contractors of the Naval Postgraduate School may have a network access account. Upon written request, users with a legitimate academic need can also get a Unix or a Mainframe account. All computer accounts are for official use only, for the sole and private use of the account holder. All new resident students, faculty, staff, and contractors must check in at the Office of Student Services in the basement of Herrmann Hall to register in the "Python" Student Information System and to get a computer account. Student Services is located in Herrmann Hall, Room 039. Phone 831.656.3815

### **Software Availability**

Many different software programs are installed and supported by ITACS. A few of these products are site licensed and can be installed at home for those with

valid NPS accounts. The software currently available for checkout includes:

Symantec Anti-Virus Client, Firewall  
Microsoft Office Suite  
Microsoft FrontPage  
Microsoft Visio  
Microsoft Project  
Math Type  
Matlab  
PKI Reader Software  
S-Plus for Windows

### **Virus Protection**

All email messages are scanned for viruses and for prohibited executable attachments on the exchange servers. Although anti-virus programs are remotely administered to on campus systems by the Technology Assistance Center ("TAC"), users are responsible for keeping non-NPS systems that connect to the network clean of viruses. Anti-virus software is available for installation on home computers—check out a copy at the TAC or visit the software download page: <https://www.nps.navy.mil/ITACS/SoftwareLib/>

### **Wireless Computing**

For wireless-capable laptops that need to connect to the NPS wireless network, please bring the laptop to the TAC to setup the connection.

## ADMISSIONS

Unless otherwise specified in this catalog, admission to the Naval Postgraduate School is accomplished as described in this section. For admission to either a degree or a non-degree program, whether on-campus or by distance learning, the minimum qualification is an accredited baccalaureate degree with appropriate preparation for the proposed program. The school requires submission of official transcripts covering all college work completed to date.

### Master's Program Admissions

A candidate entering any master's degree program must possess a baccalaureate degree from a regionally accredited institution—or in the case of foreign students, a recognized institution—with a minimum grade point average of 2.2 on a 4.0 system, of which 100 semester-hours/150 quarter-hours must be letter-graded. If the candidate does not possess an undergraduate degree, the following are standards for admission to a program leading to a graduate degree:

1. A minimum of 100 semester-hours/150 quarter-hours of letter-graded undergraduate work must have been completed at regionally accredited institutions with an average grade of "B." Courses in which grades lower than "C" were earned will not be counted in the total. Courses which have been duplicated on various transcripts should be counted only once in arriving at the number of semester-hours to be credited.
2. The general education requirements prescribed for the Naval Postgraduate School baccalaureate degree must be satisfied as specified in the Academic Policy Manual.
3. No more than 20 semester-hours may be credited for work done in non-degree granting service schools.
4. Final approval of candidacy will be made by the Academic Council upon the recommendation of the chair of the appropriate department.

### Navy Officers

Selection for the Navy's fully-funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Officers interested in this program should contact their assignment officer to determine professional qualification status; upon determination of academic qualification (by Naval Postgraduate School), individuals are eligible for

assignment. Officers who are professionally qualified, but lack academic qualifications, should contact the Admissions Officer for information on ways to improve their academic background.

### Office of Admissions

Code 01C3  
Naval Postgraduate School  
1 University Circle, He-022  
Monterey, CA 93943

Telephone: (831) 656-3093 / DSN 756-3093  
e-mail: grad-ed@nps.edu

### Other U.S. Military Officers

Officers on duty with other branches of service are eligible to attend the Naval Postgraduate School. They should apply in accordance with the directives promulgated by the Department of the Army, Department of the Air Force, Commandant U.S. Marine Corps or the Commandant U.S. Coast Guard, as appropriate. Requests for admission or transcripts from individual officers should not be sent directly to the Naval Postgraduate School.

### Military Staff of NPS and Local Commands

Military staff of NPS and tenant commands may be admitted for study upon request and approval from their supervisor and prospective academic associate. A staff member may attend up to two classes per quarter. Any overload must be approved by the Registrar. Admission to NPS must be approved prior to the granting of a degree. The Academic Council must also approve the program of study after admission is granted. The initial point of contact for military staff is the Director of Admissions at (831) 656-3093 or grad-ed@nps.edu.

### International Students

Military officers and government civilian employees from other countries may be admitted to most curricula. The procedures for application are available from the Security Assistance Office or Defense Attaché Office of the U.S. Embassy, the MLO, MAAG, OMC or ODC, as appropriate. Correspondence must be processed through official channels; requests from individual prospective students should not be sent directly to the School. All candidates must satisfy the curriculum academic standards, as described in this catalog. International candidates from non-English speaking countries will

also be required to validate their fluency in English through the Test of English as a Foreign Language (TOEFL). Under the Computer Based Test (CBT) a minimum TOEFL score of 207 is required for direct entry. If a candidate fails to achieve the 207 score, but does achieve a score of 173 or higher, he/she is eligible to attend the TOEFL Preparatory Academic Writing Course, MASL P177022 (16 weeks) at the Defense Language Institute in San Antonio, Texas. The only countries exempted from TOEFL testing are those countries who are exempted from all ECL testing requirements as determined by the Defense Security Cooperation Agency (DSCA) MSG 042101 Oct 05 (Antigua, Australia, Bahamas, Barbados, Belize, Brunei, Canada, Dominica, Grenada, Guyana, India, Ireland, Jamaica, Malta, Mauritius, New Zealand, Singapore, St. Kitts, St. Lucia, St. Vincent, Trinidad, and the United Kingdom). When applying for a TOEFL exam, the NPS identification code is 4831. On 1 Oct 2005 the Educational Testing Service (ETS) began its transition to an Internet Based Test (IBT). In conjunction with that transition and effective 1 June 2006, NPS will require a score of 220 (CBT) or a score of 83 (IBT) for direct entry. Requirements for attending the TOEFL Prep course will also increase to 183 (CBT) or 65 (IBT).

Questions regarding available programs or admission procedures should be directed to Code 04IGP, 1 University Circle, Rm B-047, Naval Postgraduate School, Monterey, CA 93943-5025. Telephone: (831) 656-2186 or e-mail from this website: [www.nps.edu/Adminsrv/IGPO/index.html](http://www.nps.edu/Adminsrv/IGPO/index.html)

### Civilian Employees of U.S. Government

A civilian who is an employee of, or sponsored by, an agency of the United States Federal Government may be admitted for study upon request and sponsorship of the agency. Federal civilian employees are not required to pursue the curricula designed for officer-students as described in this catalog but instead determine, with the guidance of assigned academic counselors, the combination of courses that will best meet their needs.

A civilian who is expecting agency sponsorship should submit a written request for evaluation for admission at least six months prior to expected commencement of studies. A request should indicate the desired curriculum and degree intentions and be accompanied by a complete set of official transcripts of all previous college work. GRE and/or GMAT scores are required for consideration for admission to any doctoral program.

Requests for admission should be directed to the Director of Admissions, Code 01C3, Naval Postgraduate School, 1 University Circle, He-022, Monterey, CA 93943. Questions about available

programs or admission procedures may be telephoned to (831) 656-3093 or DSN 756-3093 or email: [grad-ed@nps.edu](mailto:grad-ed@nps.edu).

Any civilian employee of the United States Government is eligible to participate in the programs of the School. The individual's employing agency is expected to meet the tuition expense for regular on-campus enrollment.

### Programs available to civilian students can be classified as follows:

**Regular Curricula:** The School's programs for officers are designed to meet the requirements of the services for specific education. The contents usually exceed the requirements for a graduate degree since the service's requirements, rather than degree requirements, determine the scope of each program. Civilian students may enter any curriculum at the point at which they are qualified and complete the curriculum along with regular officer students.

**Degree Programs:** Civilian students may enter programs designed to award a graduate degree, while meeting the educational goals of the individual or the sponsoring agency. To minimize the residency requirement, an off-campus preparatory program may be developed in consultation with a school advisor. If the available time in residence is insufficient to complete degree requirements, the thesis-project portion of the program may be completed off-campus.

**Non-Degree Programs:** Civilian employees may desire to pursue a program for professional advancement without a degree objective. NPS certificate programs are one such option available to civilians. These typically comprise four courses taken over one year. Certificate Program Managers are the initial point of contact for admissions. Alternatively, for groups of employees from an agency, special courses can be offered to meet particular requirements, provided the demand is in an area of expertise of the school.

### Civilian Employees of NPS and Local Commands

A civilian employee of NPS and tenant commands may be admitted for study upon request and approval of the employee's supervisor and prospective academic associate. The Human Resources Office sponsors the Civilian Academic Development (CAD) Program to provide the opportunity to pursue self-development, training and education. The CAD program is administered by the HRO Training Officer and is the initial point of contact for civilians. The Training Officer can be reached at (831) 656-3052.



## Civilian Employees of DoD Contractors

The Naval Postgraduate School accepts a limited number of employees of corporations that are contractors for the Department of Defense (DoD) in programs related to systems engineering and defense product development. Specifically, the following master's degree programs are open to employees of DoD contractors:

### Distributed Learning Programs

Product Development for the 21<sup>st</sup> Century (721)  
Systems Engineering (311)  
Contract Management (835)  
Defense Systems Program Management (836)

### Resident Programs

Operations Analysis (360)  
Systems Engineering and Analysis (308)  
Systems Engineering (580)  
Missile Systems Engineering (in Mechanical Engineering, 570)  
Electronic Systems Engineering (590)  
Space Systems Engineering (591)  
Software Engineering (369)  
Total Ship Systems Engineering (533, 570, or 590)  
Acquisition & Contract Management (815)  
Systems Acquisition Management (816)  
Defense Systems Contract Management (835)

For information on these programs, please visit our Web site at: [www.nps.edu/admissions/contractors](http://www.nps.edu/admissions/contractors)

### Contractor Application Process

All necessary forms, instructions, and an example of an application package can be found at [www.nps.edu/admissions/contractors](http://www.nps.edu/admissions/contractors)

Application packages should include

1. Application form containing candidate's statement of education objectives relevant to government and corporate enterprise.
2. Certified transcripts from all undergraduate and graduate institutions attended.
3. Two letters of recommendation.
4. Letter from employer stating their willingness to pay the tuition for the program and supply salary and benefits during your time at NPS, if a resident program.

Applications should be mailed to the Director of Admissions, Code 01C3, Naval Postgraduate School, 1 University Circle, He-022, Monterey, CA 93943, or emailed to [grad-ed@nps.edu](mailto:grad-ed@nps.edu). If you have questions

about available programs or admission procedures please call (831) 656-3093 or email: [grad-ed@nps.edu](mailto:grad-ed@nps.edu).

## Doctoral Program Admissions

### The Navy Doctoral Program

This program typically selects a limited number of Navy officers each year for doctoral studies. Details are provided in a NAVADMIN message that addresses curriculum/subspecialty quotas, service obligation, and application procedures for this program. Applications for doctoral study at NPS under this program are reviewed by appropriate departmental Ph.D. committees. The Navy Personnel Command conducts the Doctoral Program Selection Board; and selected officers are notified by their Detailers.

### The Permanent Military Professor (PMP) Program

This program is designed to prepare Navy officers to become military instructors at the U.S. Naval Academy (USNA), the Naval War College (NWC), and the Naval Postgraduate School (NPS). These officers serve a critical role in the education of the Navy's Officer Corps by combining fleet experience with advanced academic preparation to convey relevant knowledge to USNA midshipmen and officers attending NWC or NPS. Applicants for the PMP program must have attained the rank of O-5 (select); and O-6s may apply if already in possession of a completed doctorate in the discipline they propose to teach. The Navy Personnel Command announces the program and publishes application procedures through an annual NAVADMIN message. Applications for doctoral study at NPS under the PMP program are reviewed by appropriate Departmental Ph.D. committees; the Navy Personnel Command conducts the selection board and notifies selected officers. Once selected, the officers are obligated to serve as a PMP until their statutory retirement date.

### Individual Doctoral Programs - All Services, Civilians, and Internationals

NPS doctoral programs are available to officers of all U.S. services, civilian employees of the government, a limited number of DoD Contractors, and to individuals sponsored by selected allied nations. Applications may be submitted at any time. An individual applying for admission to a Ph.D. program must hold a bachelor's degree qualifying the student for graduate status in the department of his/her major study, or shall have completed an equivalent course of

study. All U.S. applications shall be submitted to the Director of Admissions, who will be responsible for processing. International applications shall be submitted to the International Graduate Programs Office. All applications are forwarded by the Director of Admissions to the chair of the Department of the proposed major subject area for determination of acceptability by the departmental Ph.D. committee. The chair will recommend appropriate action to the Director of Admissions, who will notify applicants. The application must include the following:

1. A completed application form. This form may be obtained online at [www.nps.edu/admissions/phd](http://www.nps.edu/admissions/phd) or from the Admissions Office by emailing [grad-ed@nps.edu](mailto:grad-ed@nps.edu). This form includes:
  - Full name, title/rank, date of birth and SSN.
  - Current mailing address, telephone and email.
  - Department of the proposed major subject area.
  - Description of current position and responsibilities.
  - A brief outline (200 words or fewer) of specific areas of interest within the proposed major field of study.
  - Identification of source of support for attendance at NPS.
2. Certified copies of all undergraduate and graduate transcripts. However, transcripts from NPS are not necessary.
3. Results of a Graduate Record Examination (GRE) General Test taken within the last five-years.
4. Two letters of recommendation.
5. For international applicants not currently enrolled at NPS whose native language is other than English, or whose primary language of instruction was other than English, current results of the Test of English as a Foreign Language (TOEFL) and the Test of Written English. For specific test score requirements, see the preceding section pertaining to "International Students."
6. Attestation by the student's sponsoring agency or nation that they are committed to tuition and salary support during the student's residence at NPS.

The mailing address and contact information for the Director of Admissions is:

**Admissions Office**

Code 01C3  
 Naval Postgraduate School

1 University Circle, He-022  
 Monterey, CA 93943

Telephone: (831) 656-3093 / DSN 756-3093  
 E-mail: [grad-ed@nps.edu](mailto:grad-ed@nps.edu)

The mailing address and contact information for the International Government Programs Office is

Code 04IGP, 1 University Circle, Rm B-047, Naval Postgraduate School, Monterey, CA 93943-5025.  
 Telephone: (831) 656-2186 or e-mail:  
[www.nps.edu/Adminsrv/IGPO/index.html](http://www.nps.edu/Adminsrv/IGPO/index.html)

For more information please visit  
[www.nps.edu/admissions/phd](http://www.nps.edu/admissions/phd).

**Threshold for Admission**

Each curriculum at the Naval Postgraduate School has a specified threshold Academic Profile Code (APC) for admission. See the Master Curriculum Chart in this catalog for specific APC requirements for each curriculum. Officers with deficient APCs may still qualify for entry into these curricula by completing suitable courses from any accredited civilian college. In certain instances, NPS offers a technical refresher quarter for applicants whose APC does not qualify them for direct entry to a technical curriculum. (See Technical Refresher Quarter section.) Transcripts (not grade reports) of work done at civilian schools must be forwarded to Director of Admissions, Code 01C3, Naval Postgraduate School, 1 University Circle, He-022, Monterey, CA 93943, to effect an APC change. The grades in all courses completed will be used to revise an officer's QPR.

**Academic Profile Codes**

The Academic Profile Code (APC) is a three-digit code, which summarizes pertinent portions of a student's prior college performance. The three independent digits reflect an individual's cumulative grade-point average (Quality Point Rating), exposure to and performance in calculus-related mathematics courses and exposure to and performance in selected science/engineering areas.

**First Digit**

The first digit indicates overall academic performance and is derived from the following table:

Code	QPR Range
0	3.60-4.00
1	3.20-3.59
2	2.60-3.19
3	2.20-2.59
4	1.90-2.19

5 0.00 -1.89  
(Failures and repeated courses are included in the QPR calculation.)

## Second Digit

The second digit represents mathematical background according to the following criterion:

Code	Meaning
0	Significant post-calculus math with B or better average (Math Major or strong Math Minor)
1	Calculus sequence completed with B+ or better average
2	Calculus sequence completed with average between C+ and B
3	At least one calculus course with C or better
4	Two or more pre-calculus courses with B or better average
5	At least one pre-calculus with C or better grade
6	No college level calculus or pre-calculus math with a grade of C or better

## Third Digit

The third digit represents previous course coverage in science and technical fields according to the following criteria:

Code	Meaning
0	Significant pertinent upper-division technical courses with B+ or better average
1	Significant pertinent upper-division technical courses average between C+ and B
2	Complete calculus-based physics sequence with B+ or better average
3	Complete calculus-based physics sequence with average between C+ and B
4	At least one calculus-based physics course with C or better grade
5	No pertinent technical courses

A first digit code of 0, 1, 2 or 3 (as appropriate) will be assigned only if transcripts provided exhibit at least 100 semester-hours or 150 quarter-hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 100/150 hour requirement.

A technical code of 1 or 0 ordinarily is assigned only to an officer whose undergraduate major was Physics, Aeronautical, Electrical, Mechanical or Naval Engineering, or whose undergraduate technical major is consistent with the officer's designator. (An officer designator describes their general community or naval profession.)

## Example

An APC of 221 indicates a total grade point average for all college courses in the interval 2.60-3.19, a complete sequence in calculus with an average between C+ and B and a major in physics or pertinent engineering area with upper-division courses with an average between C+ and B.

## Catalogs

The point of contact for requests for Naval Postgraduate School Catalogs and admission to resident study programs and admission to all degree programs is:

### Admissions Office

Code 01C3,  
Naval Postgraduate School  
1 University Circle, He-022  
Monterey, CA 93943

Telephone (831) 656-3093 / DSN 756-3093

### Printed catalogs:

For a printed catalog, send a request to the address above and include a check or money order for \$10 per catalog to cover shipping and handling. Make payable to U.S. Treasurer.

The online edition of the School's catalog is at:  
<http://www.nps.edu/admissions>

The point of contact for requests for printed catalogs and admissions for international students is:

### Director of International Programs

Code 04IGP, 1 University Circle, Rm B-047  
Naval Postgraduate School,  
Monterey, CA 93943-5025

Telephone: (831) 656-2186 / DSN 756-2186 / FAX  
(831) 656-3064

[www.nps.edu/Adminsrv/IGPO/index.html](http://www.nps.edu/Adminsrv/IGPO/index.html)

## GENERAL ACADEMIC INFORMATION

### Course Codes

Courses are designated by an alphanumeric symbol consisting of two letters and four numbers. The first two letters designate the academic department, committee or group that offers the course and are defined as follows:

Course Prefix	Academic Group Name	Dept or Academic Group Prefix	Administered by
AE	Mechanical and Astronautical Engineering	MAE	GSEAS
CC	Information Sciences	IS	GSOIS
CS	Computer Science	CS	GSOIS
DA	Defense Analysis	DA	GSOIS
EC	Electrical and Computer Engineering	EC	GSEAS
EO	Electrical and Computer Engineering	EC	GSEAS
FL	National Security Affairs	NS	SIGS
GB	GSBPP	GB	GSBPP
GE	GSBPP	GB	GSBPP
IO	Information Operations	IS	GSOIS
IS	Information Sciences	IS	GSOIS
IT	International Programs Office (IPO)	INT	IPO
IW	Information Sciences	IS	GSOIS
MA	Mathematics	MA	GSEAS
ME	Mechanical and Astronautical Engineering	MAE	GSEAS
MN	GSBPP	GB	GSBPP
MO	Mathematics	MA	GSEAS
MR	Meteorology	MR	GSEAS
MS	Mechanical and Astronautical Engineering	MAE	GSEAS

MV	Modeling, Virtual Environments & Simulation	MOVES	GSOIS
NS	National Security Affairs	NS	SIGS
NW	Naval War College (NW)	NW	NW
OA	Operations Research	OR	GSOIS
OC	Oceanography	OC	GSEAS
OS	Operations Research	OR	GSOIS
PH	Physics	PH	GSEAS
SE	Physics	PH	GSEAS
SI	Systems Engineering	SE	SEAC
SO	Defense Analysis	DA	GSOIS
SS	Space Systems	SP	GSEAS
SW	Computer Science	CS	GSOIS
TS	Mechanical and Astronautical Engineering	MAE	GSEAS
UW	Undersea Warfare	PH/MR	GSEAS

Courses are assigned numbers in accordance with their level of academic credit:

R001-R999	Technical Refresher (no credit)
0001-0999	No credit
1000-1999	Lower division college credit (Freshman - Sophomore Level)
2000-2999	Upper division college credit (Junior - Senior level)
3000-3999	Upper division college or graduate credit
4000-4999	Graduate credit

### Course Credit Value

Following the course designator are two numbers in parentheses separated by a hyphen, which indicate the hours of instruction per week in the classroom and in the laboratory, respectively. When calculating quarter-hours for the credit value of the course, laboratory hours are assigned half the value shown. Thus a (3-2) course, having three hours lecture and two hours of laboratory, will be assigned a credit value of four-quarter-hours.

## Course Descriptions

For the most current information about the course descriptions, access the NPS home page at [www.nps.edu/admissions/catalog](http://www.nps.edu/admissions/catalog).

## Requirements for the Master of Arts Degree and the Master of Science Degree

The master's degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree. Such curricula shall conform to current practice in accredited institutions and shall contain a well-defined major.

General Naval Postgraduate School minimum requirements for the master's degree are as follows:

- 32 quarter-hours of graduate level credits of which at least 20 quarter-credits must be earned from NPS\*.
- A thesis or its equivalent is required.

\*NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transferred from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

To be eligible for the master's degree, the student must attain a minimum average quality point rating of 3.00 in all of the 3000 and 4000 level courses in his/her curriculum and either 2.5 in all courses of the curriculum or 2.75 in all graded courses taken from NPS regardless of transfer or dual degree.

## Thesis Format Requirements

The Thesis/Dissertation/MBA Project Report and Joint Applied Project Preparation Manual provides formatting and procedural guidance for preparing and processing electronic thesis/dissertation/reports at the Naval Postgraduate School. It covers both unclassified and classified theses/reports. All references to "theses" also refer to Dissertations, MBA Professional Reports

and Joint Applied Projects. The document is on the web at [www.nps.edu/research/documents/thesis\\_prep\\_manual.doc](http://www.nps.edu/research/documents/thesis_prep_manual.doc)

## Dual Degree Programs

Students who wish to pursue a dual degree program must satisfy QPR and other curricular/departmental requirements, as set forth in the Academic Policy Manual.

A dual degree program is one in which a student pursues two distinct master's degrees simultaneously. Any program which can lead to the award of two master's degrees is, in its entirety, a *special program* that must be approved by the Academic Council.

A student is qualified to enter a dual degree program if the Program Officer and Academic Associate certify that the student possesses a Total Quality Point Rating (TQPR) which is at least 3.75 and in the top 25% of the TQPRs of the students in the last four graduating sections of his/her curriculum.

The special dual degree program will be terminated if the student does not maintain a performance which places him within the top 50% of each program. The Program Officers and Academic Associates will monitor the student's performance each quarter and will report to the Academic Council if such a performance is not being maintained.

The program which leads to two graduate degrees must satisfy the requirements of both degrees. Course validations early in the program will allow the student to take the additional 3000 and 4000 level courses as required for the dual degree program.

A single thesis may be used to satisfy the requirements of both departments provided it shows relevance to and mastery of both fields, is permitted by the policy of both departments, and is co-advised by a member of each Department.

The dual degree program must satisfy the enrollment limitations cited in the Academic Policy Manual. If a student requires waivers for enrollment limitations, the request for waiver must be included in the application for the special program.

The Academic Council requires a written endorsement of the dual degree program from the student's sponsor or a written attestation by a Department Chair, Academic Associate, or Program Officer that the sponsor has been notified of the student's proposal and approves of the program.

## Educational Skill Requirements

The majority of NPS curricular programs are developed based on Education Skill Requirements (ESRs). Education Skill Requirements define the fundamental concepts required in the graduate education curriculum as directed by each curriculum sponsor and Subject Matter Expert (SME). These ESRs represent the criteria essential for successful performance in billets requiring each subspecialty.

The Program Officers and academic staff at the Naval Postgraduate School coordinate biennial curriculum reviews with the curriculum sponsors for each curriculum. These reviews are conducted to ensure that the ESRs are current and relevant to the needs of the military, that programs meet the knowledge, skill and competencies of the ESRs, and that the changing needs of the sponsors are reflected in each curriculum. The ESRs for each curriculum offered at Naval Postgraduate School are included in this catalog at the end of each curriculum listing as applicable.

Curriculum content is continually updated to maintain pace with changes in each field of study. The Naval Postgraduate School Program Officers and faculty maintain a continuous dialogue with curriculum sponsors and Subject Matter Experts. These dialogues culminate in the biennial curriculum reviews. Curriculum sponsors and SMEs are active in each curriculum in areas such as providing current and relevant material and speakers for classes, forwarding potential thesis topics that are of interest to the military, and providing opportunities and financial support for student experience tours and travel.

These partnerships between the Naval Postgraduate School and the curriculum sponsors ensure that the educational needs of each subspecialty community are continually met through relevant education in each curriculum at NPS.

## Six-Week Math Refresher

This is a sequence of courses developed specifically to provide a refresher of subject material pertinent to the curriculum to be studied. The number and types of courses, which comprise the technical refresher, are developed by the Program Officer and Academic Associate for the student's primary curriculum. The purpose of the technical refresher is to reacquaint students with technical material and at the same time help them build good study habits.

The Six-Week Math Refreshers begin during week one or week seven of the quarter and typically consist of:

### Math Refresher I (weeks 1-6)

MA1113

MA1115

### Math Refresher II (weeks 7-12)

MA1114

MA1116

**Online Refresher:** Students who wish to shorten their time at NPS and/or improve their Academic Profile Code (APC) may take MA1113 Single Variable Calculus and MA1114 Single Variable Calculus II with Matrix Algebra online prior to arriving at NPS.

Prospective students are encouraged to contact the Program Officer regarding the specifics of their particular Six-Week Technical Refresher course sequence.

## Technical Refresher Quarter

This is a sequence of courses developed by the Program Officer and the Academic Associate to better prepare incoming students for entering a technical curriculum.

This course sequence is designed for prospective students who:

1. have an APC that indicates a deficiency in mathematics and/or scientific and technical subject matter (i.e., their APC does not qualify them for direct entry to a technical curriculum), or
2. in completing their review of the prospective student's academic record, the Program Officer and Academic Associate have concluded that sufficient time has expired since the student's most recent college experience and as such, the student would benefit from the Technical Refresher Quarter.

For some students, this may also include courses from the Six-Week Math Refresher.

The refresher sequence is normally twelve weeks in length; however, there are occasions when a student may be assigned two quarters of refresher prior to entering a technical curriculum.

Typical course sequences for refresher quarters are shown in these examples:

### Space Systems Operations

MA1113

MA1114

PH1001

PH1102

**Operations Analysis**

MA1113  
 MA1114  
 MA1025  
 OA1600

**Mechanical Engineering**

EC1010  
 MA1113  
 MA1114  
 PH1121

**Computer Science**

CS1100  
 MA2025  
 MV1000  
 NW-3230

Prospective students are encouraged to contact the Program Officer regarding the specifics of their particular refresher course sequence.

**Grading**

Student academic performance is evaluated in terms of quality points assigned to the letter grade achieved in a course. Based on the level of achievement associated with each letter grade, the corresponding quality point values range from a maximum of 4 to a minimum of 0 as follows:

Grade	Point Value
A	4
A-	3.7
B+	3.3
B	3
B-	2.7
C+	2.3
C	2
C-	1.7
D+	1.3
D	1
X	0

Letter designations for which no quality points are assigned are given as follows:

I	Incomplete
W	Withdrew
N	Un-graded
P	Pass
F	Fail
T	Thesis Research

The grade of Incomplete is given when an identifiable portion of the course remains unaccomplished at the end of the quarter. One additional quarter is granted to submit the delinquent work. If the "I" is not

removed within the twelve weeks following the end of the term in which it was assigned, it becomes an "X."

A student may withdraw from a course up to the end of the second week of the quarter without any record of it showing on the transcript. Subsequent withdrawals may be made up to the end of the eighth week of the quarter, but a grade of "W" is entered for the course on the transcript. No withdrawals can be made after the eighth week.

Courses may be designated for "P" and "F" grading when approved by the Academic Department and the Academic Council. A student in a degree program who wishes to take courses not in his or her normal program may also elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Program Officer and Department Chairman. It is the responsibility of the student to exercise the P/F option by informing the instructor in writing at the time of enrollment that a P/F grade is desired. A copy of the approval request shall be forwarded to the Registrar. Students electing to receive the P/F grade in letter graded courses may not apply the hours toward the degree and curriculum requirements of any program.

**Quality Point Rating (QPR)**

When the quarter-hour credit of a course is multiplied by the point value of the student's grade, a quality point value for the student's work in the course is obtained. Example: A student receives a grade of B in a course with three hours lecture and two hours lab. The course credit value of four quarter-hours is multiplied by the point value assigned to the grade of B, resulting in 12.0 quality points for the course.

The sum of the quality points for all courses divided by the sum of the quarter-hour credit of these courses gives a weighted numerical evaluation of the student's performance, termed the *Quality Point Rating (QPR)*. A student achieving a QPR of 3.0 has maintained a "B" average in all courses undertaken with a proper weight assigned for course hours.

**Pass Fail Grading**

Courses may be designated for "P" and "F" grading when approved by the Academic Department and the Academic Council. A student in a degree program who wishes to take courses not in his or her normal program may also elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Program Officer and Department Chairman. It is the responsibility of the student to exercise the P/F option by informing the instructor in writing at the time of enrollment that a P/F grade is

desired. A copy of the approval request shall be forwarded to the Registrar. Students electing to receive the P/F grade in letter graded courses may not apply the hours toward the degree and curriculum requirements of any program.

### **Withdrawing from a Course**

A student may withdraw from a course up to the end of the second week of the quarter without any record of it showing on the transcript. Subsequent withdrawals may be made up to the end of the eighth week of the quarter, but a grade of "W" is entered for the course on the transcript. No withdrawals can be made after the eighth week.

### **Course Registration and Credit**

Each student must be registered in each course in which he/she is a candidate for credit not later than the end of the second week of the quarter. No student will receive credit for a course unless registration in that course has been approved by one of the following: the student's Program Officer or Academic Associate, the Chairman of his/her doctoral committee or the Associate Provost for Academic Affairs.

### **Repetition of Courses**

A student may repeat a course for the purpose of improving a grade provided such course repetition is offered by the Naval Postgraduate School. Approval must be granted by both the Program Officer and the Department or Group Chairman concerned and the Registrar is to be notified.

For record purposes, both the original and the repeated courses are to be shown on the transcript. For Quality Point Rating computation, the credit hours of the course shall be counted once, using the grade received from the most recent time that the student enrolled in the course.

### **Overload**

Without special permission, a student may enroll for no more than 17 total credit hours or more than four 3000-level and/or 4000-level courses per quarter.

A student may enroll in more than 17 and less than 21 total credit hours with explicit permission of the Associate Provost for Academic Affairs and for more than 21 hours only with explicit permission of the Provost.

If an established degree program's course matrix includes a quarter with more than 17 hours, the

students in the program need not apply for a course enrollment limitation waiver. This limit is automatically waived in these cases.

### **Auditing**

Eligible persons will be allowed to audit courses on a space-available basis with the approval of the professor teaching the course. When approval is obtained to audit, students may attend classes, but they have no entitlement to submit papers, questions, or tests for grading nor consume the instructor's time outside of class. Auditors will receive no grade for the course, no credit toward graduation, and no formal recognition of accomplishment for courses they have audited.

### **Credit by Examination**

The award of credit solely on the basis of examination for any 1000- or 2000-level course is permissible. Grades for such courses shall be awarded on a Pass/Fail basis.

### **Validation**

A student with the appropriate background may validate a course that is required for his/her curriculum. Validation will allow the student to omit that course from the program of study; however, no credit will be granted for a course that has been validated. The basic purpose of course validation is to make optimal use of the student's time at the Naval Postgraduate School. Every validation must be justified by documented evidence of prior work in the area of the course to be validated.

The validation of a course must be approved in writing by the Chairman of the department offering the course or a designated representative. Specific criteria for validation (e.g., review of the student's transcripts or examination on the material of the course) are left to the discretion of the cognizant Department Chairman.

After validating one or more courses, it may be possible for a student to complete the program in less than the maximum time allowed.

### **Transfer of Credits**

Upon entry to the Naval Postgraduate School, each student's academic record will be evaluated for possible transfer of credit or for exemption from portions of the curricular program by validation of course work previously completed. Students may utilize knowledge gained through self-study or experience of service-related education to seek validation. They may also



take a departmental examination to gain credit for curricular courses.

Twelve hours of graduate-level courses previously completed may be accepted for transfer credit. These include graduate-level courses taken after completion of the baccalaureate degree and those taken in the last term before award of the baccalaureate and certified to be in excess of degree requirements.

NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transfer from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

Questions on transfer credit should be directed by letter to the appropriate curricular Academic Associate as listed in this catalog.

## Academic Counseling

The Naval Postgraduate School provides academic counseling services to assist officers in developing individual educational plans. Officers who have chosen specific curricula or who have been selected or detailed for graduate education in programs at Naval Postgraduate School, are advised to contact the appropriate Program Office listed in the Program Offices and Programs section of this catalog. Other prospective students seeking general information about the curricula offered at the school or the fully-funded graduate education selection process are advised to contact the Director of Admissions (Code 01C3), Naval Postgraduate School, or telephone (831) 656-3093, DSN 756-3093, email: grad-ed@nps.edu.

## Medical and Operational Military Absences

The academic record of a student may be deleted completely for a given term when the student is absent for a portion of the term for medical or operational reasons. The transcript will show, "Excused for the term for medical reasons" or "for operational military reasons." The student shall not be permitted to delete

only a portion of the courses for this reason. The grade "W" shall be used when it is necessary to withdraw from only a part of the student's program. Such excusals shall be requested by the Program Officer and approved by the Associate Provost for Academic Affairs.

## Honor Code

NPS students are expected to uphold the highest standard of honesty and integrity and must follow the academic honor code at all times. Plagiarism, fraud, cheating, and verbal or written misrepresentation constitute violations of the Academic Honor Code. Instructor-authorized group activities/projects should rightly acknowledge the efforts of all respective participants. Unless faculty clearly state that consultation/cooperation in an assignment or course is permissible, all work must be exclusively from the student(s) listed on the document for all graded work. Any restrictions placed by the instructor on the materials that may be used by a student in preparation for and performance of all graded work, must be followed.

While no single list can identify and define all types of academic honor code standards, the following are cited as examples of unacceptable behavior:

1. **Cheating** - Using unauthorized notes, study aids, or information on an examination; looking at another student's paper during an examination; altering a graded work after it has been returned, then resubmitting it for re-grading; allowing another person to do one's work and submitting it under one's own name; taking a longer time period than was authorized to complete a take-home exam.
2. **Plagiarism** - Submitting material that in part or whole is not entirely one's own work without attributing those same portions to their correct source. Student shall ensure all references are properly cited.
3. **Fabrication** - Falsifying or inventing any information, data, or citation.
4. **Obtaining an Unfair Advantage** - Gaining access to examination materials prior to the time authorized by the instructor; unauthorized collaboration on an academic assignment; possessing, using or circulating previously given examination materials where those materials clearly indicate that they are to be returned to the instructor at the conclusion of the examination.

Appropriate disciplinary action may include disenrollment, fitness report comments, and a letter to

appropriate government agencies or official service branches. Individuals suspecting Academic Honor Code violations are required to inform the appropriate academic/curricular officials.

## Grievance Procedures

Complaints of discrimination and sexual harassment require the continual attention of the President on how they are handled by the chain of command. A complaint is nothing more than bringing to the attention of the proper authority the known, suspected, or probable offense under UCMJ, a violation of civil law, or other inappropriate conduct. A complaint may be made orally or in writing with the Military Equal Opportunity Assistant or Officer, or the command Deputy Equal Opportunity Officer. Any service member, officer or enlisted, may initiate a complaint.

The procedures an individual must follow to present a complaint are divided into three categories:

1. Informal
2. Formal
3. Alternative avenues

All procedures for each of these courses of action are located in the NPS Military Equal Opportunity Policy Guidance and Discrimination Grievance Procedure Manual available from the Office of the Dean of Students.

## Alumni Transcript Requests

Naval Postgraduate School alumni can request a transcript of their course work from the Registrar's Office by:

1. Facsimile request: (831) 656-2891. Include your full name, Social Security Number, year last attended, your current mailing address and addresses you want the transcript sent to if different from your mailing address.
2. Mail request to:  
Naval Postgraduate School  
Office of the Registrar  
Code 01C1  
1 University Circle, Room 022  
Monterey, CA 93943
3. E-mail request: Transcripts@nps.edu. Include your full name, Social Security Number, year last attended, your current mailing address and addresses you want the transcript sent to if different from your mailing address.

For information on requesting transcripts telephone: (831) 656-2591

There is a transcript fee of \$5.00 for each copy requested. *Make checks payable to the United States Treasury.*

## CURRICULUM LISTING

The latest version of this chart is found at [www.nps.edu/admissions/catalog](http://www.nps.edu/admissions/catalog)

<b>Curric Title</b>	<b>Curric Number</b>	<b>Normal Length (Months)</b>	<b>Normal Convening Dates</b>	<b>APC</b>	<b>P-Code</b>	<b>Dept</b>	<b>Degree</b>	<b>Program Officer</b>
<b>The Graduate School of Operations &amp; Information Sciences</b>								
Information Systems & Operations	356	18	September	334	6100P	IS	MS Information Systems & Operations	Ray Elliot
Computer Technology (DL)	357	48	July/January	325	None	CS	MS Computing Technology	Loren Peitso
Operations Analysis	360	21	March September	325	3211P/I	OR	MS Operations Research	Kevin Maher
					3211D	OR	PhD Operations Research	Kevin Maher
Operational Logistics	361	21	September	325	3212P	OR	MS Operations Research	Kevin Maher
Human Systems Integration	362	24	January	345	4600	OR	MS Human Systems Integration	Kevin Maher
Master of Systems Analysis - MSA (DL)	363	24	March September	335	TBD (3200P)	OR	MSA Master of System Analysis	Kevin Maher
Joint C4I Systems	365	21	September	334	6204P/I	IS	MS Systems Technology (C3)	Karl Pfeiffer
Computer Science	368	24	March September	325	6203P	CS	MS Computer Science	Owens Walker
					6203D	CS	PhD Computer Science	Owens Walker
Software Engineering	369	12	March September	325	None	CS	MS Software Engineering	Owens Walker
					None	CS	PhD Software Engineering	Owens Walker
Software Engineering (DL)	369	18-24	Any Quarter	325	None	CS	MS Software Engineering	Owens Walker
		36	Any Quarter			CS	PhD Software Engineering	Owens Walker
Information Systems & Technology	370	24	March September	325	6201P	IS	MS Information Technology Management	Stan Bush
Modeling, Virtual Environments & Simulation	399	24	March September	325	6202P	CS	MS Modeling, Virtual Environments & Simulation	Joe Sullivan
					6202P	CS	PhD Modeling, Virtual Environments & Simulation	Joe Sullivan
Information Sciences	470	36	September		6201D	IS	PhD Information Sciences	Dan Boger
Information Warfare	595	24	September	324	6205P	IS	MS Systems Engineering	Terry Smith

CURRICULUM LISTING

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Electronic Warfare Systems (International)	596	24	September	324	None	IS	MS Systems Engineering	Karl Pfeiffer
Joint Information Operations	698	18	January/July	365	None	DA	MS Information Operations	Jennifer Duncan
Special Operations and Irregular Warfare	699	18	January/July	365	2500P	DA	MS Defense Analysis	Jennifer Duncan

**The Graduate School of Engineering & Applied Sciences**

Systems Engineering (DL)	311	24	Any Quarter	N/A	None	SEAC	MS Systems Engineering	Mark Rhoades
Space Systems Operations (International)	364	24	September	324	None	SSAG	MS Space Systems Operations	Al Scott
Space Systems Operations	366	24	September	324	6206P	SSAG	MS Space Systems Operations	Al Scott
Meteorology	372	18	March September	323	None	MR	MS Meteorology	Denise Kruse
		36			6403D	MR	PhD Meteorology	Denise Kruse
METOC	373	27	January/July	323	6401P	MR/OC	MS Joint Meteorology & Physical Oceanography	Denise Kruse
Operational Oceanography	374	24	January/July	323	6402P	OC	MS Physical Oceanography	Denise Kruse
Applied Mathematics	380	24	July	324	4100P	MA	MS Applied Math	Tim Hobbs
		36	Any quarter		4100D	MA	PhD Applied Math	Tim Hobbs
Oceanography	440	18 to 24	January/July	323	None	OC	MS Physical Oceanography	Denise Kruse
		36			6402D	OC	PhD Physical Oceanography	Denise Kruse
Undersea Warfare	525	12 to 24	Mar/Sep	323	6301P	EAAC	MS Engineering Acoustics	Denise Kruse
					6301P	EC	MS Electrical Engineering	Denise Kruse
					6301P	ME	MS Mechanical Engineering	Denise Kruse
					6301P	ME	MS Engineering Science	Denise Kruse
					6301P	OR	MS Operations Research	Denise Kruse
					6301P	OC	MS Physical Oceanography	Denise Kruse
					6301P	UW	MS Applied Science (Physical Oceanography)	Denise Kruse
					6301P	UW	MS Applied Science (Acoustics)	Denise Kruse

Curric Title	Curric Number	Normal Length (Months)	Normal Convening Dates	APC	P-Code	Dept	Degree	Program Officer
					6301P	UW	MS Applied Science (Operations Research)	Denise Kruse
					6301P	UW	MS Applied Science (Signal Processing)	Denise Kruse
					6301P	PH/EC	PhD Engineering Acoustics	Denise Kruse
					6301P	EC	PhD Electrical Engineering	Denise Kruse
					6301D	OR	PhD Operations Research	Denise Kruse
					6301D	OC	PhD Physical Oceanography	Denise Kruse
Undersea Warfare (International)	526	12 to 24	Mar/Sep		N/A	EAAC	MS Engineering Acoustics	Denise Kruse
Combat Systems Science & Technology	533	12 to 24 (MS)	January/July	334	5701/02	PH	MS Applied Physics	Bill Plott
					/04 P/I			
					5703P/I	PH	MS Physics	Bill Plott
					5700P	EC	MS Electrical Engineering	Bill Plott
					5700P	ME	MS Mechanical Engineering	Bill Plott
					5705/P	ME	MS Mechanical Engineering w/TSEE	Bill Plott
					5707P	CS	MS Software Engineering	Bill Plott
					N/A	PH	MS Combat System Technology	Bill Plott
					5704P/I	EAAC	MS Engineering Acoustics	Bill Plott
		36 (PhD)			5703D	PH	PhD Physics	Bill Plott
		36 (PhD)			5701/2/4D	PH	PhD Applied Physics	Bill Plott
		36 (PhD)			5704D	PH/ECE	PhD Engineering Acoustics	Bill Plott
Underwater Acoustic Systems (DL)	535	36	April	334	None	EAAC	MS Engineering Acoustics	Denise Kruse
Mechanical and Astronautical Engineering	570	12 to 24 (MS)	Any Quarter	323	5601P/I	ME	MS Mechanical Engineering	Bill Plott
					5100P/I	ME	MS Engineering Science	Bill Plott
					5602/P	ME	MS Mechanical Engineering w/TSEE	Bill Plott
					5601/2N	ME	Mechanical Engineers Degree	Bill Plott

CURRICULUM LISTING

Curric Title	Curric Number	Normal Length (Months)	Normal Convening Dates	APC	P-Code	Dept	Degree	Program Officer
		36 (PhD)			5601D	ME	PhD Mechanical Engineering	Bill Plott
		36 (PhD)			5602D	ME	PhD Mechanical Engineering w/TSSE	Bill Plott
Reactors/Mechanical Engineering (DL)	571	12 to 15	March September	121	5202P	ME	MS Engineering Science (ME)	Bill Plott
System Engineering (Resident) - PENDING APPROVAL	580	27	July	323	5800	SE	MS Systems Engineering	Bill Plott
Electronics Systems Engineering	590	12 to 24 (MS)	Any Quarter	323	5300P/I	EC	MS Electrical Engineering, MS Engineering Science (EE),	Tim Hobbs
					5300PN	EC	Engineers Degree	Tim Hobbs
					5300D	EC	PhD Electrical Engineering	Tim Hobbs
Electrical Engineering (DL)	590	36	January	323	None	EC	MS Electrical Engineering (MSEE) or MS Engineering Science (MSES-EE)	Tim Hobbs
Space Systems Engineering	591	27	September	323	5500P/D/N	EC	MS Electrical Engineering (Space Systems Engineering)	Al Scott
						ME	MS Astronautical Engineering	Al Scott
						PH	MS Physics (Space Systems)	Al Scott
						CS	MS Computer Science (Space Systems Engineering)	Al Scott
						ME	MS Mechanical Engineering (Space Systems Engineering)	Al Scott
						ME	MS Engineering Science (Astronautical Engineering)	Al Scott
						ME	PhD Astronautical Engineering	Al Scott
						ME	Engineers Degree	Al Scott
Systems Eng Management (SEM) Product Development (DL)	721	24	September	N/A	None	SEAC	MS Systems Engineering, Management, Systems Engineering, Product Development	Mark Rhoades

<b>Curric Title</b>	<b>Curric Number</b>	<b>Normal Length (Months)</b>	<b>Normal Convening Dates</b>	<b>APC</b>	<b>P-Code</b>	<b>Dept</b>	<b>Degree</b>	<b>Program Officer</b>
<b>The Graduate School of Business &amp; Public Policy</b>								
Executive Master of Business Admin. (DL)	805	24	October April	245	3100P	GB	EMBA	Philip A. Gonda
Executive Management	808	12	January/July	245	None	GB	Master of Executive Management	Philip A. Gonda
Transportation Management	814	18	January/July	345	3122P	GB	MBA	Philip A. Gonda
Acquisition & Contract Management	815	18	January/July	345	1306P	GB	MBA	Philip A. Gonda
Systems Acquisition Management	816	18/21	January/July	345	None	GB	MBA	Philip A. Gonda
Defense Systems Analysis	817	18	January/July	345	None	GB	MBA	Philip A. Gonda
Defense Systems Management (International)	818	18	January/July	345	None	GB	MBA ( International students)	Philip A. Gonda
Supply Chain Management	819	18	January/July	345	1302P	GB	MBA	Philip A. Gonda
Resource Planning and Management for International Defense	820	18	January	345	None	GB	MBA ( International students)	Philip A. Gonda
Log & Trans Support Management	827	18	January July	345	3121P	GB	MBA	Philip A. Gonda
Contract Management (DL)	835	24	Any Quarter	355	None	GB	MS Contract Management	Philip A. Gonda
Program Management (DL)	836	24	Any Quarter	335	None	GB	MS Program Management	Philip A. Gonda
Financial Management	837	18	January/July	345	3110P	GB	MBA	Philip A. Gonda
Manpower Systems Analysis	847	21	July	345	3130P	GB	MS Management	Philip A. Gonda
Information System Management	870	18	January/July	345	pending	GB	MBA	Philip A. Gonda

### **The School of International Graduate Studies**

Homeland Defense and Security (DL)	251	18	May/Sept	TBD		NS	MA Security Studies (Homeland Defense and Security)	Ted Lewis
Middle East, Africa, South Asia	681	18	Any Quarter	365	2101P	NS	MA NSA	Raymond Roll
Far East, Southeast Asia Pacific	682	18	Any Quarter	365	2102P	NS	MA NSA	Raymond Roll
Western Hemisphere	683	18	Any Quarter	365	2103P	NS	MA NSA	Raymond Roll
Russia, Europe, Central Asia	684	18	Any Quarter	365	2104P	NS	MA NSA	Raymond Roll

CURRICULUM LISTING

<b>Curric Title</b>	<b>Curric Number</b>	<b>Normal Length (Months)</b>	<b>Normal Convening Dates</b>	<b>APC</b>	<b>P-Code</b>	<b>Dept</b>	<b>Degree</b>	<b>Program Officer</b>
Civil-Military Relations	689a	12 or 15	January/July	365		NS	MA Security Studies (Civil-Military Relations)	Raymond Roll
Security Studies - Stabilization and Reconstruction	689b	15	July	365		NS	MA Security Studies (Security Stabilization and Reconstruction)	Raymond Roll
Defense Decision Making and Planning	689c	12 or 18	Any Quarter	365		NS	MA Security Studies (Defense-Making and Planning)	Raymond Roll
Counterterrorism Policy and Strategy	689d	15	January	365		NS	MA Security Studies (Counterterrorism Policy and Strategy)	Raymond Roll
Homeland Security - on site	690	15	September	365	2600P	NS	MA Security Studies (Homeland Defense and Security)	Raymond Roll

**System Engineering and Analysis Curriculum Committee**

Systems Engineering & Analysis	308	18	January/July	334	6500P	SEACC	MS Systems Engineering	Mark Stevens
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**Certificate Curricula (Taught Web-Based Except 222)**

Naval Nuclear Power School Certificate	222			N/A			None	Not Assigned
Advanced Acquisition Program Certificate	211	12	Quarterly	N/A	N/A	GB	None	John Dillard
Acquisition Management DL Program Certificate	212	3	Quarterly	N/A	N/A	GB	DAWIA Level III Certificate	Walter Owen
Information Systems & Operations Certificate	271	12	Quarterly	N/A	N/A	IS	None	Ray Elliott
Information Systems Technology Certificate	272	12	Quarterly	N/A	N/A	IS	None	Stan Bush
Space Systems Certificate Program	273	12		N/A	N/A		None	Joe Welch
ASW Certificate Program	274	12	Quarterly	N/A	N/A	UWAC	None	Denise Kruse
Software Engineering Certificate	275			N/A	N/A		None	David Floodeen



<b>Curric Title</b>	<b>Curric Number</b>	<b>Normal Length (Months)</b>	<b>Normal Convening Dates</b>	<b>APC</b>	<b>P-Code</b>	<b>Dept</b>	<b>Degree</b>	<b>Program Officer</b>
eFIST Fundamentals in Information Systems Technology Certificate	276	9	3 Quarters	N/A	N/A	IS	None	Stan Bush
Systems Analysis Certificate	281	12	Quarterly	335			None	Kevin Maher
Systems Engineering Certificate	282	12	Fall/Spring	N/A	N/A		None	Bill Plott

## GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY (GSBPP)

### Website

[www.nps.navy.mil/gsbpp](http://www.nps.navy.mil/gsbpp)

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#### The Graduate School of Business and Public Policy includes:

Acquisition Management Academic Area

Financial Management Academic Area

Manpower and Economics Academic Area

Operations and Logistics Management Academic Area

Organizations and Management Academic Area

Enterprise and Information Academic Area

### Mission

To serve the Nation by educating military officers and DoD civilians in Defense-focused business and public policy, by conducting scholarly research in Defense management and public policy, and by providing intellectual resources for leaders and organizations concerned with national Defense management practice and policies.

**In Education:** Through graduate degree and non-degree programs, to develop students' abilities to analyze, think critically, and take intelligent actions so they can more effectively carry out their future professional responsibilities to manage organizations, resources, people, and programs in complex and sometimes life threatening environments.

**In Research:** To conduct scholarly, technical, and applied research that supports decision-making, problem solving, and policy setting; improves management processes and organizational effectiveness; contributes knowledge to academic disciplines; and advances graduate education.

**In Professional Service:** To provide professional expertise that advances knowledge and business management within NPS, the Department of the Navy, the Department of Defense, and other government agencies; as well as in our professional and academic organizations.

### Goals

To be the Nation's premier school for Defense-focused business management and public policy education and scholarship.

To be the institution that national leaders look to for education, information, and innovation in the management of the business of Defense.

Through scholarship-based education and research, to transform our students intellectually, professionally and personally; and to transform the organizations that engage us.

### Areas of Excellence

#### The Defense-Focused MBA Program: "Business Management Knowledge for DoD"

GSBPP at NPS offers the only MBA program specifically designed to provide a defense-focused,

graduate business education. The objectives of the MBA program are both to provide professional knowledge and skills to prepare officers for management positions within DoD and to develop broad critical thinking and analytical abilities of benefit throughout an officer's career. Designed to satisfy both current and future management competencies of active duty military officers and government civilians, the MBA program consists of:

- A Business Management Core, with a distinct defense focus
- A Mission-Related Core, comprised of unique defense management courses
- Alternative Curricular Concentrations, each providing advanced study in military sub-specialty areas
- An Applications Project or Thesis, designed for students to address significant defense problems and issues.
- Professional Certification Programs, in both military and management areas

The GSBPP MBA is one of only five MBA programs in the world to hold dual accreditation from both AACSB, the premier accrediting agency for schools of business, and NASPAA, the premier accrediting agency for schools of public administration. The hallmark of the MBA program is the melding of private-sector and public-sector management education relevant to the defense community.

**Distributed Learning Programs:  
“Reaching out to Serve Defense Community Needs”**

GSBPP is a leader in developing and providing off-campus education for the Defense community. GSBPP has developed faculty, facilities and capabilities to deliver graduate programs using VTE, off-site, and Web-enhanced modes of instruction. Currently, GSBPP offers three unique distance learning degrees to serve Defense community needs.

**Executive MBA:** Developed initially to serve the needs of the Aviation community, the EMBA provides graduate business education to experienced naval officers expected to become future leaders in their military community. The program consists of broad management education coupled with a Financial and Acquisition specialization.

**Master of Science in Program Management:** Developed to respond to the need for professional education for the Defense Acquisition workforce, the MSPM meets Defense Acquisition Workforce Improvement Act (DAWIA) training requirements within the context of a graduate-level degree program.

**Master of Science in Contract Management:**

Developed to respond to the need for professional education for the Defense Acquisition workforce, the MSCM meets Defense Acquisition Workforce Improvement Act (DAWIA) training requirements within the context of a graduate-level degree program.

**Management Development Programs  
“Continuing Education for Professional Success”**

GSBPP provides Continuing Education in the form of Executive and Management Development programs. Programs are provided in residence, via VTE; and internationally, by GSBPP faculty with both academic and professional experience in discipline areas. GSBPP offers unique programs to serve Defense community needs.

**Practical Comptrollership Course (PCC):** A mid-career course sponsored by the Assistant Secretary of the Navy (Financial Management & Comptroller) that provides graduate-level financial management education to DoN civilians and military officers. Primarily resident and occasionally DL.

**Advanced Acquisition Program (AAP):** The AAP provides education and certification to DoD's acquisition workforce, including Army, Navy and Air Force acquisition commands. AAP is one of only three programs DoD wide to grant Program Management Level III certification, and the only non-resident program to do so.

**Acquisition Management Distance Learning Program (AMDLP):** GSBPP provides this educational outreach program to the Defense acquisition community, offering acquisition management courses to Defense agencies across the country. These courses satisfy certain DAU mandatory training requirements and DAWIA requirements for business subjects, and may also be taken for continuing education.

**International Defense Acquisition Resource Management (IDARM):** This international program focuses on the development of strategies for establishing or improving a country's defense acquisition resource management in a manner that contribute to both national security and economic well being. The IDARM program involves needs assessment, curriculum development, and course delivery, providing tailored executive education in Strategic Planning, Contracting, Logistics, Financial Management, and Program Management. This program is managed in the School of International Graduate Studies.

**Executive Education:** NPS' Center for Executive Education (CEE) provides courses for executive-level military officers and defense civilians, including the Executive Business Course, the Navy Corporate

Business Course, Strategic Planning Seminar and Leading Transformational Change. GSBPP supports CEE on business education requirements.

**Defense Specialty Curricula:  
“Education Responsive to Sponsor  
Requirements”**

GSBPP provides graduate management education in six curricular areas of direct relevance to military educational needs. All curricula have a senior leader from one of the services who sponsors the program. Sponsors are actively involved in the design and review of programs. These reviews, in conjunction with NPS and GSBPP assessments, result in high quality, unique, and military-relevant programs. Collectively, the curricula encompass all aspects of Resource Management, including the management of Human Resources, Physical Resources, Financial Resources, and Information Resources.

**Logistics Management:** Designed for military officers who will be responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phase-out. Emphasizes all of the aspects of providing integrated logistics support of military systems.

**Acquisition Management:** Develops the knowledge, skills and competencies necessary for graduates to assume leadership roles in the acquisition workforce and efficiently manage the resources allocated to the acquisition process.

**Manpower Management:** Serves the Navy Human Resource Community of Interest by developing leaders in the design, analysis, and management of Manpower, Personnel, Training and Education Systems to maximize fleet readiness.

**Financial Management:** Designed to prepare military officers for effectively managing financial resources to achieve the goals and objectives of the defense forces. Graduates are prepared for assignment to positions in budgeting, accounting, business and financial management, cost management, cost analysis, internal control and auditing, and financial analysis.

**Information Systems Management:** Designed to provide both technical skills and business acumen. Provides the knowledge to: acquire and manage information systems and infrastructure; address IS engineering and management problems; assimilate new technologies and transform organizations, processes, and strategies to compete in the marketplace or on the battlefield in the constantly changing digital world.

**Faculty:  
“A Unique Blend to Perform GSBPP's Academic  
Mission”**

The GSBPP faculty is unique in its composition, combining individuals with varying academic, professional, practitioner, and service backgrounds to provide relevant graduate instruction and research programs.

**Academics and Professionals:** GSBPP has 68 full-time faculty who are drawn from a wide variety of academic disciplines. A majority of the faculty holds doctoral degrees from the nation's more distinguished universities. In addition to the academics, practitioners are an integral part of the faculty. In keeping with our mission, we employ highly qualified practitioners on a full-time basis to enhance the relevance and quality of our programs. All full-time practitioners have at least a master's degree and have been recognized as accomplished professionals in their fields.

**Civilian and Military:** A combination of top notch civilian faculty combined with active and retired military officers provides BPP with expertise both within and beyond the DoD. The civilian faculty provides the theoretical and academic expertise enhanced by numerous contacts throughout the Navy and Defense community, while the military faculty provides recent DoD experience, and professional and operational expertise.

**Business and Government:** The GSBPP faculty blends backgrounds from both the private and public sectors. More than half of the faculty come with academic and/or professional experience from the business world. More than half come with academic and/or professional experience in the public sector.

**Instruction and Research:** GSBPP faculty are expected to excel in teaching as well as conduct significant research that is relevant to the Department of Defense. Faculty members maintain high degree of connectivity with sponsors of instructional and research programs. Almost all faculty work year round, teaching two quarters and conducting research and/or engaging in administrative work for the other two quarters.

**Business And Public Management Research:  
“Scholarship Analysis Relevant to Defense  
Problems”**

**Research Mission:** Research is an important component of GSBPP's mission. The primary goal of GSBPP's research programs are to provide the Navy and DoD with the capability of managing defense organizations, systems, and processes both efficiently and effectively. GSBPP recognizes the importance of

both basic and applied research to the Navy and DoD; and seeks to create a balance of both types of research in its research program. GSBPP's research programs can be grouped into six functional areas:

Acquisition and Contracting

Logistics and Transportation

Financial Management

Manpower Systems Analysis

Organization and Management

Economic and Policy Analysis

**Research Relevance:** In-depth knowledge of military problems allows the faculty to provide assistance to DoD decision makers. Expertise in private sector business practices enables the faculty to assist DoD organizations in adopting best business practices. Research in military-relevant issues additionally allows the faculty to develop unique and relevant instructional material for education of military officers.

DoD sponsorship of GSBPP research comes from several commands and areas, such as: ONR, OSD, SPAWAR, NAVSUP, AIRPAC, DAU, NETSAFA, NPRST, PERSEREC, USMC, N82, Manpower, Acquisition, and Logistics.

**Research Excellence:** GSBPP faculty include nationally/internationally recognized experts in simulation modeling, cross-docking, work motivation, knowledge management, military manpower, public sector management, change management, public budgeting, managerial communications, conflict management, acquisition, defense economics, information technology.

#### **Research Centers and Programs:**

**Acquisition Research Program:** Established in 2002, Naval Postgraduate School's Acquisition Research Program provides leadership in innovation, creative problem solving and an on-going dialogue, contributing to the evolution of Department of Defense acquisition strategies. Objectives of the NPS Acquisition Research Program include: Establishing NPS acquisition research as an integral part of policy-making for Departments of Defense and Navy officials. Creating a stream of relevant information concerning the performance of DoD acquisition policies with viable recommendations for continuous process improvement, Preparing the workforce to participate in the continued evolution of the defense acquisition process, Collaborating with other universities, think tanks, industry and Government in acquisition research.

**Center for Defense Management Reform:** When fully operational, the Center will serve three purposes:

First, as a forward-looking source of research to support current and future Defense leaders who embark upon management reform agendas; second, as a resource where knowledge of the history, theories, themes, successes and failures of past Defense reforms can help to inform and guide the design and execution of future reform; and third as a point of intellectual coordination for academic, professional and governmental entities engaged in the topic of defense management reform.

### **Programs Offered**

The Graduate School of Business and Public Policy (GSBPP) has responsibility for seven graduate academic programs and awards seven graduate degrees. The largest program is the resident defense-focused Master of Business Administration (MBA) program. GSBPP also offers a non-resident Executive MBA program and a resident Master of Executive Management program. In addition, GSBPP offers three specialized Master of Science degree programs focused on particular defense management fields, and non-degree professional development programs. These programs are:

#### **Master of Business Administration Degree Program**

- Defense-Focused MBA

#### **Executive Management Degree Programs**

- Executive MBA
- Master of Executive Management

#### **Master of Science Degree Programs**

- MS in Management
- MS in Program Management
- MS in Contract Management

#### **Professional Development Programs**

- Advanced Acquisition Program
- Practical Comptrollership Course

#### **Acquisition Management Distance Learning Program**

#### **Master of Business Administration Degree (MBA)**

This is a Defense-Focused MBA which encompasses six curricula areas: Acquisition Management, Financial Management, Logistics Management, Information Management, and Defense Management. Graduates of curricula in the MBA program are awarded the degree Master of Business Administration. This degree is accredited by the Association to Advance Collegiate Schools of Business - International (AACSB) and by the National Association of Schools of Public Affairs and

Administration (NASPAA). The MBA is a full-time resident program, open to all services, with curriculum lengths ranging from 18 to 21 months. The curricula within the Defense-Focused MBA program include: Acquisition and Contract Management (815), Systems Acquisition Management (816), Financial Management (837), Transportation Management (814), Supply Chain Management (819), Material Logistics Support (827), Information Systems Management (870), Defense Systems Management (818), Defense Systems Analysis (817), and Resource Planning and Management (820).

Program, Practical Comptrollership Course, Acquisition Management distance learning program.

### **Executive Master of Business Administration (EMBA)**

The Executive Master of Business Administration (EMBA) is a defense-focused general management program with emphasis in financial management and acquisition for more senior DoD officers and civilians. The program design and coursework capitalize on the current managerial and leadership experience of program participants. The EMBA is a 24 month, part-time, distance learning degree program.

### **Master of Executive Management (MEM)**

The Master of Executive Management (MEM) is a 1-year, full-time resident program providing a defense-focused general management graduate education. The program additionally provides the opportunity for some focus on a concentration area: financial management, acquisition, contracting, program management, logistics, manpower, information technology, among others. This program was developed to serve the needs of USAF Intermediate Development Education (IDE) officers, but is open to officers from other services with similar qualifications.

### **Master of Science Degrees (MS)**

The Graduate School of Business and Public Policy awards four Master of Science degrees, including the Master of Science in Management (847), the Master of Science in Contract Management (835), and the Master of Science in Program Management (836). Each of the Master of Science degrees is accredited by the Association to Advance Collegiate Schools of Business - International (AACSB).

### **Professional Development Programs**

The Graduate School of Business and Public Policy also administers several non-degree programs consisting of graduate education or professional courses taught in residence or via distance learning modes. These programs support professional development for managers in DoD. Current programs emphasize acquisition and financial management, and include: Advanced Acquisition

**GSBPP Degree Programs and Curricula Summary**

Curricular Area	Name	Curric #	Degree	Mode	P-Code	Entry	Qtrs
<b>Defense-Focused MBA Program</b>							
Logistics	Transportation Mgmt	814	MBA	Res	3122	Jul	6
	Supply Chain Mgmt	819	MBA	Res	1302	Jul	6
	Material Logistics Support	827	MBA	Res	3121	Jan/Jul	6
Acquisition	Acquisition & Contract Mgt	815	MBA	Res	1306	Jan/Jul	6
	Systems Acquisition Mgmt	816	MBA	Res	N/A	Jan/Jul	6
Financial	Financial Management	837	MBA	Res	3110	Jan/Jul	6
	Defense Systems Analysis	817	MBA	Res	USMC	Jan/Jul	6
Information	Information Systems Mgmt**	870	MBA	Res	1309	Jan/Jul	6
Defense Mgmt	Resource Planning & Mgmt*	820	MBA	Res	Intl	Jan	6
	Defense Systems Mgmt	818	MBA	Res	Intl	Jan/Jul	6
<b>Executive Degree Programs</b>							
Financial & Acquisition	Executive MBA	805	EMBA	VTE	3100	Oct/Apr	8
General	Master of Exec. Mgmt	808	MEM	Res	N/A	Jan/Jul	4
<b>Master of Science Degree Programs</b>							
Manpower	Manpower Systems Analysis	847	MSM	Res	3130	Jul	7
Acquisition	Contract Management	835	MSCM	VTE	N/A	Any	8
	Program Management	836	MSPM	VTE	N/A	Any	8
	Systems Eng. Mgmt ***	721	MSSEM	VTE	N/A	Sept	8

\*Joint program with NSA Dept.

\*\*Joint program with IS Dept.

\*\*\*Joint program with SE Dept. PD21 Program

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##### **Supply Chain Management Curriculum (819)**

##### **Material Logistics Support Curriculum (827)**

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**Leslie E. Sekerka**, Assistant Professor of Management (2002); Ph.D., Case Western Reserve University, 2002.

**Cary A. Simon**, Lecturer of Management (1997); D.B.A., U.S. International University, 1997.

**James E. Suchan**, Professor of Managerial Communications (1986); Ph.D., University of Illinois, 1980.

**Gail Fann Thomas**, Associate Professor of Management Communications (1989); Ed.D., Arizona State University, 1986.

**Professor Emeritus:**

**Kenneth W. Thomas**, Professor of Management (1987); Ph.D., Purdue University, 1971.

**Enterprise and Information Academic Area**

**Douglas Brinkley**, Senior Lecturer in Information Systems and Director of Computer Support Services (1998); Ed.D, Nova Southeastern University, 2003.

**Douglas A. Brook**, Professor of Public Policy (2002); Ph.D., George Mason University, 2001.

**Daniel R. Dolk\***, Professor of Management Information Systems (1982); Ph.D., University of Arizona, 1982.

**Becky D. Jones**, Lecturer (2002); M.B.A., Golden Gate University, 1998.

**Mark Nissen\***, Associate Professor in Acquisition Management and Information Systems (1996); Ph.D., University of Southern California, 1996.

**Roxanne V. Zolin**, Assistant Professor of Management and Information Systems (2002); Ph.D., Stanford University, 2002.

\*Joint appointment with Department of Information systems

The year of joining the Naval Postgraduate School faculty is indicated in parentheses

## GSBPP Programs and Curricula:

### Defense-Focused MBA Program - Curriculum 8xx

#### Program Director

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#### Brief Overview

The Master of Business Administration (MBA) is a defense-focused MBA program designed to provide officers and DoD civilians an advanced education in interdisciplinary approaches to problem solving and policy analysis by applying quantitative, financial, economic, information technology, and other state-of-the-art management techniques and concepts to military management and policy issues. Graduates of the MBA program will know the latest management theories and practices, including leadership, communication, organization design, and planning, and how to apply them within large public and private sector organizations, as well as military sub-units and activities.

The MBA degree program has been designed to meet four objectives:

- To provide a defense-focused graduate management education program of specific relevance to U.S. military officers and DoD civilians.
- To satisfy educational requirements for military subspecialties or occupational and functional areas.
- To meet the Association to Advance Collegiate Schools of Business International (AACSB) and the National Association of Schools of Public Affairs and Administration (NASPAA) accreditation requirements.
- To allow officers to complete JPME requirements, if desired.

To satisfy these objectives, the MBA program consists of four parts:

- Business Core (35 credit hours)
- Mission-Related Core (17 credit hours)
- Curricular Concentration (24+ credit hours)
- Master's Application Project or Thesis

#### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

#### Entry Dates

January and/or July, depending on curriculum.

#### Degree

Requirements for the degree of Master of Business Administration are met by:

1. Completion of all required courses in the business core.
2. Completion of all required courses in the mission-related core.
3. Completion of an approved sequence of courses in a concentration area with a minimum of 24 graduate-level credit hours.
4. Completion (excluding by validation) of a minimum of 58 credit hours of graduate-level courses, at least 22 of which are at the 4000 level.
5. Completion of an acceptable application project or thesis.
6. Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy.

#### Typical Course of Study

##### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)

##### Quarter 2

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
GB3031	(2 - 0)	Principles of Acquisition Management *

##### Quarter 3

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis

GB4053	(4 - 0)	Defense Budget and Financial Management Policy
GB/MN	(X - 0)	Subspecialty Curriculum Course

**Quarter 4**

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
GB/MN	(X - 0)	Subspecialty Curriculum Course
GB/MN	(X - 0)	Subspecialty Curriculum Course

**Quarter 5**

NW3230	(4 - 0)	Strategy & Policy***
GB/MN	(X - 0)	Subspecialty Curriculum Course
GB/MN	(X - 0)	Subspecialty Curriculum Course
GB4090	(0 - 6)	Application Project ****

**Quarter 6**

GB/MN	(X - 0)	Subspecialty Curriculum Course
GB/MN	(X - 0)	Subspecialty Curriculum Course
GB4090	(0 - 6)	Application Project ****
GB/MN	(X - 0)	Elective

\*May be replaced by appropriate concentration course (MN3301, MN3331) within a curriculum.

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students.

International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\*\* Students may elect to complete a thesis.

**Curricular Areas and Curricula**

Students in the MBA program complete a specialization curriculum in one of the following areas of particular importance to DoD:

**Logistics Management**

814	Transportation Management
819	Supply Chain Management
827	Material Logistics Support

**Acquisition Management**

815	Acquisition and Contract Management (including Strategic Purchasing)
816	Systems Acquisition Management

**Financial Management**

837	Financial Management
817	Defense Systems Analysis

**Information Management**

870	Information Systems Management
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**Defense Management**

818	Defense Systems Management - International
820	Resource Planning and Management for International Defense

**Logistics Management Curricula**

The Logistics Management curricula provide education in all aspects of the logistics function. The curricula are comprised of management core and logistics concentration subjects. The management core of the Logistics Management curricula provides study in mathematics, accounting, economics, communications, marketing management, risk analysis, DoD mission, structure and resource determination, strategy making, and the global defense marketplace. The logistics curricula subjects are significant components of the military supply chain and each provides unique and relevant education that meets the critical needs of the armed services. The specialized logistics courses concentrate on studies in production and project management, inventory management, integrated logistics support, procurement and contract administration, systems acquisition, and logistics strategic planning. The logistics curricula are rounded out by including education in national, international, and defense transportation systems. The educational skills in these curricula prepare those responsible for managing the various elements of total life cycle support from requirements determination through sustainment.

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**Transportation Management - Curriculum****814****Supply Chain Management - Curriculum****819****Material Logistics Support - Curriculum****827****Brief Overview**

The Logistics Management curricula are interdisciplinary, integrating mathematics, accounting, economics, management theory, operations analysis, and the specialty concentration into an understanding of the process by which the defense mission is accomplished. The curricula are designed to provide the officer with fundamental interdisciplinary

techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, they are intended to provide the officer with a Navy/Defense Systems-oriented graduate management education and to provide the officer with the specific functional skills required to effectively manage in these subspecialty areas. The objective of these curricula is to prepare officers for naval logistics system positions. The Logistics Management curricula emphasize all of the aspects for providing integrated logistics support of military systems. Skills resulting from the curricula will prepare those responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phase out. These curricula additionally emphasize the management of military owned inventories at the three levels of wholesale, intermediate and retail customer support, and worldwide transportation and distribution systems.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Date

July (also January for curriculum 827)

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

### Subspecialty

Completion of these curricula provides a naval officer with a specialization in Supply Chain Management (1304P), Material Logistics Support Management (subspecialty code 3121P), or Transportation Management (subspecialty code of 3122P). U.S. Marine officers receive MOS 9662.

### Typical Subspecialty Jobs

Inventory Control Methods and Requirements: Fleet and Industrial Support Center  
 Stock Control: Naval Air Station  
 Director of Program Support Office, Navy Inventory Control Point, Mechanicsburg, PA

Director of Nuclear Reactor Stock Control Requirements, Ships Parts Control Center, Mechanicsburg, PA  
 Division Director, Defense Electronic Supply Center, Dayton, OH  
 Stock Control Requirements Planning, Naval Submarine Support Facility, New London, CN  
 Director of Logistics Strategic Planning, Bureau of Medicine, Washington D.C.  
 Director, Supply Systems Design Department, Ships Part Control Center, Mechanicsburg, PA  
 Chief, Navy Systems Readiness Group, Defense General Supply Center, Richmond, VA  
 Aircraft Intermediate Maintenance: Naval Air Stations and Aircraft Carriers  
 Project Management Staff: Naval Air Systems Command, Washington, D.C.  
 Integrated Logistics Support Coordinator for Operational Support: Naval Air Systems Command, Washington, DC  
 Director of Receiving: Fleet & Industrial Support Centers (FISC)  
 Director of Storage: FISC & DLA Depots  
 Transportation Officer: CINCLANTFLT  
 Transportation Director: Fleet and Industrial Support Center (FISC) Norfolk, VA  
 Air Terminal Coordinator: COMFAIRMED  
 Cargo Handling Officer, Operations Officer: NAVCHAPRU  
 CO and XO: NAVMTO  
 Deputy Commander: MTMC  
 Commander: MSCO, COMSCEUR, COMSCMED, COMSCPAC, United Kingdom and Northern Europe  
 Tanker Control Officer: Military Sealift Command (MSC) Headquarters  
 Commander and Deputy Commander: Military Sealift Command Officer (MSCO), Norfolk, VA

### Curriculum Sponsors

Naval Supply Systems Command Headquarters (819)  
 Naval Air Systems Command Headquarters (827)  
 Navy Military Sealift Command Headquarters (814)

### Typical Course of Study: Curricula 814, 819, 827

#### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis

GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)

**Quarter 2**

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
GB3031	(2 - 0)	Principles of Acquisition Management*

**Quarter 3**

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
MN3370	(0 - 2)	Defense Logistics Seminar
GB4440	(3 - 0)	Models and Simulation for Managerial Decision Making

**Quarter 4**

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
MN3370	(0 - 2)	Defense Logistics Seminar
GB3420	(4 - 0)	Supply Chain Management
GB/MNxxxx	(X - 0)	Curriculum Elective Course*****

**Quarter 5**

MN3370	(0 - 2)	Defense Logistics Seminar
GB4410	(4 - 0)	Logistics Engineering
GB4430	(4 - 0)	Defense Distribution and Transportation
GB4090	(0 - 6)	Application Project ****
GB/MNxxxx	(X - 0)	Curriculum Elective Course*****

**Quarter 6**

NW3230	(4 - 0)	Strategy and Policy***
MN3370	(0 - 2)	Defense Logistics Seminar
GB4420	(3 - 0)	Logistics Information Systems
GB4450	(4 - 0)	Logistics Strategy*
GB4090	(0 - 6)	Application Project ****
GB/MNxxxx	Curriculum Elective Course*****	Curriculum Elective Course*****

\*May be replaced by appropriate concentration course (MN3301, MN3331)

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\*\* Students may elect to complete a thesis.

\*\*\*\*\* Replaced by NW3275, NW3276 and NW3285 for students completing JPME.

**Educational Skills Requirements (ESR)  
Transportation Management -  
Curriculum 814 Subspecialty code 3122P**

**Supply Chain Management -  
Curriculum 819 Subspecialty code 1304P**

**Material Logistics Support Management -  
Curriculum 827 Subspecialty code 3121P**

1. **Management Fundamentals - Quantitative Analysis:** The graduate will have the skills to apply mathematical, statistical, accounting, economic, and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long-range strategic planning efforts of the Navy and DoD.
2. **Management Fundamentals - Organization and Management:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning, and controlling of military organizations.
3. **Integrated Logistics Support Management:** The graduate will have a detailed understanding of the processes associated with designing an integrated logistics support system for a new weapon system. The graduate will also have detailed knowledge about the DoD processes for contracting for and acquiring a new weapon system. The graduate will be able to serve as an assistant program manager for logistics (APML) for a major weapon system.
4. **Budgeting and Financial Controls:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.
5. **Production/Operations Management:** The graduate will be able to apply the techniques of production/operations management at Naval Aviation Intermediate Activities and Depots, Navy Fleet Industrial and Support Activities, and other DoD maintenance and maintenance support activities.
6. **Materials and Physical Distribution Management:** The graduate will be able to apply the techniques



of materials management and physical distribution management in designing and operating of fleet and troop support systems, both during peacetime and during rapidly developing wartime contingencies. This will include acquiring material and transportation assets to ensure that the distribution of material is both cost-effective and efficient. The graduate will also have an in-depth understanding of domestic, international, and defense transportation systems including the various modes, types of carriers within each mode, and the regulations affecting material movement by each type of carrier.

7. **Joint and Maritime Strategic Planning:** The graduate will have knowledge of the development and execution of military strategy and the effects of technical effects on warfare, an understanding of the means of formulation of U.S. policy, the roles of military forces and joint planning, and current issues in the defense organization. The graduate will also have a detailed understanding of the plans and processes of the DoD for providing support of strategic sealift and mobilization.
8. **Thesis/Project:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

## Acquisition Management Curricula

The Acquisition Management Curricula are designed to develop the knowledge, skills and competencies necessary to effectively lead the acquisition workforce and efficiently manage the resources allocated to the acquisition process. The curricula focus on problem solving and decision-making in a variety of acquisition situations demanding critical thinking and a balanced approach in the application of theory and practical solutions. Graduates of the curricula are expected to assume leadership positions in the acquisition workforce.

## Acquisition and Contract Management Curriculum 815

The Acquisition & Contract Management Curricula are designed to develop the knowledge, skills and competencies necessary to effectively lead the acquisition workforce and efficiently manage the resources allocated to the acquisition process. The curricula focus on problem solving and decision making in a variety of acquisition situations demanding critical thinking and a balanced approach

in the application of theory and practical solutions. Graduates of the curricula are expected to assume leadership positions in the acquisition workforce.

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### Brief Overview

The Acquisition and Contract Management curricular concentration is an interdisciplinary program which integrates mathematics, accounting, economics, finance, behavioral science, management theory, operations/systems analysis, and specific courses in acquisition and contracting. The 815 curriculum includes a concentration option in strategic purchasing. Student input includes officers and civilians from all DoD services, other federal agencies and allied nations. The curricular concentration is designed to provide officers and civilians with the skills to serve effectively in systems buying offices, field contracting offices, contract administration offices, and contracting policy offices.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Date

January and July

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

## Acquisition and Contract Management Subspecialty

Completion of this curriculum qualifies naval officers as Acquisition and Contract Management Subspecialists with a subspecialty code of 1306P, Army officers as Functional Area 51C, and Marine Corps officers with a 9656 MOS. The curriculum satisfies mandatory Defense Acquisition University (DAU) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

### Typical Subspecialty Jobs

#### Contracting Officer:

Naval Inventory Control Point, Philadelphia, PA;  
Air Force Major Weapon System Program Offices

#### Director of Contracts:

Marine Corps Field Contracting System, Fleet and Industrial Supply Centers, Army and Navy Laboratories, Naval Regional Contracting Centers

#### Procuring Contracting Officer (PCO):

Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR)  
Air Force Major System Centers (Aeronautical System Center, Space and Missiles System Center)  
Army Material Command  
Major Subordinate Commands (CECOM, AMCOM)  
Business/Financial Manager (BFM)

#### Contracts and Business Policy:

Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)  
Staff of Assistant Secretary of the Army (Acquisition, Logistics and Technology)  
Staff of Assistant Secretary of the Air Force (Acquisition)  
Staff of Under Secretary of Defense (Acquisition, Technology and Logistics)

#### Administrative Contracting Officer (ACO):

Defense Contract Management Agency (DCMA)  
Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)

#### Curriculum Sponsor

Deputy Assistant Secretary of the Navy (Acquisition)

#### Typical Course of Study: Curriculum 815

(Within the 815 curriculum, students may substitute specialty courses in strategic purchasing at the approval of their service and the academic associate)

### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)

### Quarter 2

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
MN3331	(5 - 1)	Systems Acquisition and Program Management

### Quarter 3

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
MN3303	(4 - 0)	Principles of Acquisition and Contract Management

### Quarter 4

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
MN3315	(4 - 0)	Acquisition Management and Contract Administration
MN3312	(4 - 0)	Contract Law
MN2302	(0 - 2)	Seminar for Acquisition and Contracting Students

### Quarter 5

MN3318	(1 - 0)	Contingency Contracting
MN4304	(2 - 0)	Defense Systems Contracting
MN3304	(5 - 2)	Contract Pricing and Negotiations
MN2302	(0 - 2)	Seminar for Acquisition and Contracting Students
GB4090	(0 - 6)	Application Project ****

### Quarter 6

NW3230	(4 - 0)	Strategy & Policy***
MN4371	(4 - 0)	Acquisition and Contracting Policy
GB4090	(0 - 6)	Application Project ****
MN2302	(0 - 2)	Seminar for Acquisition and Contracting Students
MN3384	(5 - 1)	Principles of Acquisition Production and Quality Management *

\* U.S. Army and U.S Marine Corps only

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students.  
International students take American Life and

Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\* Students may elect to complete a thesis.

**Educational Skills Requirements (ESR)  
Acquisition Management -  
Curriculum 815 Subspecialty Code 1306P**

1. **Management Fundamentals:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial, and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.
2. **Advanced Management Concepts:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision making.
3. **Acquisition and Contracting Principles:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the federal government, including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement (DFARS); the unique legal principles applied in government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision making occurs. Finally, the graduate will have the ability to conceptualize, develop and execute strategic business alliances and relationships necessary to the successful acquisition of goods and services.
4. **Acquisition and Contracting Policy:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the federal and military contracting offices, the Boards of Contract Appeals, and the court system.
5. **Contracting Process:** The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition, and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and simplified acquisition methodologies; a comprehensive knowledge of all contract types and their application in defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions, including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.
6. **Business Theory and Practices:** The graduate will have an understanding of the business philosophy, concepts, practices, and methodologies of the global commercial industrial base, and the ability to apply these to the federal government acquisition environment.
7. **Federal and Defense Budgeting:** The graduate will have an ability to apply economic and accounting principles, including monetary and fiscal theories, to defense acquisition and contracting issues.
8. **Program Management:** The graduate will have an understanding of the basic principles and fundamentals of Program Management, with particular emphasis on the Procuring Contractor Officer's and Administrative Contracting Officer's roles and relationships with the Program Manager.
9. **Acquisition Workforce:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at Levels I, II, III.
10. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of

procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. This is fulfilled by completing the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.
12. **Analysis, Problem Solving, and Critical Thinking:** The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied project and a command-oriented briefing appropriate to this curriculum.

## Systems Acquisition Management - Curriculum 816

The Systems Acquisition Management curricular concentration is an interdisciplinary program designed to integrate business principles, program leadership and management theory, operations analysis, and systems engineering applications. It is uniquely tailored to federal government acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curricular concentration apply business analysis and problem solving techniques essential to effective major system program management within the structure of DoD acquisition management. It further focuses on the decisions and problems facing the acquisition manager, the various forces at work within industry and government, and the impact of acquisition policies and strategies. Student input includes officers and civilians from all DoD Services, other federal agencies, and allied nations.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Dates

January and July

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

### Systems Acquisition Management Subspecialty

Completion of this curriculum qualifies an Army officer for Functional Area 51 and a Marine Corps officer for MOS 9657. Department of Defense civilians are typically members of the acquisition workforce as specified by the Defense Acquisition Workforce Improvement Act (DAWIA). This curriculum satisfies the mandatory Defense Acquisition University (DAU) program management education required by the Defense Acquisition Workforce Improvement Act (DAWIA) for Program Management through Level III and provides up to 14 additional DAU equivalencies in other functional areas.

### Typical Subspecialty Jobs

#### Program Manager/Deputy Program

#### Manager/Program Office:

Army/Air Force/Navy/Marine Corps Acquisition Category I through III (ACAT I - III) Programs Program Executive Officer (PEO) staff

#### Matrix Organization Staff

Army Materiel Command (AMC)  
 Naval Air Systems Command (NAVAIR)  
 Naval Sea Systems Command (NAVSEA)  
 Air Force Systems Command  
 Army Communications - Electronics Command (CECOM)  
 Marine Corps Systems Command (MARCORSYSCOM)

#### Force Development Officer

#### Test and Evaluation Officer

#### Acquisition Logistics Officer

#### Curriculum Sponsor

Director, Acquisition Career Management, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology): ASA/ALT (DACM)

### Typical Course of Study: Curriculum 816

#### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
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GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)
<b>Quarter 2</b>		
GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
MN3221	(3 - 0)	Principles of Systems Acquisition and Program Management I
<b>Quarter 3</b>		
GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
MN3222	(3 - 0)	Principles of Systems Acquisition and Program Management II
<b>Quarter 4</b>		
GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
SE4011	(3 - 2)	Systems Engineering for Acquisition Managers
MN3384	(5 - 1)	Principles of Acquisition Production and Quality Management
<b>Quarter 5</b>		
MN4602	(3 - 0)	Test and Evaluation Management
MN3309	(4 - 1)	Acquisition of Embedded Weapon Systems Software
GB4410	(3 - 0)	Logistics Engineering
MN3303	(4 - 0)	Principles of Acquisition and Contract Management
GB4090	(0 - 6)	Application Project
<b>Quarter 6*</b>		
MN4307	(4 - 0)	Program Management Policy and Control
MN3304	(5 - 2)	Contract Pricing and Negotiations
GB4450	(4 - 0)	Logistics Strategy
GB4090	(0 - 6)	Application Project

\*The 6-quarter matrix is for USA and USAF students. USMC and Internationals may follow a 7-quarter program.

\*\* Selected from four available courses offered in the 4th quarter.

\*\*\* Not required for International students. International students take American Life and

Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\*\* Students may elect to complete a thesis.

### **Educational Skills Requirements (ESR) Systems Acquisition Management - Curriculum 816**

- 1. Management Fundamentals:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial, and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as Department of Defense managers. The graduate will have the ability to think creatively, addressing issues and problems in a dynamic, challenging environment.
- 2. Advanced Leadership and Management Concepts:** The graduate will have the ability to apply advanced leadership, management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, project leadership, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated leadership abilities.
- 3. Program Leadership and Management Principles:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of Program Leadership and Program Management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using Total Ownership Cost, schedule and performance dynamics from a total life cycle management perspective.
- 4. Program Management Policies:** The graduate will have an ability to formulate and execute defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the executive, legislative and judicial branches of the U.S. government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

5. **Systems and Acquisition Process:** The graduate will understand the theory of and have an ability to lead program teams and manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, including systems of systems, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.
6. **Contract Management:** The graduate will understand the role of the contracting process within the acquisition environment, including financial, legal, statutory, technical, and managerial constraints in the process.
7. **Business Theory and Practices:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.
8. **Government and Industry Budgeting and Financial Management:** The graduate will have an understanding of and an ability to apply the principles of government and private organizational financing, including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and Defense financial management and budgeting processes to include the Government Planning, Programming and Budgeting System (PPBS).
9. **Acquisition Workforce:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory program management courses required by the Defense Acquisition University (DAU) at Levels I, II, and III.
10. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of defense acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **Analysis, Problem Solving, and Critical Thinking:** The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied project and a command-oriented briefing appropriate to this curriculum.

## Financial Management Curricula

The objective of the Financial Management Curricula is to prepare officers for business, financial, and analysis positions within the DoN and DoD. Financial Managers assist the DoN's decision-making processes at all levels by providing accurate, timely and relevant information and analysis. They are concerned with the optimal allocation of human, physical and financial resources to achieve the DoN's goals and objectives while assuring efficient and effective expenditure of public funds. Graduates of the Financial Management Curricula will be prepared for assignment to positions in strategic planning, business analysis, financial analysis, budgeting, accounting, business and financial management, and internal control systems and auditing.

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## Financial Management - Curriculum 837

### Brief Overview

The objective of the Financial Management Curricula is to prepare officers for business, financial, and analysis positions within the DoN and DoD. Financial Managers assist the DoN's decision-making processes at all levels by providing accurate, timely and relevant information and analysis. They are concerned with the optimal allocation of human, physical and financial resources to achieve the DoN's goals and objectives while assuring efficient and effective expenditure of public funds. Graduates of the Financial Management Curricula will be prepared for assignment to positions in strategic planning, business

analysis, financial analysis, budgeting, accounting, business and financial management, and internal control systems and auditing.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting, internal control, auditing, management planning and control systems, strategic resource management, quantitative techniques used in planning and control, system acquisition and program management, and the Planning Programming and Budgeting System (PPBS) used within the Department of Defense.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Dates

January and July

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

### Financial Management Subspecialty

Completion of this curriculum qualifies a U.S. Navy officer as a Financial Management Subspecialist, subspecialty code 3110P. Completion qualifies a U.S. Marine Corps officer for MOS 9644.

### Typical Subspecialty Jobs

Comptroller: Naval Stations/Naval Air Stations/SYSCOMs  
 Budget Analyst: Office of Budget, U.S. STRATCOM  
 Public Works Officer: CONUS/OUTCONUS  
 Comptroller: Naval Hospitals  
 Business Financial Managers: Program Offices  
 Action Officer/Program Analyst: OSD  
 Budget Analyst: OPNAV  
 Fiscal Officer: BUMED  
 Budget Officer: CINPACFLT

### Curriculum Sponsor

N-82, Director, Office of Budget and Fiscal Management Division.

## Typical Course of Study: Curriculum 837

### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)

### Quarter 2

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
NW3230	(4 - 2)	Strategy and Policy***

### Quarter 3

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy

### Quarter 4

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
GB4530	(3 - 0)	Management Control Systems
MN3301	(4 - 0)	Systems Acquisition*
GB3510	(3 - 0)	Defense Financial Management Practice

### Quarter 5

GB4510	(4 - 0)	Strategic Resource Management
GB4540	(2 - 0)	Financial Management Seminar
GB4570	(2 - 0)	Advanced Finance
OA4702	(4 - 0)	Cost Estimation
GB4090	(0 - 6)	Application Project ****

### Quarter 6

GB4550	(4 - 0)	Advanced Financial Reporting
MN4157	(3 - 0)	Seminar in Management Accounting I
GB4560	(3 - 0)	Defense Financial Management
GB4090	(0 - 6)	Application Project ****
GB/MN	(X - 0)	Elective

\* Equivalent to DAU courses ACQ101 & ACQ102. May be replaced by MN3331. May be replaced by GB3031 for international students.

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students. International students take American Life and

Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\* Students may elect to complete a thesis.

**Educational Skills Requirements (ESR)  
Financial Management - Curriculum 837  
Subspecialty Code 3110P**

1. **Management Fundamentals:** The graduate will have the ability to apply quantitative techniques, accounting, economics, finance, organization theory, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practice, embracing leadership, ethics, written and oral communication, organization design, team building, human resource management, conflict resolution, quality assurance, cost-benefit analysis, risk analysis, stakeholder analysis, and planning within military organizations, as well as military sub-units and activities. This ensures internal and external constituencies are considered in resource management.
2. **Strategic Vision and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in strategic planning, setting federal fiscal policy, allocating resources to national defense, budget formulation, budget negotiation, budget justification, and budget execution strategies, including the principles of Federal Appropriations Law. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting, and Execution System with emphasis on budget formulation and execution.
3. **Funds Management:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and non-appropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Finance and Accounting System and the Federal Accounting Standards Advisory Board are relevant.
4. **Accountability, Control, and Auditing:** The graduate will be able to acquire and analyze financial data and communicate the results to a diverse audience, including maintaining an integrated financial information system and appropriate internal controls to ensure timely, accurate, and consistent financial information. In accordance with the auditing standards of the U.S. Government Accountability Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to apply audit techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.
5. **Acquisition and Program Management:** The graduate will understand the purpose and concepts, fundamentals and philosophies of the defense systems acquisition process, and the practical application of program management methods within this process. This includes systems acquisition management; the systems acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing, and controlling. This satisfies the Defense Acquisition University education equivalency requirements for defense acquisition professionals as specified in Congress' Defense Acquisition Workforce Improvement Act (DAWIA)
6. **Economy, Efficiency, and Effectiveness:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, value engineering, business process reengineering, and application of relevant OMB and Defense regulations.
7. **Cost Management and Analysis:** The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities, as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing



- guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standards for major suppliers of goods and services to the federal government.
8. **Strategic Resource Management:** The graduate will have knowledge of strategic vision and strategic core competency concepts for setting long-range goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. This includes assessing customer needs and customer satisfaction, making recommendations, and implementing improvements in the effective delivery of goods and services to customers or users.
  9. **Innovation and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budget, and program management issues that increase program effectiveness and customer satisfaction, while controlling the efficient utilization of financial, physical, and human resources. This involves the ability to identify problems and potential concerns, providing leadership, and teaming with others in the decision making process, and obtaining support for recommended decisions or courses of action.
  10. **Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

**NPS Requirement for all Navy and USMC Curriculum Sponsor and Educational Skill Requirements Approval Authority:**

Financial Management (837):  
Chief of Naval Operations (N8/N82)

## Defense Systems Analysis - Curriculum 817

### Brief Overview

This curriculum provides officers with the fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management. The curriculum educates students to evaluate others' research and analysis and to develop in them sound management and leadership skills. This curriculum is an interdisciplinary program that integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis, and a subspecialty into an understanding of the process by which the defense mission is accomplished.

This curriculum is also structured to give students the opportunity to design their own program of study. Concentration areas and courses are determined after consultation with the Academic Associate.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Dates

January and July

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

### Subspecialty

U.S. Marine Corps officers completing this curriculum fulfill the requirements for MOS 9652.

### Curriculum Sponsor

Marine Corp Systems Command, Program Analysis and Evaluation Directorate

### Typical Course of Study: Curriculum 817

#### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
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GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)

**Quarter 2**

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
NW3230	(4 - 0)	Strategy & Policy***

**Quarter 3**

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy

**Quarter 4**

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
GB4530	(4 - 0)	Management Control Systems
GB3510	(3 - 0)	Defense Financial Management Practice

**Quarter 5**

GB4510	(4 - 0)	Strategic Resource Management
OA4702	(4 - 0)	Cost Estimation
GB4570	(2 - 0)	Advanced Finance
GB/MNxxxx	(X - 0)	Curriculum Elective Course
GB4090	(0 - 6)	Application Project ****

**Quarter 6**

GB4550	(4 - 0)	Advanced Financial Reporting
MN3331	(5 - 1)	System Acquisition and Project Management
GB4090	(0 - 6)	Application Project ****
GB/MNxxxx	(X - 0)	Curriculum Elective Course

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\*\* Students may elect to complete a thesis.

**Educational Skills Requirements (ESR)  
Defense Systems Analysis - Curriculum 817**

1. **Management Fundamentals:** The graduate will have the ability to apply quantitative techniques, accounting, economics, finance, organization theory, information technology, and other state-

of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practice, embracing leadership, ethics, written and oral communication, organization design, team building, human resource management, conflict resolution, quality assurance, cost-benefit analysis, risk analysis, stakeholder analysis, and planning within military organizations, as well as military sub-units and activities. This ensures internal and external constituencies are considered in resource management.

2. **Strategic Vision and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in strategic planning, setting federal fiscal policy, allocating resources to national defense, budget formulation, budget negotiation, budget justification, and budget execution strategies, including the principles of Federal Appropriations Law. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting, and Execution System with emphasis on budget formulation and execution.
3. **Funds Management:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and non-appropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Finance and Accounting System and the Federal Accounting Standards Advisory Board are relevant.
4. **Accountability, Control, and Auditing:** The graduate will be able to acquire and analyze financial data and communicate the results to a diverse audience, including maintaining an integrated financial information system and appropriate internal controls to ensure timely, accurate, and consistent financial information. In accordance with the auditing standards of the U.S. Government Accountability Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to

- apply audit techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.
5. **Acquisition and Program Management:** The graduate will understand the purpose and concepts, fundamentals and philosophies of the defense systems acquisition process, and the practical application of program management methods within this process. This includes systems acquisition management; the systems acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. This satisfies the Defense Acquisition University education equivalency requirements for defense acquisition professionals as specified in Congress' Defense Acquisition Workforce Improvement Act (DAWIA)
  6. **Economy, Efficiency, and Effectiveness:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, value engineering, business process reengineering, and application of relevant OMB and Defense regulations.
  7. **Cost Management and Analysis:** The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities, as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standards for major suppliers of goods and services to the federal government.
  8. **Strategic Resource Management:** The graduate will have knowledge of strategic vision and strategic core competency concepts for setting long-range goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. This includes assessing customer needs and customer satisfaction, making recommendations, and implementing improvements in the effective delivery of goods and services to customers or users.
  9. **Innovation and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budget, and program management issues that increase program effectiveness and customer satisfaction, while controlling the efficient utilization of financial, physical, and human resources. This involves the ability to identify problems and potential concerns, providing leadership, and teaming with others in the decision-making process, and obtaining support for recommended decisions or courses of action.
  10. **Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

**NPS Requirement for all Navy and USMC Curriculum Sponsor and Educational Skill Requirements Approval Authority:**

Defense Systems Analysis (817): USMC: MC HQ

**Information Management Curriculum**

The Information Age has generated a revolution in the means in which we conduct business and warfare. New technologies have changed the traditional views of the marketplace, supply chain management, and logistics. As the range and complexity of computer applications have grown, the need to manage and exploit those resources has increased. This curriculum provides both the technical skills and business acumen to deal with a constantly evolving digital world.

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**Information Management - Curriculum 870****Brief Overview**

The Information Systems Management graduate shall have the knowledge skills and competencies to: 1) Manage the acquisition of Information Systems; 2) Manage Information Systems and infrastructure support afloat and ashore; 3) Solve Information Systems engineering and management problems individually and in teams; 4) Effectively manage and lead in today's constantly changing digital world; 5) Develop and implement effective strategies and policies to take advantage of technological opportunities and mitigate risk.; 6) Assimilate new technologies and transform organizations, processes, and strategies to compete in the marketplace or on the battlefield. These general education skill requirements are supported by the following topical educational skill requirements:

**Requirements for Entry**

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

**Entry Dates**

January and July

**Program Length**

Six Quarters

**Degree**

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

**Subspecialty**

Completion of this curriculum qualifies a U.S. Navy officer as a Logistics - Information Technology subspecialist (subspecialty code 1309P).

**Typical Subspecialty Jobs**

Project /Program Manager, Hardware Systems Command  
Business Manager, PEO  
CIO, Acquisition Office  
Navy Hospital CIO

**Curriculum Sponsor**

Naval Supply Systems Command

**Typical Course of Study: Curriculum 870****Quarter 1**

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
IS3302	(3 - 2)	Database Management and Decision Support
MA1000	(2 - 0)	College Algebra (if needed)

**Quarter 2**

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
IS3200	(3 - 2)	Analysis, Modeling, and Design

**Quarter 3**

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
IS3502	(3 - 2)	Computer Networks: Wide and Local Area

**Quarter 4**

NW3230	(4 - 0)	Strategy & Policy***
GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
GB/MN	(X - 0)	Curriculum Elective Course

**Quarter 5**

MN3331	(5 - 1)	System Acquisition and Program Management
IS4182	(4 - 0)	Information System Policy and Strategy
GB/MN	(X - 0)	Curriculum Elective Course
GB4090	(0 - 6)	Application Project ****

**Quarter 6**

MN3309	(4 - 0)	Information System Acquisition and Project Management
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GB/MN (X - 0) Curriculum elective Course  
GB4090 (0 - 6) Application Project \*\*\*\*

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\* Not required for International students. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

\*\*\*\* Students may elect to complete a thesis.

### **Educational Skills Requirements for Information Systems Management - Curriculum 870**

#### **Subspecialty 1309P**

1. **Management Fundamentals:** The graduate will have the ability to apply quantitative accounting, economics, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practices, embracing leadership, communication, organization design, staffing, quality, and planning within large public and private sector organizations, as well as military sub-units and activities.
2. **Information Systems Technology:** The officer must have a thorough knowledge of information systems technology to include: 1) Computer System Components: Processors, memory, input/output devices, storage devices, machine language, operating systems, and distributed operating systems; 2) Computer Networks: Reference models, network architectures, protocols, standards, routing algorithms, hardware, and network management protocols; 3) Database Management Systems: Database technologies (including object-oriented databases, data warehouses, OLAP, data mining, and XML), technical and administrative issues involved in the design, implementation and maintenance of database management systems.
3. **Decision Support and Knowledge Management Systems:** Problem identification, formulation, design of systems to support decision making, application of artificial intelligence technology to preserve perishable expertise and enhance distributed expertise. Understand the design of executive information systems, office automation, group decision support systems and crisis management systems, and their potential impacts on organizations and missions. Be familiar with knowledge collection technologies designed to capture, categorize, store, retrieve and present both tacit and explicit knowledge. Identify the challenges, current limitations, and benefits of knowledge management.
4. **Computer Security:** Methods for ensuring integrity, confidentiality, authentication, and availability of computer resources, distributed databases, and networks.
5. **Information Systems Analysis and Management:** The officer must master the following concepts to effectively manage information system assets: 1) Managerial Concepts: Decision-making theory, microeconomics, marketing, operations analysis, statistics, financial management, organizational development, and research methodologies; 2) Evaluation of Information Systems: Cost-performance (effectiveness) analysis; selection, evaluation, acquisition, installation and effective utilization of information systems hardware and software, risk assessment, and information system architectures involving alternative system concepts; 3) Systems Analysis and Design: Information systems feasibility studies, life cycle management, techniques for determining system requirements and specifications, system performance evaluation, conversion and maintenance of legacy systems, post-implementation evaluation, man-machine interfaces, system ergonomics, re-hosting applications, and security analysis of information systems; 4) Management of Information Systems: Metrics evaluation, monitoring, capacity planning, human resource management, budgeting and financial control of computer centers, design of effective organization structure, understanding architectural constraints, control and security (INFOSEC) policies, and training requirements for both the user and support staff; 5) Adapting to Technological, Organizational, and Economic Changes: Evaluation of potential impacts of new technology on information systems and organizational strategy. Decision making under uncertainty.
6. **Military Applications:** The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include: 1) DoD Decision-Making Process on Information Systems: DoD, DoN, OMB, and congressional decision making on information systems matters; 2) Information Technology Acquisition Management: Acquisition policies and procedures

of the DoD, including: statutory framework, acquisition planning, contracting, and the planning, programming, and budgeting system; 3) Joint Professional Military Education (JPME) Level 1.

7. **Independent Research:** The graduate will demonstrate the ability to conduct independent research analysis and proficiency in communicating the results in writing and orally by means of a field application study. The research in information technology and its management will include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis, and evaluation.

## Defense Management International Curricula

The Defense Management Curricula serve Allied officers. The overriding objective of the curricula is to provide international students with the analytical skills and critical thinking ability to solve problems they confront in both operational and staff jobs. Civilians and Allied officers may design their own concentrations to meet their organizations' unique staffing and operational needs. Allied officers in the REPMID curriculum blend courses from the Graduate School of Business and Public Policy and the National Security Affairs Department into an integrated Defense Resource program of study.

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## Defense Systems Management-International -Curriculum 818

### Brief Overview

This curriculum is designed for international students. It provides international officers with the core MBA interdisciplinary techniques of quantitative problem-solving methods, management theory, management

science, economic analysis, and financial management. These skills enable the officers to manage and allocate defense resources, evaluate written research, and analyze products of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required for effective leadership and defense resources management.

This curriculum permits students the opportunity to design their own concentration. Concentration areas and courses are determined after consultation with the Academic Associate. The 818 program allows students to design a program of course work specific to management effectiveness in the host country's military system. The student may elect to specialize in the relevant portion of a functional area, such as financial management, logistics, human resources and organization management, or manpower and personnel analysis. Or, the student may choose to follow a general management program, which would include an overall balance of courses from many functional areas. International students are free to choose any of the specific management curricula available

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

### Entry Dates

January and July

### Program Length

Six Quarters

### Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

### Subspecialty

Determined in consultation with the Academic Associate

### Typical Course of Study

#### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology

GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)
IT1600	(3 - 0)	Communication Skills for International Officers (if needed)

**Quarter 2**

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
IT1500	(4 - 0)	American Life and Institutions

**Quarter 3**

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
GB/MN	(X - 0)	Curriculum Elective Course

**Quarter 4**

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
GB3031	(2 - 0)	Principles of Acquisition Management
GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course

**Quarter 5**

GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course
GB4090	(0 - 6)	Application Project ****

**Quarter 6**

GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course
GB4090	(0 - 6)	Application Project ****

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\*\* Students may elect to complete a thesis.

## Resource Planning and Management- International - Curriculum 820

**Brief Overview**

The Resource Planning and Management for International Defense curriculum is an interdisciplinary program designed exclusively for officers and civilian employees in defense agencies of other countries. The program focuses on economic analysis, the management of financial, material, and human resources, domestic and international political institutions, civil-military relations, and the role of

international law. The curriculum includes a combination of existing courses within the Graduate School of Business and Public Policy and the Department of National Security Affairs, and courses especially designed for this program. In the majority of courses, international students will study and learn with U.S. students from several other management and national security affairs curricula.

**Requirements for Entry**

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

**Entry Dates**

January and July

**Program Length**

Six Quarters

**Degree**

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

**Typical Course of Study: Curriculum 820****Quarter 1**

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)
IT1600	(3 - 0)	Communication Skills for International Officers (if needed)

**Quarter 2**

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4052	(3 - 0)	Managerial Finance
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
IT1500	(4 - 0)	American Life and Institutions

**Quarter 3**

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
NS3023	(4 - 0)	Introduction to Comparative Politics

**Quarter 4**

GB4014	(4 - 0)	Strategic Management
GBXXXX	(2 - 0)	MBA Core Elective **
NS3900	(4 - 0)	International Law and Organizations
NS3030	(4 - 0)	American National Security Policy

**Quarter 5**

NS3041	(4 - 0)	Comparative Economic Systems
NS3025	(4 - 0)	Introduction to Civil-Military Relations
GB4090	(0 - 6)	Application Project ****

**Quarter 6**

GB/MNxxxx	(4 - 0)	Elective (Curriculum Option)
NS4235	(4 - 0)	Diplomacy & Strategic Coalitions - Operations other than War
GB4090	(0 - 6)	Application Project ****
GB/MN	(X - 0)	Elective

\*\* Selected from four available courses offered in the 4<sup>th</sup> quarter.

\*\*\*\* Students may elect to complete a thesis.

**Executive Master's Degree Programs**

**Program Officer**

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**Executive Master of Business Administration - Curriculum 805**

**Program Manager**

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**Brief Overview**

The Executive Master of Business Administration (EMBA) is a defense-focused general management program for more senior DoD officers. The program design and coursework capitalizes on the current managerial and leadership experience of program participants. Specifically, the EMBA goals are to provide participants with

- A solid background in management fundamentals
- Focus on financial management and acquisition knowledge and abilities
- Analytical and critical thinking skills to make decisions under conditions of extreme uncertainty
- Opportunities for interaction so that managers can learn from each other
- Projects and activities relevant for today's knowledge-driven, team-based environment

The EMBA is a 24-month, part-time, distance learning degree program. Classes meet once a week, approximately 6-8 hours per day, depending on course load.

**Requirements for Entry**

The program has the following admissions criteria:

- Lt Commander (O4) and above. Lieutenants admitted by exception
- Department Head, tour completed or middle-level management experience
- Undergraduate degree from an accredited four-year college or university
- APC of 245 (GPA > 2.6)
- GSBPP may loosen these requirements for applicants who have outstanding promotion potential.

**Entry Dates**

The EMBA program entry dates are October and April.

**Degree**

Completion of this program results in an Executive Master of Business Administration degree.

Requirements for the degree are met by completing:

- 37 hours of core EMBA courses
- 17 hours of an approved sequence of BPP electives
- Remaining a student in "good academic standing" as defined by NPS criteria
- The 17 hours of approved electives can be tailored to meet student sponsor needs.

**Curriculum Subspecialty**

Completion of the EMBA degree program qualifies an officer for subspecialty code 3100P, General Management and Acquisition Management.



**Curriculum Sponsor**

NETC. Educational Skill Requirements Approval  
Authority: N8/N82

**Typical Course of Study: Curriculum 805****Orientation Week**

GE3011 (2-0) Management of Teams

**Quarter 1**

GE3009 (3-0) Ethics and Moral Development  
GE3050 (3-0) Financial Reporting and Analysis

**Quarter 2**

GE3010 (3-0) Organizations as Systems and Structures  
GE3051 (3-0) Cost Management

**Quarter 3**

GE3070 (3-0) Economics for Defense Managers  
GE3221 (3-0) Principles of Acquisition and Program Management I

**Quarter 4**

GE3222 (3-0) Principles of Acquisition and Program Management II\*  
GE3043 (3-0) Analytical Tools for Decision Making

**Quarter 5**

GE4021 (3-0) E-Business for Defense  
GE4053 (4-0) Defense Budget and Financial Management Policy

**Quarter 6**

GE4016 (4-0) Managing Strategic Change  
GE3510 (3-0) Defense Financial Management Practice\*

**Quarter 7**

GE4052 (3-0) Managerial Finance\*  
GE3042 (4-0) Operations Management

**Quarter 8**

GE3306 (3-0) Strategic Purchasing\*  
GE4100 (5-0) Seminar in Defense Management \*

\* Other approved electives may be substituted

**Educational Skills Requirements (ESR)****Executive MBA - Curriculum****805 Subspecialty Code 3100P**

1. **Business Ethics and Moral Development:** The graduate will understand the ethical challenges of the global Defense business environment facing senior Navy corporate business leaders and resource managers, and develop the critical thinking and analytical skills required to address complex issues. In addition, the students will develop a personal approach to achieve ethical outcomes in the decision making process.
2. **Complex Systems Thinking:** The graduate will be able to diagnose complex Navy and DoD

problems from a systems perspective and offer solutions that maintain system alignments.

3. **Managing and Leading Complex Change:** The graduate will understand the managerial and leadership levers required to institute and manage complex change and the implementation strategies necessary to ensure change initiatives reach all organizational levels.
4. **Strategic Thinking:** The graduate will have knowledge of senior-level decision-making processes under conditions of significant uncertainty within the unique context of DoD organizations. In addition, students will learn how to implement these decisions, evaluate their effectiveness, and determine steps to take if desired outcomes aren't reached.
5. **Understanding of Information Technologies:** The graduate will be able to analyze critically, from a senior management perspective, their own organizations in light of electronic-business (e-Business) technologies, business models, and managerial techniques. Students also explore the relationship between Information Technologies (e-Business) strategy and Department of Defense Transformation, and how to integrate both theory and application to effectively organize and manage in the networked, paperless, on-line enterprise of today and tomorrow.
6. **Analysis for Efficiency and Effectiveness:** The graduate will be able to use various statistical methods to solve complex and unstructured problems in which alternatives will be evaluated and selected based on cost and systems analysis factors. This includes the use of probability theory, decision models and decision analysis, decision trees, forecasting, and simulation to make decisions under conditions of uncertainty with competing objectives.
7. **Program Management Policies:** The graduate will have an ability to execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the executive, legislative and judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

8. **System Acquisition Process:** The graduate will understand the theory of the systems acquisition process. This involves the major system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.
9. **Federal and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in setting Federal/Defense fiscal policy, allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the Federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting and Execution (PPBE) process with emphasis on budget formulation and execution of the budget authority provided by Congress in response to DoD budget requests, including an evaluation of the expected benefits to be derived under funded programs.
10. **Defense Financial Management:** The graduate will understand how appropriated, revolving, and non-appropriated funds are to be managed in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will understand and be able to review financial reports, ask pointed questions about budget execution against operating and financial plans, assess the quality of alternate plans based on analyses of an activity's financial performance, and determine the quality of recommendations regarding the reallocation or reprogramming of funds. The graduate will be familiar with federal and private sector financial reporting systems, standards, and practices.
11. **Cost Management and Analysis:** The graduate will be able to understand and evaluate different costing systems encountered within Defense and Navy organizations and activities as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand cost accounting standards applicable to Federal organizations and to private sector suppliers of goods and service to the federal government.
12. **Defense Economics:** The graduate will be able to apply the fundamental tools of micro- and macroeconomic theory to Defense management and resource allocation decisions. Additionally, the student will understand markets and their interactions with Defense acquisition and contracting processes, the national security implications of globalization, and efficiency in Defense decision making.
13. **Operations/Supply Chain Management:** The graduate will understand the management of manufacturing and service operations and how Defense managers can effectively design and control operational processes to achieve world-class performance in these types of operations. The student will also have a knowledge of the use of strategic purchasing initiatives to derive a competitive advantage from Defense procurement and sourcing strategies to achieve increased efficiency and enhanced performance in the global Defense and commercial supply chain management environments.

## Master of Executive Management - Curriculum 808

### Academic Associate

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### Brief Overview

The Master of Executive Management (MEM) degree program is a defense-focused, general management program for more senior DoD officers. The MEM goals are to provide participants with

- A solid background in management fundamentals
- Analytical and critical thinking skills to make decisions under conditions of uncertainty
- Understanding of Defense Business Management functions, including Acquisition, Program Management, Financial Management, Information Technology Management, Logistics Management.

## Requirements for Entry

The program has the following admissions criteria:

- USAF Lt Colonel (O4) and above, or analogous rank for other services.
- USAF selected for Intermediate Development Education (IDE)
- APC of 245 (GPA > 2.6)

## Entry Dates

January and July

## Program Lengths

One Year

## Degree

Completion of this program results in the Master of Executive Management degree. Requirements for the degree are met by completing:

- Completion of a minimum of 54 credit hours of graduate level courses, at least 12 hours of which are at the 4000 level
- Completion of a MEM Core sequence consisting of a minimum of 37 credit hours of 3000 and 4000 level GB and MN courses.
- Completion of a specialty sequence of 3000 or 4000 level courses, totaling a minimum of 15 credit hours, as approved by the Academic Associate

## Curriculum Sponsor

Deputy Assistant Secretary of the Air Force (Contracting), Assistant Secretary (Acquisition)

## Typical Course of Study: Curriculum 808

### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis
GB3070	(4 - 0)	Economics of the Global Defense Environment
MA1000	(2 - 0)	College Algebra (if needed)
IT1600	(3 - 0)	Communication Skills for International Officers (if needed)

### Quarter 2

GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course

### Quarter 3

GB3012	(3 - 0)	Communication for Managers
GB3042	(4 - 0)	Operations Management
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
GB/MN	(X - 0)	Curriculum Elective Course

### Quarter 4

GB4014	(4 - 0)	Strategic Management
GB4021	(3 - 0)	Strategic Management of IT
GB/MN	(X - 0)	Curriculum Elective Course
GB/MN	(X - 0)	Curriculum Elective Course

## Educational Skills Requirements (ESR)

### Master of Executive Management - Curriculum 808

1. **Complex Systems Thinking:** The graduate will be able to diagnose complex DoD problems from a systems perspective and offer solutions that maintain system alignments.
2. **Managing and Leading Complex Change:** The graduate will understand the managerial and leadership levers required to institute and manage complex change and the implementation strategies necessary to ensure change initiatives reach all organizational levels.
3. **Strategic Thinking:** The graduate will have knowledge of senior-level decision-making processes under conditions of significant uncertainty within the unique context of DoD organizations. In addition, students will learn how to implement these decisions, evaluate their effectiveness, and determine steps to take if desired outcomes aren't reached.
4. **Understanding of Information Technologies:** The graduate will be able to analyze critically, from a senior management perspective, their own organizations in light of electronic-business (e-Business) technologies, business models, and managerial techniques. Students also explore the relationship between Information Technologies (e-Business) strategy and Department of Defense Transformation, and how to integrate both theory and application to effectively organize and manage in the networked, paperless on-line enterprise of today and tomorrow.
5. **Analysis for Efficiency and Effectiveness:** The graduate will be able to use various statistical methods to solve complex and unstructured problems in which alternatives will be evaluated and selected based on cost and systems analysis factors. This includes the use of probability theory, decision models and decision analysis,

decision trees, forecasting, and simulation to make decisions under conditions of uncertainty with competing objectives.

6. **System Acquisition and Program Management**

**Policies and Process:** The graduate will understand the theory of the systems acquisition process. This involves the major system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness. The graduate will have an ability to execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various Federal agencies of the Executive, Legislative and Judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), Congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

7. **Federal and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in setting Federal/Defense fiscal policy, allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the Federal and Defense budget cycles including the Planning, Programming, Budgeting and Execution (PPBE) process with emphasis on budget formulation and execution of the budget authority provided by Congress in response to DoD budget requests, including an evaluation of the expected benefits to be derived under funded programs.

8. **Cost Management and Analysis:** The graduate will be able to understand and evaluate different costing systems encountered within Defense organizations and activities as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand cost accounting standards applicable to Federal organizations and to private sector suppliers of goods and service to the Federal government.

9. **Defense Economics:** The graduate will be able to apply the fundamental tools of micro- and macroeconomic theory to Defense management and resource allocation decisions. Additionally, the student will understand markets and their interactions with Defense acquisition and contracting processes, the national security implications of globalization, and efficiency in Defense decision making.
10. **Operations Management:** The graduate will understand the management of manufacturing and service operations and how Defense managers can effectively design and control operational processes to achieve world-class performance in these types of operations.

## Master of Science Degree Programs

### Program Officer

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### Master of Science in Management (MSM)- Manpower Systems Analysis - Curriculum 847

#### Academic Associate

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#### Brief Overview

The Manpower Systems Analysis Curriculum (MSA) leading to the MSM degree is designed for U.S. and international officers. Officers enrolled in the Manpower Systems Analysis curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill leadership and analytical roles in military manpower personnel, training, and education management. MSA subspecialists are responsible for developing and analyzing policies to ensure that the Navy and DoD

are recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MSA is an analytical curriculum intended to develop skills necessary to perform and evaluate manpower analyses and manage the Navy's Human Resource community of interest. As such, the curriculum emphasizes mathematical, statistical, and other quantitative and qualitative analysis methods. Successful completion of the curriculum yields an officer skilled in conducting manpower personnel, training, and education policy analysis. The areas covered in the MSA curriculum include an understanding of manpower, personnel, training, education policy development, managing diversity, compensation systems, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix, enlistment and reenlistment incentives, training effectiveness measures, and hardware/manpower trade-offs. Students gain familiarity with current models and methods of manpower analysis and economics as well as military manpower organizations, information systems and issues. The curriculum directly supports the Navy Human Resource Community of Interest.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. Additional preparation in calculus and statistics is advisable. An APC of 345 is required for entry. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students. Prospective students electing MSA as a curriculum must be adequately prepared by their undergraduate course work and comfortably oriented to a quantitatively and analytically rigorous graduate curriculum.

### Entry Date

July

### Program Length

Seven Quarters

### Degree

*The Master of Science in Management degree requires:*

1. Completion or validation of the Management Fundamentals program, which consists of a total of 32 quarter-hours of 2000 and 3000 level courses, including a minimum of the following hours by discipline:
 

Accounting and Financial Management	(6)
Economics	(6)

Organization and Management (6)

Quantitative Methods (8)

2. In addition to the above, completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.
3. Completion of an approved sequence of courses in the student's area of concentration.
4. Completion of an acceptable thesis.
5. Approval of the candidate's program by the Dean, GSBPP.

### Subspecialty

Completion of this curriculum qualifies an officer as a Manpower Systems Analysis Subspecialist, subspecialty code 3130P. U.S. Marine Corps officers qualify for MOS 9640.

### Curriculum Sponsors

OPNAV, N-1, Chief of Naval Personnel and Subject Matter Expert, OPNAV, N14, Director of Strategic Planning and Analysis

Military Personnel Plans and Policy and Headquarters - United States Marine Corps (Manpower & Reserve Affairs)

### Typical Subspecialty Jobs

Military Personnel Policy and Career Progression (N13)  
 Joint Manpower Management Branch, JCS (J-1)  
 Manpower Resources Branch, Director Total Force Programming/Manpower (N12)  
 Manpower and Training Analyst, DCNO (Resources, Warfare Requirements and Assessment (N801D)  
 Manpower Plans,  
 COMCDRPAC/COMCDRLANT (N1)  
 Naval Manpower Analysis Center (NAVMAC)  
 Bureau of Medicine and Surgery, BUMED  
 Marine Corps MCCDC and M&RA  
 Headquarters - United States Marine Corps  
 Manpower & Reserve Affairs (M&RA)  
 Marine Corps Combat Development Command (MCCDC)

### Typical Course of Study: Curriculum 847

#### Quarter 1

GB3013	(0 - 2)	Problem Analysis and Ethical Dilemmas
GB3010	(4 - 0)	Managing for Organizational Effectiveness
GB3020	(4 - 0)	Fundamentals of Information Technology
GB3050	(4 - 0)	Financial Reporting and Analysis

GB3070	(4 - 0)	Economics of the Global Defense Environment
<b>Quarter 2</b>		
GB3040	(4 - 0)	Managerial Statistics
GB3051	(3 - 0)	Cost Management
GB4071	(4 - 0)	Economic Analysis & Defense Resource Allocation
MN2111	(2 - 0)	Navy Manpower, Personnel, and Training Systems I
MN2039	(4 - 0)	Basic Quantitative Methods in Econ Analysis
<b>Quarter 3</b>		
GB3012	(3 - 0)	Communication for Managers
GB4043	(3 - 0)	Business Modeling Analysis
GB4053	(4 - 0)	Defense Budget and Financial Management Policy
MN4110	(4 - 1)	Multivariate Manpower Data Analysis I
<b>Quarter 4</b>		
GB4014	(4 - 0)	Strategic Management
MN3111	(4 - 0)	Human Resource Management
MN3760	(4 - 0)	Manpower Economics I
MN4111	(4 - 1)	Multivariate Data Analysis II
<b>Quarter 5</b>		
GB3042	(4 - 0)	Operations Management
OS4701	(4 - 0)	Manpower and Personnel Models
MN4106	(4 - 0)	Manpower and Personnel Policy Analysis
MN4761	(4 - 0)	Applied Manpower Analysis
MN2112	(4 - 0)	HR Issues II
<b>Quarter 6</b>		
MN0810	(0 - 8)	Thesis Research
MN0810	(0 - 8)	Thesis Research
OS3401	(3 - 0)	Human Factors Engineering
MN4118	(3 - 0)	Modeling for Decision Support in Manpower Systems
<b>Quarter 7</b>		
NW3230	(4 - 0)	Strategy & Policy***
MN0810	(0 - 8)	Thesis Research
MN0810	(0 - 8)	Thesis Research
MN4114	(4 - 0)	Sociology and Psychological Perspectives on Military Service

\*\*\* Not required for International students.  
 International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

**Educational Skills Requirements (ESR)  
 Manpower Systems Analysis -  
 Curriculum 847 Subspecialty Code 3130P**

1. **Management Fundamentals - Organization and Management:** The graduate will have the ability to apply contemporary management principles, organizational theory, and social science

methodology to the development, implementation, and management of effective MPT&E polices and programs throughout DoN/DoD. The graduate will have the ability to use and understand computer systems in problem solving and will have a basic understanding of management information systems and E-Business.

2. **Budgeting and Financial Controls:** The graduate will have an understanding of basic financial management practices of DoN/DoD and will be able to conduct cost benefit analyses and participate in the budgetary planning of commands and/or DoN programs. The graduate will have an understanding of the Planning, Programming, Budgeting and Execution System (PPBES) and the ability to analyze the impact of budgetary changes on DoN/DoD manpower and personnel programs and polices.

3. **Automated Data Analysis:** The graduate will possess the skills in data manipulation, statistics, and exploratory data analysis to be able to formulate and execute analyses of a wide variety of manpower, personnel, and training issues. The graduate will have proficiency in computing and interactively apply a variety of methods to large-scale DoN and DoD databases. The graduate will have a working understanding of the manpower information systems.

4. **Management Fundamentals - Analytical Techniques:** The graduate will be able to apply mathematical, statistical, accounting, economic and other analytical techniques and concepts to day-to-day military management issues. The graduate will be able to gather and analyze qualitative data. The graduate will also be able to use these techniques and concepts as a participant in the long-range strategic planning efforts of the Navy and DoD.

5. **Advanced Quantitative and Qualitative Analysis:** The graduate will have the ability to apply a wide range of advanced organizational, economics, statistical, and mathematical techniques and concepts to manpower and personnel polices and issues. These include the use of econometric techniques in the quantitative analysis of large-scale DoN/DoD manpower and personnel databases, of qualitative techniques in the analysis of survey and personnel data, of manpower decision support systems, and of Markov models in the analysis of force structure and manpower planning, forecasting, and flow models.

6. **Manpower Systems Analysis Fundamental Concepts:** The graduate will have an understanding of the fundamental concepts and basic functional areas of manpower, personnel, training, and education (MPT&E) within DoN/DoD as listed below, as well as an understanding of the MPT&E systems and their interrelationships.
7. **Manpower:** Requirements determination; billet authorizations; billet costs; end strength planning; and total force planning and programming.
8. **Personnel:** Recruiting; accession plans and policies; officer and enlisted community management; attrition; retention; compensation; and readiness.
9. **Training:** Applications of theories of learning; instructional technologies; the systems approach to training; evaluation of training effectiveness and cost; and the relationship between training and fleet readiness.
10. **Manpower Systems Policy Analysis:** The graduate will have the ability to analyze critically the strengths and weaknesses of proposed manpower, personnel, and training policies and to suggest alternatives that recognize the potential impact on DoN/DoD program planning, resources, and objectives.
11. **Joint Military Strategic Planning:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, and the processes for formulating U.S. policy, the roles of military forces, joint planning, and current issues in the defense organization. This understanding will include expertise on the combined use of active and reserve forces in joint warfare.
12. **Evaluation, Innovation, and Creativity:** The graduate will demonstrate individual initiative and creativity in the application of the skills and knowledge gained from the Manpower Systems Analysis program. The graduate will select a manpower, personnel, training, or education policy or management issue of importance to DoN/DoD, develop a plan to investigate the issue, analyze all of its aspects, suggest a solution as appropriate, and report the significant findings and recommendations in writing by means of a thesis.

#### **Curriculum Sponsor and ESR Approval Authority**

Chief of Naval Operations (N14)

## **Master of Science in Contract Management - Curriculum 835**

### **Academic Associate**

Elliott Cory Yoder, CDR, USN  
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### **Brief Overview**

The Master of Science in Contract Management (MSCM) degree is designed to provide civilians in the Department of Defense (DoD) and other federal government agencies an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of acquisition and contracting within complex organizations. The curriculum focuses on problem solving and decision making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation, and other similar activities. Lecture and laboratory tasks require the application of critical thinking to problem solving within actual situations. The MSCM Program embodies an interdisciplinary approach to problem solving and analysis, including quantitative financial analysis, economics, and public and private sector operations. The curriculum is designed to provide civilians with the knowledge, skills, and abilities to manage and lead effectively in systems buying offices, field contracting offices, contract administration offices, and contracting policy offices.

### **Requirements for Entry**

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20; full certification at Level II or higher in the contracting career field under the provisions of the Defense Acquisition Workforce Improvement Act (DAWIA) (or equivalent certification for non-DoD personnel); and completion of an undergraduate course in management accounting.

### **Entry Dates**

January, April, July, October. (Dependent on cohort availability)

### **Program Length**

Eight Distance-Learning Quarters

### **Application Process**

Navy Department civilians may apply for the MSCM by submitting an application to the DACM via the chain of command for the ASN (RD&A) Scholarship.

Applicants from other services and federal agencies will use their organization's application process. For further information, contact the Academic Associate for this curriculum or the Program Officer.

**Degree**

The Master of Science in Contract Management degree requires:

- Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 that are at the 4000 level. (Credit hour requirement does not include 4 hours assigned for the Joint Applied Project)
- Completion of an acceptable Joint Applied Project, with at least one advisor from the Graduate School of Business and Public Policy.
- Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy.

**Curriculum Sponsor**

The Curriculum Sponsor is the Director, Acquisition Career Management (DACM) in the Office of the Assistant Secretary of the Navy (Research, Development and Acquisition). The curriculum satisfies the mandatory Defense Acquisition University (DAU) contracting course (CON Level III) requirements of the Defense Acquisition Workforce Improvement Act (DAWIA).

**Typical Course of Study: Curriculum 835**

**Quarter 1**

MN3001	(3-0)	Economics for Defense Managers
MN3155	(3-0)	Financial Management for Acquisition Managers

**Quarter 2**

MN3341	(4-2)	Advanced Contracting Principles
MN3115	(2-0)	Managing from a Systems Perspective

**Quarter 3**

MN4474	(2-0)	Organizational Analysis
MN3342	(4-1)	Advanced Contract Management

**Quarter 4**

MN3333	(2-0)	Communication Strategies for Effective Leadership
MN3172	(3-0)	Resourcing National Security: Policy and Process

**Quarter 5**

MN3306	(3-0)	Strategic Purchasing
MN4304	(2-0)	Defense Systems Contracting

**Quarter 6**

MN3307	(3-0)	Entrepreneurship in Purchasing
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MN4090	(0-6)	Joint Applied Project
MN3318	(2-0)	Contingency Contracting

**Quarter 7**

MN4374	(3-0)	Seminar in Acquisition / Strategic Purchasing
MN4105	(3-0)	Strategic Management

**Quarter 8**

MN4371	(4-0)	Acquisition and Contracting Policy
MN4090	(2-0)	Joint Applied Project

**Educational Skills Requirements (ESR)  
Contract Management - Curriculum 835**

1. **Advanced Management Concepts:** The graduate will have the ability to apply advanced management theory and techniques to problems in both the public and private sectors. This includes policy formulation and execution, strategic planning, resource allocation, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated approaches. The graduate will have the ability to apply state-of-the-art management concepts and practices to problem solving and decision-making responsibilities as middle and senior managers.
2. **Acquisition and Contracting Principles:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the federal government including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the Defense FAR Supplement (DFARS); the unique legal principles applied in government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to Defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision making occurs. Finally, the graduate will have the ability to conceptualize, develop and execute strategic business alliances and relationships necessary to the successful acquisition of goods and services.
3. **Contracting Process:** The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition and contract administration processes. This involves a knowledge of the defense system life



- cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and simplified acquisition methodologies; a comprehensive knowledge of all contract types and their application in Defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.
4. **Acquisition and Contracting Policy:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the federal and military contracting offices, the Boards of Contract Appeals, and the court system.
  5. **Business Theory and Practices:** The graduate will have an understanding of the business philosophy, concepts, practices and methodologies of the commercial industrial base (both domestic and global) and the ability to apply these to the federal government acquisition environment.
  6. **Defense Financial Management and Budgeting:** The graduate will have an ability to apply sound financial management theories, principles and practices to defense acquisition and contracting issues, including fiscal and monetary policy.
  7. **Production and Quality Management:** The graduate will have an understanding of principles and fundamentals of Production and Quality Management, with particular emphasis on the Procuring Contracting Officer's and Administrative Contracting Officer's roles and relationships with industry and the Government Program Manager.
  8. **Analysis and Application:** The graduate will demonstrate an ability to apply acquisition, contracting and management principles in dealing with the significant issues encountered in managing the contracting process in one of the following areas: (1) major weapon systems acquisition, (2) research and development, (3) field procurement, and (4) facilities contracting.
  9. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.
  10. **Acquisition Workforce:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at Level III.
  11. **Analysis, Problem Solving and Critical Thinking:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

## Master of Science in Program Management (MSPM) - Curriculum 836

### Academic Associate

Brad R. Naegle  
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### Brief Overview

The Master of Science in Program Management (MSPM) degree is designed to provide primarily civilians (officers may participate with sufficient time on station to complete the program) in the Department of Defense (DoD) and other federal agencies an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of programs/projects within complex organizations. The curriculum focuses on leadership, problem solving and decision making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation and integrative exercises. Lecture and laboratory tasks require the application of critical thinking to problem solving within notional and actual situations. Student input includes civilians (officers) from all DoD services and other federal agencies. The curriculum is designed to provide graduates with the knowledge, skills and abilities to manage and lead effectively in the federal government acquisition environment.

## Requirements for Entry

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20; full certification at Level II or higher in one of the following career fields: program management; contracting acquisition logistics; test & evaluation; systems planning, research, development and engineering; or manufacturing, production, quality assurance under the provisions of the Defense Acquisition Workforce Improvement Act (DAWIA) (or equivalent certification for non-DoD personnel); and completion of the following two courses: (1) a course in statistics, and (2) a course in calculus.

## Entry Dates

January, April, July, October (Dependent on cohort availability)

## Program Length

Eight Distance-Learning Quarters

## Degree

The Master of Science in Program Management degree requires:

- Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.
- Completion of an acceptable joint applied project, with at least one advisor from the Graduate School of Business and Public Policy.
- Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy

## Curriculum Sponsor

The Curriculum Sponsor is the Director, Acquisition Career Management (DACM) in the Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology). The curriculum satisfies the mandatory Level III Defense Acquisition University (DAU) in Program Management and provides numerous other DAU certifications satisfying requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and provides qualifying training and education for critical acquisition positions. (For those who have not already obtained certification in the Test & Evaluation; Systems Engineering; and Manufacturing/Production, Quality Assurance career fields, this program achieves Level II in these career fields, as well as satisfying Intermediate Software Acquisition Management (SAM 201)).

## Typical Course of Study: Curriculum 836

### Quarter 1

MN3001	(4-0)	Economics for Defense Managers
MN3302	(2-0)	Advanced Program Management

### Quarter 2

MN3115	(2-0)	Managing from a Systems Perspective
MN3371	(4-0)	Contracts Management and Administration

### Quarter 3

MN3384	(5-1)	Principles of Acquisition Production & Quality Management
MN4474	(2-0)	Organizational Analysis

### Quarter 4

EO4011	(3-2)	Systems Engineering for Acquisition Managers
MN3333	(2-0)	Managerial Communication Skills

### Quarter 5

MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software
MN3172	(4-0)	Public Policy and Budgeting

### Quarter 6

MN4602	(2-0)	Test and Evaluation Management
MN4470	(4-0)	Strategic Planning & Policy for the Logistics Manager

### Quarter 7

MN3155	(2-0)	Financial Management for Acquisition Managers
MN4105	(3-0)	Strategic Management
MN4090	(0-6)	Joint Applied Project

### Quarter 8

MN4307	(4-0)	Program Management Policy and Control
MN4090	(0-6)	Joint Applied Project

## Educational Skills Requirements (ESR) Program Management - Curriculum 836

1. **Management Fundamentals:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as Department of Defense managers. The graduate will have the ability to think creatively, addressing issues and problems in a dynamic, challenging environment.
2. **Advanced Leadership and Management Concepts:** The graduate will have the ability to apply advanced leadership, management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation,

- project leadership, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated leadership abilities.
3. **Program Leadership and Management Principles:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of Program Leadership and Program Management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using Total Ownership Cost, schedule and performance dynamics from a total life cycle management perspective.
  4. **Program Management Policies:** The graduate will have an ability to formulate and execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the Executive, Legislative and Judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), Congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.
  5. **Systems Acquisition Process:** The graduate will understand the theory of and have an ability to lead program teams and manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, including systems of systems, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.
  6. **Contract Management:** The graduate will understand the role of the contracting process within the acquisition environment including financial, legal, statutory, technical and managerial constraints in the process.
  7. **Business Theory and Practices:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of the defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.
  8. **Government and Industry Budgeting and Financial Management:** The graduate will have an understanding of and an ability to apply the principles of government and private organizational financing including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and Defense financial management and budgeting processes to include the Government Planning, Programming and Budgeting System (PPBS).
  9. **Acquisition Workforce:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory Program Management courses required by the Defense Acquisition University (DAU) at Levels I, II, and III.
  10. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of defense acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.
  11. **Analysis, Problem Solving and Critical Thinking:** The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied project and a command-oriented briefing appropriate to this curriculum.

#### **Curriculum Sponsor and ESR Approval Authority**

836 U. S. Army ASA/ALT (DDACM)

#### **Non-Degree Professional Development Programs**

The Graduate School of Business and Public Policy also administers several non-degree professional development programs consisting of both graduate education and professional courses taught in residence or via distance learning modes. Below is a brief explanation of each program.

## Advanced Acquisition Program (AAP) - Certificate in Program Management - Curriculum 211

### Program Manager

John T. Dillard  
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### Brief Overview

The Advanced Acquisition Program (AAP) is a 12-month, part-time, distance learning graduate certificate program that can also earn graduate credit toward NPS master's degree programs. Designed for both the DoD acquisition workforce and other professionals working with system acquisition and program management processes, the Advanced Acquisition Program provides a flexible, on-site alternative for education and Defense Acquisition Workforce Improvement Act (DAWIA) Program Management Level III certification. The AAP provides Acquisition Professionals and those associated with the DoD acquisition process an education resource for achieving DAWIA Level III Certification in Program Management with no student travel. This program is funded by the student's parent command, and is designed to accommodate professionals who are unable to travel away from the office for weeks of education. Schedules are coordinated with sponsoring commands, avoiding conflicts with major projects and deadlines

The AAP is a three-phased graduate certificate program of seven courses delivered over four NPS academic quarters. While the three phases must be completed in sequence, there is no requirement to complete them in the normal one-year timeframe (four academic quarters). AAP is a graduate-level program of in-depth acquisition and program management education, earning successful students 19.5 graduate credit hours towards a master's degree. It also provides DoD students with up to 195 hours of Continuous Learning under the USD(AT&L) Continuous Learning Program (CLP), 31.5 Continuing Education Units (CEU), 6.33 Business Credits toward the requirement for 24 for the GS-1102 series. The combined courses are equivalent to Defense Acquisition University's ACQ101, ACQ201, PMT250 and PMT352.

### Requirements for Entry

A baccalaureate degree with above-average grades is desired.

### Entry Dates

At the beginning of any quarter throughout an academic year (Jan, Apr, Jul, Oct).

### Program Length

Four Quarters

### Graduate Certificate Requirements

Requirements for the graduate certificate in program management are met by successful completion of all seven courses. Graduate credit is obtained by maintenance of a 3.0 grade point average on a 4.0 scale. Should a graduate of the Advanced Acquisition Program matriculate into the Master of Business Administration degree program in the Systems Acquisition Management (816) curriculum, or the Master of Science in Program Management (836), graduate credit for AAP courses will be applied to the curricula as appropriate.

### Past Sponsors

U.S. Army Tank Automotive Command, Warren, MI; U.S. Army Soldier Support Center, Natick, MA; U.S. Navy Undersea Warfare Center, Newport, RI; U.S. Navy Surface Warfare Center, Dahlgren, VA.

### Program Phases

The program is administered with a phased approach:

- Phase I is a full-quarter distance-learning course taught via VTC (6 hours in class per week) concentrating on Acquisition and Program Management breadth. Students who have completed ACQ101, 201, and PMT250 can omit this phase.
- Phase II is a series of five one-week courses (40 hours in class per week) taught on-site at the command.
- Phase III is a full-quarter, distance-learning course taught via VTC (4 hours of class per week) concentrating on Program Leadership through examination of case studies from actual Defense systems, IPT exercises, and application and written analysis of program management concepts.

### Required Courses: Curriculum 211

#### Quarter 1

MN3331	(5-1)	Principles of Acquisition and Program Management
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#### Quarter 2 and 3

MN3361	(2-0)	Information Technology and Software Acquisition Management
MN3362	(2-0)	Design Verification and System Assessment

MN3363	(2-0)	Manufacturing and Quality Management
MN3364	(2-0)	Business Financial Contract and Management
MN3365	(2-0)	Acquisition Logistics Management and Program Sustainment

**Quarter 4**

MN4366	(4-0)	Program Management and Leadership
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Significant Budget and Financial Management  
 Legislation  
 Planning, Programming, Budgeting & Execution System  
 Budget Formulation & Review  
 Appropriations & Fiscal Law  
 Reimbursables & Support Agreements  
 Working Capital Fund Management  
 Overview of the Acquisition & Contracting Processes  
 DoD Accounting  
 Critical Aspects of Budget Execution  
 Management of Major Cost Drivers  
 Property Accounting  
 Performance Measurement  
 Management Control and Auditing  
 Ethics

**Practical Comptrollership Course (PCC)****Program Manager**

Philip J. Candreva, CDR, USN, SC  
 Code GB/Pc, Ingersoll Hall, Room 215

(831) 656-2884, DSN 756-2884  
 pcc@nps.edu

**Brief Overview**

The Naval Postgraduate School offers an intensive two-week course in defense financial management under the sponsorship of the Assistant Secretary of the Navy (Financial Management and Comptroller). The course is part of the Department of the Navy Civilian Financial Management Career Program as outlined in SECNAVINST 12400.5C. The Practical Comptrollership Course (PCC) is specifically designed for individuals (civilians and military officers) who are either incumbent or about to report to responsible positions in financial management at the headquarters, major command, or field activity level. The course content reaches across all disciplines involved in financial management and comptrollership including: planning, budgeting, budget execution, fiscal law, accounting, and internal controls.

**Requirements for Entry**

The course is designed for civilian (GS-9 through GS-14 or equivalent pay plan) and military (0-2 and above) financial managers. Quotas are allocated to major commands by ASN(FM&C) through the Financial Management Education Services Specialist (FMB-59). Prospective students should contact their major command comptroller's office for nomination procedures. NPS does not control quotas for this course.

**Entry Dates, Location, Length of Course**

The course is two weeks in length (eight classroom days) and is offered seven times per year. Annual course schedules and quotas are announced in July each year by letter from ASN(FM&C) and published on the course website: <http://pcc.nps.navy.mil>.

**Typical Topics of Study**

The Congressional Budget Process

**Acquisition Management Distance Learning Program (AMDLP) - Curriculum 212****Program Manager**

Walter E. Owen, D.P.A.  
 (Joint GSBPP/GSEAS)  
 Code GB/On, Ingersoll Hall, Room 335

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 wowen@nps.edu

**Brief Overview**

The Naval Postgraduate School offers acquisition management distance education graduate acquisition courses that satisfy certain Defense Acquisition University (DAU) mandatory training requirements and Defense Acquisition Workforce Improvement Act (DAWIA) requirements for 24 semester-hours of business subjects. These courses can also be taken for continuing education that can lead to a master's degree program. These courses are offered primarily by video tele-education (VTE) distance learning methods.

**Requirements for Entry**

Courses are offered to both military and federal civilians. Undergraduate degree is preferred. Courses must be sponsored in full by a federal organization. Organizations interested in sponsoring courses must have a standards-based H.320-compatible system with a dialup network capability at 384KPS (3- ISDN lines). The NPS AMDLP program manager can help arrange cost sharing partnerships between various interested organizations. Contact the AMDLP program manager for more information and the latest price list.

**Available Program of Courses**

NPS/DAU equivalent courses are listed in the below matrix.

**Advanced Principles of Defense Acquisition and Program Management**

**DAU:** ACQ101/201, PMT250

**NPS:** MN3331 (5-1)

**Available:** Every quarter

**Fundamental Principles of Defense Acquisition and Program Management**

**DAU:** ACQ101

**NPS:** MN3221 (2-1)

**Available:** Every quarter

**Advanced Principles of Defense Acquisition and Program Management**

**DAU:** ACQ201/PMT250

**NPS:** MN3222 (3-0)

**Available:** Every quarter

**Fundamental Principles of Government Acquisition and Contracting**

**DAU:** CON101

**NPS:** MN3303 (4-0)

**Available:** Fall/Spring

**Management Functions and Decision-making Techniques for Best Value Competitively Negotiated Contracts**

**DAU:** CON202

**NPS:** MN3315 (4-0)

**Available:** Fall/Spring

**Examination of the Federal Government Legal Structure for Contracts with Private Industry**

**DAU:** CON210

**NPS:** MN3312 (4-1)

**Available:** Winter/Summer

**Concepts, Processes and Methods of Strategic Logistics Planning and Execution**

**DAU:** LOG304

**NPS:** MN4470 (4-0)

**Available:** Winter/Summer

**Principles and Concepts of Production and Quality Management in Defense Acquisition**

**DAU:** PQM101/201

**NPS:** MN3384 (5-1)

**Available:** Fall/Spring

**Management of Mission Critical Computer Resources In defense Software Acquisition**

**DAU:** SAM201

**NPS:** MN3309 (4-0)

**Available:** Winter/Summer

**Systems Engineering in the Defense Acquisition and Project Management Environment**

**DAU:** SYS201

**NPS:** EO4011 (3-2)

**Available:** Fall/Spring

**Management of Advanced Systems Engineering**

**DAU:** SYS301

**NPS:** MN4012 (2-2)

**Available:** Every Quarter

**Test and Evaluation of Defense Weapon Systems**

**DAU:** TST202/301

**NPS:** OS4601 (4-0)

**Available:** Winter/Summer

**GSBPP Courses**

**GB Courses (MBA Program)**

**GB2000 MBA Group Meetings (0-2) Winter/Summer**

**GB3010 Managing for Organizational Effectiveness(4-0) Winter/Summer**

Organizations, including defense organizations, are complex, purposive, open systems. As open systems, they face challenges of external adaptation and effectiveness and of internal coherence and efficiency. Our purpose is to understand the structures and processes that make up organizations in order to appreciate how they succeed and why they falter or fail. Our focus is on organizational diagnosis, which requires us to apply relevant theories to evaluate organizational performance. To do this, we will examine topics that include: organizational structure, motivation and reward systems, organizational culture, power and conflict, effective teams, and the leadership characteristics involved in effectively managing today's organizations. Although these topics are relevant to all organizations, we will pay special attention to their application in the context of the DoD and military organizations. Prerequisite: Enrollment in MBA Degree Program.

**GB3012 Communication for Managers (3-0)**

**Winter/Summer**

This course provides DoD and international military officers and civilians with the communication strategies and skills to manage and lead in the dynamic DoD environment. Instruction focuses on assessing various communication models, making strategic media choices, writing effective informative documents, developing associates' communication competencies through various feedback roles, and giving lucid briefings. Prerequisite: GB3010; Open to MBA students, or by consent of instructor.

**GB3013 Problem Analysis & Ethical Dilemmas (0-2)**

**Winter/Summer**

The objective of the Problem Analysis and Ethical Dilemma (PAED) seminar is to provide an introduction to applied analytic decision making involving complex issues and applied

ethical dilemmas in a wide variety of seemingly chaotic situations. Problem analysis and ethical dilemmas are two topics that are relevant in a variety of organizational settings. Thus, an essential part of a professional's education is the identification of issues, the analysis among alternatives, consideration of the implications and consequences of alternatives, and making a decision that confronts the specific issue at hand, is timely, and ethical. Analysis of problems is a vital competence for leaders in arriving at a decision that may affect their command, the local environment, and even the course of future events. Ethical dilemmas are those unclear situations that seem to have a series of diverse, chaotic variables and where having the facts is not enough. Facts may not take in values, rightness, culture, moral up-bringing, or even religious convictions. This seminar provides an orientation to the process of awareness, identification, contemplation and reflection, consideration of alternative actions, and decision making when presented with an unclear situation. Prerequisite: Open to MBA students, or by consent of instructor.

**GB3020 Fundamentals of Information Technology (4-0)**  
**Winter/Summer**

Successful organizations in today's Information Age are more dependent than ever on information technology (IT). This course provides business students and other non-IT majors a broad overview of computer technology, information systems, database/knowledge management, networks and information security. The course focuses on IT as a tool to support business processes throughout an organization, regardless of functional specialty. The study of principles and theory is combined with hands-on laboratory exercises to improve both IT literacy and competency. The knowledge and skills acquired will make the students more effective IT users and help them recognize opportunities where the application of IT solutions can provide a strategic advantage. Prerequisite: Enrollment in the MBA Degree Program; Open to MBA students, or by consent of instructor.

**GB3030 Marketing Management (3-0) Fall/Spring**

Focuses on managerial skills, tools and concepts required to produce a mutually satisfying exchange between consumers/users/ organizations and providers of goods, services and ideas. Emphasis on understanding the marketplace, individual parts of the marketing program (product, pricing, distribution and communication), and strategic formulation (orientation, target segmentation, positioning). Prerequisite: Enrollment in the MBA Degree Program; Open to MBA students, or by consent of instructor.

**GB3031 Principles of Acquisition Management (2-0)**  
**Fall/Spring**

This course introduces the fundamental principles of public and private sector acquisition management by examining current acquisition policy issues, strategies, contractual decisions, and program management concepts. The aspects of planning, organizing, staffing, directing and controlling efforts within a risk-managed process will be examined. Acquisition functional areas addressed in this course include: logistics, test and evaluation, systems engineering, manufacturing management, quality assurance, funds management, budgeting, research and development, and contracting management. Prerequisite: Open to MBA students, or by consent of instructor.

**GB3040 Managerial Statistics (4-0) Fall/Spring**

This course focuses on the descriptive and inferential statistical concepts useful for conducting basic managerial analysis. Topics include descriptive statistics for quantitative and qualitative data, basic probability concepts and distributions, sampling distributions, interval estimation, hypothesis testing, goodness-of-fit tests, contingency table tests, and multiple regression analysis. Prerequisite: College algebra and knowledge of Excel; Open to MBA students, or by consent of instructor.

**GB3041 Analytical Tools for Managerial Decisions (4-0) Fall/Spring**

GB3041 continues the development and understanding of the analytical process and the role of analysis in business. Building on skills from GB3040, students will expand their ability to formulate problems and identify solution methods. Topics and tools covered in GB3041 include sampling theory and sampling design strategies, survey methods, observational studies and experimentation, measurement scales, process quality control, time series smoothing methods, probabilistic and risk analysis, assessing the implications of modeling assumptions, and presenting analyses in clear, comprehensive and convincing format. Prerequisite: GB3040.

**GB3042 Operations Management (4-0)**  
**Winter/Summer**

This course provides an overview of operations in military and commercial systems. The course has three sections: (1) Creating processes, including a survey of process types, capacity planning, and service system design; (2) Controlling processes, including MRP/ERP systems and the role of information; and (3) Coordinating processes, including inventory management, purchasing, and supply chain management. Prerequisite: None.

**GB3050 Financial Reporting and Analysis (4-0)**  
**Winter/Summer**

This course covers theory, concepts, and practices underlying financial Accounting and Financial Reporting. The conceptual structure underlying the reporting of economic events in the form of the balance sheet, the income statement, and the statement of cash flows is first presented. Accounting recognition and measurement issues surrounding revenues, expenses, assets, liabilities and equity are introduced and analyzed. Finally, different forms of financial analysis based on financial report information are addressed. Throughout the course, emphasis is placed on the manager or user perspective. Attention is given to the federal government financial reporting model and standards. Prerequisite: Enrollment in the MBA Degree Program.

**GB3051 Cost Management (3-0) Fall/Spring**

This course introduces students to cost management concepts and theories which are used by managers to make decisions on the allocation of financial, physical, and human resources to achieve strategic as well as short-term organizational goals and objectives and evaluate performance using financial and non-financial measures. The course is designed for those having a prior course in financial reporting and analysis or financial accounting. Cost management includes traditional tools and techniques such as cost behavior for decision making, activity costing, cost allocation, and standard costing. Prerequisite: GB3050.

**GB3070 Economics of The Global Defense****Environment (4-0) Winter/Summer**

This course develops the fundamental tools of microeconomics and macroeconomics, and applies them to defense management and resource allocation. The course centers on defense applications of economic theory. Topics covered include: defense and the macro economy; markets and their interactions with defense acquisition and contracting; national security implications of globalization; and efficiency in defense decision making. Prerequisite: MA2XXX College algebra or equivalent.

**GB3420 Supply Chain Management (4-0) Fall/Spring**

This course is designed to provide an introduction to supply chain management (SCM). A supply chain is a network of organizations that supply and transform materials, and distribute final products to customers. Supply chain management is a broadly defined term for the analysis and improvement of flows of material, information, and money through this network of suppliers, manufacturers, distributors, and customers. The objective of SCM is to deliver the right product to the right customer at the right time. SCM emphasizes inventory-service level tradeoffs across the chain of players that, together, provide the product to a customer. There is probably no universal agreement on the distinction between logistics and supply chain management.

However, we might say that logistics has traditionally focused on materials issues within and downstream from the factory while SCM looks at the entire network of players, both up and down stream, and perhaps has more of an emphasis on information flows through the network. Logistics has traditionally been considered a more tactical topic and less likely to capture the attention of upper management while SCM has risen to prominence in last few years, attracting high-level attention. Many companies and/or divisions have added Supply Chain Analyst positions that frequently report to high-level managers.

Ultimately, logistics and SCM activities are concerned with coordinating demand and supply. Common elements in that coordination are the management of materials (inventories), the location of materials (warehouses), and the movement of materials (transportation). As part of the coordination, an analyst must consider product and process designs as well as information flows between various players in the networks. These elements will form the basis of this course. We will review some elements of basic theory and consider applications of the theory in cases that span operational and strategic concerns.

This course, as all courses, is shaped and influenced by the background of the instructor. Prerequisite: None.

**GB3510 Defense Financial Management Practice (3-0)**

This course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable, and revolving funds. Basic principles of fiscal law are explored. It

then addresses financial management and stewardship topics including budgetary accounting, management of cost drivers, the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

**GB4014 Strategic Management (4-0) Fall/Spring**

Strategic Management entails the establishment of an organization's direction and the implementation and evaluation of that direction in view of the organization's external environment and its internal capabilities. The principal aim of this course is the transfer and adaptation of the principles of business strategic management to the Department of Defense and other government agencies. In previous courses, students concentrated on the functional elements of management (e.g., accounting, finance, acquisition, logistics, contracting, etc.). This course addresses the challenges of setting direction and implementing strategies for the total system or whole organization. Cases and approaches from the public and private sectors enable students to develop the knowledge, skills, and abilities to strategically think, plan, and manage. Prerequisite: GB3010, GB3012.

**GB4015 Management of Change (3-0) Winter/Summer**

This course recognizes and describes the dilemmas inherent in any effort to change a human system. Emphasis is placed on strategies and technologies for planning, managing, and implementing change. The course emphasizes approaches to planning and managing change that reflect the complexity of organizations comprised of several interdependent systems--technology, structure, task, culture, and people. The course is application-oriented and intended to enhance skill development. Prerequisite: GB4014.

**GB4021 Strategic Management of IT (3-0) Winter/Summer**

The management of Information Technology (IT) within the government and corporate environments has become a function that is shifting from the traditional IT management structure to the General Manager. In today's environment, it is imperative to understand the importance of and unique issues related to technology. Network Centric Warfare has been deemed mission critical to the success of the military now and in the future. This course provides the student with a general understanding of the key components and underlying concepts related to the valuation of technology within organizations. Topics include e-business, e-government, strategic outsourcing, software make vs. buy decisions, business process, re-engineering with technology, and the impacts of technology on force transformation. The course is not intended to be focused on the technical aspects of technology, but rather on the impact of technology on the manner in which DoD organizations function. Prerequisite: GB3020 or consent of instructor.

**GB4043 Business Modeling and Analysis (3-0) As Required**

This course introduces mathematical modeling for a sound conceptual understanding of the decision-making process. This course familiarizes the students with applications, assumptions, and limitations of the quantitative methods in



modeling. It focuses on the development of mathematical and spreadsheet models, the verification of those models, sensitivity analysis of the solutions generated from a model, and the implementation of those solutions. Some of the topics covered include linear programming, non-linear and integer programming, simulation, and forecasting. The process of modeling and particular modeling tools are applied to business problems in finance, acquisition, logistics and manpower planning. Prerequisite: GB3040 and GB4071.

**GB4044 Defense-Focused Managerial Inquiry (3-0) Fall/Spring**

Fundamentally, this is a course in thinking critically and analytically. It is also a unique, practical opportunity for students to develop a research question, methodology, and proposal for their MBA project or master's thesis. Indeed, many students can expect to complete the initial stages of their MBA project or thesis by fulfilling the course requirement for a team-based research report. As Cooper and Schindler write: "Research is any organized inquiry carried out to provide information for solving problems. Business research is a systematic inquiry that provides information to guide business decisions. This includes reporting, descriptive, explanatory, and predictive studies. The managers of tomorrow will need to know more than any managers in history. Research will be a major contributor to that knowledge. Managers will find knowledge of research methods to be of value in many situations. They may need to conduct research either for themselves or for others. As buyers of research services, they will need to be able to judge research quality. Finally, they may become research specialists themselves."

Punch prefers to describe research as "organized common sense," since it "supports the idea that good research is within the grasp of many people." In this way, we can "simplify the more technical aspects of research methods, and enhance understanding, by showing the logic behind them." This course similarly seeks to examine the logic of research methods--recognizing that these methods may differ across disciplines and subspecialties--rather than focus on detailed models or procedures that may hold little meaning for the military's managers. It is not a course in rules or required steps; rather, it is a course in understanding the principles, concepts, and range of techniques that define the craft of research. Prerequisite: None.

**GB4052 Managerial Finance (3-0) Fall/Spring**

This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision-making process encountered by commercial enterprises. The major emphasis is on financial environment, risk and return analysis, valuation models, cost of capital determination, optimal capital structure, and short-term and long-term financing. Prerequisite: GB3050.

**GB4053 Defense Budget and Financial Management Policy (4-0) Winter/Summer**

This course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the federal government. It begins with a summary of the current threat situation and potential changes to it. Once the threat is defined, the study of the resource

allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting and Execution system (PPBES) used by DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: GB3010, GB3070.

**GB4071 Economic Analysis and Defense Resource Allocation (4-0) Fall/Spring**

Develops the tools and techniques of economic efficiency to assist public sector decision makers in analyzing resource allocation in government activities. Focuses on developing the principles of cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). Stresses the application of CBA and CEA to specific investment projects, programs and policies in the federal government, especially in the Department of Defense. Prerequisites: GB3070.

**GB4090 MBA Project (0-6) Winter/Summer**

MBA Project. Prerequisite: Open to MBA students, or by consent of instructor.

**GB4210 Knowing Management (3-0) Fall/Spring**

Online course. This elective course on knowing management integrates theory with practice to help prepare current and future leaders to manage knowledge and lead knowers in learning organizations. Knowing refers to knowledge in action, and is concerned with activities (e.g., decision, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand how knowledge is both critical and unique, and equips them to design effective knowledge management (KM) programs around knowledge flows. Using real-time cases for group critique, the problem-based learning part of the course examines a diverse set of KM programs in operation today, and offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational KM programs for evaluation, and work individually as consultants to assess and redesign them based on knowledge flows. This asynchronous (e.g., Web-based) course offers opportunities for cutting-edge graduate education beyond the classroom. Prerequisites: GB3020, IS3301, IS3302 or by consent of instructor.

**GB4410 Logistics Engineering (4-0) Winter/Summer**

The concept of integrated logistics support in the design and maintenance of weapon systems. Operational requirements,

reliability, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, test and evaluation, production, spare/repair parts management are discussed. This course also covers topics in logistics information technology, inventory management culture and commercial-sector best practices for military. Case studies include logistics life-cycle cost, reliability and readiness analysis for major weapon systems. Prerequisite: GB3042 or equivalent.

**GB4420 Technology and Information Systems for Logistics and Operations (3-0) Fall/Spring**

Overview of the use and value of information systems and technology applied to logistics and operations management. Examines the cost-benefit analysis of technology, and the evaluation of technological alternatives. Surveys commercial software available to facilitate logistics and operations management, including enterprise resource planning systems. Explores typical difficulties confronted when implementing technological solutions. Prerequisite: None.

**GB4430 Defense Transportation System (4-0) Winter/Summer**

This course examines how the Defense Transportation System supports the DoD mission, including the responsibilities of USTRANSCOM and its Transportation Component Commands, CONUS transportation and strategic lift, as well as institutional constraints and other managerial issues. Prerequisite: None.

**GB4440 Simulation Modeling for Management Decision Making (3-0) Winter/Summer**

Modeling and analysis of computer simulation for managerial decision making. Case studies of simulation modeling applications to weapon system acquisition, logistics, transportation, distribution, communications and production systems. Prerequisite: Introductory probability and statistics (may be taken concurrently).

**GB4450 Logistics Strategy (4-0) Fall/Spring**

DAU Equiv: LOG 304. This is the logistics capstone course. The course explores and analyzes the concepts, processes and methods of strategic planning and execution emphasizing aggressive proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life cycle management of fielded systems. Cultural constraints of the current logistics environment and how to succeed in it is a significant focus of the course. The course examines and analyzes key opportunities for maximum logistics influence in requirements, development, contracting, test and evaluation, reliability, and maintainability as well as financial management and communications. The course features logistics management relevance to service roles and missions. The course employs lectures, guided discussions, case studies, role-playing, panel discussions, and lessons learned in the DoD acquisition environment. For the final examination project, the class is divided into teams and produces a comprehensive strategic plan for logistics for a fictitious major program. Prerequisite: GB4410 or consent of instructor.

**GB4510 Strategic Resource Management (4-0) Winter/Summer**

The objective of this course is to integrate business analysis, financial analysis, and strategic analysis in solving complex

management problems involving the allocation of scarce resources to achieve overall organization objectives. Resources here are not limited to financial resources but also include human and physical resources. The course will make use of a wide variety of management tools such as value chain analysis, competitive strategy, market positioning, supply chain management, activity analysis, target costing, cost of quality, and business process improvement techniques. Prerequisites: GB3051, GB3042.

**GB4520 Internal Control & Audit (3-0) Fall/Spring**

This course provides an introduction to the objectives of and activities related to internal control and audits, including design and evaluation of internal controls, auditing standards, audit reports, audit evidence, and audit tests. The course includes an overview of audits of financial reports and records and of government operations, with attention given to Government Auditing Standards. Prerequisite: GB3051, Management Accounting.

**GB4530 Management Control Systems (4-0) Winter/Summer**

Overview of internal controls processes. Study of the design, implementation, and evaluation of management planning and control systems in Navy and Defense organizations with comparisons to large, complex private sector organizations. Specific topics include the need for planning and control, strategic planning, the resource allocation process, organization of the management control function, measurement of inputs and outputs, budgeting, reporting, and performance evaluation. Prerequisite: GB3051.

**GB4540 Conrad Seminar (2-0) Winter/Summer**

This course provides DoD military officers with an awareness of real life implementation of the education they have received (MBA (FM) curriculum). There are lectures on the Budgeting process and pending changes thereto, an exercise in taking a hypothetical reduction, and five VTCs originated in the Pentagon by FMB, Director of Navy Resource Requirements (N-8), Resource Director for the JCS (J-8), ASN(FM&C) Counsel (FMC), Director of Navy Budget (N-82) and Graduates presently in their "Pay Back" tour. There is also an Air Force Cohort which covers about 40% of their course and addressing Air Force "Unique" processes and paralleling the framework of the Navy/Marine Cohort. Sixty percent of the Air Force course is jointly conducted with the Generic part of the Navy/Marine allowing for more Joint education. International Students are welcomed to participate as an elective. Prerequisite: GB3510.

**TGB4550 Advanced Financial Reporting (4-0) Fall/Spring**

This course explores management accountability and financial reporting systems in public and private organizations. The course builds on financial accounting foundations presented in an introductory course and on basic concepts covered in cost management, economics, and finance courses. Also included are internal financial controls and auditing which are two management tools used to ensure timely, accurate, and consistent financial information. Professional standards of the Government Accountability office and the American Institute of Certified Public Accountants will be examined, along with relevant regulations and statutes on financial measurements and communication to decision makers, users, and managers. Prerequisites: GB3051, GB4052, GB3510.

**GB4560 Defense Financial Management (3-0)****Fall/Spring**

This course focuses on the competencies required of a Defense Financial Manager. It examines the diverse concepts, theories, and practices addressed in numerous specialty courses and ties them together in the framework of Defense Financial Management. The areas of coverage include: the Government Resource Management Environment, the Defense Resource Management Environment, Personnel Management, Manpower Management, Management and Internal Controls, Fiscal Law, the Planning, Programming, Budgeting, and Execution System (PPBES), Cost and Economic Analysis, Business Management Process Improvement, Accounting, Finance, and Auditing. Prerequisite: None.

**GB4570 Advanced Finance (2-0) Fall/Spring**

This course is designed to provide insights into advanced topics in financial decision making process encountered by commercial enterprises. Major topics covered include long-term financing, lease financing, optimal capital structure determination, dividend policy, security issues and refunding, risk analysis and real options, derivatives and risk management. Prerequisite: GB4052.

**GB4580 Modeling for Planning and Control (3-0)****Fall/Spring**

Study of sophisticated analytical methods for various cost, policy and decision scenarios in DoD and other organizations. Emphasis is on developing analytical methods as decision support tools, with available computer software as computational aids. Major topics include regression, learning curve, Monte Carlo simulation, and time series models. Prerequisite: GB4043.

**GB4999 Elective (4-0) Fall/Spring**

Elective course to be selected by student with approval by academic associate.

**GE Courses (EMBA Program)****GE3010 Organizations As Systems and Structures (3-0)****Winter/Summer**

Open to EMBA DL students only. Defense organizations are purposive systems comprising tasks and technologies, vertical and lateral coordination structures and processes, reward systems, and individual motivation. This course prepares leaders to understand the organizational system components and their relationships: inputs (e.g., environment, history), design factors (i.e., people, task, structure, culture) and outputs/outcomes (e.g., productivity, satisfaction, growth). A primary focus is on the organizational level of analysis and includes such topics as environment, hierarchy and structural configuration, ideology and doctrine with special emphasis on the context and organization of DoD. Applications and cases in command and control, joint task forces and network centric operations are related to organizational theory and design tradeoffs. Prerequisite: None.

**GE3011 Management of Teams (2-0) Winter/Summer**

Open to EMBA DL students only. Teams are a building block of today's organizations. Teams are evident throughout DoD in such forms as operational squads, integrated product teams (IPTs), R&D innovation teams, and Joint Task Forces.

The course examines the differences between groups and teams, between leader-managed and self-managed teams, between virtual and face-to-face teams, and between effective and ineffective teams. Analysis of effective teams include such issues as team dynamics, decision making, rewards, commitment, and the management of conflict (inter-personal, intra-team, and inter-team) in which power, influence and negotiation play central parts. Prerequisite: None.

**GE3031 Principles of Acquisition Management (3-0) As Required**

Open to EMBA students only. This course introduces the fundamental principles of public and private sector acquisition management by examining current acquisition policy issues, strategies, contractual decisions, and program management concepts. The aspects of planning, organizing, staffing, directing and controlling efforts within a risk managed process will be examined. Acquisition functional areas addressed in this course include: logistics, test and evaluation, systems engineering, manufacturing management, quality assurance, funds management, budgeting, research and development, and contracting management. Prerequisite: None.

**GE3042 Operations Management (4-0) As Required**

Open to EMBA students only. An overview of operations in military and commercial systems. The course has three sections: (1) Creating processes, including a survey of process types, capacity planning, and service system design; (2) Controlling processes, including MRP/ERP systems and the role of information; and (3) Coordinating processes, including inventory management, purchasing, and supply chain management. Prerequisite: GE3043.

**GE3043 Analytical Tools for Decision Making (3-0) As Required**

Open to EMBA students only. The objective of this course is to enhance students' ability to solve complex managerial problems and make decisions under conditions of uncertainty and competing objectives through the use of computer-based modeling techniques. The course incorporates probability material, decision models and decision analysis, decision trees, forecasting and simulation. The interactive environment of the electronic spreadsheet is used to provide an intuitive understanding of basic principles (e.g., understanding uncertainty and risk with Monte Carlo simulation rather than mathematical analysis). Prerequisite: None.

**GE3050 Financial Reporting and Analysis (3-0)****Winter/Summer**

Open to EMBA DL students only. This course covers theory, concepts, and practices underlying Financial Accounting and Financial Reporting. The conceptual structure underlying the reporting of economic events in the form of the balance sheet, the income statement, and the statement of cash flows is first presented. Accounting recognition and measurement issues surrounding revenues, expenses, assets, liabilities and equity are introduced and analyzed. Finally, different forms of financial analysis based on financial report information are addressed. Throughout the course, emphasis is placed on the manager or user perspective. Attention is given to the federal government financial reporting model and standards. Prerequisite: None.

**GE3051 Cost Management (3-0) Spring**

Open to EMBA students only. This course introduces students to cost management concepts and theories which are used by managers to make decisions on the allocation of financial, physical, and human resources to achieve strategic as well as short-term organizational goals and objectives and evaluate performance using financial and non-financial measures. The course is designed for those having a prior course in financial reporting and analysis or financial accounting. Cost management includes traditional tools and techniques such as cost behavior for decision making, activity costing, cost allocation, and standard costing. Prerequisite: GE3050.

**GE3070 Economics for Defense Managers (3-0) As Required**

Open to EMBA students only. Develops the fundamental tools of microeconomics and macroeconomics, and applies them to defense management and resource allocation. Course centers on defense applications of economic theory. Topics covered include: defense and the macro economy; markets and their interactions with defense acquisition and contracting; national security implications of globalization; and efficiency in defense decision making. Prerequisite: MA2XXX, College algebra.

**GE3109 Ethics and Moral Development (3-0) As Required**

Offered to EMBA students in their first quarter: The objective of this course is to provide newly-enrolled Executive MBA students with an introduction to the ethical challenges of the global Defense business environment facing Navy corporate business leaders and resource managers. Through the use of case analyses and discussion, the course will explore the application of ethical thinking to contemporary issues in the private and public sectors. The course goals include: 1) introduce ethical concepts which are relevant to the moral and ethical dilemmas inherent in business decisions; 2) help students develop the critical thinking and analytical skills required to address complex issues; 3) identify the range of ethical problems facing senior leaders in business and government; and 4) encourage the students to develop a personal approach to achieve ethical outcomes in the corporate-level decision-making process. The students will use the managerial perspective and critical thinking skills developed in this course throughout the remainder of their studies to identify the ethical dimension in the process of formulating and implementing Navy policy and business strategies required to build and maintain the Fleet of the 21st Century. Prerequisite: None.

**GE3221 Principles of Acquisition and Program Management I (3-0) As Required**

Open to EMBA students only. This is the first of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition

management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Combined with GE3222, this course provides DAU Equivalency for ACQ 101, ACQ 201, and PMT 250. Prerequisite: None.

**GE3222 Principles of Acquisition and Program Management II (3-0) As Required**

Open to EMBA students only. This is the second of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Combined with GE3221, this course provides DAU Equivalency for ACQ 101, ACQ 201, and PMT 250. Prerequisite: GE3221 or consent of instructor.

**GE3306 Strategic Purchasing (3-0) As Required**

For EMBA students only. This course is a graduate-level seminar in strategic purchasing. The course will be taught through a combination of formal lecture, guided discussion, and case analysis. The primary goal of this course is to develop, structure, and execute purchasing, not as a functional activity, but rather as a strategic component of total supply chain management. The course emphasizes the concept that companies with world-class purchasing practices derive a competitive advantage in their industries from their procurement and sourcing strategies. The course develops the concept of competitive advantage through strategic purchasing as it relates to efficient and effective structure and management within the Department of Defense. The emphasis on world-class purchasing practices entails observation and analysis of commercial organizations and their purchasing practices. The student will investigate whether select commercial organizations' purchasing practices are useful to the DoD, and determine practical implementation for use in the DoD acquisition environment. Prerequisite: None.

**GE3510 Defense Financial Management Practice (3-0) As Required**

For EMBA students. This course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated,

reimbursable, and revolving funds. Basic principles of fiscal law are explored. It then addresses financial management and stewardship topics including budgetary accounting, management of cost drivers, the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

**GE4015 Managing Complex Change in the DoD Environment (3-0) As Required**

Open to EMBA students only. This course recognizes and describes the dilemmas inherent in any effort to change a human system. Emphasis is placed on strategies and technologies for planning, managing, and implementing change. The course emphasizes approaches to planning and managing change that reflect the complexity of organizations comprised of several interdependent systems--technology, structure, task, culture, and people. The course is application-oriented and intended to enhance skill development. Prerequisite: GE3010.

**GE4016 Managing Strategic Change (4-0) Winter/Summer**

The course focuses on senior-level decision-making processes under conditions of significant uncertainty. Part of the process includes assessment of the organization's external environment and its internal capacity to respond to decisions made to be responsive to that environment. The course takes into account the unique context of public organizations, particularly the context of DoD organizations. Furthermore, the course focuses on the challenges of implementing these decisions and evaluating the extent to which the decisions are reaching the desired outcomes, and determining what to do if they are not. The overall purpose of the course is to provide opportunities for students to grapple constructively with, and exercise good managerial judgment in, situations that are complex, rapidly changing, multidimensional, and potentially highly consequential in terms of their impact on the future. The course deals with the role of uncertainty in situations and issues that are critical for the long-term future health, survival and prosperity of the organization. Prerequisite: None.

**GE4021 E-Business for Defense (3-0) As Required**

Open to EMBA students only. The network era has revolutionized the manner in which business processes are conducted, and we have only just begun to understand the potential of how such processes can be conducted in the future. What we do understand is that electronic business (e-business) represents a combination of technologies, business models and managerial techniques that can enable fundamental process innovation with order-of-magnitude performance improvement, if conceived and implemented well. This applies in particular to military enterprises of the U.S. Defense Department, under tremendous pressure to modernize their forces and improve the quality of life for service men and women, because of the huge size, global reach, time-critical processes and hazardous missions associated with the "business" processes of military operations. This course addresses the application of e-business technologies, business models and management to defense. The course builds on students' knowledge of operations management, supply chain management, and strategy to address technologies, models and applications of business (e-

business). The course has an explicit focus on e-business applications, opportunities and implications in defense organizations, even though many exemplars from private industry are discussed, and it integrates both theory and application to provide knowledge necessary to organize and manage in the networked, paperless enterprise of today and tomorrow. Course topics will include: IT and Strategy, IT and Organization, Extending the Enterprise (transformation), Making a Case for IT, Understanding Internetworking Infrastructure, Assuring Reliable and Secure IT Services, Managing Diverse IT Infrastructures and Managing IT Outsourcing. Prerequisite: None.

**GE4052 Managerial Finance (3-0) As Required**

Study of capital budgeting techniques. This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision-making process encountered by commercial enterprises. The major emphasis is on financial environment, risk and return analysis, valuation models, cost of capital determination, optimal capital structure, and short-term and long-term financing. Prerequisite: GE3050.

**GE4053 DoD Mission and Resource Determination 4-0) As Required**

This course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the U.S. federal government. It begins with a summary of the current threat situation and potential changes to it. Once the threat is defined, the study of the resource allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting and Execution system (PPBES) used by DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: None.

**GE4100 Seminar In Defense Management (5-0) As Required**

The Seminar in Defense Management is a capstone course that uses a project-based learning approach to integrate the knowledge and skills gained thus far in the EMBA. Participants will be introduced to a consulting framework designed to facilitate delivery of the business knowledge and skills learned in the EMBA to their command. Participants will work individually or in a small team to prepare a Project Proposal and a Final Project Report containing

recommendations that could solve the command's business problems. Prerequisite: None.

**GE4310 Strategic Acquisition Management (3-0) Spring**

This course extends students' understanding of the complex and dynamic defense acquisition environment and ways in which various functional disciplines (e.g., contracting, test and evaluation, logistics) may be effectively integrated in successful acquisition programs. The effects and implications of current policy initiatives (e.g., acquisition reform, outsourcing) and contemporary industry trends on defense acquisition will be explored. Students will use relevant acquisition program cases to apply their knowledge by analyzing management challenges and developing strategies for success. Prerequisite: GE3222.

**GE4510 Strategic Resource Management (3-0) As Required**

The objective of this course is to integrate business analysis, financial analysis, and strategic analysis in solving complex management problems involving the allocation of scarce resources to achieve overall organization objectives. Resources here are not limited to financial resources, but also include human and physical resources. The course will make use of a wide variety of management tools such as value chain analysis, competitive strategy, market positioning, supply chain management, activity analysis, target costing, cost of quality, and business process improvement techniques. Prerequisite: GE3051.

**MN Courses**

**MN0163 Thesis Writing Workshop (0-1) Spring**

Guidelines for scientific writing for the thesis are given with examples and opportunities for practice. Prerequisite: Consent of instructor.

**MN0810 Thesis Research for Systems Management Students (0-8) Fall/Winter/Spring/Summer**

Every student conducting thesis research in Systems Management resident programs will enroll in this course. Prerequisite: None.

**MN0811 Thesis Research for Non-Resident Business & Public Policy Students (0-4) Fall/Winter/Spring/Summer**

Every student conducting thesis research in the Distance Learning Contract Management (835) and Program Management (836) degree programs will enroll in this course.

**MN2039 Basic Quantitative Methods In Management (4-0) Fall/Spring**

This course introduces the mathematical basis required for advanced management and cost-benefit analysis. Math topics include algebra, graphs, differential calculus, including both single and multiple variable functions, and indefinite and definite integrals. Management concepts include cost-benefit and cost-effectiveness analysis, marginal analysis, unconstrained and constrained optimization, and welfare analysis. Prerequisite: College algebra or consent of instructor.

**MN2111 Navy Manpower, Personnel, and Training Systems I (2-0) Winter/Summer**

An introduction to the major issues, theory, and practice of the military MPT system. Graded on a Pass/Fail basis only. Prerequisite: Consent of instructor.

**MN2112 Seminar In Manpower, Personnel, and Training Issues II (0-2) Fall/Spring**

Continuation of MN2111. Graded on a Pass/Fail basis only. Prerequisite: Consent of instructor.

**MN2150 Financial Accounting (4-0) Winter/Summer**

Study of basic accounting models, concepts, and standards underlying financial reports. Emphasis is on the reporting of an organization's results of operations, financial position and cash flows. Specific topics include the accounting cycle, asset and liability valuation, income measurement, capital structure, and financial statement analysis. Includes discussion of financial reporting for federal government organizations. Prerequisite: None.

**MN2155 Accounting for Management (4-0) Winter/Summer**

Study of the fundamentals of financial and managerial accounting relevant to financial management. Introduction to financial accounting stressing accrual concepts and the content and analysis of financial statements. More in-depth focus on management accounting topics, including costing techniques for products and programs, use of cost information for decision making, capital budgeting, and financial performance measures. Applications of managerial accounting tools to DoD situations. Prerequisite: None.

**MN2302 Seminar for Acquisition and Contracting Students (0-2) Fall/Winter/Spring/Summer**

This course brings both government and industry contract managers into the academic forum for interaction with students. Visits to government and industry facilities. Thesis and research presentations. Preparation for Certified Professional Contracts Manager (CPCM) certificate examinations. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

**MN2303 Seminar for Program Management Students (0-2) Fall/Winter/Spring/Summer**

This course brings both government and industry acquisition/program managers into the academic forum for interaction with students. Guest lecturers include program executive officers, program managers, laboratory and field personnel, department officials, congressional members and staff personnel, and industry representatives. Visits to government and industry facilities. Thesis and research presentations. Preparation for Program Manager Certification. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

**MN2304 Seminar In Product Development (0-4) As Required**

This course brings both government and industry product development leaders into the academic forum for interaction with students. Guest lecturers include government and industry product development executives, program managers, laboratory and field personnel, department officials, congressional members and staff personnel. Visits to government and industry facilities. Thesis and research

presentations. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

**MN3001 Economics for Acquisition Managers (3-0)  
Fall/Winter/Spring/Summer**

Develops the fundamental tools of microeconomics and macroeconomics and applies them to topics in the management and allocation of resources in defense acquisition management with particular emphasis on the applications of economic theory to defense decision making. Topics covered include defense and the macro economy; markets and their effects on defense acquisition and contracting practices; the economics of corporate strategy; and efficiency in defense decision making. Prerequisite: None.

**MN3012 Communications Strategies for Effective Leadership (2-0) Fall/Winter/Spring/Summer**

This course provides DoD military officers and civilians with the communication strategies and skills to manage and lead in the dynamic DoD environment. Instruction focuses on assessing various communication models, making strategic media choices, writing effective informative documents, developing associates' communication competencies through various feedback roles, and giving lucid briefings. Prerequisite: None.

**MN3101 Models of Leadership In Complex Organizations (2-0) Winter/Summer**

A broad range of leadership models is presented to demonstrate the evolution of approaches to the study of leadership and to provide a framework for subsequent leadership courses. These models range from trait approaches to current transformational concepts. Students will acquire a systems view of leadership in organizations and an approach to analyze the variables that influence leadership. Prerequisite: Undergraduate course in Naval Leadership and admission to graduate standing. The course demands critical reasoning and systematic thinking on an advanced level.

**MN3102 Military Leadership (2-0) As Required**

Military leadership is studied in the context of leadership qualities and styles of notable military leaders. Primary emphasis is on development of officer candidates and subordinate leaders. Course objectives also include improved self assessment and development of students' own leadership styles. Prerequisite: MN3101.

**MN3103 Group Dynamics and Teambuilding (2 - 0) As Required**

Human behavior in group settings and leadership in building cohesive teams are the focus of this course. Group structural characteristics, stages of team development, group problem solving and decision making are studied. Prerequisite: MN3129.

**MN3104 Motivation and Empowerment (1-0) As Required**

The major cognitive and behavioral theories of motivation are examined from the perspectives of the leader and subordinates. A model of empowerment is introduced, and a framework of motivation research and applications is created. Case analysis is used to balance theory and application through cases that focus on a variety of Navy organizations. Prerequisite: MN3101.

**MN3106 Conflict Management (2-0) As Required**

Students study a model that offers five conflict-handling strategies used for various conflict situations. An overview of negotiation literature is provided and students practice using the strategies and negotiation techniques. Prerequisite: MN3101.

**MN3107 Contemporary Issues In Organization and Management (2-0) As Required**

This course is an abridged version of MN3105 for students who have significant undergraduate coursework in organization and management. Students learn to apply open-systems models and cognitive frames to DoD cases as a way of capturing complex causal dynamics. Within these broad frameworks, students learn to address contemporary management issues, including team-based designs, empowerment, positive political skills, managing organizational cultures, organizational learning, and contemporary models of leadership. The development of written analyses and action plans are emphasized. Prerequisites: At least two undergraduate courses in the content area of Organization and Management (organizational behavior, organization development, organization theory, or principles of management) with a grade of "B" or better, and approval by course coordinator.

**MN3108 Leadership In Product Development (3-2) As Required**

This is a product development course providing a broad framework for the leadership of end-to-end product commercialization with a student hands-on design challenge, to give students perspective and appreciation for the critical success factors and inhibitors to successful commercialization of complex products and systems. The format includes lectures, guest speakers, case studies and a design challenge. Topics include product development strategy and leadership, the front-end process, product delivery, distribution and customer support. The Design Challenge is as a multi-disciplinary system design experience. Students work in teams to design, build, test and demonstrate a real product. The Design Challenge culminates with a prototype demonstration competition. Prerequisite: None.

**MN3109 Ethics and Moral Development (3-0) As Required**

An examination of the major traditions in Western ethical thinking. Application of these theories to moral dilemmas encountered in the profession of arms, involving a critical exploration of the meaning and validity of arguments offered on various sides of current ethical controversies. Course includes reading, discussing, and writing about military virtues and their place in the everyday life of the officer. This course demands critical reasoning and systematic thinking at an advanced level. Prerequisite: Undergraduate course in Naval Leadership and admission to graduate standing.

**MN3111 Analysis of Human Resource Management (4-0) Fall/Spring**

A broad coverage of human behavior in the work situation, with key emphasis on the issues of work in the Navy Manpower Personnel and Training Environment. Topical areas covered include selection, placement, training development, and evaluation of personnel; motivation, remuneration, morale, supervision, and working conditions in military organizations; job design and organization

development within complex military bureaucracies; equipment design and man-machine interface, and the impact of technological programs within the military. Prerequisites: GB3070.

### **MN3112 Counseling (3 - 0) As Required**

The basic theory, principles, and techniques of counseling will be presented in this course. An emphasis will be placed on counseling in military settings. Students will learn and practice basic listening and therapeutic skills. Prerequisite: MN3135.

### **MN3115 Managing From A Systems Perspective (2-0) As Required**

This course is about leading and managing Groups/Teams as a system -- a system being defined as a "whole" whose elements interact and "hang together" in the pursuit of a common purpose. It begins the process of identifying the basic concepts and components in the management and diagnosis of systems, and prepares the student for other courses that focus on the managerial spectrum from the components of organizations to management of the organizational system as a whole. The course addresses the following specific subject areas: Group/Team Work Designs; Group/Team Roles; Stages of Development; Group/Team Dynamics; Team Building; Building Commitment and Empowerment; Self-Managing Teams; Characteristics of High Performing Teams; and Inter-Group Relations. Prerequisite: None.

### **MN3117 Organizational Processes (4-0) As Required**

The purpose of this course is to provide the conceptual framework and skills needed to manage and lead organizations. The focus will be on three levels of skills needed to manage modern organizations: skills needed to manage individuals, skills needed to manage teams, and skills needed to manage the organization as a whole. It focuses on the organization of the future, identifies its characteristics, and explores the implications for living in, managing, and leading such an organization. The course also focuses on skills such as negotiating, cross-cultural communication, and teamwork. It examines the creation of the structures needed within the firm and the alliances, learning, and change practices needed to maintain global leadership. The course will use cases, experiential exercises, readings, discussions, and papers. Students have the opportunity to integrate conceptual material with their own experiences, beliefs, and actions. Prerequisite: None.

### **MN3118 Strategies for Building Consensus (4-0) Spring**

Post-conflict environments bring together representatives from different nations and organizations. In order to accomplish the goals of interest, these varying representatives must develop awareness, appreciation, and ability to collaborate with each other. There is no formal organization that provides structures or standards to guide the collaboration of these individuals; they must rely on informal mechanisms for collaborative post-conflict efforts. Because the goals and interests of the participating parties frequently are not in alignment, consensus-building capabilities contribute importantly to success. Consensus is a decision process that makes use of all available resources and perspectives for the resolution of problems.

Consensus is difficult to reach and requires a complex set of skills related to interpersonal and group dynamics such as conflict management, building trust, perspective taking, and

negotiation. Consensus building challenges students to develop their skills on two levels. At the dyadic level, students learn communication, mediation, and negotiation strategies, especially for use in scenarios marked by high levels of cultural, ethnic, organizational, and ideological diversity. At the group level, students learn how to function as high-performing teams in complex dynamical systems. Using simulations, cases, and experiential exercises, they become proficient at small group meeting management, problem solving, conflict management, team building, and decision making. Consensus building at both the dyadic and group levels is based on principles of self-organization and self-management, given the value diversity, potential for conflict, and inability to use hierarchical controls as the mechanism of coordination in these situations. Prerequisite: None.

### **MN3121 Organizational Design for Special Operations (4-0) As Required**

Principles of organizational design are critically examined and applied to special operations' missions and organizations. Focus is on the organizational level of analysis and includes such topics as organizational environments, key success factors, technology and information systems, configuration and structure, organizational learning, reward systems, and decision making. Case method is used to develop diagnostic skills and a systemic perspective. Prerequisite: Enrollment in the SOLIC curriculum or consent of instructor.

### **MN3129 Organization Design (2-0) As Required**

Organizations are studied from a systems perspective in which the leader must analyze the internal and external components and their interrelationships to design the appropriate structural configuration for the organization. Organizational theory provides the foundation for this study of the structure and design of military organizations. Special emphasis is given to the ability to apply these concepts in an integrated manner to DoD/DoN management situations. Prerequisite: MN3101.

### **MN3135 Educational Theory (3-0) As Required**

This class focuses on the range of educational theories and applications for the teaching-learning process. Students examine the areas of the cognitive, affective, and behavioral basis of human learning. The emphasis will be on obtaining a solid foundation for understanding and applying educational theory. The theoretical foundation will provide an understanding of DoD, DoN and USNA educational needs. Prerequisite: MN3101.

### **MN3137 Instructional Systems Design (1-0) As Required**

A system approach as applied to the design, development, delivery, implementation and evaluation of educational and training programs. Navy and Marine Corps models are examined. Prerequisite: MN3135.

### **MN3138 Adult Development (2 - 0) As Required**

Theory and research in personality are examined as a function of individual development. Various theories are explored with emphasis on college student development. Prerequisite: MN3135.

### **MN3145 Marketing Management (4-0) Spring**

This course takes a general management approach to marketing, examining (1) marketing as a process that creates



and sustains customer value; and (2) the manager's role in assuring that the firm delivers products that are successful in the marketplace. The curriculum will emphasize approaches to market research (the "voice of the customer"), innovation, creating customer value in product development, product management, and general management of marketing activities. Topics include: market oriented strategic planning, the TQM marketing process, market research, segmentation, target markets, differentiation, product management, the marketing mix, customer satisfaction, and e-commerce. Case studies are used extensively. Prerequisite: None.

**MN3154 Financial Management in the Armed forces (3-0) Winter/Summer**

This course is designed for non-MBA students and focuses on financial management policies and practices in the DoD. It begins with a foundation including the origin of the Defense budget from national strategic planning through the PPBE system and the submission of the President's Budget to Congress. The Congressional Authorization and Appropriation processes and the flow of funds to the activity level complete the foundation. The course next explores the funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable and revolving funds. Basic principles of fiscal law are explored. The course concludes with financial management and stewardship topics including budgetary accounting, management of cost drivers, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

**MN3155 Financial Management for Acquisition Managers (2-0) Fall/Winter/Spring/Summer**

This course is a study of financial management practices and issues associated with federal government acquisition programs. The course has emphasis on (1) the resource management process flow from initiation of a new acquisition program through execution of appropriated funds (procurement and research & development accounts) for that program, (2) the congressional approval and review process unique to procurement, and (3) cost estimation, analysis and evaluation as tools for sound acquisition management decision making, and long-term investment analysis. Prerequisites: MN2155; and MN3331 or MN3221 or consent of instructor.

**MN3156 Financial and Managerial Accounting (4-0) As Required**

This course is designed as a first course in Business Financial Management for graduate students. The course covers a range of topics in financial accounting, managerial accounting and business finance. All topics covered share a common theme in that they are related to the creation and use of financial models and information. The course requires critical thinking and the ability to analyze and apply financial models and reasoning in the context of case studies. The course is divided into two broad areas: Financial Information and Financial Management. Within these areas, specific topics include: financial accounting, financial reports, financial analysis, capital structure, costing systems, performance measurement and control, and investment analysis. Prerequisites: Admission to graduate standing, college algebra, MN3108 and MN3117.

**MN3160 Methods of Inquiry (3-0) As Required**

Basic concepts and principles fundamental to inquiring systems, scientific reasoning, and research design are provided. The strengths and weaknesses of traditional research methods (e.g., experiments, surveys, field research) and inquiring system are examined. Methods appropriate for multi-disciplinary inquiry into complex, dynamic, and uncertain phenomena are addressed, as are action research strategies in organizational contexts. Prerequisite: Admission to Graduate standing.

**MN3162 Tools of Inquiry (3-0) As Required**

Statistical methods used to explain and predict the organizational behavior of individuals and groups are developed. Particular emphases are given to developing skills in the use of regression analysis using PC software and applying the methods using DoD/DoN data. Prerequisite: MN3160.

**MN3172 Resourcing National Security: Policy and Process (3-0) Winter/Summer**

This course analyzes federal policy-making with emphasis on resource decision making for national defense. The roles of principal budget participants are examined in detail. Executive (especially DoD) and congressional budget processes are assessed to indicate how national security policy is implemented through resource allocation. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. The politics of budgeting for national defense is evaluated to indicate the dynamics of executive-legislative competition over scarce federal resources. Graded Course. Prerequisite: None.

**MN3221 Principles of Acquisition and Program Management I (3-0) Summer**

This is the first of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Combined with MN3222, this course provides DAU Equivalency for ACQ 101, ACQ201, and PMT 250. Prerequisite: None.

**MN3222 Principles of Acquisition and Program Management II (3-0) As Required**

This is the second of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for

interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Combined with MN3221, this course provides DAU Equivalency for ACQ 101, ACQ 201, and PMT 250. Prerequisite: MN3221 or consent of instructor.

### **MN3301 Acquisition of Defense Systems (4-0)**

#### **Fall/Spring**

This course introduces the principles and concepts that underlie successful defense acquisition management. The course focuses on management of the acquisition process for defense systems from the development of an initial desired capability or need through design, development, production, fielding, sustainment, and disposal. Students gain an understanding of successful acquisition as an interdisciplinary activity through contributions and applications of principles from business, management, and technical disciplines. The course also emphasizes the statutory, regulatory, and policy environment of acquisition. Numerous case studies illustrate the application of concepts and principles in actual acquisition programs. Prerequisite: None.

### **MN3302 Advanced Program Management (2-0) As Required**

Course builds on the student's experience in the acquisition workforce. Cases are used to examine each of the major disciplines in the acquisition process and bring each student to a current and common understanding of the acquisition environment, process, requirements and management approaches. Prerequisite: DAWIA Level II Certification.

### **MN3303 Principles of Acquisition and Contract Management (4-0) Winter/Summer**

This course is an introduction to the principles of government acquisition and contracting. It presents the fundamentals of the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement; the federal acquisition and contracting processes, including requirements determination, acquisition strategies, government contract law, ethics, contract types, contracting methods, and acquisition/contract management techniques. Prerequisite: None.

### **MN3304 Contract Pricing and Negotiations (5-2) Winter/Summer**

This course involves the study and application of pricing theory and strategies, cost methods, cost and price analysis, cost principles, Cost Accounting Standards, and contract negotiations as used in the Federal Government. Students develop and sharpen negotiating skills by participating in practical negotiation exercises with corporations. Prerequisites: MN3140 and MN3303.

### **MN3306 Strategic Purchasing (3-0) Fall/Spring**

This course is a graduate-level seminar in strategic purchasing. The course will be taught through a combination of formal lecture, guided discussion, and case analysis. The primary goal of this course is to develop, structure, and execute purchasing, not as a functional activity, but rather as a strategic component

of total supply chain management. The course emphasizes the concept that companies with world-class purchasing practices derive a competitive advantage in their industries from their procurement and sourcing strategies. The course develops the concept of competitive advantage through strategic purchasing as it relates to efficient and effective structure and management within the Department of Defense. The emphasis on world-class purchasing practices entails observation and analysis of commercial organizations and their purchasing practices. The student will investigate whether select commercial organizations' purchasing practices are useful to the DoD and determine practical implementation for use in the DoD acquisition environment. Prerequisite: None.

### **MN3307 Entrepreneurship in Strategic Purchasing (3-0) Winter/Summer**

MN3307 is a graduate level seminar on the entrepreneurial concept and management and its application to strategic purchasing. Entrepreneurial thinking is designed to exploit opportunities in uncertain environments. The primary goal for MN3307 is to explore and develop strategic and critical thinking in entrepreneurial concepts and management along with specific methods for utilizing these concepts and tools within world-class purchasing organizations. Students will critically examine how the entrepreneurial mindset is applied in progressive business ventures and how DoD and the government can effectively apply these concepts and management tools for effective and efficient purchasing operations. The foundation of MN3307 is an analysis of the process by which the entrepreneurial mindset generates new ideas, researches the likelihood of success, and successfully implements the idea. The course will also investigate the critical role of entrepreneurial leadership and scanning the environment for opportunity, and capitalizing on opportunities to benefit DoD purchasing operations. The course will be taught through a combination of informal lecture, guided discussion, case study, and student presentations. Prerequisite: None.

### **MN3309 Acquisition of Embedded Weapon Systems Software (4-0) Winter/Summer**

This course focuses on the key aspects of mission critical computer resources with particular emphasis on major weapon systems embedded software. The course analyzes software development, software risk management, software in the systems acquisition life cycle, software metrics, contracting methods for software, software test and evaluation, and software configuration management. Case studies, reports, software specifications and standards, and other similar documents/materials are used. The course addresses the underlying management principles involved in software acquisition. Significant software acquisition issues and problems are examined and solutions developed. Prerequisites: MN3331 or MN3222 or MN3302.

### **MN3312 Contract Law (4-0) Fall/Spring**

This course examines the legal structure within which federal government contracts with private industry are formulated and executed. The course addresses the unique aspects of government contract law including such topics as agency authority, contract interpretation, disputes and remedies, Alternative Dispute Resolution (ADR), socio-economic laws, labor law, property, patent and data rights, conflicts of interest, protests, and ethics. Comparisons are made with the Uniform Commercial Code (UCC). Emphasis is on the use of

Court and Board of Contract Appeals (BCA) cases. Prerequisites: MN3303 or MN3341.

### **MN3315 Acquisition Management and Contract Administration (4-0) As Required**

This course focuses on the management functions and decision-making techniques involved in the award and administration of Best Value competitively negotiated contracts. The first phase of the course concentrates on the source selection phase of the acquisition process; specific topics include acquisition planning, market research, source selection planning, proposal development, solicitation management, source selection evaluation, contract award, and contractor debriefings. The second phase of the course emphasizes the performance phase of the acquisition process; specific topic areas include organizing for contract administration, transitioning to performance, quality management, subcontract management, financial management, performance monitoring, change management, and contract closeout. Emphasis is on the use of legal case studies and practical exercises. Prerequisites: MN3304 and MN3312.

### **MN3316 Acquisition Management of Information Systems and Services (2-0) Spring**

This course provides the student with an understanding of the underlying philosophies, management concepts and processes associated with the acquisition of information systems, services and related requirements. The course is a study of the Federal Acquisition System, the fundamental principles that influence the decisions of acquisition team members, and the various phases of the acquisition process from requirements determination through contract performance. Prerequisite: None.

### **MN3318 Contingency Contracting (2-0) Winter/Summer**

This course is a study of the principles of contingency contracting and the fundamental skills required to provide direct contracting support to joint tactical and operational forces participating in the full spectrum of armed conflict and military operations other than war, both domestic and overseas. Topics include: Types of Contingencies, Cross-Cultural Awareness, Contingency Contracting Officer Authority, Roles and Responsibilities, Anti-terrorism and Security, Planning, Contractual Methodologies and Instruments, Contract Administration, and Ethics/Standards of Conduct. Prerequisite: None.

### **MN3331 Principles of Acquisition and Program Management (5-1) Fall/Winter/Spring/Summer**

This course provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning,

organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Provides DAU Equivalency for ACQ 101, ACQ 201, and PMT 250. Prerequisite: None.

### **MN3333 Communication Strategies for Effective Leadership (2-0) Winter/Summer**

This course provides DoD and international military officers and civilians with the communication theory, strategies, and skills to manage and lead in the dynamic DoD environment. Instruction focuses on assessing various communication models, making strategic media choices, writing effective bottom-lined documents, developing associates' communication competencies using effective feedback strategies, thinking on one's feet, and delivering persuasive, high impact briefings. Prerequisite: None.

### **MN3341 Advanced Contracting Principles (4-2) As Required**

This course builds on the student's knowledge and experience in contracting to address the more complex pre-award contracting issues in the acquisition environment, including contracting methods, contract types, negotiation, source selection, contingency contracting, environmental contracting, contracting for services, R&D contracting and international procurement. Major issues regarding acquisition reform are addressed. Ethical issues throughout the contracting process are examined. Cases are used to illustrate methods for attacking contracting problems and challenges. Prerequisite: Enrolled in 835 curriculum or consent of instructor.

### **MN3342 Advanced Contract Management (4-1) As Required**

This course builds on the student's knowledge and experience in contracting to address the more complex post-award contracting issues in the acquisition environment including disputes and appeals, claims, intellectual and technical data rights, post-award pricing and negotiations, terminations, contract modifications, traffic and transportation, value engineering, environmental contracting, contractor systems reviews, property administration, quality assurance, contract financing, alternative dispute resolution (ADR), labor relations, contractor performance monitoring and surveillance, contractor performance evaluation. Prerequisites: MN3341, MN3312.

### **MN3361 Software Acquisition Management (2-0) Fall/Winter/Spring/Summer**

Advanced Acquisition Program. This course concentrates on the management of software products and software intensive systems. It is intended to focus essential program management techniques on the software element to ensure successful and timely system development. The course provides the student with knowledge of software acquisition management control processes and tools. Current software acquisition articles and caselets are analyzed for application of program leadership, software development techniques, and management tools applied. Topic areas include: DoD software environment; software acquisition strategies; impediments to successful software intensive system development; software oriented requirements development; contracting for software, software discriminate proposals; software test and evaluation management; Post Deployment Software Support; risk management; and software costing and budgeting. Integrative exercises involving software managerial problem solving and

decision making in the program management environment are used. Prerequisite: MN3331 or consent of instructor.

**MN3362 Acquisition Design Verification and System Assessment (2-0) Fall/Winter/Spring/Summer**

Advanced Acquisition Program. This course examines Developmental, Operational, and Joint Test & Evaluation as viewed from the Program Manager's perspective. The student will be able to distinguish the difference between the various testing types and the impact testing results will have on the decision makers thought process. Actual military and civilian test cases are used as examples for discussion purposes. Topics include the role of T&E in the Systems Engineering Process, T&E policy Structure and Oversight Mechanism, Requirements Generation, Modeling and Simulation, Alternative Acquisition Program T&E, Human systems Integration and Live Fire T&E. Integrative case studies involving managerial problem solving and decision making in the PMO environment are also used to provide application of concepts in both IPT teaming and multiple-role individual settings. Teamwork exercises are conducted to reinforce concepts and add real-world human dynamics. Upon completion, all exercises are evaluated with after-action reviews and assessments. Prerequisite: MN3331 or consent of instructor.

**MN3363 Acquisition Manufacturing and Quality Management (2-0) Fall/Winter/Spring/Summer**

For AAAP program students. This course provides the student with knowledge and application of integrated management control processes with regard to performance, cost, and schedule, while examining higher-level and real world defense systems. Issue-oriented topic areas likely to affect Program Management Office personnel include: acquisition reform; acquisition strategy; industrial base; production and manufacturing; quality management; and risk management. Integrative case studies involving managerial problem solving and decision making in the PMO environment are also used to provide application of concepts in both IPT teaming and multiple-role individual settings. Teamwork exercises are conducted to reinforce concepts and add real-world human dynamics. Upon completion, all exercises are evaluated. Prerequisite: MN3331 or consent of instructor.

**MN3364 Business Financial and Contract Management (2-0) Fall/Winter/Spring/Summer**

Advanced Acquisition Program. The course builds on the student's knowledge and experience in contracting, and contracting related fields, to address the more complex pre-award, award and post-award issues in the acquisition and contracting, and business and financial management arenas. Prerequisite: MN3331 or consent of instructor.

**MN3365 Acquisition Logistics & Program Sustainment (2-0) Fall/Winter/Spring/Summer**

Advanced Acquisition Program. This course focuses on the logistics and sustainability planning for new major weapon systems in each phase of the DoD acquisition process. It links logistics and sustainability planning, in the early stages of system development, to the effects on the system's total ownership cost. The course describes sustainability planning and management through the Systems Engineering Process and supportability analyses techniques. The course addresses the following specific subject areas: Designing for Life Cycle

Cost and Cost As an Independent Variable (CAIV); Logistics Supportability Elements; Supportability analyses; Logistics Open Systems; Software Support Planning; Supply Chain Management; and Post-Production Support Planning. Prerequisite: MN3331 or consent of instructor.

**MN3370 Seminar on Leadership in Supply Chain Management (0-2) Fall/Winter/Spring/Summer**

Graduate-level seminar emphasizing current and emerging issues from a broad range of logistics and supply chain management subjects. Speakers from the Department of Defense, other government agencies, and industry. Graded on Pass/Fail basis. Prerequisite: Consent of instructor.

**MN3371 Contracts Management and Administration (4-0) Fall/Spring**

This course is a study of procurement planning, negotiation, and contract administration, including the determination of need, basic contract law, methods of procurement and fundamentals of management techniques. Topics include procurement organizations, procurement by sealed bidding and competitive negotiation, source selection, pricing, types of contracts, negotiating techniques, structuring incentives, the terms and conditions of contracts, managing contract progress, total quality management, change control, cost and schedule control, contract termination, dispute situations, and international contracting issues. Prerequisite: None.

**MN3372 Material Logistics (4-0) Winter/Summer**

An overview of material logistics emphasizing trade-off analysis and the total cost concept of logistics. Topics include forecasting, customer service level optimization, inventory management, transportation, warehousing, facilities location, and the potential trade-offs within and between all of these areas. The similarities and differences between commercial and DoD applications are developed throughout the course. Prerequisites: MA2300 (or equivalent) and OS3101.

**MN3373 Transportation Management (4-0) Fall**

Overview and analysis of the U.S. domestic transportation system and the international transportation network from a managerial perspective. The emphasis is on commercial transportation resources that are of particular importance to DoD. The course focuses on an analysis of the individual freight modes followed by an examination of intermodal and passenger services. Students are also introduced to current research and industry literature in commercial transportation that is relevant to DoD's partnerships with the transportation industry. Prerequisite: MN3140 (may be taken concurrently).

**MN3374 Production and Operations Management (4-0) Winter/Summer**

Qualitative issues and quantitative techniques for managing DoD production and service operations. Qualitative issues covered include process design, operations strategy, and Just-in-Time techniques. Qualitative techniques include quality monitoring and measurement, forecasting, queuing, scheduling and aggregate planning. The context is DoD production and service activities, with special emphasis on DoD repair depot processes. Prerequisite: OS3006.

**MN3375 Materials Handling Systems Design (4-0) Fall**

Principles and techniques for managing military material handling systems. Topics include warehousing, storage systems design, intra-facility material movement, and the role of information in distribution. Particular emphasis is placed on

DLA automated warehousing systems and Navy shipboard operations. Prerequisite: OS3006.

**MN3377 Inventory Management (4-0) Winter/Summer**

Fundamental models and qualitative techniques for managing DoD inventory systems. Covers demand-based and readiness-based inventory systems, including deterministic and stochastic inventory models, availability-based models, and multi-echelon techniques. Applications and case studies emphasize current problems in DoD and supply-chain solutions such as outsourcing, improved supplier relationships, and vendor-managed inventory. Course highlights the distinctive nature of defense inventories and their effect on military readiness. Prerequisite: OS3006.

**MN3378 Logistics in a Post-Conflict Environment (4-0) As Required**

This course examines logistics support in a post-conflict environment. The course centers on transitioning from logistics support of national forces to effective logistics support of a multinational force that may be working with Non-Governmental Organizations (NGOs). The course stresses the political and administrative context of logistics in a post-conflict environment. Attention is paid to assessment and planning for support of national contingent, mobilization, deployment, and for host-nation participation on a multinational logistics planning staff. Emphasis will be placed on familiarity with UN, NATO, U.S. and allied concepts of logistics operations, terms of reference, assessment tools and case studies in multinational and joint logistics. In addition, the course will cover logistics support to and coordination with other international, regional, NGO and host nation organizations involved in civilian police operations, humanitarian crises, and a variety of relief, rescue and resettlement actions. Prerequisite: None.

**MN3384 Principles of Acquisition Production and Quality Management (5-1) Fall/Spring**

This course provides the student with an understanding of the principles and concepts of production and quality management in the DoD acquisition environment. Topics include production planning and control, "lean" production, and bottleneck analysis; quality management systems, statistical process control, and six sigma; cost estimating methods, activity based costing, and progress payments in support of production; producibility; environmental, safety and occupational health; warranties; specs and standards reform; and the Defense industrial base. Prerequisite: MN3331 or MN3221 / MN3222 or MN3302 or consent of instructor.

**MN3392 Systems and Project Management (4-0) Summer**

Management ensures progress toward objectives, proper deployment and conservation of human and financial resources, and achievement of cost and schedule targets. Topics include strategic project management, project and organizational learning, lean thinking, cost, schedule planning and control, structuring of performance measures and metrics, technical teaming and project management, information technology support, risk management, and process control. Course delivery consists of lectures, speakers, case studies, and experience sharing, and reinforces collaborative project-based learning and continuous improvement. Prerequisite: MN3108.

**MN3402 Seminar in Installation Management I (0-2) As Required**

Introduces students to a variety of topics associated with the management of a complex military base installation. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

**MN3403 Seminar in Installation Management II (0-2) As Required**

Continuation of MN3402. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

**MN3471 Installation Management in the Armed forces (4-0) As Required**

Examines fundamental concepts of commanding and managing a typical base installation. Topics covered include: roles and mission, installation organizational structure, functions, duties and responsibilities of the organizational elements, personnel management, commercial activities and best sourcing, environmental management, facilities management, media and community relations, morale, welfare, recreation, retail, medical, dental, security, religious and emergency services, and munitions storage. Prerequisites: MN3402, MN3105, MN3161, MN3140, MN3172.

**MN3510 Defense Financial Management Practice (3-0) Fall/Spring**

This distance learning course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable, and revolving funds. Basic principles of fiscal law are explored. It then addresses financial management and stewardship topics including budgetary accounting, management of cost drivers, the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

**MN3610 Microeconomics for Operations Research (4-0) As Required**

Basic concepts involved in the decision processes of individuals and groups faced with scarcity of resources. Topics include consumer theory and demand, producer theory and supply, market structures, optimization and efficiency, partial and general equilibrium analysis, welfare analysis, and optimal investment decision rules. Applications focus on DoD's roles as demander and supplier of resources. A required course for 360 and 361 curricula. Prerequisite: None.

**MN3760 Manpower Economics I (4-0) Fall/Spring**

An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. Prerequisites: GB3040, GB4071.

**MN3801 Technology Transfer (4-0) As Required**

The study of dissemination and utilization of technology and associated problems, with emphasis on communications, sociology, and organizational factors. Course uses in-depth recent case studies to examine technology transfer issues of concern to the military. Also relies on guest speakers from military and private sector organizations. Prerequisite: MN3105 or consent of instructor.

**MN3900 Readings In System Management (V-0)  
Fall/Winter/Spring/Summer**

An individualized program of readings and study in some area of the systems management, designed to meet the student's special educational needs. Prerequisites: A background in the area of study and departmental approval; graded on a Pass/Fail basis only.

**MN3902 Computer Skills Enhancement (2-0)  
Fall/Spring**

An introduction to computer analysis of manpower data files. Topics include methods of file creation, storage, and transfer. Statistical concepts are applied using the SAS statistical software package. Taken concurrently with MN4110. Prerequisite: A course in statistics.

**MN4012 Management of Advanced Systems  
Engineering (2-2) As Required**

This course provides the student with an understanding of architecting, Object Oriented Systems Engineering, the Unified Modeling Language, and the control of complex projects with many Systems Engineers through the use of metrics. Specific emphasis is placed on exploring the relationship between science, art, deductive processes, inductive processes, systems engineering, and acquisition management. In order to solve today's complex problems, the student will become familiar with heuristic tools, progressive design, intersecting waterfalls, feedback architectures, spiral to circle acquisition, technological innovation, autonomous systems, and the rules of the political process as they affect system design. Case studies and projects will be used to evaluate and better understand the use of metrics. Prerequisite: EO4011 or consent of instructor.

**MN4053 Defense Budget and Financial Management  
Policy (4-0) Winter/Summer**

This distance learning course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the federal government. It begins with a summary of the current threat situation and potential changes to it. Once the threat is defined, the study of the resource allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting and Execution system (PPBES) used by DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for

national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: None.

**MN4080 Research Colloquium (2-0) As Required**

Meetings are held throughout the thesis research process to integrate course work with thesis progress and results. Prerequisite: Consent of instructor.

**MN4090 Joint Applied Project I (2-0)  
Fall/Winter/Spring/Summer**

Intended to help students attack unstructured managerial problems. Student teams must determine the organizational objective and identify what the underlying issues are; determine the most appropriate tools from the curriculum to apply in order to provide insight into these issues; and recommend appropriate courses of action. Graded course. Prerequisite: None.

**MN4091 Joint Applied Project II (2-0)  
Fall/Winter/Spring/Summer**

Intended to help students attack unstructured managerial problems. Student teams must determine the organizational objective and identify what the underlying issues are; and determine the most appropriate tools from the curriculum to apply in order to provide insight into these issues; and recommend appropriate courses of action. Graded course. Prerequisite: None.

**MN4101 Leadership In The Military Culture (2-0) As  
Required**

This course focuses on the relationships between leaders and the aspects of their organizations that are moderated by culture: people, tasks, missions, goals, structure, and strategies. Assessment and implementation techniques are studied to enable leaders to achieve a desired culture state leading to positive organizational outcomes. Prerequisites: MN3101 and MN3102.

**MN4103 Installation Strategic Management (4-0) As  
Required**

Study and analysis of complex managerial events confronting Installation Commanders and how to produce optimal cost effective solutions. Throughout this course, the student will apply critical thinking to achieve tactical and strategic objectives through comprehensive integrated decision making. Area of study includes: strategic planning, operational support, crisis management, strategic integrations with DoN and DoD organizations, and the effects of current legislative changes. Prerequisites: MN3105, MN4125, MN4145, MN4472.

**MN4104 Strategic Management Issues In Military  
Organizations (3-0) As Required**

Examination of strategic management from the perspective of leadership in military education and training organizations. This course explores strategic planning, policy formulation, and organizational adaptation with a dual emphasis on understanding the concepts as well as acquiring the ability to isolate and communicate concepts relevant to developing subordinates. Prerequisites: MN3101, MN3102, MN3103, MN3104, MN3129, and MN4101.

**MN4105 Strategic Management (3-0)****Fall/Winter/Spring/Summer**

Strategic Management entails the establishment of an organization's direction and the implementation and evaluation of that direction given the organization's external environment and its internal capabilities. The principal aim of this course is the transfer and adaptation of the principles of business strategic management to the Department of Defense and other federal agencies. In previous courses, students concentrate on the functional elements of management (e.g., accounting, finance, acquisition, logistics, contracting, etc.). This course addresses the challenges of setting direction and implementing strategies for the total system or whole organization. Cases and approaches from the public and private sectors enable students to develop the knowledge, skills, and abilities to strategically think, plan, and manage. Prerequisites: MN3115, MN3012.

**MN4106 Manpower / Personnel Policy Analysis (4-0)****Winter/Summer**

Study and analysis of military manpower / personnel policy alternatives with emphasis on identifying the trade-offs involved, the dynamic impact of major policy decisions and the short-term and long-term consequences of decisions. Review, use and evaluation of tools to aid in selecting policy alternatives. Analysis of issues in the DoD and military services. Prerequisites: MN3760, MN4111.

**MN4107 Systems Thinking and Modeling for a Complex World (4-0) Fall/Winter/Spring/Summer**

This course introduces you to System Dynamics modeling for the analysis of organizational policy and strategy. You will learn to visualize an organization in terms of the structures and policies that create dynamics and regulate performance. The goal is to use the analysis and modeling techniques of System Dynamics to improve understanding of how complex organizational structures drive organizational performance, and then to use that understanding to design high leverage interventions to achieve organizational goals. We use role-playing games and computer-based simulations called "microworlds," where space and time can be compressed, slowed, and stopped so we can experience the long-term side effects of decisions, systematically explore new strategies, and develop our understanding of complex systems (analogous to the "flight simulators" that pilots use to learn about the dynamics of flying an aircraft). The course presents system dynamics with a minimum of mathematical formalism. The goal is to develop the students' intuition and conceptual understanding, without sacrificing the rigor of the scientific method. (No prior computer modeling experience is needed.) Prerequisite: None.

**MN4110 Multivariate Manpower Data Analysis I (4-1)****Winter/Summer**

An introduction to multivariate data analysis. This section will focus on the tools necessary to perform data analysis. The primary goal of this course is to introduce multiple linear regression models. The second goal involves making correct inferences and interpretations of the findings. Special topics include hypothesis testing, model specification issues, multicollinearity, dummy variables, and research methodology. Prerequisite: GB3040 or consent of instructor.

**MN4111 Multivariate Manpower Data Analysis II (4-1)****Fall/Spring**

An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include advanced linear estimation techniques, such as panel data analysis and two-stage models. In addition, nonlinear methods are introduced, such as binary choice models and survival analysis. The course also covers special techniques for policy evaluation and reduction of estimation bias due to omitted variables or sample selection. Students apply techniques to manpower databases. Prerequisite: MN4110, or consent of instructor.

**MN4113 Military Sociology / Psychology: Leadership Dimensions (2-0) As Required**

Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting, with specific emphasis on leadership applications. Study of the military as a social institution, focusing on the internal organizations and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of psychological and sociological principles employed in a variety of research areas such as recruit screening and job classification, personnel adaptability and trainability, the military family, population representation, diversity, equal opportunity, personnel security, institutional versus occupational constructs, the military life course, and civil-military relations. Extensive use of representative cases in DoD and the U.S. armed forces as well as cases in the militaries of other nations. Prerequisite: MN3101.

**MN4114 Sociological and Psychological Perspectives on Military Service (4-0) Winter/Summer**

Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting. Study of the military as a social institution, focusing on the internal organization and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of the psychological principles employed in a variety of military areas such as health care, selection and job classification, human factors, organizational systems, personnel security, and performance appraisal. Emphasis on representative cases in DoD and the armed forces. Prerequisite: GB3010.

**MN4115 Foundations of Education and Learning in DoD Organizations (4-0) Fall/Spring**

Analysis of issues in DoD education, learning and training (ELT). Major course themes focus on understanding adult military ELT from a strategic systems perspective; analyzing instructional program design, implementation, and technologies and applying methods of needs analysis and program evaluation. Examination of how DoD can become a learning organization to respond to the dynamic demands of both the organization and its military members. Guest speakers, military publications, student cases, and discussion based on the experience of the instructor and the students are utilized to maintain the necessary focus on current military applications. Prerequisite: GB3010.

**MN4116 Society of Human Resource Management (0-3) Fall/Spring**

This course prepares students for taking the Human Resource Certification Institute (HRCI) certification examination.

Prerequisite: Enrollment in the MSA curriculum and consent of instructor.

**MN4118 Modeling for Decision Support in Manpower Systems (3-2) Fall/Spring**

An introduction to applied manpower models and modeling techniques. Students will gain insight into how models are used by policy makers in the decision process and into the complexity of the military manpower system. Several models that are currently used by the Bureau of Naval Personnel and Headquarters USMC will be analyzed, including accession planning, sea-shore rotation policy, promotion planning and inventory projection models. Other topics covered include the manpower planning process, types of models, model evaluation and good modeling practices. Prerequisites: GB3040, GB4043, OS4701 (may be taken concurrently).

**MN4119 Navy Manpower Requirements Process (3-0) Winter/Summer**

An in-depth analysis of fleet and shore unit Manpower requirements and personnel documents. The course will cover the determination and validation of fleet requirements as they pertain to an operational unit's Required Operational Capabilities and Projected Operational Environment and the resulting Ship Manpower Document (SMD), Squadron Manpower Document (SQMD), and Fleet Manpower Document (FMD); and how the Shore Manpower Requirements Determination Process (SMRDP) links the Mission, Function and Task statement to the resulting Statement of Manpower Requirements (SMR). The course covers how fleet and shore manpower documents link with the Activity Manpower Document (AMD). The Personnel sub-process will be studied as it relates to the Enlisted Distribution and Verification Report (EDVR) in support of fleet readiness. Prerequisites: Enrollment in the MSA curriculum and consent of instructor.

**MN4120 Managing Diversity (3-0) As Required**

Individual differences in the workplace and how these differences inhibit and enhance the way people work together are examined. The leader's roles in creating a cohesive organization in which every individual can achieve his or her maximum potential and productivity are explored. Prerequisites: MN3104 and MN3138.

**MN4121 Organization Theory (4-0) Winter/Summer**

Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenomena from multiple perspectives, using theories of individual, group, and organizational behavior. Topics include organization design and culture, political analysis of organizations, management of change, open systems theory, and contingency theories. Prerequisite: MN3105.

**MN4122 Planning and Control: Measurement and Evaluation (4-0) Fall**

Theory and techniques of the managerial functions of planning and control in both governmental and private sector organizations. Emphasis is placed on the effects of the planning and control structure on the behavior of human components of the system. Examples are drawn extensively from the governmental sector. Topics include the problems associated with the utilization of surrogates for measurement purposes, the analysis of the influence of assumptions, values, and objectives on the planning and control process, budgeting,

forecasting, performance evaluation, and the reward structure. Prerequisite: MN4161.

**MN4123 Organizing and Planning In Complex Networks (4-0) Summer**

In 21st century operational and policy settings, people are expected to work in networks to get things done. Operating beyond the boundaries of any one organization in an inter-organizational domain, network members are called upon to join forces and work collaboratively with others. Network collaborations are difficult, however, because they challenge traditional management assumptions. Members must coordinate without hierarchy, lead without formal authority, and solve problems and make decisions without someone being "in control:" or "in charge." This course provides the basic knowledge, skills, and abilities to enable students to work collectively in networks, especially those with members who come from different cultural, ethnic and national organizations. With the use of cases, experiential exercises, and simulations, students learn how to craft and execute collaborative strategies to improve network performance. Prerequisite: Consent of instructor.

**MN4124 Defense Management of Change (3-0) Summer**

Review and evaluation of techniques and strategies for planning and managing change efforts in complex social systems. This course emphasizes implementing change in military organizations in which leadership development is a key concern -- for example, military education and training institutions. Examples are provided through course work to address the unique nature of managing change within the culture and structure of the military. Prerequisites: MN3103, MN3104, and MN3129.

**MN4125 Managing Planned Change in Complex Organizations (4-0) Winter/Summer**

Examination of the approaches to planning and managing change efforts in complex social systems made up of the interdependent components of technology, structure, task, and people; and of the role of the manager or staff specialist; and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at effective implementation. Course provides opportunities for practice using both simulations and actual organizational cases. Particular emphasis is placed on the DoD/ DoN organizations and the special problems they have in bringing about change. Prerequisite: CC3000 or consent of instructor.

**MN4127 Seminar In Organization Behavior (V-0) Fall/Spring**

Study of a variety of topics of current interest in organization behavior, to be determined by the instructor. Prerequisites: A background in organization behavior and consent of instructor.

**MN4129 Performance Assessment (2-0) As Required**

Theory and methods of assessing the performance of individuals and organizations are studied. Applications are provided that use leadership-related data on midshipmen. Students use data to assess leadership potential of subordinates. Prerequisites: MN3160, MN3162.



**MN4130 Marine Manpower Management (3-0)****Winter/Summer**

Upon completion of this course, the student will have an in-depth understanding of USMC Manpower Management and implementation of management policy techniques through analysis, procedures, organizational and administrative actions to better staff Headquarters Marine Corp management policy issues. USMC officers will gain insight into management actions that support budget requirement requests and the resource allocation efforts subsequent to budget approval. Each officer will develop an understanding of the relationship between the Table of Organization (T/O), Troop List (TL) and the Authorized Strength Report (ASR). Each officer will complete an UNS report. Graded (3-0). Prerequisite: MN2111 or consent of instructor.

**MN4143 Defense Manpower and Personnel Analysis (2-0) As Required**

This course applies the statistical tools developed in MN3162 in the analysis of DoD/DoN manpower and personnel issues. The focus is on officer personnel issues. Topics include officer accession programs, training, performance measurement, retention, promotion, the structure of career paths, and compensation systems. Prerequisites: MN3160 and MN3162.

**MN4145 Policy Analysis (4-0) Fall/Spring**

Develops the tools and techniques of economic efficiency to assist public sector decision makers in analyzing resource allocation in government activities. Focuses on developing the principles of cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). Stresses the application of CBA and CEA to specific investment projects, programs, and policies in the federal government, especially in the Department of Defense. Prerequisites: MN3140, MN3161, and OS3101 or equivalent.

**MN4151 Internal Control and Auditing (2-0) Spring**

Study of the objectives and activities of internal control. Overview of audits of financial reports and records, and of government operations, in accordance with Government Auditing Standards. Specific topics include the design and evaluation of internal controls, auditing standards, audit reports, audit evidence, and audit tests. Prerequisite: MN3161.

**MN4152 Corporate Financial Management (4-0)****Winter/Summer**

This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision making process encountered by commercial enterprises, with particular emphasis on risk analysis, valuation models, cost of capital determination, optimal capital structure, short term financing, and working capital management. Prerequisite: MN3161.

**MN4154 Applied Ethics (4-0) Fall/Spring**

An examination of ethical issues in a managerial environment. Students will recognize ethical problems in the context of organizational activity and develop knowledge and skills for dealing with them from a moral point of view. Focus is on three aspects of managerial behavior and leadership: defining and maintaining an ethical framework for the organization, establishing a structure to ensure that organizational members act in ethically appropriate ways, and developing attitude, skill

and knowledge to make decisions that are ethically sound.

Prerequisite: None

**MN4157 Seminar in Management Accounting I (3-0)****Winter/Summer**

This course complements the financial management program by covering significant topics not otherwise included in the program to prepare students to obtain the Certified Management Accountant (CMA) and/or Certified in Financial Management (CFM) designation. This course covers topics in business analysis, corporate financial management, management accounting and reporting, and strategic management. This course reviews, in more depth, topics covered in the introductory financial and cost management course. Specific topics addressed in the course may vary. Prerequisite: GB3050 and GB3051.

**MN4158 Seminar in Management Accounting II (0-2)****As Required**

Complements the financial management program by covering significant topics not otherwise included in the program. These topics are integrated into financial management as a whole. A strong emphasis is placed throughout on motivational and ethical considerations. Topics include foreign currency translation and transactions, fund accounting, branch office accounting, fiduciary accounting, the differences and responsibilities of external and internal auditing, and the design of accounting information systems. Prerequisite: None.

**MN4159 Financial Reporting and Analysis (4-0) Spring**

Advanced study of accounting concepts underlying published financial reports. Emphasis is placed on the evaluation of financial reporting approaches and measures from the perspective of managers and users of financial information. Topics include accounting policies and standards; asset and liability recognition and valuation; income measurement; and the use of financial report information in financial analysis. Course project investigating financial reporting in DoD settings. Prerequisite: MN3161.

**MN4161 Management Control Systems (4-0)****Winter/Summer**

Study of the design, implementation, and evaluation of management planning and control systems in Navy and Defense organizations with comparisons to large, complex private sector organizations. Specific topics include the need for planning and control, strategic planning, the resource allocation process, organization of the management control function, measurement of inputs and outputs, pricing government services programming, budgeting, reporting, and performance evaluation. Prerequisites: MN3105 and MN3161.

**MN4162 Strategic Cost Management (4-0)****Winter/Summer**

Examines cost accounting and cost management concepts and policies used to identify, measure, and report cost information for strategic decision making and long-term resource allocation. Includes the study of alternative cost allocation systems, activity-based management, benchmarking, target costing, and value chain analysis. Also covered are the Cost Accounting Standards used by the federal government for negotiated procurement contracts. Prerequisite: MN3161.

**MN4163 Decision, Cost and Policy Analysis (4-0)****Fall/Spring**

Study of sophisticated analytical methods for various cost, policy and decision scenarios in DoD and other organizations. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are pertinent segments of DoD instructions in economic analysis, program evaluation, and risk management, relevant quantitative techniques for decision analysis, the conditions for successful applications, data needed for applications, and the use of computational aids for problem solving. Prerequisites: MN3161 and OS3101.

**MN4301 Contracting for Major Systems (4-0) Summer**

This course is the study of the major systems contracting process, procedures, and practices. Topics include contracting organizations for systems acquisition, systems acquisition process, business clearance process, source selection, multi-year procurement, pricing, and administration of major systems contracts. Related topics include funding, reliability/maintainability, logistics support, research and development, test and evaluation, and congressional activity. Prerequisite: MN3315.

**MN4302 Defense Resource Policy and Management (V-0) As Required**

National defense and Navy policy formulation and execution and its impact on the defense budget. Analysis of contemporary defense policy and management issues and their resource implications. Relationships between DoD, the Navy and other military departments, Congress, and the defense industry in the policy and resource decision making process. Textbook written specifically for this course by instructor: Reinventing the Pentagon. Prerequisite: MN3172.

**MN4304 Defense Systems Contracting (2-0) Winter/Summer**

This course is the study of the DoD's major systems contracting policies, processes, procedures, and practices. A review of major systems acquisition and program management is provided but the primary focus is on the contracting process used to acquire defense systems for the various services. The topics covered include: acquisition environment, acquisition strategy, source selection, incentive contracting, alpha contracting, multi-year procurement, and requirement/capability specifications. Prerequisites: MN3331 or MN3222.

**MN4305 Defense Technology Policy (4-0) As Required**

This seminar examines the problems of identifying and acquiring U.S. military technology in the post - cold war environment. Readings in the literature of defense technology, bureaucracy and economics explore changes in the defense technology base, developments in DoD technology policy and organization, including the defense laboratories, defense cooperation, foreign dependence, technology security, shifts in U.S. economic policy, and assets and the evolution of global technological capabilities, especially in the Asia-Pacific region. Prerequisite: MN3172 or consent of instructor.

**MN4306 Research & Development Contracting (2 - 0) As Required**

This course focuses on the issues and problems associated with contracting for research and development requirements.

Additionally, methods for acquiring R&D, such as using Other Transactions (OT) authority and Federally Funded Research & Development Centers (FFRDCs) are explored. Prerequisite: MN4473 or consent of instructor.

**MN4307 Program Management Policy and Control (4-0) Fall/Winter/Spring/Summer**

This course provides the student with knowledge and understanding of major systems management control processes and tools, application of program management control systems and the use of computer-based management information systems with emphasis on real world, practical systems for performance, cost and schedule control. Case studies involving program management problem solving and decision making in the acquisition environment are used. Prerequisites: MN3331/or MN3302, MN3309, MN3371, MN4602 or equivalent, EO4011 and MN3384.

**MN4308 Field Contract Management (2-0) As Required**

Examines procurement at the installation and center level. Emphasis is on (1) simplified acquisition procedures, (2) contracts for other than major systems, (3) services contracting, and (4) contracting for information technology resources. Prerequisite: MN4473 or consent of instructor.

**MN4309 Facilities Contracting (2-0) As Required**

This course is a concentrated analysis of facilities, construction utilities and architecture-engineering contracting. It focuses on the contract formation and contract administration requirements in these areas. Topics covered include cost estimating and analysis for construction, design-build, pre and post award contract actions, environmental remediation, energy contracting, base operating support contracts, contractor performance evaluation, leases and easements, A-76 public/private competitions, outsourcing, privatization, public/private ventures and base closure issues. Prerequisite: MN4473 or consent of instructor.

**MN4310 Logistics Engineering (4-0) Fall/Spring**

The concept of integrated logistics support in the design and maintenance of weapon systems. Operational requirements, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, test and evaluation, production, spare/repair parts management are discussed. This course also covers topics in logistics information technology, inventory management culture and commercial-sector best practices for military. Case studies include logistics life cycle cost, reliability and readiness analysis for major weapon systems Prerequisite: GB4043, OS3006, (both may be taken concurrently).

**MN4312 Simulation Modeling for Managerial Decision Making (4-0) As Required**

Modeling and analysis of computer simulation for managerial decision making. Case studies of simulation modeling applications to weapon system acquisition, logistics, transportation, distribution, communications and production systems. Prerequisite: Introductory probability and statistics (taken concurrently).

**MN4333 Media Relations and Crisis Communications (2-1) As Required**

This course examines strategies for developing, maintaining, and enhancing base-community relations as a means of forming partnerships with the community. Students will learn to make strategic media choices so as to develop effective

media campaigns, interact effectively with the print and broadcast news media, and handle press conferences and similar media events. Particular attention is focused on anticipating and handling crisis communication. Specifically, students will learn to organize crisis management teams, develop crisis management plans, and create communication plans to manage information and public perception. Prerequisite: MN3333.

**MN4366 Program Management and Leadership (4-0) As Required**

This course provides the student with knowledge and understanding of major systems management control processes and tools, application of program management control systems and the use of computer-based management information systems with emphasis on real world, practical systems for performance, cost and schedule control. Case studies involving program management problem solving and decision making in the acquisition environment are used. Prerequisites: MN3331/or MN3302, MN3309, MN3371, MN4602 or equivalent, EO4011 and MN3384; or MN3361, MN3362, MN3363, MN3364, MN3365.

**MN4371 Acquisition and Contracting Policy (4-0) Fall/Spring**

This course uses case studies and current acquisition issues to analyze government and business acquisition/contracting policies. Emphasis is on acquisition decision making and policy formulation/execution. Prerequisites: MN3304 and MN3312 (or equivalent)

**MN4374 Seminar In Acquisition Management: Strategic Purchasing (3-0) Fall/Spring**

This course is a graduate-level seminar in strategic purchasing. The primary purpose and objective of MN4374 is to provide the student with an opportunity to review and analyze the concepts and disciplines of strategic purchasing, to demonstrate critical analysis and thinking skills in applying strategic purchasing management and execution to make DoD and other agencies "world-class" buying organizations. A second purpose is to investigate the specific topics, concepts and theories that are projected to be of high interest to DoD acquisition activities of the future. The course is divided into three components. The MN4374 course includes 15 blocks of instruction, focusing on those areas of the world-recognized Institute for Supply Management as world-class business practices for progressive purchasing. Specific cases and in-class "exams" are designed to reinforce class readings and discussions. The course is designed to capitalize on the foundations provided by MN3303, MN3306, and MN3307. Critical thinking and analytical skills are developed in designing and executing the most efficient and effective purchasing organizations and associated business processes. Prerequisite: None

**MN4376 Defense Transportation System (4-0) As Required**

Study and analysis of the structure and environment of the Defense Transportation System. Topics include organizations providing transportation support for war and other operations, strategic mobility triad, and studies of defense transportation issues. Prerequisites: MN3373 or consent of instructor. Classification: An active SECRET clearance.

**MN4377 TQM/TQL: Philosophy, Theory, Tools (4-0) As Required**

Deming's 14 points (philosophy and basic theory). The seven basic graphic tools (flow charts, cause and effects diagrams, Pareto charts, histograms, scatter diagrams, run charts and control charts), which help analyze generic processes. Advanced theories and techniques, designed to address quality issues of specific types, including SMED (Single minute exchange or die, or setup reduction), Poka-Yoke (mistake proofing), Synchronized Operations (also known as Just-In-Time), and Statistical Experimental Methods for off-line quality improvement such as Taguchi Methods, and Group Technology. Discussions of how methods developed predominantly in the manufacturing environment are used in services. Prerequisite: Any 3000 level course in probability and statistics.

**MN4379 Operations Management (4-0) Winter**

This course introduces students to problems and analysis related to the design, planning, control, and improvement of manufacturing and service operations. It will extensively utilize case studies and analytical problem sets. Topics include operations strategy, process analysis, project analysis, materials management, production planning and scheduling, quality management, computer-aided manufacturing, capacity and facilities planning, and theory of constraints applied to product development. The course will equip students with the basic tools and techniques used in analyzing operations, as well as the strategic context for making operational decisions. Prerequisites: MN3108, MN3117, and OS3211, or consent of instructor.

**MN4470 Strategic Planning and Policy for The Logistic Manager (4-0) Winter/Summer**

The course explores and analyzes the concepts, processes and methods of strategic logistics planning and execution, emphasizing proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life cycle management of fielded systems. The course will examine and analyze key opportunities for maximum logistics influence in requirements development, contracting, test and evaluation, reliability and maintainability, as well as financial management and communications. The course will feature logistics management relevance to service roles and missions. The course will employ lectures, guided discussions, case studies, role-playing, panel discussions and lessons learned in the DoD acquisition environment. Upon successful completion of the course, the student will be awarded a DAWIA (Defense Acquisition Workforce Improvement Act) Level III certificate for Acquisition Logistics. Prerequisite: GB4410 or consent of instructor.

**MN4472 Base Installation Issues ( 4-0) As Required**

This course critically examines complex issues associated with base installation management. Students will analyze facility management issues ranging from defining resource requirements and budget planning to mission execution. Cases, student exercises, and selected readings will be used throughout the course. Students will also examine emergent issues in a fiscally constrained and politically sensitive environment. Prerequisite: MN3471.

**MN4473 Strategic Acquisition and Contract Management (4-1) As Required**

Tailored toward the students in the class, the course examines the unique contracting issues/problems encountered in a variety of organizational situations. Analysis, discussion and potential resolution of actual working problems are undertaken. A comprehensive written case study is the capstone effort in the course for each student. Students will be grouped into teams simulating integrated product team (IPT) organization to address various issues germane to the students' organizations. Prerequisite: MN3342.

**MN4474 Organizational Analysis (2-0) As Required**

This course concentrates on analysis of acquisition organizations from an open systems perspective. Focus is on tools and techniques for diagnosing managerial problems by analyzing structure, task requirements, technology, culture, and various organizational subsystems. The course emphasizes application in that students complete a course project requiring integrated application of the systems model in an analysis of their own acquisition organization. Prerequisite: MN3115.

**MN4500 Productivity Analysis (4-0) As Required**

Study of the theoretical and institutional foundations of the analysis of productivity measurement and enhancement programs in DoD. Emphasis is placed on methods of applying microeconomic and organizational effectiveness principles and concepts to the critical analysis of proposed and existing DoD productivity programs, as well as to the development of alternatives that have higher probabilities of affecting the desired increases in program effectiveness and efficiency. Prerequisites: MN3105 and MN3140.

**MN4602 Test and Evaluation Management (2-0) Fall/Winter/Spring/Summer**

Designed to cover Developmental, Operational and Joint Test and Evaluation, including planning concepts and procedures frequently used in test and evaluation programs. Taught from the perspective of the Program Manager, Test Project Officer and Test Engineer. Actual military cases are used for examples. Topics include the role of Test and Evaluation in Systems Engineering and Acquisition Management, DT and OT test planning, introduction to test design, conduct of tests, live fire testing, modeling and simulation, human systems integration (HIS), reporting of test results, range and resource issues, and lessons learned. Student teams will write a detailed test plan. Prerequisite: MN3302.

**MN4613 Theory and Practice of Systems Analysis (4-0) As Required**

Systems analysis (cost-effectiveness analysis) formulated as capital investment decision models. Topics include the nature of opportunity costs, theory of the second best, the social discount rate, methods of risk assessment, modeling, and solution computation. Planning and control models emphasizing decentralization of the decision problem are also addressed. DoD cost effectiveness models are examined, and institutional procedures and processes of DoD, such as PPBS, FYDP, and DAB, are discussed. Prerequisite: MN3610.

**MN4650 The Military Health Care Delivery System and Analysis (4-0) Fall/Winter/Spring/Summer**

This course is designed to acquaint the student with the structure and operation of the Department of Defense's

system for providing health care to those eligible under current regulations; to identify current problem areas; and, through application of systems analysis and management techniques, to address the possible solutions to these problems in a course project. Prerequisite: Consent of instructor.

**MN4760 Manpower Economics I ( 4-0 ) Fall/Spring**

An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. Prerequisite: None.

**MN4761 Applied Manpower Analysis (4-0) Winter/Summer**

Application of theoretical models and quantitative techniques to Navy and DoD manpower, personnel, and training issues. Topics include application of cost-benefit and cost-effectiveness analysis techniques to manpower policies, manpower supply models, attrition and reenlistment models, force structure analysis, manpower productivity, and compensation systems. Course uses specialized readings in DoD and Navy manpower. Prerequisites: MN3760 and MN4111.

**MN4790 Managing Diversity (4-0) Spring**

This is an experiential course developing awareness, understanding, and leadership action for managing diversity and inclusion in the uniform and civilian military. The course explores social constructs of gender, race, class, and culture; builds personal, leadership, and organizational skills for addressing diversity and inclusion issues; and develops the competency of leaders to respond effectively to the opportunities and the challenges posed by the increasing presence of diversity in the military. The objective of managing inclusion is to maximize the organization's performance through understanding, valuing, and leveraging diversity both in the workplace and in the customer base. Managing diversity competency is developed through personal and organizational introspection and change. Graded on a Pass/Fail basis only. Prerequisite: None.

**MN4900 Readings in Management (V-0) Fall/Winter/Spring/Summer**

An individualized program of advanced readings and study in some area of Systems Management. Prerequisites: A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

**MN4970 Seminar in Strategic Management (4-0) Fall**

Study of a variety of topics of general interest in the systems management, to be determined by the instructor. Prerequisites: A background in systems management and consent of instructor.

**MN4999 Elective (4-0) As Required**

Course elective.

**PD Courses****PD0810 Thesis Research (0-8) Fall/Winter/Spring/Summer**

Thesis research for PD21 students.

## GRADUATE SCHOOL OF ENGINEERING AND APPLIED SCIENCES (GSEAS)

### Website

www.nps.edu/Academics/GSEAS

### Dean

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### The Graduate School of Engineering and Applied Sciences consist of seven Departments, two Committees, and one Academic Group:

Department of Applied Mathematics	MA
Department of Electrical and Computer Engineering	ECE
Engineering Acoustics Academic Committee	EAAC
Department of Mechanical and Astronautical Engineering	MAE
Department of Meteorology	MR
Department of Oceanography	OC
Department of Physics	PH
Space Systems Academic Group	SP
Department of Systems Engineering	SE
Undersea Warfare Academic Committee	UWAC

### Overview

The Graduate School of Engineering and Applied Sciences (GSEAS) supports the Navy and the Department of Defense by educating future leaders to lead, innovate and manage in a changing, highly technological world, and by conducting research recognized internationally for its relevance to national defense and academic quality. More specifically, GSEAS provides advanced technical and scientific knowledge and understanding so graduates:

- understand the capabilities and limitations of current and future technologies in battle space environments

- understand and apply emerging and advanced technologies to enhanced war fighting capabilities
- are able to grow, anticipate, respond and lead in future complex, rapidly changing technological environments
- are able to represent their organization's technical needs and interests with and within myriad constituencies, to include DoD, the Joint Staff, and industry

GSEAS accomplishes the above by offering high quality, traditional academic degrees that include:

- Science and engineering curricula tailored to the needs of naval communities and other DoD constituents
- Research programs funded by the defense community, aligned to future capabilities--integrated into curricula and courses
- Hands-on education--classroom theory linked to real-world experiences in laboratories, experiments, testing--often classified
- Blending current operational experience of students, emerging technologies, and cutting-edge faculty in a joint, international culture
- Life changing education--transforming officers into technical generalists, sub-specialists and war fighters

### Curricula

Traditional degree granting programs are offered by departments, normally at both the master's and Ph.D. levels. Most of these degree programs are an integral part of one or more unique interdisciplinary curricula designed for relevance to national security needs. Each of these curricula infuses cutting edge knowledge into academic courses taught by a dedicated, world-class faculty:

Applied Mathematics (380)  
Combat Systems Sciences and Technology (533)  
Electronic Systems Engineering (Distance Learning) (590)  
MAE Reactors/Mechanical Engineering (Distance Learning) (571)  
Mechanical & Astronautical Engineering (570)  
Meteorology (372)  
Meteorology and Oceanography (373)  
Oceanography (440)  
Operational Oceanography (374)  
Space Systems Engineering (591) \*  
Space Systems Operations (366) \*

Space Systems Operations (International) (364)  
 Systems Engineering (580)  
 Systems Engineering and Analysis (308) \*  
 Systems Engineering Certificate (282)  
 Systems Engineering (Distance Learning) (311) \*  
 Systems Engineering Management (MSSEM) /  
 Product Development (Distance Learning) (721)  
 Underwater Acoustics (Distance Learning) (535)  
 Undersea Warfare (525)  
 Undersea Warfare (International) (526) \*

\*Indicates an interdisciplinary curriculum offered with the Graduate School of Operations and Information Sciences

### Degrees

Within each of these curricula, students have the opportunity to earn a high quality academic degree while focusing on an area relevant to national defense and war fighting capabilities. For example, a student enrolled in Space Systems Engineering (Curriculum 591) has an opportunity to study and do research related to space systems while earning an academic degree from either the Department of ECE, PH, MAE, SE or CS (Computer Science). Student research is under the tutelage of faculty with research experience related to national security and is an integral part of the educational experience of each student.

GSEAS offers the following degree programs, each designed and evolved to meet the changing needs of the Navy and defense communities while maintaining high academic standards:

Master of Science in Applied Mathematics, Ph.D. in Applied Mathematics

Master of Science in Applied Physics, Ph.D. in Applied Physics

Master of Science in Applied Science

Master of Science in Astronautical Engineering, Astronautical Engineer, Ph.D. in Astronautical Engineering

Master of Science in Combat Systems Technology

Master of Science in Electrical Engineering, Electrical Engineer, Ph.D. in Electrical & Computer Engineering

Master of Science in Engineering Acoustics, Ph.D. in Engineering Acoustics

Master of Science in Engineering Science

Master of Science in Mechanical Engineering, Mechanical Engineer, Ph.D. in Mechanical Engineering

Master of Science in Meteorology, Ph.D. in Meteorology

Master of Science in Meteorology and Physical Oceanography

Master of Science in Physical Oceanography, Ph.D. in Physical Oceanography

Master of Science in Physics, Ph.D. in Physics

Master of Science in Systems Engineering

Master of Science in Systems Engineering and Analysis

### Department of Applied Mathematics

#### Chairman

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**Carlos Borges**, Professor and Associate Chair for Research (1991)\*; Ph.D., University of California, Davis, 1990.

**David Canright**, Associate Professor and Associate Chair for Labs and Computing (1988); Ph.D., University of California at Berkeley, 1987.

**Lester E. Carr, III**, Lecturer (2005); Ph.D., Naval Postgraduate School, 1989.

**Donald Alfred Danielson**, Professor (1985); Ph.D., Harvard University, 1968.

**Doyle Daughtry**, Lecturer (2004); MA, East Carolina University, 1973.

**Fariba Fahroo**, Associate Professor (1992); Ph.D., Brown University, 1991.

**Harold M. Fredricksen**, Professor (1980); Ph.D., University of Southern California, 1968.

**Christopher Frenzen**, Associate Professor (1989); Ph.D., University of Washington, 1982.

**Raluca Gera**, Assistant Professor (2005); Ph.D., Western Michigan University, 2005.

**Frank Giraldo**, Associate Professor (2006); Ph.D., University of Virginia, 1995.

**William Gragg**, Professor (1987); Ph.D., University of California at Los Angeles, 1964.

**Wei Kang**, Professor (1994); Ph.D., University of California at Davis, 1991.

**Bard Mansager**, Senior Lecturer (1991); M.A., University of California, San Diego, 1979.

**Beny Neta**, Professor, Associate Chair for Instruction and Academic Associate (1985); Ph.D., Carnegie-Mellon University, 1977.

**Guillermo Owen**, Distinguished Professor (1983); Ph.D., Princeton University, 1962.

**Craig Rasmussen**, Associate Professor (1991); Ph.D., University of Colorado at Denver, 1990.

**Clyde Scandrett**, Professor (1987); Ph.D., Northwestern University, 1985.

**Pantelimon Stanica**, Associate Professor (2006); Ph.D., State University of New York at Buffalo, 1998.

**Hong Zhou**, Assistant Professor (2004); Ph.D., University of California at Berkeley, 1996.

#### **Professors Emeriti:**

**Richard Franke**, Professor Emeritus (1970); Ph.D., University of Utah, 1970.

**Toke Jayachandran**, Professor Emeritus (1967); Ph.D., Case Institute of Technology, 1967.

**Gordon E. Latta**, Professor Emeritus (1979); Ph.D., California Tech, 1951.

**Arthur L. Schoenstadt**, Professor Emeritus (1970); Ph.D., Rensselaer Polytechnic Institute, 1968.

**Maurice Dean Weir**, Professor Emeritus (1969); D.A., Carnegie-Mellon University, 1970.

\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

#### **Brief Overview**

As well as the Master of Science and Ph.D. programs in Applied Mathematics, the Applied Mathematics Department offers individually tailored minor programs for many of the school's doctoral students. The majority of the department instructional—effort is devoted to the service courses offered.

#### **Degrees**

##### **Master of Science in Applied Mathematics**

To enter a program leading to the degree Master of Science in Applied Mathematics, a student must be qualified by background for a Bachelor of Science degree with a major in mathematics or with a strong mathematical orientation in physical science or engineering.

A program that leads to the Master of Science in Applied Mathematics degree for a student who has met the entrance criteria must contain a minimum of 45 quarter-hours of graduate-level courses with a minimum QPR of 3.0, subject to the following conditions:

1. The program must be approved by the Chairman of the Department of Mathematics and the Academic Associate.
2. The program must include at least fifteen hours at the 4000 level, with at least twelve hours in 4000 level mathematics courses.
3. The program must contain at least nine hours in an approved sequence of application courses from within the Applied Mathematics Department, or outside the department.
4. An acceptable thesis is normally required and is credited as the equivalent of nine hours of 3000 level mathematics courses. A student receiving a dual masters and writing a thesis in another department may petition the Chairman of the Applied Mathematics Department to substitute two or three approved courses for the thesis. The thesis, however, must contain a strong mathematical content.
5. Courses in the following areas are specifically required in any program; some of these courses may be used to satisfy part (or all) of the mathematics sequence requirement in item (3) above:
  - a. Real Analysis (a two-course sequence) and Modern Applied Algebra;
  - b. Ordinary and Partial Differential Equations
  - c. Numerical Analysis

- d. Probability and Statistics
- e. Linear Algebra (a two-course sequence)
- f. Mathematical Modeling Processes

In addition to the core courses required in item (3), the program allows the student to select an applied subspecialty option from the following list: applied mathematics, numerical analysis and computation, discrete mathematics, operations research, theoretical mathematics, and intelligence.

### Doctor of Philosophy

The Department of Applied Mathematics offers the Doctor of Philosophy in Applied Mathematics degree. Areas of specialization will be determined by the department on a case by case basis. Requirements for the degree include course work followed by an examination in both major and minor fields of study, and research culminating in an approved dissertation. It may be possible for the dissertation research to be conducted off-campus in the candidate's sponsoring organization.

Entrance into the program will ordinarily require a master's degree, although exceptionally well-prepared students with a bachelor's degree in mathematics may be admitted. A preliminary examination may be required to show evidence of acceptability as a doctoral student. Prospective students should contact the Chairman of the Applied Mathematics Department or the Academic Associate for further guidance.

### Certificate Program (Mathematics of Secure Communication)

The *Mathematics of Secure Communication* certificate program comprises four courses (MA3025, MA3560, MA4560, and MA4570), designated below by an asterisk. Upon successful completion of the coursework, students will be awarded a certificate of accomplishment, in keeping with standard practices of the Naval Postgraduate School. The purpose of this program is to provide mathematics education to naval officers and DoD civilians in the broad area of Cryptography and Secure Communications.

### Prerequisites

Prerequisites are as described in the course descriptions. If a student has not taken the prescribed prerequisites at NPS, then a validation examination by the Applied Mathematics Department may be substituted.

## Applied Mathematics Course Descriptions

### MA Courses

### MA125 Introduction to Finite Mathematics (No Credit) (Meets Last Six Weeks of Quarter) (3-0) As Required

An introduction to the elements of set theory and mathematical reasoning. Topics covered include: symbolic logic (propositional calculus, truth tables, predicates, and quantifiers); methods of proof (direct and indirect proof, mathematical induction, case analysis and counter examples); sets and set operations; relations and functions.

### MA0134 Problem Solving Session for MA1113/4 (No Credit) (0-3) Spring/Summer/Fall/Winter

Offered for no credit, pass/fail. Students must be concurrently enrolled in either MA1113 or MA1114, but the course is not mandatory for either course. Prerequisites: None.

### MA0156 Problem Solving Session for MA1115/6 (No Credit) (0-3) Spring/Summer/Fall/Winter

Offered for no credit, pass/fail. Students must be concurrently enrolled in either MA1115 or MA1116, but the course is not mandatory for either course. Prerequisites: None.

### MA0810 Thesis Research (0-8) As Required

Every student conducting thesis research will enroll in this course. Prerequisites: None.

### MA1010 Algebra and Trigonometry (4-0) As Required

Real number system, complex numbers, exponents and radicals, algebraic expressions and operations, linear and quadratic equations, inequalities, functions and graphs, polynomials and their zeros, rational functions, exponential and logarithmic functions, systems of equations, matrices, trigonometry and unit circles, trigonometric identities and functions. Prerequisites: None.

### MA1025 Finite Mathematics for Operations Research (4-0) As Required

An introductory course in logic and elementary discrete mathematics to be taken by students in the Operations Research curriculum. Considerable emphasis is placed on propositional and predicate logic, and on techniques of proof in mathematics. Mathematical topics include sets, functions, and relations. Coverage of combinatorics includes an introduction to permutations, combinations, the pigeon-hole principle, and the principle of inclusion/exclusion. No previous experience with this material is assumed. Prerequisites: None.

### MA1113 Single Variable Calculus (4-0) Spring/Summer/Fall/Winter

Review of analytic geometry and trigonometry, functions of one variable, limits, derivatives, continuity and differentiability; differentiation of algebraic, trigonometric, logarithmic and exponential functions with applications to maxima and minima, rates, differentials; product rule, quotient rule, chain rule; antiderivatives, integrals and the fundamental theorem of calculus; definite integrals, areas. Taught at the rate of nine hours per week for five weeks. Prerequisites: Pre-Calculus mathematics.

### MA1114 Single Variable Calculus II with Matrix Algebra (4-0) Spring/Summer/Fall/Winter

Topics in calculus include applications of integration, special techniques of integration, infinite series, convergence tests, and Taylor series. Matrix algebra topics covered are: the fundamental algebra of matrices including addition,



multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix; elementary matrices and inverses, together with the properties of these operations; solutions to  $m \times n$  systems of linear algebraic equations using Gaussian elimination and the LU decomposition (without pivoting); determinants, properties of determinants; and a brief introduction to the arithmetic of complex numbers and DeMoivre's theorem. Taught at the rate of nine hours per week for five weeks. Prerequisites: MA1113.

**MA1115 Multi Variable Calculus (4-0)**

**Spring/Summer/Fall/Winter**

Vector algebra and calculus, directional derivative, gradient, polar coordinates and parametric equations, functions of several independent variables, limits, continuity, partial derivatives, chain rule, maxima and minima, double and triple integrals, cylindrical and spherical coordinate systems. Taught at the rate of nine hours per week for five weeks. Prerequisites: MA1114.

**MA1116 Vector Calculus (3-0)**

**Spring/Summer/Fall/Winter**

The calculus of vector fields; directional derivative, gradient, divergence, curl; potential fields; Green's, Stokes', and the divergence integral theorems. Applications in engineering and physics. Taught at the rate of seven hours per week for five weeks. Prerequisites: MA1115.

**MA2025 Bridge to Advanced Mathematics (4-1)**

**Summer/Winter**

MA2025 is a first course in discrete mathematics for students of mathematics and computer science. Topics include propositional and predicate logic up to the deduction theorem, methods of mathematical proof, naive set theory, properties of functions, sequences and sums, mathematical induction, an introduction to divisibility and congruencies, and an introduction to enumerative combinatorics. Prerequisites: None, although a review of algebra skills is recommended.

**MA2043 Introduction to Matrix and Linear Algebra (4-0) As Required**

The fundamental algebra of vectors and matrices including addition, scaling, and multiplication. Block operations with vectors and matrices. Algorithms for computing the LU (Gauss) factorization of an  $M \times N$  matrix, with pivoting. Matrix representation of systems of linear equations and their solution via the LU factorization. Basic properties of determinants. Matrix inverses. Linear transformations and change of basis. The four fundamental subspaces and the fundamental theorem of linear algebra. Introduction to eigenvalues and eigenvectors. Prerequisites: Students should have mathematical background at the level generally expected of someone with a B.S. in Engineering, i.e., familiarity with Calculus and solid algebra skills. EC1010 (May be taken concurrently.)

**MA2121 Differential Equations (4-0)**

**Spring/Summer/Fall/Winter**

Ordinary differential equations: linear and nonlinear (first order) equations, homogeneous and non-homogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms. Applications include radioactive decay, elementary

mechanics, mechanical and electrical oscillators, forced oscillations and resonance. Prerequisites: MA1114.

**MA2300 Mathematics for Management (5-0)**

**Winter/Spring/Summer**

Mathematical basis for modern managerial tools and techniques. Elements of functions and algebra; differential calculus of single- and multi-variable functions; integration (antidifferentiation) of single-variable functions. Applications of the derivative to rates of change, curve sketching, and optimization, including the method of Lagrange multipliers. Prerequisite: College algebra.

**MA3001 Incremented Directed Study (Variable 1-0 or 2-0) (V-0) As Required**

Provides the opportunity for a student who is enrolled in a 3000 level mathematics course to pursue the course material and its applications in greater depth by directed study to the extent of one additional hour beyond the normal course credit. Prerequisites: Enrollment in a 3000 level mathematics course and consent of instructor.

**MA3025\* Logic and Discrete Mathematics (4-1) As Required**

Provides a rigorous foundation in logic and elementary discrete mathematics to students of mathematics and computer science. Topics from logic include modeling English propositions, propositional calculus, quantification, and elementary predicate calculus. Additional mathematical topics include elements of set theory, mathematical induction, relations and functions, and elements of number theory. Prerequisites: MA1025 or MA2025.

**MA3030 Introduction to Combinatorics and Its Applications (4-1) As Required**

Provides a thorough grounding in elementary combinatorics and its applications to computer science and discrete probability theory to students of computer science who concurrently take MA3025, Logic and Discrete Mathematics. Topics from combinatorics include fundamental counting rules, binomial and multinomial theorems, the pigeonhole and inclusion/exclusion principles, and homogeneous recurrence relations. Elementary discrete probability is covered, up to the expectation of a discrete random variable. Corequisite: MA3025.

**MA3042 Linear Algebra (4-0) As Required**

Finite-dimensional vector spaces, linear dependence, basis and dimension, change of basis. Linear transformations and similarity. Scalar product, inner product spaces. Orthogonal subspaces and least squares. LU (with pivoting), Cholesky, and QR factorizations. Eigenvalues/eigenvectors, diagonalization. Hermitian matrices, quadratic forms, definite matrices. Vector and matrix norms, orthogonal transformations, condition numbers. Prerequisites: MA1115 taken concurrently, MA1114.

**MA3046 Matrix Analysis (4-1) As Required**

This course provides students in the engineering and physical sciences curricula with an applications-oriented coverage of major topics of matrix and linear algebra. Matrix factorizations (LU, QR, Cholesky), the Singular Value Decomposition, eigenvalues and eigenvectors, the Schur form, subspace computations, structured matrices. Understanding of practical computational issues such as stability,

conditioning, complexity, and the development of practical algorithms. Prerequisites: MA2043 and EC1010.

**MA3110 Intermediate Analysis (4-0) Summer/Winter**

Multi-variable calculus integrated with linear algebra. Functions of several variables, continuous transformations, Jacobians, chain rule, implicit function theorem, inverse function theorem, extreme, optimization and Lagrange multiplier technique. Applications in Operations Research. Prerequisites: MA1115 and MA3042.

**MA3132 Partial Differential Equations and Integral Transforms (4-0) Spring/Summer/Fall/Winter**

Solution of boundary value problems by separation of variables; Sturm-Liouville problems; Fourier and Bessel series solutions, Fourier transforms; classification of second-order equations; applications, method of characteristics. Applications to engineering and physical science. Satisfies the ESR in differential equations for the Applied Mathematics program. Prerequisites: MA2121 and MA1116.

**MA3139 Fourier Analysis and Partial Differential Equations (4-0) Summer/Winter**

Fourier series; solution of the one and two-dimensional wave equations, D'Alembert's solution, frequency and time domain interpretations; Fourier integral transforms and applications to ordinary and partial differential equations and linear systems; Convolution theorems. Course covers basic material essential for signal processing, filtering, transmission, waveguides, and other related problems. Applications include spectral analysis of electronic signals, e.g., radar or sonar. Designed for UW and EW/IW students. Prerequisites: MA1115 and MA2121.

**MA3185 Tensor Analysis (3-0) Fall**

Definition and algebra of tensors. Dyadic representation in Cartesian and general components. Calculus of tensor fields in curvilinear coordinates. Derivation and application of the basic equations of heat conduction, rigid body mechanics, elasticity, fluid mechanics, electromagnetism, Newtonian and Einsteinian orbital mechanics. Prerequisites: MA1116.

**MA3232 Numerical Analysis (4-0) Spring/Summer/Fall/Winter**

Provides the basic numerical tools for understanding more advanced numerical methods. Topics for the course include: Sources and Analysis of Computational Error, Solution of Nonlinear Equations, Interpolation and Other Techniques for Approximating Functions, Numerical Integration and Differentiation, Numerical Solution of Initial and Boundary Value Problems in Ordinary Differential Equations, and Influences of Hardware and Software. Prerequisites: MA1115, MA2121 and ability to program in MATLAB and MAPLE.

**MA3243 Numerical Methods for Partial Differential Equations (4-1) Winter**

Course designed to familiarize the student with analytical techniques as well as classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning applicable algorithms, the student will be required to do programming. Topics covered include: Implicit, Explicit, and Semi-Implicit methods in the solution of Elliptic and Parabolic PDE's, iterative methods for solving Elliptic PDEs (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDEs. Prerequisites: MA3132 and the ability to

program in a high level language such as Fortran, C, or MATLAB.

**MA3261 Basic Parallel Computation (3-0) As Required**

The course has two goals: First, to introduce fundamental issues such as shared vs. distributed memory, connection topologies, communication algorithms, speedup, efficiency, storage requirements, granularity, pipelining, problem scaling, and useful paradigms for algorithm development. Second, to develop working proficiency by designing, implementing, and evaluating the performance of several parallel algorithms. These include, but are not limited to, numerical quadrature, matrix computations, sorting, network analysis, and dynamic programming. Prerequisites: MA1115 or MA3025 and ability to program in a high-level language.

**MA3301 Linear Programming (Same as OA3201) (4-0) As Required**

See OA3201 for course description.

**MA3393 Topics in Applied Mathematics (V-0) As Required**

A selection of topics in applied mathematics. The course content varies and the credit varies. This course is intended to reflect study for the beginning graduate student in an area for which no formal course is taught. Credit for this course may be granted more than one time to an individual student. Prerequisites: Consent of instructor.

**MA3560\* Applied Modern Algebra and Number Theory (4-0) As Required**

This course is devoted to aspects of modern algebra and number theory that directly support applications, principally in communication. The algebraic emphasis is on ring and field theory, with special emphasis on the theory of finite fields, as well as those aspects of group theory that are important in the development of coding theory. Elements of number theory include congruences and factorization. Applications are drawn from topics of interest to DoN/DoD. These include error correcting codes and cryptography. Prerequisites: MA3025.

**MA3607 Introduction to Real Analysis (4-0) Summer**

The objective of this course is for students to achieve a solid understanding of the basic concepts, analysis, and proofs in advanced calculus, including: limits, sequences, series, continuous functions, uniform convergence and uniform continuity, differentiation, and Riemann integration. This is a mathematics course in the pure sense. Proofs will be emphasized, and the student will learn how to reproduce, understand, create and enjoy mathematical proofs. Prerequisites: MA1114.

**MA3610 Topology, Fractals, and Chaotic Dynamics (3-0) As Required**

An introductory course on chaotic dynamics systems and fractals. Topics covered include: flows on the line, bifurcations, linear systems, phase plane, limit cycles, the Lorenz equations, fractals, and one-dimensional maps. Applications include population growth, laser threshold, the pendulum, relaxation oscillations, and synchronized chaos. Prerequisites: MA1115 and MA2121.

**MA3677 Theory of Functions of a Complex Variable I (4-0) Fall**

Selected topics from the theory of functions of a complex variable; analytic functions, power series, Laurent series. Singularities of analytic functions; contour integration and residues; applications of residues to real integrals and Laplace transforms, zeros of analytic functions, infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. Applications include interference effects in optics and problems from heat flow and fluid flow. Prerequisites: MA1116.

**MA3730 Theory of Numerical Computation (3-0) As Required**

Analysis of computational methods used for the solution of problems from the areas of algebraic equations, polynomial approximation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. Prerequisites: MA2121.

**MA4026 Combinatorial Mathematics (4-0) As Required**

Advanced techniques in enumerative combinatorics and an introduction to combinatorial structures. Topics include generating functions, recurrence relations, elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications in probability, game theory, network design, coding theory, and experimental design. Prerequisites: MA3025.

**MA4027 Graph Theory and Applications (4-0) As Required**

Advanced topics in the theory of graphs and digraphs. Topics include graph coloring, Eulerian and Hamiltonian graphs, perfect graphs, matching and covering, tournaments, and networks. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications to coding theory, searching and sorting, resource allocation, and network design. Prerequisites: MA3025.

**MA4103 Thesis Topics Seminar (3-0) As Required**

Explores in depth discrete dynamical systems and the thesis topics of students enrolled in the Applied Mathematics degree program. Fulfills the ESR to provide students with the experience of organizing and presenting applied mathematical ideas to students and faculty, including a classroom environment. Prerequisites: Consent of instructor. Graded on a Pass/Fail basis only.

**MA4237 Advanced Topics in Numerical Analysis (V-0) Fall**

The subject matter will vary according to the abilities and interest of those enrolled. Applications of the subject matter to DoD/DoN are discussed. Prerequisites: Consent of instructor.

**MA4242 Numerical Solution of Ordinary Differential Equations (3-1) As Required**

Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. Prerequisites: MA3232.

**MA4243 Numerical Solution of Partial Differential Equations (3-1) As Required**

Finite difference methods for parabolic, elliptic, and hyperbolic equations, multi-grid methods; convergence and stability, error estimation and control, numerical solution of finite difference equations, applications. Prerequisites: MA3132, MA3232 suggested.

**MA4245 Mathematical Foundations of Finite Elements (3-1) As Required**

Variational formulation of boundary value problems, finite element and boundary element approximations, types of elements, stability, eigenvalue problems. Prerequisites: MA3132, MA3232.

**MA4248 Computational Linear Algebra (4-1) As Required**

Development of algorithms for matrix computations. Rounding errors and introduction to stability analysis. Stable algorithms for solving systems of linear equations, linear least squares problems and eigen problems. Iterative methods for linear systems. Structured problems from applications in various disciplines. Prerequisites: MA3046, or consent of instructor, advanced MATLAB programming.

**MA4261 Distributed Scientific Computing (3-2) As Required**

General principles of parallel computing, parallel techniques and algorithms, solution of systems of linear equations, eigenvalues and singular value decomposition, domain decomposition and application (e.g., satellite orbit determination and shallow water fluid flow). Prerequisites: MA3042 or MA3046, MA3132, and MA3232.

**MA4301 Nonlinear Programming (Course Taught by or Staff, Same as OA4201) (4-0) As Required**

See OA4201 for course description.

**MA4302 Design of Experiments (Course Taught by or Staff, Same as OA4101) (3-1) As Required**

See OA4101 for course description.

**MA4303 Regression Analysis (Course Taught by or Staff, Same as OA4102) (4-0) As Required**

See OA4102 for course description.

**MA4304 Time Series Analysis (Course Taught by or Staff, Same as OA4308) (4-0) As Required**

See OA4308 for course description.

**MA4311 Calculus of Variations (3-0) As Required**

Euler equation, Weierstrass condition, Legendre condition, numerical procedures for determining solutions, gradient method, Newton method, Transversability condition, Rayleigh Ritz method, conjugate points. Concepts are related to geometric principles whenever possible. Prerequisites: MA2121 (programming experience desirable).

**MA4321 Stability, Bifurcation and Chaos (3-0) As Required**

Differential equations and dynamical systems, equilibrium of autonomous systems, stability, Liapunov's method, examples of chaos, local bifurcations of vector fields and maps, chaotic dynamical systems. Prerequisites: MA3610.

**MA4322 Principles and Techniques of Applied Mathematics I (3-0) As Required**

Linear operators, generalized functions and Hilbert spaces; solutions of partial differential equations by Green's functions and eigen functions; variational techniques; Fredholm and Volterra integral equations; asymptotic methods and perturbations. Applications to wave propagation, optimization, fluid dynamics, and numerical methods. Prerequisites: MA3042 and MA3132; MA3232 strongly recommended.

**MA4323 Principles and Techniques of Applied Mathematics II (3-0) As Required**

Continuation of MA4322. Prerequisites: MA4322.

**MA4332 Partial Differential Equations (3-0) As Required**

Diffusion, wave and Laplace equations. Classification of second order equations, discontinuities and signal propagation, transform methods, Green's functions, first order equations and characteristics. Prerequisites: MA3132.

**MA4362 Astrodynamics (3-0) As Required**

Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. Prerequisites: SS3500 or equivalent.

**MA4372 Integral Transforms (3-0) As Required**

The Laplace, Fourier and Hankel transforms and their inversions; Asymptotic behavior. Applications to problems in engineering and physics. Prerequisites: MA3132, MA3675.

**MA4377 Asymptotic and Perturbation Methods I (3-0) As Required**

Advanced course in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. Prerequisites: MA3132.

**MA4378 Asymptotic and Perturbation Methods II (3-0) As Required**

Continuation of MA4377. Prerequisites: MA4377.

**MA4391 Analytical Methods for Fluid Dynamics (4-0) As Required**

The basic fluid dynamic equations will be derived, and a variety of analytical methods will be applied to problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. Prerequisites: MA3132 or MA3139.

**MA4392 Numerical Methods for Fluid Dynamics (4-0) As Required**

Numerical methods exclusively will be applied to fluid dynamics problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. Prerequisites: MA3232 and MA4391.

**MA4393 Topics in Applied Mathematics (3-0) Fall**

The course content varies but applications of interest to the DoN/DoD will be discussed. Credit may be granted for taking this course more than once. Prerequisites: Consent of instructor.

**MA4560\* Coding and Information Theory (4-0) As Required**

Mathematical analysis of the codes used over communication channels is made. Techniques developed for efficient, reliable and secure communication are stressed. Effects of noise on information transmission are analyzed and techniques to combat their effects are developed. Linear codes, finite fields, single and multiple error-correcting codes are discussed. Codes have numerous applications for communication in the military, and these will be addressed. Prerequisites: MA3560.

**MA4565 Advanced Modern Algebra (3-0) As Required**

A continuation of MA3560. Rings, ring homomorphism, integral domains and Euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, Field extension and Galois theory. Prerequisites: MA3560.

**MA4570 Cryptography (4-0) As Required\***

The methods of secret communication are addressed. Simple cryptosystems are described and classical techniques of substitution and transposition are considered. The public-key cryptosystems, RSA, Discrete Logarithm and other schemes are introduced. Applications of cryptography and cryptanalysis. Prerequisites: MA3560.

**MA4593 Topics in Algebra (3-0) Fall**

A selection of topics in algebra. Content of the course varies. Credit for taking the course more than once is allowed. Students may select a topic of interest to the DoN/DoD, so the course can support the MERs in a variety of curricula. Prerequisite: MA3560.

**MA4620 Theory of Ordinary Differential Equations (3-0) As Required**

Introduction to the modern theory of ordinary differential equations. Systems of equations. Theoretical and constructive methods of solutions. Prerequisites: MA2121 and MA3042.

**MA4635 Functions of Real Variables I (3-0) As Required**

Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesgue measure and integration theory, convergence theorems and  $L_p$  spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesgue decomposition and product measure; Daniell integrals and integral representation of linear functionals. Prerequisites: MA3606.

**MA4636 Functions of Real Variables II (3-0) As Required**

Continuation of MA4635. Prerequisites: MA4635.

**MA4675 Complex Analysis (3-0) As Required**

A continuation of MA3675, MA3676. Differential equations in the complex plane, transform methods, the Wiener-Hopf method, integral equations, discrete Fourier analysis. Prerequisite: MA3675.

**MA4693 Topics in Analysis (3-0) Spring**

Content of the course varies. Students will be allowed credit for taking the course more than once. Prerequisites: Consent of instructor.

**MO Courses**

MO designated courses are intended for students in operational curricula only. They do not satisfy the mathematics course requirements for accredited engineering curricula, nor do they satisfy the prerequisites for any of the MA designated courses.

**MO1180 Topics in Mathematics for Systems Analysis (3-2) Spring/Fall**

A one quarter course in logic, elementary mathematics, combinatorics, and matrix algebra, plus a review of selected topics from single variable calculus with extensions to two variables. This course is intended for first-quarter students in the distributed learning Master of Systems Analysis curriculum. Logic places emphasis on the Propositional and Predicate Calculus. Elementary mathematical topics include sets, functions, and relations. Coverage of combinatorics includes an introduction to basic principles of counting (sum and product rules), permutations, and combinations. The fundamental algebra of matrices includes addition, multiplication of matrices, and multiplication of a matrix by a constant, and a column (vector) by a matrix; elementary matrices and inverses, together with the properties of these operations; solutions to  $m \times n$  systems of linear algebraic equations using Gaussian elimination. Selected topics from single-variable calculus are extended to functions of two-variables, including double integrals over rectangles and general regions. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course). Prerequisite: Single-variable calculus.

**MO1901 Mathematics for ISSO (3-0) As Required**

A brief survey of selected calculus and post-calculus topics—single variable derivatives and integrals, infinite series and sequences, complex numbers, and Fourier series and transforms. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course.) Prerequisites: None.

**MO1903 Mathematics for ISSO Space Systems Operations Specialization (3-0) Fall**

To be taken concurrently with MA1114. The course consists of a brief survey of the following topics: Complex numbers, Fourier series and transforms, and Ordinary Linear Differential Equations. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course.) Taught at the rate of seven hours per week for five weeks. Prerequisites: MA1113.

\*Required courses for the certificate program  
*Mathematics of Secure Communications.*

**Advanced Science (Applied Mathematics) - Curriculum 380****Program Officer**

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**Brief Overview**

This program is designed to meet the needs of the Department of Defense for graduates who are skilled in applying concepts of higher mathematics. The objective of the program is to equip an officer with the skill to analyze a military problem, formulate it in mathematical terms, solve or approximate a solution, and interpret and present the results.

Completion of this curriculum also qualifies an officer as an Applied Mathematics Subspecialty with a code of XX41P. A typical job in this subspecialty is an instructor in mathematics at the U.S. Naval Academy or the U.S. Military Academy at West Point.

**Requirements for Entry**

Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level or the first three quarters of the mathematics core sequence, which includes linear algebra, advanced calculus in one and several variables, ordinary differential equations, probability and statistics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) curriculum. An APC of 324 is required.

**Entry Date**

Advanced Science (Applied Mathematics) is an eight-quarter course of study with preferred entry date in June. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

**Typical Course of Study****Quarter 1**

MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II w/ Matrix Algebra

MA1025	(4-0)	Finite Math for Ops Research
SO2410	(4-0)	Math Modeling

**Quarter 2**

MA1115	(4-0)	Multi-variable Calculus
MA1116	(3-0)	Vector Calculus
MA3025	(5-0)	Discrete Mathematics
MA2043	(4-0)	Matrix Algebra

**Quarter 3**

MA3046	(4-0)	Linear Algebra
MA3110	(4-0)	Intermediate Analysis
MA2121	(4-0)	Differential Equations
MA3560	(3-0)	Modern Applied Algebra
NW3230	(4-2)	Strategy & Policy

**Quarter 4**

MA3xxxx	(3-0)	Elective
MA3301	(4-1)	Linear Programming
MA3132	(4-0)	PDEs
OA3101	(4-1)	Probability

**Quarter 5**

MA4xxx	(3-0)	Elective
MA3607	(4-0)	Real Analysis
MA3232	(4-0)	Num Analysis
OA3102	(4-1)	Statistics

**Quarter 6**

MA4322	(3-0)	Principles and Techniques of Applied Math
MA3677	(4-0)	Complex Analysis
MA4372	(3-0)	Integral Transforms
OA3103	(4-1)	Data Analysis

**Quarter 7**

MA4323	(3-0)	Principles and Techniques of Applied Mathematics II
MA0810	(4)	Thesis Research Experience Tour

**Quarter 8**

MA0810	(4)	Thesis Research
MA0810	(4)	Thesis Research
MA4xxx	(3-0)	Elective
MA4103	(3-0)	Thesis Topic Seminar

**Educational Skill Requirements (ESR)****Applied Mathematics - Curriculum 380****1. Basics:**

- Linear Algebra, Calculus, Differential Equations, Probability, Statistics, Discrete Mathematics, Applied Algebra, Mathematical Modeling.
- Ability to use workstations and the microcomputer as tools to aid in analysis.
- Exposure to basic physical and technological principles of real-world problems of importance to the military.

- Joint and Maritime Strategic Planning:** Military history, Joint and Service planning and doctrine, Current strategies, Maritime component of National Strategy, Structure of Defense Establishment, Commanders roles in planning.
- Fundamental Areas:**
  - Probability
  - Algebraic Structures
  - Numerical Analysis
  - Applied Mathematics
  - Mathematical Modeling
  - Linear Algebra and Vector Analysis
  - Real and Complex Analysis
  - Ordinary Differential Equations
  - Partial Differential Equations
  - Calculus
- Applications:** Well-versed in the applications of mathematics to real world problems of interest to the military.
- Computer Skills:** Ability to use higher level, structured computer language and operating system.
- Practice:** Written and oral presentation skills, instructional experience.

**Department of Electrical and Computer Engineering****Chairman**

Jeffrey Knorr, Ph.D.  
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**Richard W. Adler**, Research Associate Professor (1970)\*; Ph.D., Pennsylvania State University, 1970.

**Robert W. Ashton**, Associate Professor (1992); Ph.D., Worcester Polytechnic Institute, 1991.

**Jon T. Butler**, Professor (1987); Ph.D., Ohio State University, 1973.

**Roberto Cristi**, Professor (1985); Ph.D., University of Massachusetts, 1983.

**Monique P. Fargues**, Associate Professor and Associate Chair for Student Programs (1989); Ph.D., Virginia Polytechnic Institute and State University, 1988.

**Douglas J. Fouts**, Professor (1990); Ph.D., University of California at Santa Barbara, 1990.

**Tri T. Ha**, Professor (1987); Ph.D., University of Maryland, 1977.

**Timothy Hobbs**, CDR, USN, Military Instructor and Program Officer (2002); MSEE, Naval Postgraduate School, 1990.

**Robert (Gary) Hutchins**, Associate Professor (1993); Ph.D., University of California at San Diego, 1988.

**David C. Jenn**, Professor (1990); Ph.D., University of Southern California, 1989.

**Alex Julian**, Assistant Professor (2004); Ph.D., University of Wisconsin, Madison, 1997.

**Jeffrey B. Knorr**, Professor and Chair (1970); Ph.D., Cornell University, 1970.

**Frank Kragh**, Assistant Professor (2003); Ph.D., Naval Postgraduate School, 1997.

**Herschel H. Loomis, Jr.**, Professor (1981); Ph.D., Massachusetts Institute of Technology, 1963.

**John McEachen**, Associate Professor (1996); Ph.D., Yale University, 1995.

**Sherif Michael**, Professor (1983); Ph.D., University of West Virginia, 1983.

**Michael A. Morgan**, Professor (1979); Ph.D., University of California at Berkeley, 1976.

**Phillip E. Pace**, Professor (1992); Ph.D., University of Cincinnati, 1990.

**Andrew Parker**, Research Associate (1996); M.S., University of Maryland, 1994; MSES, Naval Postgraduate School, 1992

**John P. Powers**, Distinguished Professor (1970); Ph.D., University of California at Santa Barbara, 1970.

**R. Clark Robertson**, Professor and Associate Chair for Instruction (1989); Ph.D., University of Texas at Austin, 1983.

**Weilian Su**, Assistant Professor (2004); Ph.D., Georgia Institute of Technology, 2004.

**Frederick Terman**, Senior Lecturer (1983); MSEE, Stanford University, 1964.

**Charles W. Therrien**, Professor (1984); Ph.D., Massachusetts Institute of Technology, 1969.

**Murali Tummala**, Professor and Associate Chair for Research (1987); Ph.D., India Institute of Technology, 1984.

**W. Ray Vincent**, Research Associate Professor (1980); M.S., Michigan State University, 1948.

**Donald van Z. Wadsworth**, Senior Lecturer (1988); Ph.D., Massachusetts Institute of Technology, 1958.

**Todd Weatherford**, Associate Professor (1995); Ph.D., North Carolina State University, 1993.

**Lonnie Wilson**, Research Associate Professor (1997); Ph.D., University of California at Los Angeles, 1973.

**Xiaoping Yun**, Professor (1994); Sc.D., Washington University, 1987.

**Lawrence J. Ziomek**, Professor (1982); Ph.D., Pennsylvania State University, 1981.

\*The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

**Brief Overview**

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering curriculum, the Combat Systems Engineering curriculum, and the Space Systems Engineering curriculum. Additionally, the department offers courses in support of other curricula such as Information Warfare/Electronic Warfare; Information Technology Management; Command, Control, Communications, Computers and Intelligence (C4I);

Space Systems Operations; Underwater Acoustics and Engineering Acoustics.

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone: (410) 347-7700.

If needed, an MSEE student will usually spend six to twelve months learning or reviewing material at a junior or senior level before entering into graduate studies. The graduate study portion of a typical program is about one year in duration with a combination of course study and thesis work being performed. The thesis portion of the study is the equivalent of four courses with an acceptable written thesis being a requirement for graduation.

The curriculum is organized to provide the students with coursework spanning the breadth of Electrical and Computer Engineering. In addition, students concentrate in one major area of Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

Communications Systems  
 Computer Systems  
 Guidance, Navigation and Control Systems  
 Electromagnetic Systems (Radar/EW)  
 Joint Services Electronic Warfare (International students only)  
 Power Systems and Microelectronics  
 Signal Processing Systems

The department has about thirty-two faculty members, either on a permanent or visiting basis, contributing to the instructional and research programs.

### Mission

The ECE department seeks to provide NPS students with the highest quality and most DoD-relevant graduate education available in electrical and computer engineering.

### Degree

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the Master of Science in Engineering Science with a major in Electrical Engineering [MSES(EE)], the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). A student is able to earn an academic degree listed above while enrolled in Electronic Systems Engineering (Curriculum 590), Electrical Engineering (Curriculum 590), Space Systems Engineering (Curriculum 591), Combat Systems Science & Technology (Curriculum 533), and

Undersea Warfare (Curriculum 525). The department typically graduates over forty MSEE degree candidates, one EE degree recipient and three Ph.D.s per year.

A Bachelor of Science in Electrical Engineering or its equivalent is required. Credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve the degree equivalence.

To complete the course requirements for the master's degree, a student needs a minimum of 52 credit hours of graduate level work. There must be a minimum of 36 credits in the course sequence 3000 - 4999, of which at least 30 credits must be in Electrical and Computer Engineering. The remainder of these 36 credits must be in engineering, mathematics, physical science, and/or computer science. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits, must be in the course sequence 4000 - 4999.

An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the department.

**MSEE Program Objectives:** The MSEE program has the following objectives (i.e., skills and abilities that graduates can bring to their position after having graduated from NPS and receiving 3-5 more years of on-the-job training and professional development):

- **Leadership:** Students will be provided with an educational foundation that prepares them for leadership roles along diverse career paths.
- **Program Management:** Students will be provided with an educational foundation that prepares them for assignments related to research, design, development, procurement, maintenance, and life cycle management of electronic systems for Naval platforms.
- **Operational Utilization:** Students will be provided with an educational foundation that allows them to understand the capabilities and limitations of military electronic systems and to effectively employ electronic systems in military operations.

**MSEE Program Outcomes:** In order to achieve the above objectives, we expect to provide the student with a program with the following attributes upon completion of their program.

- **Breadth:** Students will possess and be able to apply knowledge and principles at a graduate level in three or more of the following areas: electronics, controls, signal processing, communications, computers and electromagnetics.
- **Depth:** Students will possess and be able to apply knowledge and principles at a graduate level in



one or more of the following areas: electronics and power systems, control systems, signal processing systems, communication systems, electromagnetic systems, signals intelligence systems, computer systems.

- **Independent Investigation:** Students will develop the ability to conduct and report the results of a technically challenging, defense-relevant independent investigation.

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science with an emphasis in Electrical Engineering [MSES{EE} degree]. The program of each student seeking this degree must contain at least 52 credit hours of graduate level work including 36 credit hours in the course sequence 3000 - 4000. Of these 36 course credits, at least 20 must be in Electrical and Computer Engineering, and an additional 12 must be in engineering, mathematics, physical science and/or computer science. At least 12 of the 36 must be in the course sequence 4000-4999. All students must submit an acceptable thesis of at least 16 credit hours. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The department chairman's approval is required for all programs leading to this degree.

Students with strong academic backgrounds may enter a program leading to the degree of Electrical Engineer.

A minimum of 96 total graduate credits is required for the award of the engineer's degree, of which at least 24 must be in accepted thesis research, and at least 54 credits must be in Electrical and Computer Engineering courses.

At least 36 of the total hours are to be in courses in the sequence 4000 - 4999. Approval of all programs must be obtained from the Chairman, Department of Electrical and Computer Engineering.

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer Degree are also eligible for participation. Entry

requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that address system design issues are welcome.

The Department of Electrical and Computer Engineering has an active program leading to the Doctor of Philosophy degree. Joint programs with other departments are possible. A noteworthy feature of these programs is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the federal government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

The laboratories of the department serve the dual role of supporting the instructional and research activities of the department. The department has well-developed laboratories in each specialty area.

#### **Micro-electronics Lab**

This lab supports design and analysis of semiconductor devices, design and development of VLSI integrated circuits, and design, implementation and testing of microprocessor and VLSI systems. Major equipment of the lab includes: Semiconductor Parameterization Equipment, Capacitance-Voltage measurement equipment, Semi-automatic Probing station, High Speed Sampling Scopes, Logic Analyzers, Printed Circuit Assembly tools, Unix and PC workstations, Silvaco(TM) TCAD simulation tools, Tanner and Cadence Design tools and Semiconductor Parameterization Equipment (high power capability), Manual Probing stations (2+), Wire-bonding equipment, and PC workstations. The lab also runs a Flash X-ray facility and a Linear accelerator (LINAC) facility for testing electronic devices.

#### **Circuits, Signals, and Digital Systems Lab**

This laboratory provides support for instruction and research in the areas of basic analog and digital logic design, discrete component testing, fundamental circuit design, micro-processing interfacing, assembly language programming and communication theory. The laboratory is equipped with micro-processing development systems including an HP64000 for advanced course work and thesis research, CAD facilities capable of schematic capture, circuit simulation, and fault detection. The lab utilizes various test equipment to include, but not limited to, oscilloscopes, signal generators, spectrum analyzers, multi-meters, and high-speed data acquisition equipment.

### **Academic Computing Lab**

This laboratory is the primary computational facility within the Department of Electrical and Computer Engineering and incorporates PC/Windows, PC/Linux, and Sun/Solaris workstations. Various high-performance computing platforms are also available, such as a SRC Computers model SRC-6e, which has a reconfigurable processor architecture. The laboratory also includes a secure computing facility for classified computing up to the Secret level on PCs, workstations, and a high-performance Linux cluster. The Academic Computing Laboratory is first and foremost a teaching facility for accomplishing computer assignments that are assigned as a part of ECE courses. It is used for research-related computing only when such computing does not interfere with course work. Typically, this is accomplished by reserving workstations for specific times when courses meet and by running research-related programs at lower priority levels. The laboratory serves approximately 350 students annually and supports over 25 courses and over 12 curriculums. The software installed on the servers in this laboratory are engineering design, analysis, and simulation tools related to the disciplines of Electrical and Computer Engineering, such as OPNET for network design and simulation, PSPICE and SmartSPICE for circuit design and simulation, and the entire suite of software from Silvaco International for modeling and simulating solid state devices, virtual wafer fabrication, and the design, modeling, and simulation of analog, digital, and mixed-signal integrated circuits.

### **Optical Electronics Lab**

This laboratory provides educational and research support in the areas of fiber optics, lasers, and electro-optics. The laboratory has a variety of fiber optics instrumentation (including two OTDRs, a fusion splicer, optical spectrum analyzer, connector application equipment, a 1.5 Gb/s digital pattern generator and BER tester, an optical fiber amplifier, optical autocorrelator for pulse width measurement, various diode laser controllers), RF and microwave instrumentation (signal synthesizer, microwave spectrum analyzer), and general-purpose test instrumentation. Various detectors and imaging equipment is also available.

### **Electromagnetics Lab**

This laboratory supports instruction and research in the area of microwave systems and technology. This is accomplished with a mix of hardware, instruments, test systems, and software. Included in the lab inventory are scalar and vector microwave network analyzers, electromagnetic software for simulating antennas, ships and aircraft, and a software design system for simulation of microwave circuits and

systems. There is also a fully automated anechoic chamber for antenna pattern measurements.

### **Radar and Electronic Warfare Systems Lab**

The objective of the Radar and Electronic Warfare (EW) Systems Laboratory is to educate military officers and civilians in the technology and operational characteristics of electronic warfare. The Radar and Electronic Warfare Systems Laboratory supports both research and teaching. The hardware laboratory contains instrumented radar and electronic warfare equipment and has been in operation for over 35 years. Each radar system is well instrumented to operate as a teaching tool. The equipment allows the student to experience hands-on knowledge of performance characteristics, conduct experimental research, and reinforces concepts that are taught in the classroom.

### **Controls and Robotics Lab**

This laboratory is mainly an instructional lab that supports experiments for all courses in Guidance, Navigation, Controls, and Robotics. Lab facilities include servo control stations and associated computers (equipped with A/D and D/A data acquisition cards, LabView, and Matlab/SIMULINK software) that are used to conduct simulations and physical experiments, modeling, analysis, and design of control systems. The lab is also equipped with advanced robots to support robotics laboratory assignments and thesis projects in robotics.

### **Power Systems Lab**

The Power Systems Laboratory supports postgraduate education and thesis research related to the design, analysis, simulation and implementation of power converter and electric drive technology. Thesis research projects are closely coupled to current Department of Defense priorities including more-survivable power system architectures such as DC Zonal Electric Distribution, Integrated Power Systems, and electric propulsion. In coursework and projects, students employ modern device technologies, hardware-in-the-loop synthesis tools, simulation packages, measurement devices, and power converter and electric machine modules to assess component operation, develop feedback controls, and study evolving power system challenges. An emphasis is placed on prototyping and validating against detailed simulation models.

### **Digital Signal Processing Lab**

This laboratory supports instruction and research in the area of Digital Signal Processing. Research and thesis work include, or have included, work in acoustic data modeling and processing, image analysis and modeling, signal detection and classification, multirate processing, target tracking, and other areas. Lab

facilities include several Windows NT-based workstations, including eight workstations equipped with TI DSP boards for real-time processing, and a number of SUN workstations, including Ultra-10 and Ultra-60 for Unix-based activities.

### **Computer Communications and Networking Lab**

This laboratory supports instruction and research in the area of network design, engineering, and infrastructure development. Thesis work and research undertaken include modeling and simulation of high-speed and wireless networks and related protocols, video transmission over ATM networks, traffic modeling, simulation and analysis, design and simulation of wide area networks, and related areas. Lab facilities include ATM switches, routers, LAN switches, video processing equipment, a channel simulator, a protocol analyzer, network simulation packages, and NT workstations.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory. Classified instruction and research are supported by appropriately certified facilities.

## **Electrical and Computer Engineering Course Descriptions**

### *EC Courses*

#### **EC0810 Thesis Research (0-8) Spring/Summer/Fall/Winter**

Every student conducting thesis research will enroll in this course. Prerequisites: None.

#### **EC0950 Seminar (No Credit) (0-1) As Required**

Lectures on subjects of current interest will be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School. Prerequisites: None.

#### **EC1010 Introduction to Matlab (1-1) Spring/Summer/Fall/Winter**

An introductory course for students with little or no programming background using MATLAB. Basic concepts of the MATLAB environment are considered, such as matrix operations, vector and matrix manipulations, equation solving, simulation, programming, and graphing. This course prepares students for using MATLAB in future course work in the ECE department. Graded on a Pass/Fail basis only. Prerequisites: None.

#### **EC2010 Probabilistic Analysis of Signals and Systems (3-1) Summer/Winter**

The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on signal processing, communication systems, and computer networks relevant to military applications. Topics include probability, random variables, and random sequences; density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and the r.m.s. values of nondeterministic signals, correlation and covariance; radar and

sonar signal detection; LTI systems, transformation of random variables and the central limit theorem; basic queuing theory and computer communication networks. Prerequisites: EC2410 (may be taken concurrently).

#### **EC2100 Circuit Analysis (3-2) Summer/Winter**

The fundamental circuit analysis course for Electrical Engineering majors. The course considers circuit principles, circuit topology, direct current circuits, natural response, forced response, total response, impedance concepts, the application of the Laplace transformation to solve circuit problems and device transfer functions. The laboratories will utilize both computer software and hands-on exercises. Prerequisites: PH1322, MA2043 and MA2121 (may be concurrent).

#### **EC2110 Circuit Analysis II (3-2) Spring/Fall**

A continuation of EC2100. The course considers circuit principles, impedance concepts and steady-state ac circuits, ac power, frequency response and selectivity, basics of operational amplifiers and an introduction to machines and power converters. Prerequisites: EC2100.

#### **EC2200 Introduction to Electronics Engineering (3-3) Summer/Winter**

An introduction to electronic devices and circuits. Solid state physics and semiconductor fundamentals. Properties of p-n junctions in diodes; Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET); static and dynamic models for these devices, and their linear and nonlinear applications. Applications of transistors in the design of amplifiers and digital systems. Ideal operational amplifiers characteristics and applications. Fabrication and the design of integrated circuits. Prerequisites: EC2110.

#### **EC2220 Electrical Engineering Design (3-4) Spring**

A team-based capstone engineering design course emphasizing the application of electrical engineering principles, devices, and circuits to the design, analysis, implementation, and testing of electronic systems. The intensive laboratory component initially reviews various electronic circuits useful in the design of the final project. Final projects require the design, analysis, implementation, testing and demonstration of an electronic system that also incorporates realistic parameters impacting the design process, such as economics, ergonomics, ethics, environmental impact, safety, etc. Prerequisites: EC2200.

#### **EC2300 Control Systems (3-2) Summer/Winter**

The main subject of this course is the analysis of feedback systems using basic principles in the frequency domain (Bode plots) and in the s-domain (root locus). Performance criteria in the time domain, such as steady-state accuracy, transient response specifications, and in the frequency domain such as bandwidth and disturbance rejection, will be introduced. Simple design applications using root locus and Bode plot techniques will be addressed in the course. Laboratory experiments are designed to expose the students to testing and evaluating mathematical models of physical systems using computer simulations and hardware implementations. Prerequisites: EC2100 and ability to program in MATLAB.

#### **EC2320 Linear Systems (3-1) Spring/Fall**

Formulation of system models including state equations, transfer functions, and system diagrams for continuous and sampled-data systems. Computer and analytical solution of

system equations. Stability, controllability, and observability are defined. Introduction to design by pole placement using measured and estimated state feedback. Application to military systems is introduced via example. Prerequisites: EC2100 and ability to program in MATLAB.

**EC2400 Discrete Systems (3-1) Spring/Fall**

Principles of discrete systems, including modeling, analysis and design. Topics include difference equations, convolution, stability, bilateral z-transforms and application to right-sided and left-sided sequences, system diagrams and realizations, and frequency response. Simple digital filters are designed and analyzed. Prerequisites: MA1116/MA3677 (may be concurrent) and ability to program in MATLAB.

**EC2410 Analysis of Signals and Systems (3-1) Summer/Winter**

Analysis of digital and analog signals in the frequency domain; properties and applications of the discrete Fourier transform, the Fourier series, and the continuous Fourier transform; analysis of continuous systems using convolution and frequency domain methods; applications to sampling, windowing, and amplitude modulation and demodulation systems. Prerequisites: EC2400.

**EC2450 Accelerated Review of Signals and Systems (4-0) As Required**

An advanced review of continuous and discrete system theory intended for students who have previous education in these areas. Topics covered by each student will depend upon background and competence in the subject matter of EC2400, EC2410, and EC2320. Prerequisites: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

**EC2500 Communications Systems (3-2) Spring/Fall**

In this first course on the electrical transmission of signals, the theory, design, and operation of analog and digital communication systems are investigated. Included are A/D conversion, modulation, demodulation, frequency-division multiplexing, and time-division multiplexing. Prerequisites: EC2200 and EC2410.

**EC2650 Fundamentals of Electromagnetic Fields (4-1) Spring/Fall**

This course covers electromagnetic field theory and engineering applications. Both static and dynamic electric and magnetic field theory is covered. The complete theory is presented in terms of Maxwell's equations and boundary conditions. Applications include induction, plane wave propagation in lossless and lossy media, analysis of finite transmission lines, and plane wave reflection. Labs provide practical experience with microwave instruments, components, and measurement techniques. Prerequisites: MA1116 or equivalent.

**EC2820 Digital Logic Circuits (3-2) Spring/Fall**

An introductory course in the analysis and design of digital logic circuits that are the basis for military and civilian computers and digital systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: data representation, Boolean algebra, logic function minimization, the design and application of combinatorial and sequential SSI, MSI, and LSI logic functions including PLAs and ROMs, and the fundamentals of finite state machine design and applications. Laboratories are devoted to the analysis, design, implementation, construction, and debugging

of combinatorial and sequential logic circuits using SSI, MSI, LSI, and programmable logic devices. Prerequisites: None.

**EC2840 Introduction to Microprocessors (3-2) Summer/Winter**

An introduction to the organization and operation of micro processing and microcomputers, both key embedded elements of military systems. Topics include: the instruction set, addressing methods, data types and number systems, stack and register organization, exception processing, assembly language programming techniques including macros, assembly language implementation of typical control structures, data structures, and subroutine linkage methods. Laboratory sessions teach a systematic method for program design and implementation. The laboratory assignments consist of a series of programs which collectively implement a major software project. Prerequisites: A high level language.

**EC2990 Design Projects in Electrical Engineering (0-8) Spring/Summer/Fall/Winter**

Design projects under the supervision of faculty members. Individual or team projects involving the design of devices or systems. Projects will typically be in support of faculty members. Prerequisites: Consent of instructor. Graded on Pass/Fail basis only.

**EC3000 Introduction to Graduate Research (1-0) Spring/Summer/Fall/Winter**

This course is designed to prepare students to undertake graduate research and to write a thesis or dissertation. The first part of the course provides an overview of (1) the NPS Department of Electrical and Computer Engineering, the department's research program and its faculty, (2) the NPS Research Program and the organization and functions of the NPS Research Office, (3) NPS library electronic resources, (4) an overview of S&T planning in the DoD, and (5) guidance on the thesis process. In the second part of the course, research opportunities are presented by the faculty. A broader view of the field of electrical and computer engineering is gained through student attendance at ECE Department seminars delivered by outside speakers. In the third part of the course, students are exposed to thesis research currently being carried out in the ECE Department by attending thesis presentations delivered by graduating students. Prerequisites: Consent of instructor. Graded on Pass/Fail basis only.

**EC3130 Electrical Machinery Theory (4-2) Winter**

An introduction to the analysis of magnetically-coupled circuits, dc machines, induction machines, and synchronous machines. The course will include explicit derivations of torque, voltage, and flux linkage equations, formulation of steady-state circuits, development of reference frame theory, and the basics of machine simulation as required in shipboard electric drive analysis. Prerequisites: EC2110 (may be taken concurrently).

**EC3150 Solid State Power Conversion (3-2) Summer**

A detailed analytical approach is presented for the operation, performance, and control of the important types of solid state power converters found in naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices. A systems approach is used to analyze high power converters: phase controlled rectifiers, line commutated inverters, self-commutated inverters, transistor converters, and

switching regulators. Prerequisites: EC2100 or consent of instructor.

**EC3200 Advanced Electronics Engineering (3-2) Spring**

Characteristics of differential and multistage amplifiers. Transistors frequency response, including Bipolar Junction Transistors (BJT), Junction Field Effect Transistors (JFET), and Metal Oxide Semiconductor Field Effect Transistors (MOSFET); characteristics and design consideration. Integrated circuit OPAMP applications; analysis and design of non-ideal OPAMPs. Applications of BJTs and Complementary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor Logic (TTL), Emitter Coupled Logic (ECL), and CMOS logic families. Applications and design feedback amplifiers and operational amplifiers applications in analog filters and oscillators. Prerequisites: EC2200.

**EC3210 Introduction to Electro-Optical Engineering (3-1) Fall**

An overview of the elements that comprise current electro-optical and infrared (EO/IR) military systems. Topics include radiation sources (both laser and thermal), detector devices, modulators, optical elements, and propagation characteristics. Examples of the application of the concepts taught to various military EO/IR systems, such as missile seekers, laser communications, and laser designators, are discussed. Prerequisites: EC2200 (may be concurrent).

**EC3220 Semiconductor Device Technologies (3-2) Fall**

This course is intended to familiarize the student with solid state device operation and fabrication of present day semiconductors and transistor technologies. Topics include: fundamental theory of charge transport, semiconductor materials (Si, GaAs, SiGe, InP), bandgap engineering, epitaxy crystal growth, and semiconductor device manufacturing technology. A virtual wafer lab is accomplished in the software labs to visualize parameters as impurity implants to electron flow. Measurement labs will utilize hands-on wafer probe measurements of digital and analog devices. Prerequisites: EC2200 or equivalent.

**EC3230 Space Power and Radiation Effects (Formerly E03205) (3-1) Spring**

Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid-state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics. Radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design. Note: EC3230 is taught with compressed scheduling (first six weeks of quarter). Prerequisites: EC2200.

**EC3310 Optimal Estimation: Sensor and Data Association (3-2) Winter/Summer**

The subject of this course is optimal estimation and Kalman filtering with extensions to sensor fusion and data association. Main topics include the theory of optimal and recursive estimation in linear (Kalman filter) and nonlinear (extended

Kalman filter) systems, with applications to target tracking. Topics directly related to applications, such as basic properties of sensors, target tracking models, multihypothesis data association algorithms, reduced order probabilistic models and heuristic techniques, will also be discussed. Examples and projects will be drawn from radar, EW, and ASW systems. Prerequisites: EC2320, EC2010, MA3046.

**EC3320 Optimal Control Systems (3-2) Spring**

This course addresses the problem of designing control systems which meet given optimization criteria. The student is exposed to the development of the theory, from dynamic programming to the calculus of variation, and learns how to apply it in control engineering. Prerequisites: EC2300, EC2320.

**EC3400 Digital Signal Processing (3-1) Spring/Fall**

The foundations of one-dimensional digital signal processing techniques are developed. Topics include Fast Fourier Transform (FFT) algorithms, block convolution, the use of DFT and FFT to compute convolution, and design methods for nonrecursive and recursive digital filters. Multirate signal processing techniques are also introduced for sampling rate conversion, efficient analog to digital, digital to analog conversion, time frequency decomposition using filter banks and quadrature mirror filters. Computer-aided design techniques are emphasized. The algorithms introduced have direct applications in sonar and radar signal processing, IR sensor arrays, modern navy weapon systems, and also in voice and data communications. Prerequisites: EC2410.

**EC3410 Discrete-Time Random Signals (3-1) Summer/Winter**

Fundamentals of random processes are developed with an emphasis on discrete time for digital signal processing, control, and communications. Topics include Bernoulli, random walk, Wiener, and Gaussian processes; second moment and higher-order statistics; linear transformations; cyclostationary analysis; and fundamentals of estimation theory. The theory is applied to the development of the matched filter, classical methods of spectral estimation, and the FIR and IIR forms of the Wiener filter. Prerequisites: EC2410 (may be concurrent) and EC2010.

**EC3450 Fundamentals of Ocean Acoustics (4-0) Fall**

Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality relationships, etc., that are used to model and solve real world problems concerning the propagation of sound in the ocean. Topics include, for example, reflection and transmission coefficients, ocean waveguide pulse-propagation models based on normal mode and full-wave theory, the WKB approximation, three-dimensional ray acoustics, and the parabolic equation approximation. Prerequisites: Standard undergraduate sequence of calculus and physics courses for engineering and science students.

**EC3500 Analysis of Random Signals (4-0) Spring/Fall**

Fundamental concepts and useful tools for analyzing non-deterministic signals and noise in military communication, control, and signal processing systems are developed. Topics include properties of random processes, correlation functions, energy and spectral densities, linear systems and mean square estimation, noise models and special processes. Prerequisites:

EC2500 (may be concurrent) and EC2010, or consent of instructor.

**EC3510 Communications Engineering (Unclassified) 3-1 (Summer/Winter)**

The influence of noise and interference on the design and selection of digital and analog communications systems is analyzed. Topics include link budget analysis and signal-to-noise ratio calculations, receiver performance for various analog and digital modulation techniques, and bandwidth and signal power trade-offs. Examples of military communications systems are included. Prerequisites: EC2220 and EC3500 or EC3410.

**EC3550 Fiber Optic Systems (3-1) Fall**

An introduction to the components and to the concepts of designing fiber optic communications systems for military applications. Includes fiber properties and parameters, fiber fabrication and testing, LED and injection laser sources, pin photodiodes and avalanche photodiode detectors, receiver design considerations, connector and splice techniques, and system design incorporating analysis and trade-offs. Data distribution techniques are also studied. Prerequisites: EC2220, EC2500, and EC2650.

**EC3600 Electromagnetic Radiation, Scattering and Propagation (3-2) Summer/Winter**

The principles of electromagnetic radiation are applied to antenna engineering, scattering, and propagation. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF, and satellite communications.

**EC3610 Microwave Engineering (3-2) Spring**

This course provides an overview of the circuits and devices used in microwave radar communication and electronic warfare systems. The course covers network analysis using scattering parameters, transmission media, selected circuits, electron tubes, solid state devices, and monolithic integrated circuits. Circuits and devices are studied in the laboratory using both hardware and computer simulation.

**EC3630 Radiowave Propagation (3-0) Spring**

This course treats the effects of the earth and its atmosphere on the propagation of electromagnetic waves at radio frequencies. Topics covered include ground waves, sky waves, ducting, reflection, refraction, diffraction, scattering, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Prerequisites: EC3600 or consent of instructor.

**EC3700 Introduction to Joint Services Electronic Warfare (3-2) Fall**

The fundamental electronic warfare analysis course for Electrical Engineering majors. The course considers the sensors and associated weapon systems in use by the Army, Air Force, Navy, and Marines. Also, electronic warfare in joint theater, electronic warfare receiving systems, communications electronics, signal and telemetry intelligence systems, artillery, directed energy, and laser weapon systems.

Active, passive, IR, and dual-mode seeker technologies are also discussed. Prerequisites: EC2010.

**EC3750 Sigint Systems (3-2) Fall**

Introduction to National Signals Intelligence (SIGINT) systems with focus on tasking, exploitation, collection, processing, and dissemination of products derived by special SIGINT systems. This course focuses on applying numerical and analytical techniques to exploit realistic navigation, communications, radar, telemetry, and other threat target sets critical to national security. A thorough review of fundamentals in radar and communications to include the utilization of spread spectrum by these systems will be discussed. The analysis of systems is presented for SIGINT operations or measurements such as: encoding/decoding, multiplexing, demultiplexing, modulation/demodulation, signal-to-noise ratio, bit-error rate, bandwidth efficiency, power budget, and polarization. Prerequisites: EC2500 or EO3512 or consent of instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

**EC3760 Information Operations Systems (3-2) Winter**

This course examines the Network-centric Environment that is the focus of the Information Operations (IO) infrastructure with emphasis on current and future implementation models. A Signals Intelligence (SIGINT) approach is taken in which the adversary's computer network system architecture is examined and evaluated for the purpose of exploitation, protection, and/or attack. A thorough review of the fundamentals of communications, computer networks, and advanced digital technologies is discussed. This course works closely with the Department of Defense to reinforce realistic approaches for solving critical IO issues within the community. Prerequisites: EC2500 or EC2512 or consent of instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

**EC3800 Microprocessor Based System Design (3-2) Fall**

Advanced microprocessor system concepts are studied. Microprocessor systems are widely used for embedded control in military systems as well as for stand-alone computers. Topics covered are CPU operation and timing, address decoding, typical LSI support chips, exception processing, design of static and dynamic memory systems, worst-case timing analysis, bus arbitration, and direct memory access controllers. The laboratory consists of a design project integrating hardware and software using a state-of-the-art development system. Prerequisites: EC2820 and EC2840.

**EC3820 Computer Systems (3-1) Summer**

The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software, and firmware. General features of operating systems are studied as well as specific features of an existing system. The elements of a multiprogramming system are introduced. Prerequisite: EC2840.

**EC3830 Digital Computer Design Methodology (3-2) Winter**

A design and project-oriented course covering basic principles, theories, and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential

elements of classical switching theory with a thorough understanding of modern design aids. Current military and commercial systems are used as design examples. Prerequisite: EC2820.

### **EC3840 Introduction to Computer Architecture (3-2)**

#### **Spring**

The fundamental principles of computer architecture and processor design, including the influences of implementation technology, cost, performance, and the historical development of computer architecture. Levels of abstraction and instruction set/architecture design. Processor design and implementation, including the data path and the control unit. Computer design, including buses, the memory hierarchy, and the input/output subsystem. Factors affecting performance and performance measurement, evaluation, and comparison. The effects of embedded military applications on computer architecture. Prerequisites: EC2820 and EC2840.

### **EC3850 Computer Communications Methods (3-1)**

#### **Spring/Fall**

The course objective is to develop an understanding of computer communications networks with emphasis on the requirements of military environments and the U.S. Navy's combat platforms. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput, and performance analysis. The layered network architectures, such as the seven-layer OSI model and DoD's TCP/IP protocol suite, are covered. The techniques and protocols used in these layers are discussed. Local area networking technologies such as Ethernet, FDDI and wireless Ethernet, and wide area technologies such as X.25 and frame relay are covered. Principles of networking devices (hubs, switches, and routers) are presented. Some distributed applications are presented briefly. Prerequisites: EC2010 and EC2500.

### **EC3910, 30,90 Special Topics in Electrical Engineering (V-V) Spring/Summer/Fall/Winter**

Courses on special topics in Electrical Engineering are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

### **EC4010 Principles of Systems Engineering (3-2)**

#### **Spring/Fall**

An introduction to systems engineering concepts and methods for the design and integration of complex defense systems, with emphasis on electrical engineering applications. Familiarity with the systems engineering process is developed through case studies of representative defense systems and a group design project which includes determination of system requirements from mission needs and operational requirements. Digital simulation models, including those in current use by DoD, are used to determine engineering and performance tradeoffs. Prerequisites: Four quarters in an NPS engineering curriculum or equivalent.

### **EC4130 Advanced Electrical Machinery Systems (4-2)**

#### **Spring**

Advanced analysis of detailed and reduced-order representations of shipboard electric machinery and power electronic drives. This course will include extensions to 3-

phase machine and network connections, constant flux and current source control, extensive simulation examples including saturation and open-phase conditions, comprehensive investigation of linearized and reduced-order machine and drive representations, the modeling and control of a dc link system, and the fundamentals of AC machine vector control. Prerequisites: EC3130.

### **EC4150 Advanced Solid State Power Conversion (4-1)**

#### **Fall**

Design and analysis of modern power electronic drives with particular emphasis on electric drives for present and future ship propulsion systems and variable frequency/variable speed power converters for advanced shipboard electric power distribution. Electrical and mechanical systems compatibility and electrical system interfacing topics are addressed. This course begins by examining the non-ideal aspects of power semiconductor switches and other components. In addition, dynamic performance of power electronic circuits is explored. The course includes some more advanced topics like resonant converters and active power line conditioners. Prerequisites: EC3150 and electrical machine theory, or consent of instructor.

### **EC4210 Electro-Optic Systems Engineering (3-0)**

#### **Winter**

Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest. Prerequisites: EC3210.

### **EC4220 Introduction to Analog Vlsi (3-1) Summer**

Modern active circuit design topologies; analog and sampled data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications. Prerequisites: EC2400 and EC3200.

### **EC4230 Reliability Issues for Military Electronics (3-1)**

#### **Winter**

This course investigates where and why semiconductor devices fail in military environments. Topics include limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues, radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers. Prerequisites: EC3220.

### **EC4300 Advanced Topics in Modern Control Systems (3-1) As Required**

Advanced topics and current developments in control systems are presented in this course. The list of special topics includes (but it is not limited to) robotics systems, autonomous vehicles, and design by robust techniques. Prerequisites: Consent of instructor.

### **EC4310 Fundamentals of Robotics (3-2) Fall**

This course presents the fundamentals of land-based robotic systems covering the areas of locomotion, manipulation,

grasping, sensory perception, and tele-operation. Main topics include kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration. Several Nomad mobile robots will be used for class projects. Military applications of robotic systems will be discussed. Prerequisites: MA3042; either EC2300 or EC2320, or consent of instructor.

#### **EC4320 Design of Robust Control Systems (3-2) Winter**

This course presents advanced topics on control system design. Major emphasis is on robust techniques in order to account for uncertainties on the systems to be controlled. Several applications show the trade-offs in several applications, such as missile and/or underwater vehicles control design. Advanced concepts on H2 and H-infinity will be introduced as part of the course. Prerequisites: EC3310, EC3320.

#### **EC4330 NAVIGATION, MISSILE, AND AVIONICS SYSTEMS (3-2) SPRING**

Principles of missile guidance, including guidance control laws, basic aerodynamics and six degree-of-freedom motion simulation. Additional topics are selected from the following areas to address the general interests of the class: advanced guidance laws, passive sensors, INS guidance, fire control and tracking systems, and ballistic missile targeting. Prerequisites: EC3310. Classification: U.S. citizenship and SECRET clearance.

#### **EC4340 Navigation, Missile, and Avionics Systems for International Students (3-2) Spring**

This course covers essentially the same material as EC4330, but with deletion of detailed analysis of specific systems. This course is intended for officers who do not have U.S. citizenship. Prerequisites: EC3310.

#### **EC4350 Nonlinear Control Systems (3-2) Spring**

This course presents techniques for automatic control of nonlinear systems with application to current military and robotic systems. Main topics include the analysis and design of nonlinear systems with phase plane and describing function methods, Lyapunov and sliding mode control techniques. Accuracy limit cycles, jump resonances, relay servos, and discontinuous systems will also be considered. Prerequisites: EC2300, EC2320.

#### **EC4360 Adaptive Control Systems (3-2) Summer**

This course addresses the problem of control systems which can self-adjust to changes in the operating conditions. Typical examples are autopilots for large ships which have to adapt to changes in load and/or sea conditions. Several techniques are presented, ranging from classical adaptive linear models to more modern techniques based on neural networks. Prerequisites: EC3310, EC3320.

#### **EC4400 Advanced Topics in Signal Processing (3-0) As Required**

Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest. Prerequisites: Consent of instructor.

#### **EC4410 Speech Signal Processing (3-1) As Required**

This course covers methods of digital signal processing as they are applied to speech communication for transmission, encryption, and recognition. The production and perception mechanisms are discussed. Topics include speech modeling analysis, synthesis, coding (including LPC), and speech and speaker recognition. The techniques introduced here are also applied to sonar signal processing, voice controlled remote security and access, voice operated aircraft control, and others areas. Prerequisites: EC3400 and EC3420 or consent of instructor.

#### **EC4420 Modern Spectral Analysis (3-1) As Required**

Spectral estimation is the key to passive sonar detection, signal parameter estimation, and identification. Classical and modern spectral estimations are developed from their basic ideas and compared in terms of performance and implementation. Topics include Fourier-based, model-based and eigenspace-based estimators, Capon's and Prony's method, time-frequency distributions, and wavelets. Extensions are made to address non-stationary conditions and to use higher order moments (i.e., polyspectra). Advanced topics, such as cyclo-stationary, cepstral, and coherence estimation, are introduced. Prerequisites: EC3400 (may be concurrent) and EC3410 or EC3500.

#### **EC4430 Multimedia Information and Communications (3-1) Fall**

The course objective is to present essentials of real-time communication of digital multimedia (audio, video and text) information over packet-switched networks by bringing together topics from digital signal processing (information processing), digital communications (information transmission and reception), and computer networking (information distribution). Algorithms for compression of multimedia information are presented. Related international standards, such as G.728, JPEC, MPE3, MP3, LZW, and IS95, are discussed. Major topics include digital representation and compression of multimedia information, transmission (storage) and distribution of compressed information, and end-to-end delivery issues, such as loss, reliability, security and encryption of multimedia information. Prerequisites: EC3410 or EC3500.

#### **EC4440 Statistical Digital Signal Processing (3-1) Spring/Fall**

Modern military systems are highly dependent on advanced statistical signal processing techniques. Modern methods of digital signal processing are developed in this course from a statistical point of view. Methods are developed for processing random signals through statistical data analysis and modeling. Topics include adaptive filtering, linear prediction, MA, AR, and ARMA signal modeling, lattice structures, and an introduction to subspace methods and other modern methods of spectrum estimation. Prerequisites: EC3410 or EC3500 and MA3046.

#### **EC4450 Sonar Systems Engineering (4-1) Winter**

Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operations. Topics from complex aperture theory, array theory, and signal processing are covered. This course supports the undersea warfare and engineering acoustics curricula and others.



Prerequisites: EC3450 or PH3452 or OC3260 and either EC3410 or EC3500 or EO3402 or equivalent.

**EC4480 Image Processing and Recognition (3-2) Winter**

This course provides image processing background for understanding modern military applications, such as long range target selection, medium range identification, and short range guidance of new weapons systems. Subjects include image sampling and quantization, image representation, enhancement, transformation, encoding, and data compression. Predictive coding, transform coding, and interframe coding techniques are also introduced. 3D to 2D imaging projections are also introduced to extract 3D information either from motion or stereo imaging. Some effort is directed toward image compression techniques particularly suited for multimedia video conferencing. Prerequisites: EC3400.

**EC4500 Advanced Topics in Communications (3-0) As Required**

Topics and current developments in communications relevant to advanced naval and other military applications. Offered on an occasional basis with the topics determined by the instructor. Prerequisites: Consent of instructor.

**EC4510 Cellular Communications (3-0) Winter**

This course presents the fundamentals of cellular communications. Cellular architectures, propagation models, modulation formats, diversity techniques, equalization, error control, multiple access techniques, networking, and standards such as AMPS, N-AMPS, IS-54, GSM, and IS-95 are covered. Prerequisites: EC3510.

**EC4550 Digital Communications (4-0) Spring/Fall**

This course presents the advantages and limitations of modern military M-ary digital communications systems. M-ary modulation formats, matched filter receivers, probability of symbol error calculations, coherent and non-coherent receivers, carrier and symbol synchronization, modems, bandwidth and signal energy, diversity combining, and fading channels are covered. Examples of current operational and proposed military and commercial space and earth links are treated. Prerequisites: EC3510.

**EC4560 Spread Spectrum Communications (3-2) Summer**

Methods of reducing the effects of hostile jamming on military radio communications systems are considered. Direct sequence spread spectrum systems and frequency-hopped spread spectrum systems are examined with regard to their LPI, LPD, AJ, and multiple access capabilities. Time-hopped and hybrid systems are also considered. Coarse and fine synchronization problems and techniques are presented. Prerequisites: EC3510.

**EC4570 Signal Detection and Estimation (4-0) Winter**

Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include maximum likelihood, Bayes risk, Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves). Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE), and maximum a posteriori estimators are introduced. Integral equations and the Karhunen-Loeve expansion are introduced. The estimator-correlator structure is

derived. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations. This course provides students the necessary foundation to undertake research in military radar and sonar systems. Prerequisites: EC3410 or EC3500.

**EC4580 Error Correction Coding (4-0) Spring/Fall**

Digital military communication systems often employ error control coding to improve effectiveness against noise, fading, and jamming. This course, together with EC4560, provides students the necessary foundations for understanding the principles of such systems. Topics include Shannon's channel capacity theorem and coding methods for error control in digital communications systems, including convolutional, block, concatenated, and turbo codes, as well as trellis-coded modulation. Applications of error control coding to modern digital communications systems are discussed. Prerequisites: EC3510.

**EC4590 Communications Satellite Systems Engineering (3-0) Winter**

Communication satellite systems including the satellite and user terminals. Subjects include orbital mechanics, satellite description, earth terminals, detailed link analysis, frequency division multiple access, time division multiple access, demand assignment, random multiple access, and spread spectrum multiple access. Various military satellite communications systems are introduced. Prerequisites: EC3510.

**EC4600 Advanced Topics in Electromagnetics (3-0) As Required**

Selected advanced topics in electromagnetics that are not currently covered in regular courses offerings, and relevant to naval and other military applications. Topics may include, but are not limited to, computational electromagnetics, scattering and radiation, propagation, and new device and antenna concepts. Prerequisites: EC3600 or consent of instructor.

**EC4610 Radar Systems (3-2) Summer**

The radar range equation is developed in a form including signal integration, the effects of target cross-section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency modulated radar, moving target indicator (MTI) and pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross-section of targets. Prerequisites: EC3410 or EC3500, EC3600, and either EC3610 or EC3630.

**EC4630 Radar Cross Section Prediction and Reduction (3-0) Fall**

This course covers the design and engineering aspects of stealth and its impact on platform and sensor design. Signature prediction methods in the radar, infrared (IR), and laser frequency bands are discussed. Radar cross section (RCS) analysis methods include geometrical optics and diffraction theory, physical optics and the physical theory of diffraction, and numerical solutions to integral and differential equations. Prediction methods for IR and laser cross sections (LCS) are also introduced. Signature reduction by shaping, materials

selection, and active and passive cancellation are applied to each frequency regime. The measurement of these cross sections is also covered. Prerequisites: EC3600 or consent of instructor.

#### **EC4640 Airborne Radar Systems (3-0) Fall**

The main objective of this course is to discuss concepts and digital signal processing techniques involved in modern airborne radars, which detect targets in presence of large ground clutter and other interferences. Radar waveform (or modes) are treated as continuous wave (CW), high pulse repetition frequency (HPRF), medium pulse repetition frequency (MPRF), and low pulse repetition frequency (LPRF). Practical implementation and the signal processing associated with each mode will be elaborated. Advantages and limitations of each mode shall be discussed. Military applications of these modes will be discussed in the existing airborne and surface based radar systems. Concepts and algorithms are covered for digital pulse compression, MTI clutter cancellation, Doppler processing, constant false alarm rate (CFAR) detection, ambiguity resolution, synthetic array radar (SAR) processing and other associated techniques and algorithms. Prerequisites: EC4610 or equivalent.

#### **EC4660 Electromagnetic Environmental Effects on Communication System Performance (3-2) As Required**

This course covers the effects of the electromagnetic environment on the performance of VLF-UHF land based and shipboard communications systems with emphasis on SIGINT applications. Methods of evaluating system performance in the presence of electromagnetic interference (EMI) are discussed. Newly developed techniques that overcome shortcomings of classical EMI test procedures of locating and eliminating sources of EMI in order to improve system performance are demonstrated in the laboratory. Current research in non-classical propagation and antenna effects are covered. Computational tools for evaluating these effects are demonstrated. Students participate in a project by applying the test procedures and computer tools to a current military system or sub-system, gaining an appreciation for the impact of the EM environment on operational systems. Prerequisites: EC3650 or consent of instructor.

#### **EC4680 Network-Centric Radar Electronic Warfare Techniques and Systems (3-3) Spring**

The scope of radar electronic warfare has become network-centric in order to support a coordinated multi-platform C2W by employing a distributed, networked system-of-systems. Network-centric EW compensates for most of the platform-centric limitations by achieving geometric flexibility, eliminating look-through and providing the ability to initiate coordinated jammer responses (improved jammer management through better information). Radar EW now involves a wide range of electronic combat and sensor technologies networked in a distributed system-of-systems for C2W. This course will concentrate on both platform-centric and network-centric radar electronic attack and protection concepts. The capabilities and information requirements for wideband vs. narrowband sensors, stand-off, high altitude sensors vs. stand-in low altitude sensors will be evaluated. The role of stand-in vs. escort vs. stand-off jammers in a distributed sensor grid will also be examined. Students build and test a heterogeneous EW sensor network using the Airborne Reactive EW Simulation (Ares) software package developed by NRL using the EWIRDB parameters.

PREREQUISITES: EC3700 or EC4610 or knowledge of radar and radar signal processing concepts or concurrently taking a course in radar analysis. U.S. citizenship and SECRET level clearance required.

#### **EC4690 Network-Centric Radar Electronic Warfare Techniques and Systems for International Students (3-3) Spring**

This course covers essentially the same material as EC4680. This course is intended for students who do not have U.S. citizenship. Prerequisite: EC4610.

#### **EC4700 Advanced Topics in Information Warfare (3-0) As Required**

Special advanced topics in electronic warfare not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include electronic warfare, signals intelligence, psychological operations, deception techniques, physical destruction and operations security. Prerequisites: EC3700 or consent of instructor.

#### **EC4750 Sigint Systems II (3-4) Winter**

Detailed problems and principles of Signals Intelligence (SIGINT) are presented. Several SIGINT scenarios are studied in class, and students select one for a team project. The scenarios taught are based on SIGINT needs from the National Security Agency (the scenarios are highly classified). The selected SIGINT scenario will require a conceptual design or realignment of national SIGINT systems to satisfy the operational commander's SIGINT needs. Prerequisites: EC3750 or consent of instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

#### **EC4800 Advanced Topics in Computer Engineering (3-0) As Required**

Advanced topics and current developments in computer architecture including such subjects as: graphics and multimedia processors relevant to military applications and workstations; computer structures for artificial intelligence and large data bases; supercomputers and massively parallel architectures; advanced logic design, hardware/software co-design, and multiple-valued logic. Prerequisites: Consent of instructor.

#### **EC4810 Fault-Tolerant Computing (3-2) Summer**

Introduction to fault-tolerant computing. The causes and effects of computer, digital system, and software failure. The fundamental concepts and techniques for the design and implementation of fault-tolerant computers, testing digital systems, and software. Modeling, simulation, and evaluation of fault-tolerant systems. Military and space applications of fault-tolerant computing. Prerequisites: EC3840.

#### **EC4820 Advanced Computer Architecture (3-1) Fall**

Techniques to achieve high-performance computing, including advanced architectural features and highly parallel processors. Techniques for improving processor, memory subsystem, and I/O subsystem performance, including pipelining, memory interleaving, multi-level caching, and parallel I/O. Parallel computer models, scalability, and clustering. Parallel programming, the role of the compiler, and compiler parallelization techniques. Performance metrics, evaluation, and comparisons between parallel processors. Enabling technologies for highly parallel computers, including

the use of the microprocessor as a building block. Distributed memory. Processor/cluster interconnection networks. Advanced implementation technologies and techniques. Military applications of high-performance computers and parallel processors. Prerequisites: EC3840.

#### **EC4830 Digital Computer Design (3-1) Spring**

This course presents digital system design techniques that can be used in tactical embedded systems. It involves a study of the architecture of and the design process for digital computer systems. Topics covered include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, and design of systems using standard and custom VLSI devices. Modern computer-aided design tools are emphasized. Laboratory project is the design of a digital computer. Prerequisites: EC3800 and EC3830.

#### **EC4840 Advanced Microprocessors (3-1) Fall**

Advanced topics and current developments in high-end microprocessor architecture and implementation; RISC vs. CISC; superscaler design; cache coherency; multimedia processors; bus and memory interfaces; military applications. Prerequisites: EC3840.

#### **EC4850 High-Speed Networking (3-2) Summer**

The course systematically develops the traffic characteristics of DoD and commercial broadband services (video, voice, text, and other multimedia information) and determines the need for high-speed networks with emphasis on quality of service. Queuing theory is used in the design and analysis of the various modules of a high-speed network: traffic modeling, switches, admission control, scheduling, traffic monitoring, and congestion control. Emerging trends and technologies that enable deployment of high-speed global networks for tactical, commercial, and residential use are discussed. Topics include queuing theory, traffic models, traffic management, and broadband technologies, such as ATM, Gigabit Ethernet, DSL, and cable access. Laboratory is concerned with the use of OPNET for simulation studies of various network topologies. Prerequisites: EC3850 or consent of instructor.

#### **EC4870 VLSI Systems Design (3-2) Winter**

Introduction to the design and implementation of Complementary Metal Oxide Semiconductor (CMOS) and Bipolar CMOS (BiCMOS) Very Large Scale Integration (VLSI) digital Integrated Circuits (ICs). Topics covered include the specification of the high-level functional design, the design, implementation, and simulation of low-level cells, floor planning and the assembly of low-level cells into the high-level design using hierarchical place-and-route techniques, circuit extraction and simulation for functional verification, timing analysis, and power estimation, and the principles of bulk CMOS, BiCMOS, and SOS/SOI IC fabrication. Applications of VLSI ICs in military systems are also covered. The course is centered around laboratory projects where student groups design, implement, simulate, and submit for fabrication, a full-custom CMOS, BiCMOS, VLSI IC. IC functionality is selected by each student group. A field trip to a commercial foundry and clean room tour is also included. Prerequisites: EC2200 and either EC3800 or EC3830 or EC3840.

#### **EC4900 Topics for Individual Study in Electrical Engineering (V-V) Spring/Summer/Fall/Winter**

Supervised study in selected areas of Electrical Engineering to meet the needs of the individual student. A written report is required at the end of the quarter. Prerequisites: Consent of the department chairman. Graded on Pass/Fail basis only.

#### **EC4910, 20 Advanced Special Topics In Electrical Engineering (V-V) Fall**

Courses on advanced special topics in Electrical Engineering are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

#### *EO Courses*

#### **EO2102 Basic Electronics and Electrical Machines (4-2) Summer/Winter**

An introduction to the fundamental tools of circuit analysis including Kirchhoff's current and voltage laws, series-parallel resistance combinations, voltage and current dividers, superposition, Thevenin and Norton equivalent circuits, source transformations, and nodal and mesh analysis. The students are then exposed to frequency domain phasor techniques for analyzing ac circuits. An introduction to power calculations and three-phase systems is next presented. The remainder of the course focuses on the basic operational characteristics of power system components such as transformers, synchronous machines, induction machines, dc machines and power converters. Prerequisites: MA2043, MA2121 (may be concurrent) and ME3450.

#### **EO2402 Introduction to Linear Systems (4-1) Summer**

A course in the rudiments of linear systems for naval officers in non-electrical engineering curricula. Principles of discrete and continuous-time systems. Topics include difference equations, discrete and continuous convolution, correlation, transfer functions, and system diagrams. Transform applications in communication and control systems. Prerequisites: Ability to program in a higher level language.

#### **EO2514 Introduction to Communications Systems Engineering for ITM (4-2) As Required**

A first course in communications systems for the Information Technology Management curriculum. The course considers basic electricity and electronics, signals and systems, and amplitude modulation transmission and reception. Prerequisites: MO1901.

#### **EO2525 Probabilistic Analysis of Signals and Communications Systems (4-1) Spring**

Basic analog and digital communications techniques are discussed. The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on communication systems relevant to military applications. Topics include AM, FM, probability, random variables, probability density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and rms values of nondeterministic signals, correlation and covariance; LTI systems, transformation of random variables, and the central limit theorem. Prerequisites: MA2121 and PH1322

**EO2652 Fields, Waves, and Electromagnetic Engineering (4-1) Winter**

This course covers electromagnetic field theory and engineering applications. Static electric and magnetic field theory is developed and Maxwell's equations are presented. Applications include plane wave propagation, analysis and design of transmission lines, waveguides, resonators, and high frequency components. Labs provide practical experience with microwave instruments, components, and measurement techniques. The objective of the course is to provide a foundation for subsequent study of microwave engineering, antennas, scattering, and radio wave propagation for application in the areas of communications, radar, and electronic warfare. Prerequisites: MA1116 and PH1322, or consent of instructor.

**EO3402 Signals and Noise (3-1) Fall**

A course in the rudiments of modern signal processing for naval officers in non-electrical engineering curricula. Topics include signal processing in the frequency domain using the DFT and FFT, random signals, their description and processing. Applications to signal detection, demodulation, filtering, beam forming, target tracking, and other relevant naval and military operations. Prerequisites: EO2402 and OS2103 or equivalent.

**EO3502 Telecommunications Systems Engineering (2-2) Winter/Summer**

A broad-based course in telecommunications systems technology for a multidisciplinary audience. The course considers analog and digital communications systems. Specific topics include amplitude and angle modulation transmission and reception; baseband and passband digital modulation; system noise; transmission lines, waveguides and antennas; fiber optics; satellite communications. Prerequisites: MO1901.

**EO3512 Communications and Countermeasures (3-2) Summer**

The second course in communications and countermeasures for the Information Warfare curriculum. The course considers signals and protocols for networks, time and frequency domain multiplexing, transmission lines, antennas, and fiber optics, and cellular communication concepts. Prerequisites: MA3139.

**EO3513 Communications Systems Engineering (4-2) Spring**

The second course in communications systems engineering for the C4I curriculum. The course considers analog and digital communications systems. Specific topics include angle modulation transmission and reception; the sampling theorem; spectral representation of pulse and digital signals; pulse and digital modulations; baseband coding forms; frequency and time division multiplexing; transmission lines, waveguides and antennas. Prerequisites: EO2513.

**EO3516 Introduction to Communication Systems Engineering (4-2) Spring**

A first course in communication systems for the Space Systems Operations curriculum. The course considers basic electricity and electronics, signals and systems, and amplitude modulation transmission and reception. Prerequisites: None.

**EO3525 Communications Engineering (4-1) Summer**

The influence of noise and interference on the design and selection of digital communications systems is analyzed.

Topics include link budget analysis and signal-to-noise ratio calculations, receiver performance for various digital modulation techniques, bandwidth and signal power trade-offs, an introduction to spread spectrum communications, and multiple access techniques. Examples of military communications systems are included. Prerequisites: EO2525.

**EO3602 Electromagnetic Radiation, Scattering and Propagation (4-2) Spring**

The principles of electromagnetic radiation are applied to antenna engineering, scattering, and propagation. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. This course is intended for students not in the 590 curriculum. Prerequisites: EO2652 or equivalent.

**EO3911 Interdisciplinary Studies in Electrical and Computer Engineering (V-V) Fall**

Courses on special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

**EO4512 Communications and Countermeasures (4-2) Fall**

The final course in communications and countermeasures for the Information Warfare curriculum. The course develops encryption and decryption concepts, secure communications, and communications countermeasures. Prerequisites: EO3512. Classification: U.S. citizenship and SECRET clearance.

**EO4513 Communications Systems Analysis (4-2) Summer**

The final course in communications systems engineering for the C4I curriculum. The course considers propagation effects on signal transmission; end-to-end path calculations for wire/coax, optical fiber, and RF systems including terrestrial ground links and satellite communications; spread spectrum; wireless/cellular communications. Prerequisites: EO3513.

**EO4516 Communications Systems Analysis (4-2) Summer**

The final course in communications systems engineering for the Space Systems Operations curriculum. The course considers propagation effects on signal transmission; end-to-end path calculations for wire/coax, optical fiber, and RF systems including terrestrial ground links and satellite communications; spread spectrum; wireless/cellular communications. Prerequisites: EO3516.

**EO4612 Microwave Devices and Radar (4-2) Summer**

Those microwave devices most important in radar and in electronic warfare systems are studied, including magnetrons, traveling-wave tubes, and solid-state diodes. The radar range equation is developed. In addition to basic pulse radar, modern techniques are discussed including Doppler systems, tracking radar, pulse compression, and electronically steerable array radars. Electromagnetic compatibility problems

involving radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross-section of targets. Prerequisites: EO3602 (may be concurrent) or consent of instructor.

#### **EO4622 Information Warfare Systems (3-2) As Required**

This course covers electronic warfare in that portion of the electromagnetic spectrum through the millimeter wavelength region. Electronic denial and deceptive countermeasure against fuses, communications, and various radar detection and tracking systems are discussed. Equations for required jammer gain and power output are developed. The characteristics of passive countermeasures are discussed. Other topics include anti-radiation missiles, counter-countermeasure circuits, target masking and modification, signal intercept, signal identification and direction finding. Techniques are discussed in relation to U.S., allied, and former communist bloc systems. Laboratory work reinforces the classroom discussions. Prerequisites: EO4612. Classification: U.S. citizenship and SECRET clearance.

#### **EO4911 Advanced Interdisciplinary Studies in Electrical and Computer Engineering (V-V) Fall**

Courses on advanced special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings Prerequisites: None.

### **Electronic Systems Engineering - Curriculum 590**

#### **Website**

<http://Web.nps.navy.mil/~ece/>

#### **Program Officer**

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#### **Brief Overview**

This curriculum is designed to educate officers in current electronics technology and its application to modern naval warfare. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems, ship/weapon control systems, and

communication/information processing applicability. It will enhance individual performance in all duties throughout a naval career, including operational billets, technical management assignments and policy making positions, thereby preparing the officer for progressively increased responsibility, including command, both ashore and afloat.

#### **Requirements for Entry**

A baccalaureate degree in engineering or the physical sciences is desired. Differential and integral calculus, one year of calculus-based college physics and at least one semester of college chemistry are required. The Engineering Science Program within the ESE curriculum is available for candidates who do not meet all admission requirements. The time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will earn/have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

#### **Entry Date**

Electronic Systems Engineering is typically an eight-quarter course of study with entry dates in every quarter. A six-quarter program is available for officers with an ABET accredited BSEE degree on a case-by-case basis. If further information is needed, contact the Academic Associate or the Program Officer.

#### **Degree**

Requirements for the Master of Science in Electrical Engineering degree are met en route to satisfying the educational skill requirements.

#### **Subspecialty**

Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code 530XP. A limited number of particularly well qualified students may be able to further their education beyond the master's degree and obtain the Degree of Electrical Engineer and a 530XN subspecialty code. The curriculum sponsor is the Space and Naval Warfare Systems Command.

#### **Typical Subspecialty Jobs**

Instructor: Naval Academy, Annapolis, MD  
Project Manager: SPAWARSYSCOM;  
NAVSEASYSYSCOM; NIWA  
Operations Test and Evaluation: COMOPTVFOR  
Electronics Research Manager: NSA/CSS, FT.  
Meade  
C3 Staff Officer: DISA HQ, Washington, DC  
Project Officer: Warfare Systems Architecture and  
Engineering, SPAWARHDQTRS  
Electrical Engineer: USSTRATCOM

### Typical Course of Study: - Computer Systems Option

#### Quarter 1

EC2100	(4-2)	Circuit Analysis
EC2820	(3-2)	Digital Logic Circuits
MA1115	(4-0)	Multi-Variable Calculus
NW3230	(4-2)	Strategy & Policy

#### Quarter 2

EC2110	(3-2)	Circuit Analysis II
EC2200	(3-3)	Introduction to Electronics Engineering
EC2400	(3-1)	Discrete Systems
EC2840	(3-2)	Introduction to Microprocessors

#### Quarter 3

CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
EC2210	(3-2)	Electronics Engineering II
EC2410	(3-1)	Analysis of Signals and Systems
EC3800	(3-2)	Microprocessor Based System Design
EC3000	(1-0)	Introduction to Graduate Research

#### Quarter 4

ECXXXX		BSEE Elective I
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
EC3500	(4-0)	Analysis of Random Signals
EC2420	(3-0)	Systems Theory
EC3000	(1-0)	Introduction to Graduate Research

#### Quarter 5

ECXXXX		BSEE Elective II
EC2220	(2-4)	Applied Electronics
EC3820	(3-1)	Computer Systems
ECXXXX		BSEE Elective III

#### Quarter 6

EC4010	(3-2)	Principles of Systems Engineering
EC4830	(3-1)	Digital Computer Design
EC3830	(3-2)	Digital Computer Design Methodology
EC0810	(0-8)	Thesis Research

#### Quarter 7

ECXXXX		MSEE Elective I
EC3850	(3-1)	Computer Communications Methods
EC0810	(0-8)	Thesis Research
EC0810	(0-8)	Thesis Research

#### Quarter 8

ECXXXX		MSEE Elective II
EC4800	(3-0)	Advanced Topics in Computer Engineering
EC4870	(3-2)	VLSI Systems Design
EC0810	(0-8)	Thesis Research

The Communications Systems option is designed to provide an advanced education in modern

communication engineering topics such as digital communications, spread spectrum communication including anti-jam and low probability of intercept applications, forward error correction coding, wireless networks, and satellite communications.

The Computer Systems option is designed to provide an advanced education in the design, implementation, and application of military computer systems, including such topics as logic circuits, logic design and synthesis, microprocessors, computer and digital systems architecture, military computer architectures, fault tolerant computing, high speed networking, silicon VLSI and gallium arsenide digital IC design, parallel processing, and the hardware/software interface.

The Electromagnetic Systems option provides an advanced education in the application of electromagnetic phenomenology to the design and analysis of military systems used for communications, interrogation and signal intercept, and targeting. Courses are offered in a range of areas including antennas, propagation, scattering and RCS control, microwave and millimeter wave devices, as well as in modern numerical methods for analysis and simulation of electromagnetic systems.

The Guidance, Control, and Navigation Systems option is designed to provide an advanced education in the modeling and simulation advanced dynamic systems, the current state of knowledge regarding state estimation (linear and nonlinear filtering), system identification, and the control of dynamic systems, and to unite the theory with military applications. Courses in specific areas of military application currently include military robotics, missile guidance and control, and integrated target tracking.

The Microelectronics and Power Systems option is designed to provide advanced education in the analysis, design, simulation, and control of power electronic and electromechanical components and integrated topologies common to existing and proposed military systems.

The Signal Processing Systems option is designed to provide advanced education in algorithms and design of systems for analysis and processing of signals and images encountered in communications, control, surveillance, radar, sonar, and underwater acoustics.

## Total Ship Systems Engineering (Under Department of Electrical and Computer Engineering)

### Program Director

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### Total Ship Systems Engineering

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Technology students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590/591 curricula.

### Entry Date

Total Ship Systems Engineering will generally fit as part of an eight or nine-quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the program officer or academic associate as early as possible.

### Subspecialty

Completion of this program will contribute toward the graduate's subspecialty code within his/her designated curriculum. The student will also receive 5602P subspecialty code for completion of the TSSE Program.

### Typical Subspecialty Jobs

Upon award of the subspecialty code, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

## Educational Skills Requirements (ESR) Electronic Systems Engineering - Curriculum 590

### Subspecialty Codes: 5300P-5309P

1. **Mathematics:** The officer will have a thorough knowledge of mathematical tools, which are intrinsic to electrical and computer systems engineering, including but not limited to differential equations, vector analysis, linear algebra, probability, and Fourier and Laplace methods.
2. **Engineering Science and Design:** To acquire the requisite background needed to meet the other military education requirements, the officer will acquire proficiency in modern physics, electromagnetic, electronic devices and circuits, system theory, modern electronic system design, and integrated electrical power systems and their controls. In addition, proficiency will be gained in other appropriate fields, such as underwater acoustics, dynamics, fluid mechanics or thermodynamics, that provide the requisite breadth to a military engineering education.
3. **Computers:** The officer will have a sound understanding of computer hardware, software, and their integration into military systems including programming in higher order languages, digital logic, and microprocessor applications.
4. **Electronic and Electrical Engineering:** To provide officers skilled in the application of electronic systems to military needs, the officer will have competence in the broad area of electrical engineering including circuits, electronics, computer communications networks, and systems engineering. The officer will select elective courses to obtain breadth in his/her understanding of military electronic systems. In addition to achieving depth of understanding, the officer shall specialize in one of the following areas: (a) communication systems; (b) guidance, navigation, and control systems; (c) electromagnetic systems; (d) computer systems; (e) signal processing systems; (f) microelectronics and power engineering.
5. **System Design and Synthesis:** The officer will have a sound understanding of engineering principles utilized in engineering system design, particularly as they relate to military systems, including establishment of system related operational requirements and criteria.
6. **Conducting and Reporting Independent Investigation:** The officer will demonstrate the

ability to conduct independent investigation of a Navy and/or DoD relevant electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

## Engineering Acoustics Academic Committee

### Chairman

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**Steven R. Baker\***, Associate Professor, Department of Physics (1985); Ph.D., University of California at Los Angeles, 1985.

**Roberto Cristi\***, Associate Professor, Department of Electrical and Computer Engineering (1985); Ph.D., University of Massachusetts, 1983.

**Monique P. Fargues\***, Associate Professor, Department of Electrical and Computer Engineering (1989); Ph.D., Virginia Polytechnic Institute and State University, 1988.

**Daphne Kapolka\***, Senior Lecturer, Department of Physics (2000); Ph.D., Naval Postgraduate School, 1997.

**Joseph A. Rice\***, Research Chair of Engineering Acoustics (2000); M.S., University of California at San Diego, 1990.

**Kevin B. Smith\***, Associate Professor, Department of Physics (1995); Ph.D., University of Miami, 1991.

(\* indicates faculty member has a joint appointment to another department at NPS)

### Brief Overview

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics and signal processing applied to undersea warfare. Subjects covered include the generation, propagation and reception of sound in the ocean; military applications of underwater sound; and acoustic signal processing. These programs are designed specifically for students in the Combat Systems Sciences and Technology, Undersea Warfare, and Underwater Acoustics curricula, government

employees in acoustics-related laboratories and systems commands, and international students.

### Degree

#### Master of Science in Engineering Acoustics

The Master of Science in Engineering Acoustics degree will be awarded as an interdisciplinary program in accordance with the following degree requirements:

1. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.
2. The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter-hours of course work; at least 20 graduate quarter-hours must be taken in acoustics and its applications. Three 4000 level courses must be included from any three of the following six areas: wave propagation; transducer theory and design; noise, shock, and vibration control; sonar systems; signal processing; and communications. In addition, these courses must include at least one from each of the sponsoring disciplines (physics and electrical engineering).
3. An acceptable thesis must be completed.

Approval of each program by the Chair of the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

#### Doctor of Philosophy and Doctor of Engineering

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the Doctor of Philosophy or Doctor of Engineering degree. Areas of special strength in the departments are physical acoustics, underwater acoustics, acoustic signal processing, and acoustic communications. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other federal government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctorate degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.



## Underwater Acoustics - Curriculum 535

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### Brief Overview

The Underwater Acoustics curriculum is currently available to Distance Learning students and leads to a Master of Science in Engineering Acoustics. Students typically take one course per quarter for a period of 12 quarters (36 months), and must complete a thesis to qualify for the degree. The courses are offered via Video Tele-Conferencing (VTC) and are ordinarily timed to coincide with resident offerings. The course of studies is designed to improve the student's performance in operational, maintenance, and acquisition positions by providing them with a firm background in the fundamental science and engineering of acoustic systems.

### Requirements for Entry

This curriculum is open to both military officers and selected civilian government employees. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential equations and integral calculus, plus at least one course in calculus-based physics. An APC of 323 is required for direct entry.

### Entry Date

The Underwater Acoustics Program can be started during any quarter; however, a minimum of 10 students from the same command must elect to take the sequence together to offset the cost of the VTC component.

### Typical Course of Study

#### Quarter 1

EC2410 (3-1) Analysis of Signals and Systems

#### Quarter 2

PH2401 (3-0) Introduction to Sonar Equations

#### Quarter 3

PH3991 (4-1) Theoretical Physics

#### Quarter 4

PH2151 (4-1) Particle Mechanics

#### Quarter 5

EC3400 (3-1) Digital Signal Processing

#### Quarter 6

PH3119 (4-2) Oscillations and Waves

#### Quarter 7

PH3451 (4-2) Fundamental Acoustics

#### Quarter 8

PH3452 (4-2) Underwater Acoustics

#### Quarter 9

PH3458 (4-2) Noise, Shock, and Vibration Control

#### Quarter 10

PH4455 (4-0) Sound Propagation in the Ocean

#### Quarter 11

PH4454 (4-2) Sonar Transducer Theory and Design

#### Quarter 12

EC4450 (4-1) Sonar Systems Engineering

## Department of Mechanical and Astronautical Engineering

### Chairman

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**Brij N. Agrawal**, Distinguished Professor (1989)\*; Ph.D., Syracuse University, 1970.

**Christopher M. Brophy**, Research Associate Professor (1998); Ph.D., University of Alabama-Huntsville, 1997.

**Muguru S. Chandrasekhara**, Research Professor (1987); Ph.D., University of Iowa, 1983.

**Vladimir Dobrokhodov**, Research Assistant Professor (2001); Ph.D., Zhukovskiy Air Force Engineering Academy, Russia, 1999.

**Jarema Didoszak**, Research Assistant Professor (2004); M.S., Naval Postgraduate School, 2003.

**Morris R. Driels**, Professor (1989); Ph.D., City University of London, 1973.

**Indranath Dutta**, Professor (1988); Ph.D., University of Texas, Austin, 1988.

**Ashok Gopinath**, Associate Professor and Academic Associate (1994); Ph.D., University of California, Los Angeles, 1992.

**Joshua H. Gordis**, Associate Professor and Academic Associate (1992); Ph.D., Rensselaer Polytechnic Institute, 1990.

**Douglas P. Horner**, Research Assistant Professor (2005); M.S., Naval Postgraduate School, 1999.

**Anthony J. Healey**, Distinguished Professor and Chairman (1986); Ph.D., Sheffield University, United Kingdom, 1966.

**Sheshagiri K. Hebbar**, Senior Lecturer (1988); Ph.D., University of Maryland, 1976.

**Garth V. Hobson**, Professor (1990); Ph.D., Pennsylvania State University, 1990.

**Kevin D. Jones**, Research Associate Professor (1997); Ph.D., University of Colorado, 1993.

**Isaac I. Kaminer**, Professor (1992); Ph.D., University of Michigan, 1992.

**Ramesh Kolar**, Research Assistant Professor (1997); Ph.D., University of Arizona, 1984.

**Young W. Kwon**, Professor (1990); Ph.D., Rice University, 1985.

**Terry R. McNelley**, Distinguished Professor (1976); Ph.D., Stanford University, 1973.

**Knox T. Millsaps**, Professor and Associate Chairman (1992); Ph.D., Massachusetts Institute of Technology, 1991.

**Fotis A. Papoulias**, Associate Professor (1988); Ph.D., University of Michigan, 1987.

**Marcello Romano**, Assistant Professor (2004); Ph.D., Politecnico di Milano, Italy, 2001.

**I. Michael Ross**, Professor (1990); Ph.D., Pennsylvania State University, 1990.

**Young S. Shin**, Distinguished Professor (1981); Ph.D., Case Western Reserve University, 1971.

**Jose O. Sinibaldi**, Research Associate Professor (1999); Ph.D., University of Michigan, 1999.

**Oleg A. Yakimenko**, Research Associate Professor (1989); Ph.D., Russian Academy of Sciences, 1991.

#### **Professors Emeriti:**

**Charles N. Calvano**, Professor Emeritus (1991); M.S., Ocean Engineer, Massachusetts Institute of Technology, 1970.

**Robert E. Ball**, Distinguished Professor Emeritus (1967); Ph.D., Northwestern University, 1962.

**Oscar Biblarz**, Professor Emeritus (1968); Ph.D., Stanford University, 1968.

**Matthew D. Kelleher**, Professor (1967); Ph.D., University of Notre Dame, 1966.

**Gerald H. Lindsay**, Professor Emeritus (1955); Ph.D., California Institute of Technology, 1966.

**Paul J. Marto**, Distinguished Professor Emeritus (1965); Sc.D., Massachusetts Institute of Technology, 1965.

**Max F. Platzer**, Distinguished Professor Emeritus (1970); Dr. Tech. Science; Technical University of Vienna, Austria, 1964.

**Paul F. Pucci**, Professor Emeritus (1956); Ph.D., Stanford University, 1955.

**David Salinas**, Associate Professor Emeritus (1970); Ph.D., University of California, Los Angeles, 1968.

**Turgut Sarpkaya**, Distinguished Professor Emeritus (1967); Ph.D., University of Iowa, 1954.

**Raymond P. Shreeve**, Professor Emeritus (1971); Ph.D., University of Washington, 1970.

**Luis V. Schmidt**, Professor Emeritus (1964); Ph.D., California Institute of Technology, 1963.

**E. Robert Wood**, Professor Emeritus (1988); Degree of .Engineer., Yale University (1967).

**Edward Ming-Chi Wu**, Professor Emeritus (1984); Ph.D., University of Illinois, 1965.

\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

### Brief Overview

The Department of Mechanical and Astronautical Engineering (MAE) provides a strong academic program, which spans the engineering disciplines of thermal-fluid sciences, structural mechanics, dynamic systems, guidance and control, materials science and engineering, propulsion, and systems engineering, including total ship systems engineering, spacecraft, and missile design. These disciplines are blended together with a strong emphasis on naval engineering applications required by surface vessels, submarines, and spacecraft. Furthermore, the department provides advanced education in classified topics in Astronautical Engineering. Programs leading to the degrees of Master of Science in Mechanical Engineering and Master of Science in Astronautical Engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council. Any program leading to a degree must be approved by the Department Chairman at least two quarters before completion. In general, approved programs will require more than the stated minimum degree requirements in order to conform to the needs and objectives of the United States Navy, and satisfy the applicable subspecialty-code requirements.

### Objectives

The overall educational objective of the Mechanical and Astronautical Engineering program is to support the NPS mission by producing graduates who have knowledge and technical competence, at the advanced level in Mechanical and Astronautical Engineering, in support of national security. To achieve this goal, the specific objectives are to produce graduates who have:

1. The ability to identify, formulate, and solve technical and engineering problems in Mechanical and Astronautical Engineering and related disciplines using the techniques, skills and tools of modern practice, including modeling and simulation. These problems may include issues of research, design, development, procurement, operation, maintenance or disposal of engineering components and systems for military applications.
2. The ability to provide leadership in the specification of military requirements, in the organization and performance of research, design,

testing, procurement and operation of technically advanced, militarily effective systems. The graduate must be able to interact with personnel from other services, industry, laboratories and academic institutions, and be able to understand the role that engineering and technology have in military operations, and in the broader national and global environment.

3. The ability to communicate advanced technical information effectively in both oral and written form.

### Degree

The following degrees are available. Consistent with NPS Academic Policy, with the exception of the Engineer's or Doctoral degrees, all degree requirements must be satisfied independently. A student is able to earn an academic degree listed below while enrolled in Mechanical and Astronautical Engineering (Curriculum 570), Reactors/Mechanical Engineering DL (Curriculum 571), Space Systems Engineering (Curriculum 591), and Combat Systems Science and Technology (Curriculum 533).

#### Master of Science in Mechanical Engineering

A candidate shall have completed work equivalent to the requirements of this department for the Bachelor of Science degree in Mechanical Engineering. Candidates who have not majored in mechanical engineering, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in mechanical engineering and mathematics to fulfill these requirements in preparation for their graduate program.

The Master of Science degree in Mechanical Engineering requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: There must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science degree in Mechanical Engineering must also demonstrate competence at the advanced level in at least one of the available disciplines of Mechanical Engineering. These disciplines are the thermal-fluid sciences; solid mechanics, shock and vibration; dynamic systems and control; system design; and materials science. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in

this department and a thesis in one of these discipline areas.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science degree in Mechanical Engineering. An acceptable thesis for the degree of Mechanical Engineer may also meet the thesis requirement of the Master of Science in Mechanical Engineering degree. The student's thesis advisor, the Academic Associate, the Program Officer and the Department Chairman must approve the study program and the thesis topic.

### **Master of Science in Astronautical Engineering**

The Master of Science degree in Astronautical Engineering requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: There must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science degree in Astronautical Engineering must demonstrate knowledge of orbital mechanics, space environment, attitude determination, guidance and control, telecommunications, space structures, spacecraft/rocket propulsion, and spacecraft design. The student must also demonstrate competence at the advanced level in one of the above disciplines of Astronautical Engineering. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this department and a thesis in one of these discipline areas.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science degree in Astronautical Engineering. An acceptable thesis for the degree of Astronautical Engineer may also meet the thesis requirement of the Master of Science in Astronautical Engineering degree. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the thesis topic.

### **Master of Science in Engineering Science (Mechanical Engineering)**

Candidates with acceptable academic background may enter a program leading to the degree of Master of Science in Engineering Science (with major in Mechanical Engineering). Candidates who have not majored in mechanical engineering or closely related subject areas, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in mechanical

engineering and mathematics to prepare for their graduate program.

The Master of Science in Engineering Science (with major in Mechanical Engineering) degree requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science in Engineering Science degree must also demonstrate competence at the advanced level in at least one of the available disciplines of Mechanical Engineering. These disciplines are the thermal-fluid sciences; solid mechanics, shock and vibration; dynamic systems and control; system design; and materials science. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this department and a thesis in one of these discipline areas.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science in Engineering Science (with major in Mechanical Engineering) degree. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the thesis topic.

Under special circumstances as approved by the Academic Associate, the Program Officer, and the Department Chair, students may take four additional courses in lieu of a thesis. Those four additional courses should be at least 3000 and 4000 level courses offered by the MAE Department, and among them at least two courses should be at the 4000 level.

Entrance into the 571 Reactors/Mechanical Engineering Curriculum program, leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering), is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES) and who have an academic profile code (APC) of 121 or better. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors (SEA-08).

This program includes the following BRES courses: BRES 200 Mathematics; BRES 340 Applied Structural Mechanics; BRES 350 Heat Transfer and Fluid Flows; BRES 360 Reactor Dynamics, Control and Safeguards. The foregoing are equivalent to 16 credit hours of ME3XXX level courses. In addition,

the BRES 370 Reactor and Power Plant Design Project and report must be successfully completed. In addition, the program must include 20 hours of graduate level (ME4XXX) level NPS courses in a program approved by the Department Chairman.

### **Master of Science in Engineering Science (Astronautical Engineering)**

Candidates with acceptable academic background may enter a program leading to the degree of Master of Science in Engineering Science (with major in Astronautical Engineering). Candidates who have not majored in astronautical engineering or closely related subject areas, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in astronautical engineering and mathematics to prepare for their graduate program.

The Master of Science in Engineering Science (with major in Astronautical Engineering) degree requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science degree in Astronautical Engineering must demonstrate knowledge of orbital mechanics, space environment, attitude determination, guidance and control, telecommunications, space structures, spacecraft/rocket propulsion, and spacecraft design. The student must also demonstrate competence at the advanced level in one of the above disciplines of Astronautical Engineering. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this department and a thesis in one of these discipline areas.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science in Engineering Science (with major in Astronautical Engineering) degree. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the thesis topic.

### **Master of Science in Engineering Science (Materials Science and Engineering)**

Students with acceptable backgrounds in science or engineering may enter a program leading to the Master of Science in Engineering Science degree (with major in Materials Science and Engineering). The

candidate must take all courses in a curriculum approved by the Chairman of the MAE Department and the faculty member designated to represent the materials program. At a minimum, the approved curriculum must satisfy the requirements listed below.

The program must include at least 48 quarter-hours of graduate work in Materials Science, consisting of 32 credit hours in graduate level courses and 16 credit hours of thesis work. Of the 32 course credit hours, at least 16 must be at the 4000 level and at least 8 quarter-hours of graduate credit must be earned outside of Materials Science and Engineering.

An acceptable thesis is required for the Master of Science in Materials Science and Engineering degree. The thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the thesis topic.

### **Mechanical Engineer**

A graduate student with a superior academic record (as may be demonstrated by a graduate QPR of 3.70 or better) may apply to enter a program leading to the Mechanical Engineer degree. A candidate must prepare his or her application and route it through the Program Officer to the Department Chairman for a decision. Typically, the selection process occurs after completion of the candidate's first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the MAE Department. At a minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer degree requires at least 64 quarter-hours of graduate level credits in Mechanical Engineering and Materials Science, at least 32 of which must be at the 4000 level. At least 12 quarter-hours of graduate level credits must be earned outside of the MAE Department. At least one advanced mathematics course should normally be included in these 12 quarter-hours.

An acceptable thesis of 28 credit hours is required for the Mechanical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the MAE Department.

### **Astronautical Engineer**

A graduate student with a superior academic record (as may be demonstrated by a graduate QPR of 3.70 or better) may apply to enter a program leading to the Astronautical Engineer degree. A candidate must prepare his or her application and route it through the Program Officer to the Department Chairman for a decision. Typically, the selection process occurs after completion of the candidate's first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the MAE Department. At a minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Astronautical Engineer degree requires at least 64 quarter-hours of graduate level credits in Astronautical Engineering or Mechanical Engineering and Materials Science, at least 32 of which must be at the 4000 level. At least 12 quarter-hours of graduate level credits must be earned outside of the MAE Department. At least one advanced mathematics course should normally be included in these 12 quarter-hours.

An acceptable thesis of 28 credit hours is required for the Astronautical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the MAE Department.

### **Total Ship Systems Engineering Program**

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical and Astronautical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer's degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that address system design issues are welcome.

### **Missile Systems Engineering**

The Missile Systems Engineering Track is an option that can be pursued within the framework of the Master of Science in Mechanical Engineering (MSME) or Master of Science in Engineering Science degree programs. This program is a regular part of the TEMASEK program, but is also open to DoD contractors. The program provides a solid engineering foundation in analysis and design techniques involved in developing offensive and defensive missile systems.

This option consists of a four-course sequence of special missile courses embedded in the normal MSME or MSES(ME) degree program of courses and a thesis.

The courses for this program are:

1. ME3205 Missile Aerodynamics (4-1) in Winter.
2. ME4703 Missile Flight Dynamics and Control (4-1) in Spring.
3. AE4452 Advanced Missile Propulsion (4-1) in Summer.
4. ME4704 Missile Design (3-2) in Fall.

NPS works with industry, primarily with Raytheon Missile Systems Division in Tucson, AZ, to create this unique blend of high-quality academic courses and "real world" systems engineering focus in missile design and manufacturing, leading to a program of unique military relevance.

### **Doctor of Philosophy and Doctor of Engineering**

Students who have a superior academic record may request entrance into the doctoral program. All applicants will be screened by the departmental doctoral committee for admission into the program. The department also accepts officer students selected in the Navy-wide doctoral study program, qualified international officers, and civilian students selected from the employees of the United States Federal Government.

An applicant to the doctoral program who is not already at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test (if available), to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, California 93943-5100.

Every applicant who is accepted for the doctoral program will initially be enrolled in the Mechanical and Astronautical Engineering Program under a special option which satisfies the broad departmental requirements for the Engineer's degree, which includes research work. As soon as feasible, the student must identify a faculty advisor to supervise research and to help formulate a plan for advanced study. As early as practicable thereafter, a doctoral committee shall be appointed to oversee that student's individual doctoral program as provided in the school-wide requirements for the doctor's degree. Joint programs with other departments are possible.

A noteworthy feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installations of the federal government. The degree requirements are as outlined in the general school requirements for the doctor's degree (see Academic Policy manual, Section 5.4h).

## Laboratories

MAE Laboratories are designed as complements to the educational mission and research interests of the department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes equipment and facilities for the investigation of problems in engineering mechanics; a completely equipped materials science laboratory, including advanced scanning electron microscopes, an Auger microprobe, a transmission electron microscope and X-ray diffractometers; an oscillating water tunnel, a unique underwater towing tank and a low turbulence water channel; a vibration analysis laboratory; a fluid power controls laboratory; a robotics and real-time control laboratory; facilities for experimentation with low velocity air flows; equipment for instruction in thermal transport phenomena; a laser Doppler velocimeter; nuclear radiation detection equipment and an interactive CAD/ CAE computer graphics laboratory. Experimentation is further enhanced by a broad selection of analog and digital data acquisition and processing equipment and instrumentation. The Mechanical Engineering Department also houses the largest of several machine shops on campus. The ME Department shop includes a state-of-the-art 3-axis CNC milling machine, a CNC lathe, and a variety of other high-precision machine tools and fabrication equipment which allow the manufacture of parts and systems in support of teaching and research.

The following laboratories are available for teaching and research:

**Unmanned Systems Lab/Ctr:** Unmanned Systems are a critical element in Navy planning for future littoral operations. They include fixed bottom-mounted data gathering nodes, unmanned submarines, surface vessels, and aerial vehicles. Interconnectivity with acoustic and radio communications links are key to the development of modern naval systems. These assets may be used for mine clearing and other shallow water reconnaissance and intelligence gathering operations. The laboratory houses two autonomous Submarines (ARIES and REMUS) as well as the UAV FROG and subsurface Acoustic Doppler Current Profilers (ADCP), equipped with acoustic modems and supports coursework in Control and Autonomous Systems.

**CAD/CAE Computer Laboratory:** This lab consists of Windows PCs and is used heavily by students for both class and thesis related work. This lab has a wide range of special mechanical engineering software for analysis and design.

## Additional Laboratories

**Nano/Memslaboratory:** This laboratory provides a facility for teaching the emerging technologies of NANO/MEMS.

**Fluid Mechanics and Hydrodynamics Laboratories:** The fluid mechanics laboratory supports instruction in basic courses in fluid mechanics. It is equipped with a small wind tunnel for specific instructional purposes. The hydrodynamics laboratory includes a unique U-shaped oscillating water tunnel for the study of a wide range of phenomena, such as flow about stationary and oscillating bodies, vortex-induced vibrations, stability of submarines and boundary layers, and vortex-free-surface interactions. The hydrodynamics laboratory also houses a recirculating water tunnel for numerous flow-separation and vibration phenomena and a vortex-breakdown facility for the investigation of the stability of swirling flows. These facilities are supported by a 3-beam Laser-Doppler-Velocimeter, numerous other lasers, high-speed motion analyzers, data-acquisition systems, and dedicated computers for numerical simulations.

**Technical Support Facility:** This facility provides broad support, to both students and faculty, in electronics, data acquisition, computation; machining fabrication, and instrumentation calibration.

**Materials Laboratory:** Laboratory supports teaching and research in processing, characterization, and testing of advanced structural, functional, and nanotechnology materials for defense applications.

- **Auger Surface Analysis Laboratory:** It consists of an ultrahigh vacuum system and an electron beam source to probe the surface and interface structure of composites and microelectronic devices.
- **Transmission Electron Microscopy Lab:** Contains a TOPCON 002B TEM used for materials science and engineering teaching and research.
- **Scanning Electron Microscopy Lab:** Contains a TOPCON 540 SEM used for materials science and engineering teaching and research.
- **X-Ray Diffraction Laboratory:** Two Philips X-ray Systems are used for materials science and engineering teaching and research.
- **Optical Microscopes Laboratory:** This lab includes several optical microscopes as well as electronic imaging and image analysis systems that are used for materials science and engineering teaching and research.
- **Metallurgical Polishing Laboratory:** This laboratory supports all teaching and research in materials by provision of facilities for the polishing of samples for metallo-graphic examination.

- **Metallurgical Sectioning Laboratory:** This laboratory supports all teaching and research in materials by provision of facilities for the cutting/sectioning of samples for metallo-graphic examination.
- **Wet Sample Preparation Facility:** This facility provides support mainly for the Transmission and Scanning Microscopy labs. It is used for chemical preparation of samples for microscopic examination.
- **Dark Room Facility:** This facility is used in support of photographic work in the materials and other departmental laboratories.
- **Transmission Electron Microscopy II Lab:** This laboratory is equipped with a JEOL-100CX microscope and is used primarily for instruction of students in the techniques of electron microscopy.
- **Scanning Electron Microscopy Laboratory:** This laboratory is equipped with an older model Cambridge Instruments SEM.
- **Physical Testing (Dilatometer) Laboratory:** This laboratory is dedicated to dilatometry and is primarily used for research applications.
- **Heat Treatment Laboratory:** This laboratory supports courses and research mainly in the materials area and includes a selection of conventional furnaces.
- **Corrosion Laboratory:** This laboratory supports the instructional program in the area of corrosion science and engineering.
- **Metallurgical Etching Laboratory:** This laboratory supports all teaching and research in materials by provision of facilities for the chemical treatment of samples for metallo-graphic examination.
- **Welding Laboratory:** Welding is the primary method of fabrication for Naval vessels, and instruction and research on welding/joining of both conventional and advanced alloys is carried out in this facility.
- **Materials Processing Laboratory:** This laboratory supports both teaching and research involving deformation and thermal processing of materials. It is equipped with presses, a rolling mill, and various heat treatment furnaces.
- **Creep Test Laboratory:** This laboratory supports research in high-temperature structural metals and composites.
- **Mechanical Test Laboratory:** This lab supports mechanical testing with impact, creep, and fatigue instrument and electromechanical properties.

- **Ceramics Laboratory:** This laboratory is devoted primarily to research on high temperature materials based on various ceramic compositions.
- **Composites Laboratory:** This laboratory supports research in composite materials, especially metal matrix composites.

### Marine Propulsion Laboratory

This laboratory has gas turbine (Allison C-250) and diesel (Detroit 3-53) engines connected to water brake dynamometers, located in separate, isolated engine test cells. These engines are instrumented to obtain steady-state performance and high-frequency, time-resolved measurements. Aerothermodynamic, acoustic, and vibration phenomena in turbo-machinery and reciprocating engines are being investigated, particularly relating to non-uniform flow and condition-based maintenance (CBM) in naval machinery. These engines are used for both instructional and applied research programs in the area of marine power and propulsion. In addition, this lab has bench-top rotordynamics experiments for demonstrating high-speed machinery balancing and investigating rotordynamic instabilities. The lab has sub-scale flow facilities for developing and testing low observable (stealth) technologies for engine inlets and exhausts.

### Rocket Propulsion Laboratory

This lab conducts research on advanced concepts in solid, liquid, and combined mode propellants. Experimental and computational research is conducted in the areas of propellant mixing, combustion, pulse detonation, thrust control, and plume mixing. A full range of mechanical and optical diagnostic techniques are used on small and subscale experiments

### Structural Dynamics Laboratory

This lab is devoted to structural dynamics and is especially designed to facilitate both teaching and research into vibration and shock effects associated with underwater explosions, as well as related shipboard vibration problems. The ability to validate simulation models with lab-scale tests is critical for student education. The lab includes a state of the art multi-channel data acquisition system, and a large variety of transducers and instrumentation.

### Thermal Engineering Labs

These labs are used mainly for instruction in heat transfer to investigate convection phenomena of single and multi-phase flows and include facilities for measurement of temperature change and fluid motion in a range of systems. The lab also includes equipment/instrumentation for measurements in microelectronics and micro-heat exchanger systems.



- **Convection Heat Transfer Laboratory:** Used mainly for instruction in heat transfer by convection phenomena and includes facilities for measurement of temperature change and fluid motion in a range of systems.
- **Electronic Cooling Laboratory:** The operation of microelectronic devices results in intense, but very localized, heating of electronic devices. The phenomena involved are unique because of the small scale.
- **Two-Phase Heat Transfer Laboratory:** This is an instructional and research laboratory for the study of heat transfer involving more than one phase, e.g., heat transfer involving liquid and vapor phases during boiling or condensation.

### Ship Systems Engineering (TSSE) Lab

This is an integrated design center in which student teams perform a capstone design project of a Navy ship. Ship design encompasses hull, mechanical, and electrical systems as well as combat systems, and is done in cooperation with the Meyer Institute of Systems Engineering.

### Astro-Engineering Lab

- **Spacecraft Design Laboratory:** This laboratory houses computer-aided design tools for spacecraft design and a spacecraft design library. It is used heavily by students for three spacecraft design courses, AA 3870, AA 4870, and AA 4871. Students can do collaborative spacecraft design using the unique design tools on Windows or Unix PCs that are not available in other education institution.
- **Smart Structure and Attitude Control Laboratory:** This lab consists of five major ongoing experiments to facilitate the instruction and research by students in the area of both smart structures, sensors, and actuators for active vibration control, vibration isolation, and shape control in space applications and attitude control of flexible spacecraft and space robotic manipulators. In addition to students' thesis research, it also supports courses AE4816 Dynamics and Control of Smart Structures, and AE3811 Space System Laboratory, and AA 3818 Spacecraft Attitude Dynamics and Control.
- **Optical Relay Spacecraft Laboratory:** This joint laboratory of NPS and AFRL is used for both instruction and research on acquisition, tracking, and pointing of flexible military spacecraft. The main facilities includes a bifocal relay mirror spacecraft attitude simulators, actuated by variable

speed control moment gyros; a single focal spacecraft attitude simulators, actuated by reaction wheels; an optical beam and jitter control test bed. This laboratory is used for courses AA3811, AA3818, and AA4818.

- **Spacecraft Robotics Laboratory:** The Spacecraft Robotics Laboratory, funded by NPS and AFRL, hosts the Autonomous Docking and Spacecraft Servicing Simulator (AUDASS). This test bed, consisting of two independent robotic vehicles (a chaser and a target), aims to carry out on-the-ground testing of satellite servicing and proximity formation flight technologies. The vehicles float, via air pads, on a smooth epoxy floor, providing a frictionless support for the simulation in 2-D of the zero-g dynamics. This is used for course AE 3811
- **FLTSATCOM Laboratory:** This laboratory consists of a qualification model of the Navy communications satellite, FLTSATCOM, the associated ground support equipment for testing the satellite. This is an instructional laboratory and is used by students in laboratory course AA 3811. Students get operational experience including spin-up of a reaction wheel, rotation of a solar array drive, firing sequence of thrusters, and receiving telemetry on the satellite operational parameters.

### Research Centers

The following Research Centers are organized in the MAE Department:

- **Center for Materials Sciences and Engineering:** The Center for Materials Sciences and Engineering provides a focus for research and education in Materials Science and Engineering at NPS. Research projects span the range from basic research sponsored by the NSF to applied work on microelectronics reliability sponsored by Intel Corp. through the Semiconductor Research Corporation (SRC), and the Army Research Office (ARO). Also, projects include advanced processing of naval materials sponsored by DARPA.
- **Center for Autonomous Underwater Vehicle Research:** The primary goal of the NPS Center for AUV Research is to educate Navy and USMC officer students in the development and use of technologies needed for unmanned underwater vehicles through coursework, thesis, and dissertation research. The secondary goal of the Center is to advance Naval UUV operations by providing: Support to the Fleet, Navy Labs and

Program Offices; Testing and Experimentation of Advanced Technologies; Independent Verification and Validation of UUV Concepts; and Innovative Concept Development. Research is conducted in topics falling in the following broad areas: Underwater Navigation, Control and Communication; Tactical Decision Aids; Collaborative Multi-Vehicle Operations; Obstacle Avoidance (OA) using Forward Look Sonar; and Common UUV Mission Description Language.

- **Turbo-Propulsion Laboratory:** The Turbo Propulsion Laboratory houses a unique collection of experimental facilities for research and development related to compressors, turbines, and advanced air-breathing propulsion engine concepts. In a complex of specially designed concrete structures, one building, powered by a 750 HP compressor, contains 10 by 60 inch rectilinear and 4 to 8-foot diameter radial cascade wind tunnels, and a large 3-stage axial research compressor for low speed studies. A two-component, automated traverse, LDV system is available for CFD code verification experiments. A second building, powered by a 1250 HP compressed air plant, contains fully instrumented transonic turbine and compressor rigs in explosion-proof test cells. A spin-pit for structural testing of rotors to 50,000 RPM and 1,800 degrees Fahrenheit is provided. Model experiments and equipment for instrumentation development are located in a separate laboratory. Data acquisition from 400 channels of steady state and 32 channels of non-steady measurements, at up to 200 kHz, is controlled by the laboratory's Pentium workstations. A third building houses a 600 HP radial and 150 HP boost compressor capable of delivering 2000 scfm of air at 10 and 20 atmospheres respectively. These charge four tanks for blow-down to a supersonic wind tunnel (4 x 4 inches), a transonic cascade wind tunnel (2 x 3 inches), and two free jets (one 6-inch and one 1-inch in diameter). The large free jet is equipped with an instrumented thrust stand for the testing of small gas turbine engines. The building also houses a 3-inch diameter shock tube. Pressure measurements are made with a 96-channel Scani-valve ZOC system and pressure sensitive paint, and Schlieren and shadowgraph techniques are used routinely.
- **Spacecraft Research and Design Center:** The Spacecraft Research and Design Center at the Naval Postgraduate School consists of six state-of-the-art laboratories: Fltsatcom Laboratory,

Spacecraft Attitude Dynamics and Control Laboratory, Smart Structures Laboratory, Spacecraft Design Center, NPS-AFRL Optical Relay Mirror Spacecraft Laboratory, and Satellite Servicing Laboratory. These laboratories are used for instruction and research in space system engineering and space operations curricula. The emphasis has been on providing students with hands-on experience in the design, analysis, and testing of space systems, and to provide students with facilities for experimental research. The emphasis in the research is on acquisition, tracking, and pointing of flexible spacecraft with optical payloads; active vibration control, isolation, and suppression using smart structures; space robotics, satellite servicing, space system design, and computer aided design tools. These laboratories have been used in joint projects with Naval Satellite Operational Center, NRL, AFRL, Columbia University, and Boeing.

## Mechanical and Astronautical Engineering Course Descriptions

### AE Courses

#### **AE0810 Thesis Research (0-8)** **Spring/Summer/Fall/Winter**

Every student conducting thesis research will enroll in this course. Prerequisites: None.

#### **AE2440 Introduction to Digital Computation (3-2) Fall**

Introduction to system operations and program development on the department UNIX workstations and the NPS computer facilities. High-level programming languages, including C, MATLAB, and FORTRAN. Development of computer programs, subroutine organization, input and output. Applications of programming techniques to the solution of selected problems in engineering. Prerequisites: MA1115.

#### **AE2820 Introduction to Spacecraft Structures (3-2)** **Fall**

Review of statics and strength of materials. Beam theory: axial, bending, shear and torsional loading, stress analysis and deflection of beams. Design of spacecraft structures for launch loads and a survey of typical launch vehicles. Beam buckling and vibration, critical buckling loads, natural frequencies, and mode shapes. Truss structures and introduction to the finite element method. Prerequisites: None.

#### **AE3804 Thermal Control of Spacecraft (3-0) Summer**

Conduction, radiation, thermal analysis, isothermal space radiator, lumped parameter analytical model, spacecraft passive and active thermal control design, heat pipes, and louvers. Prerequisites: None.

#### **AE3811 Space Systems Laboratory (2-2) Spring**

Principles of spacecraft test programs; component, subsystem, and system level tests; military standard test requirements for

space vehicles, laboratory experiments in Fltsatcom Laboratory on satellite performance, in Spacecraft Test Laboratory for vibration, modal and thermal tests; and in Spacecraft Attitude Control Laboratory for spacecraft control performance. Graded Pass/Fail. Prerequisites: Consent of instructor.

**AE3815 Introduction to Spacecraft Dynamics (3-2) Spring**

Coordinate system transformations (GCI, LVLH, etc.), time differentiation operator, velocity and acceleration in 3D-frames of reference, Poisson's equations, spacecraft application examples (strapdown INS, etc.), angular momentum, inertia tensor transformations, Newton-Euler equations of motion, spin stability, single-spin spacecraft, nutation and precession, energy-sink analysis, passive nutation control, dynamics and stability of dual spin spacecraft, gravity-gradient stabilization. Prerequisites: PH2511, MA2121, MA3046, and AE2440 or equivalent.

**AE3818 Spacecraft Attitude, Dynamics, and Control (3-2) Fall**

Stability of dual-spin stabilized spacecraft, active nutation control, disturbance torques: solar, magnetic, gravity gradient, and aerodynamic, attitude sensors, antenna beam pointing accuracy, three-axis-stabilized spacecraft, fixed momentum wheel with thrusters, three reaction wheel system, attitude control pointing requirements for military spacecraft. Prerequisites: EC2300 or equivalent, and AE3815.

**AE3820 Dynamics of Space Systems (3-2) Fall**

This course is an intermediate level analysis of the dynamics of space systems, including: ascent and descent of rockets, tethers, yo-yo despin, spinning hubs with flexible appendages, single stage to orbit, and various problems in spacecraft attitude dynamics such as nutation dampers. The analysis will include developing the equation of motion, equilibrium and stability analysis, solutions of nonlinear systems using perturbation methods and numerical techniques. Computational and symbolic manipulator packages will be used extensively. Prerequisites: MA2121.

**AE3830 Spacecraft Guidance and Control (3-2) Spring**

Overview of the Spacecraft Guidance, Navigation, and Control System. Sources and effects of navigation and modeling errors on guidance and control systems. Error propagation techniques: linearization of spacecraft dynamical equations, covariance propagation and Monte Carlo simulations. Applications to spacecraft rendezvous and attitude control. Introduction to optimal control theory. Optimal bang-bang control for spacecraft thrusters. Linear-quadratic control problems and feedback control. Selection of weights and performance analysis. Perturbation guidance. Application of the matrix Riccati equation to spacecraft stability, control and guidance. Prerequisites: MA2121, SS3500, EC2300 or equivalent, and AE3815.

**AE3851 Spacecraft Propulsion (3-2) Summer**

Introduces concepts and devices in spacecraft propulsion. It reviews fundamental fluid mechanics, electricity and magnetism, and thermodynamics with molecular structure. Conventional chemical means such as H<sub>2</sub>/O<sub>2</sub> and monopropellants are discussed. Electric propulsion schemes (resistojets, arc-jets, ion, magneto-plasma-dynamic, etc.) are introduced and their performances contrasted with chemical

schemes. Characteristics of more advanced concepts (laser, solar, nuclear, etc.) are also considered. Prerequisites: None.

**AE3852 Propulsion for Launch Vehicles (4-0) Fall**

Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices. Performance analysis, operating characteristics and propellant selection criteria are considered for air breathing and solid, liquid and nuclear rocket motor propulsion systems. Advanced cycles and concepts are presented. Design of components and subsystems. Prerequisites: ME3201.

**AE3870 Computational Tools for Spacecraft Design (2-4) Winter**

In this course, the students become familiar with the use of computer aided design tools for spacecraft subsystems and system design. The tools are for conceptual spacecraft design trade-offs and detailed subsystem design, such as for structures, thermal, attitude control, and communications. Prerequisites: Consent of instructor.

**AE4362 Astrodynamics (3-0) As Required**

Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. Prerequisites: SS3500 or equivalent.

**AE4452 Advanced Missile Propulsion (4-1) Summer**

Analysis and design of solid propellant rockets, ramjets, dual-combustion ramjets, scramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, combustor design, combustion instabilities and damping, mission and flight envelope effects on design requirements and technology requirements. Use of performance and grain design codes (SPP, PEP, and NASA SP233) and laboratory test firings for comparison with measured performance. Prerequisites: AE3852 or consent of instructor.

**AE4502 Supersonic and Hypersonic Flows (4-0)**

One-dimensional, compressible flow is reviewed. Two-dimensional and axis-symmetric supersonic of ideal gases. Oblique shocks and expansion waves. General compressible flow equations. Potential supersonic and conical flows. Compressible scaling and transonic area ruling. Effects of very high velocity and low density. Hypersonic flow. Mach number independence and equivalence principles. Newtonian method. Blunt and slender body solutions. Real gas behavior and effect on shock and boundary layers. Applications are presented to satellite parasitic drag and re-entry flows. Prerequisites: ME3201 or consent of instructor.

**AE4506 Rarefied Gas Dynamics (4-0) Summer**

Topics include advanced thermodynamics with molecular structure, kinetic theory, distribution functions, Boltzmann equation and transport phenomena from a kinetic theory point of view. Types of flow range from free-molecule to transition, to high temperature continuum. Numerical approaches are discussed. Applications to space problems and hypersonics are treated. Prerequisites: ME3201 or equivalent.

**AE4816 Dynamics and Control of Space Structures (4-0) Spring**

Review of dynamics, finite element method, structural natural frequencies, mode shapes, and control of flexible structures. Smart sensors and actuators and applications to active vibration control, shape control, vibration isolation and fine beam pointing. Equation of motion of spacecraft with flexible structures, and control of spacecraft and flexible structures. The interaction of flexibility and control. Impact of flexibility on the performance of military spacecraft and future trends. Prerequisites: Graduate AE3830, ME3521, and EC2300 or equivalent.

**AE4818 Acquisition, Tracking, and Pointing of Military Spacecraft (3-2) Summer**

Acquisition, tracking, and pointing (ATP) requirements for military spacecraft, effects of jitter on ATP performance, jitter control, acquisition system, tracking algorithms, laser beam control, spacecraft attitude control using control moment gyros, example of ATP designs for military spacecraft, laboratory experiments on spacecraft attitude control and laser beam control. Prerequisites: AE3818.

**AE4830 Spacecraft Systems I (Intended For Curriculum 366) (3-2) Spring**

This course emphasizes the systems analysis of geosynchronous spacecraft and covers the analysis of GNC (orbit and attitude control), structures, propulsion, thermal and electrical power subsystems. Basic mathematical equations will be used in the preliminary design of the subsystems and the tradeoff studies involved. The differences and similarities between dual-spin and three-axis stabilized spacecraft will be covered in detail. Systems aspect of a typical mission profile will be illustrated. Throughout, emphasis will be on the spacecraft bus. Students will be engaged in problem solving during most of the laboratory period. Prerequisites: Completion of Space Operations core-curriculum.

**AE4831 Spacecraft Systems II (Intended for Curriculum 366) (3-2) As Required**

In this course, students will be involved in a group project to design a spacecraft to meet mission requirements. Material presented in AE4830 as well as AE4831 will be utilized. In parallel, this course covers some or all of the following aspects of spacecraft systems: spacecraft testing, TT&C subsystem, and design of observation payloads. Differences and similarities between geosynchronous spacecraft and LEO/HEO spacecraft will be discussed. Topics include gravitational perturbation (J2 effects), gravity-gradient stabilization, and atmospheric drag effects. Prerequisites: AE4830.

**AE4850 Astrodynamics Optimization (3-2) Fall**

This course develops basic measures of performance of a space vehicle (including launch vehicles) with methods to target a set of conditions and optimize the performance. Topics include an overview of the Guidance, Navigation and Control System, fundamentals of nonlinear programming, state-space formulation, vehicle and environmental models, performance measures, problem of Bolza, the Maximum Principle, and transversality conditions. A significant focus of the course will be in practical methods and numerical techniques, particularly pseudospectral methods. Computational methods will be used to solve a wide range of problems in astrodynamics optimization arising in military space, such as rapid spacecraft

reorientation and targeting problems, launch-on-demand, strategic low-thrust orbital maneuvers, and optimal formation-keeping strategies. Where appropriate, the course will illustrate systems aspects of mission design. Prerequisites: MA2121, SS3500, and AE3815.

**AE4860 Military Space Maneuvers (2-2) Summer**

This course develops the fundamentals of tactical and strategic space maneuvers and addresses the issues pertaining to space warfare. The course covers a wide range of specific military maneuvers that include their mathematical modeling, mission definitions, mission design and optimization. Special attention will be paid to the class of following maneuvers: pursuit-evasion problems, orbital intercept, destructive and nondestructive asset denial problems, rapid retargeting and minimum-time space maneuvers. These maneuvers and certain elements of high-speed velocity guidance will be modeled, simulated, optimized and analyzed as part of the laboratory sessions. Students will also gain practical experience in a state-of-the-art software to analyze the implementation of future military space maneuvers. Additional details pertaining to the course are classified. Prerequisites: MA2121, SS3500, and AE3815. Classification: Security Clearance Required: Secret/NOFORN

**AE4870 Spacecraft Design and Integration I (4-0) Spring**

Principles of spacecraft design considerations, spacecraft configurations, design of spacecraft subsystems, interdependency of designs of spacecraft subsystems, launch vehicles, mass power estimation, and trade-offs between performance, cost, and reliability. The emphasis is on military geosynchronous communications satellites. The course includes an individual design project. Prerequisites: AE2820, AE3804, AE3851, AE3818, EC3230.

**AE4871 Spacecraft Design and Integration II (2-4) Summer**

A team project-oriented course on design of non-geosynchronous spacecraft systems. Provides understanding of the principles of space system design, integration, and systems engineering, and their application to an overall spacecraft mission. Considerations are given to cost, performance, and test plan. Several DoD/NASA organizations, such as Naval Research Laboratory and Jet Propulsion Laboratory, provide support in the definition of the mission requirements for the project, spacecraft design, and design reviews. Prerequisites: AE4870.

**AE4902 Advanced Study in Astronautical Engineering (V-V) Spring/Summer/Fall/Winter**

Directed advanced study in Astronautical Engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May be repeated for credit with a different topic. This course is graded on a Pass/Fail basis only. Prerequisites: Consent of Department Chairman.

*ME Courses***ME0810 Thesis Research (0-8) Spring/Summer/Fall/Winter**

Every student conducting thesis research will enroll in this course.

**ME0820 Integrated Project (0-12)****Fall/Winter/Spring/Summer**

Integrated project.

**ME0951 MAE Seminars (No Credit) (0-1)****Fall/Winter/Spring/Summer**

Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government or industrial activities. All students must register for this course every quarter.

**ME0952 Special Topics in Mechanical Engineering (1-0) Fall/Winter/Summer/Spring**

This course provides students with essential computer knowledge and topics of current research interest in mechanical engineering and materials science. Prerequisites: None. This is a Pass/Fail course required to all students in the curriculum.

**ME1000 Preparation for Professional Engineers Registration (3-0)**

The course will cover the topics from the 8-hour Professional Examination given by the State of California for Professional Engineer. Discussion will involve applicable engineering techniques, including design and analysis of mechanical systems and components. Prerequisites: Prior passage of Fundamentals of Engineering (FE) Exam or consent of instructor. Graded on Pass/Fail basis only.

**ME2101 Engineering Thermodynamics (4-2) Spring/Fall**

A comprehensive coverage of the fundamental concepts of classical thermodynamics, with insight toward microscopic phenomena. The laws of thermodynamics. Equations of state. Thermodynamic properties of substances. Entropy, irreversibility and availability. Cycle analysis, gas-vapor mixtures, combustion. Prerequisites: MA1118.

**ME2201 Introduction to Fluid Mechanics (3-2) Spring/Fall**

Properties of fluids, hydrostatics and stability of floating and submerged bodies. Fluid flow concepts and basic equations in steady flows: mass, momentum, and energy considerations. Dimensional analysis and dynamic similitude. Viscous effects and fluid resistance. Drag and separated flow over simple bluff bodies. Prerequisites: ME2503.

**ME2503 Engineering Statics and Dynamics (5-0) Fall/Spring**

Forces and moments, equilibrium equations, statically indeterminate objects, trusses, methods of joints and sections, centroids, composites, rectilinear and plane curvilinear motion, absolute and relative motion, work and energy, virtual work, impulse and momentum, impact, system of particles, rigid body motion, moving frame, plane motion, fixed-axis rotation. Prerequisites: MA1118 (may be concurrent).

**ME2601 Mechanics of Solids I (4-1) Summer/Winter**

Stress-strain. Plane stress and plane strain, principal stresses, maximum shear stress, thermal stress, Mohr's circle, axial loading, indeterminate members, pressure vessels, elastic torsion, indeterminate torsion, shear moment diagram, elastic bending, beam deflection, combined loading, theory of failure. Supporting laboratory work. Prerequisites: ME2503 and MA1118 or equivalent.

**ME2801 Introduction to Engineering System Dynamics and Control (3-2) Fall/Spring**

Review of system modeling principles and reduction to mathematical forms. Introduction to feedback and control, reduction of complex block diagrams to simple forms, Response of first and second order systems to standardized inputs, characteristic equations, transient response, steady state errors. Complex plane representation of open loop systems. Stability methods including Routh-Hurwitz criterion and the root locus method. Design of systems in the complex plane. Prerequisites: ME2503 and MA2121.

**ME3150 Heat Transfer (4-1) Summer/Winter**

Introduction to the various modes of heat transfer and their engineering applications. Steady and unsteady conduction involving the use of thermal circuit analogs, analytical, and numerical techniques. Introduction to conservation of mass, momentum and energy. External and internal forced convection fundamentals and correlation. External natural convection. Boiling. Condensation. Heat exchanger analysis and design including a design project. Thermal radiation. Prerequisites: ME2101, ME2201, and MA3132 (may be taken concurrently).

**ME3201 Applied Fluid Mechanics (4-1) Summer/Winter**

Steady one-dimensional compressible flow. Fundamentals of ideal-fluid flow, potential function, stream function. Analysis of viscous flows, velocity distribution in laminar and turbulent flows, introduction to the elements of the Navier-Stokes equations, solution of classical viscous laminar flow problems. Applications to Naval Engineering. Prerequisites: ME2101, ME2201, and MA3132 (may be taken concurrently).

**ME3205 Missile Aerodynamics (4-1) Winter**

Potential flow, thin-airfoil and finite wing theories. Linearized equations, Ackeret theory, Prandtl-Glauert transformations for subsonic and supersonic wings. Planform effects. Flow about slender bodies of revolution, viscous crossflow theory. Prerequisites: ME3201.

**ME3240 Marine Power and Propulsion (4-2) Summer/Winter**

This course provides an introduction to the basic principles of power and propulsion systems, with an emphasis on performance of platforms and weapons for naval applications. The laws of thermodynamics and fluid mechanics are applied to analyze and design of components and systems. The thermodynamics of simple gas and vapor cycles are presented, including the Otto, Diesel, Brayton and Rankine cycles, and complex and combined cycles with intercooling, reheat, regeneration and combined cycles. The aerothermodynamics of compressors, combustors, turbines, heat exchangers, inlets and nozzles are presented along with preliminary design methods, such as meanline design of turbomachinery. Component matching and engine operation of simple gas generators is treated. Mechanical and structural design aspects of engine development are presented. Propeller characteristics and propulsion/vehicle integration are presented. This course includes laboratories on gas turbines, diesels and turbomachinery. Prerequisites: ME2101, ME3201, ME3521, (ME3201 and ME3521 may be taken concurrently).

**ME3410 Mechanical Engineering Instrumentation and Measurement Lab (2-4) As Required**

Introduction to measurement systems, statistical analysis of data, error analysis, uncertainty analysis, manipulation of data including electrical readout and processing, data acquisition fundamentals and Fourier decomposition and dynamic signals. Measurements of temperature, pressure, velocity, flow rates. Energy balances, surface temperature visualization, flow visualization. Measurement of motion using accelerometers and encoders. Measurement of strain and force. Operational amplifiers, analog computers, filters. Prerequisites: ME3601, ME2801, ME3150, ME3521 (ME3150 and ME3521 may be taken concurrently).

**ME3440 Engineering Analysis (4-0) As Required**

Rigorous formulation of engineering problems arising in a variety of disciplines. Approximate methods of solution. Finite difference methods. Introduction to finite element methods. Prerequisites: ME2201, ME2503, and ME3601.

**ME3450 Computational Methods in Mechanical Engineering (3-2) Fall/Spring**

The course introduces students to the basic methods of numerical modeling for typical physical problems encountered in solid mechanics and the thermal/fluid sciences. Problems that can be solved analytically will be chosen initially and solutions will be obtained by appropriate discrete methods. Basic concepts in numerical methods, such as convergence, stability and accuracy, will be introduced. Various computational tools will then be applied to more complex problems, with emphasis on finite element and finite difference methods, finite volume techniques, boundary element methods and gridless Lagrangian methods. Methods of modeling convective non-linearities, such as upwind differencing and the Simpler method, will be introduced. Discussion and structural mechanics, internal and external fluid flows, and conduction and convection heat transfer. Steady state, transient and eigenvalue problems will be addressed. Prerequisites: ME3150, ME3201, ME3601.

**ME3521 Mechanical Vibration (3-2) Summer/Winter**

Elements of analytical dynamics, free and forced response of single degree and multi-degree of freedom systems. Dynamic response using modal superposition method. Properties of stiffness and inertia matrices, orthogonality of modal vectors, eigenvalue problem, modal truncation, vibration isolation and suppression. Vibration of bars, shafts, and beams. Supporting laboratory work. Prerequisites: ME2503, ME2601, MA2121 or equivalent (may be taken concurrently)

**ME3611 Mechanics of Solids II (4-0) Spring/Fall**

Differential equations of bars, shafts and beams with Macauley functions. Unsymmetric bending. Curved beams. Shear flow in thin walled sections. Shear center. Torsion of thin walled open sections. Thick walled cylinders. Energy including Castigliano and unit dummy load methods for displacements. Statically indeterminate systems including beams, frames, trusses, arches and combined structures. Prerequisites: ME2601.

**ME3711 Design of Machine Elements (4-1) Spring/Fall**

Design of representative machine elements with consideration given to materials selection, tolerances, stress concentrations, fatigue, factors of safety, reliability, and maintainability. Typical elements to be designed include fasteners, columns,

shafts, journal bearings, spur and helical gears, and clutches and brakes. In addition to traditional design using factors of safety against failure, particular emphasis is placed on design for specified reliability using probabilistic design methods. Prerequisites: ME3601.

**ME3712 Capstone Design (1-6) Summer/Winter**

Design teams apply integrated and systematic design processes to real multifunctional and multidisciplinary problems in mechanical systems. Students develop process concepts, planning, design methodology, material selection, manufacturing and engineering analysis. Capstone design projects include projects provided by industry partners as well as DoD sponsors. The scope of design problems range across both engineering and non-engineering issues in the integrated design process. Prerequisites: ME2801, ME3150, ME3201, ME3450, ME3521, ME3711, MS3202, OS3104.

**ME3750 Platform Survivability (4-0) As Required**

This course introduces the concepts and analytical tools used in designing and testing survivable combat platforms and weapon systems. The applications are to a broad range of platforms and weapons, including submarines, surface ships, fixed and rotary wing aircraft, cruise missiles, and satellites in a hostile (non-nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of surviving hostile environments are presented. Topics covered include: current and future threat descriptions; the mission/threat analysis; combat analysis of SEA, vulnerability reduction technology for the major systems and subsystems; susceptibility reduction concepts, including stealth; vulnerability, susceptibility, and survivability assessment; and trade-off methodology. Prerequisites: None.

**ME3780 Introduction to Micro Electro Mechanical Systems Design (3-3) Fall**

This is a class introducing students to Micro Electro Mechanical Systems (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals; Surface, bulk and non-silicon micromachining; forces and transduction; forces in micro- nano- domains and actuation techniques. Case studies of MEMS based microsensor, microactuator and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) of MEMS devices and group design projects. Prerequisites: EC2200, or MS2201 or PH1322 or consent of instructor.

**ME3801 Autonomous Systems and Vehicle Control I (3-2) Winter/Summer**

Study of frequency response methods for determining closed loop stability including those of Nyquist, Bode and Nichols including gain and phase margins. Compensation methods including phase lead, phase lag and PID controller design. Introduction to state space representation of Multiple-Input, Multiple-Output (MIMO) control systems. Prerequisite: ME2801.

**ME4101 Advanced Thermodynamics (4-0) As Required**

This course reviews elementary definitions, concepts and laws of thermodynamics and then extends these to cover general thermodynamics, and advanced topics. The concepts of availability, exergy, irreversibility, and general equilibrium conditions in single and multi-component systems are presented. Ideal and non-ideal solutions and chemical

potential are treated along with an introduction to statistical thermodynamics and non-equilibrium concepts such as Osager's reciprocal relations. Prerequisites: ME2101.

**ME4160 Applications of Heat Transfer (4-0) As Required**

Applications of heat transfer principles to engineering systems. Design topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. Prerequisites: ME3150.

**ME4161 Conduction Heat Transfer (4-0) As Required**

Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. Prerequisites: ME3150.

**ME4162 Convection Heat Transfer (4-0) Fall**

Fundamental principles of forced and free convection. Laminar and turbulent duct flows and external flows. Dimensionless correlations. Heat transfer during phase changes. Heat exchanger analysis with Mechanical Engineering applications. Prerequisites: ME3150, ME3201, ME4220, or consent of instructor.

**ME4163 Radiation Heat Transfer (4-0) As Required**

Basic laws and definitions. Radiation properties of surfaces. Radiant interchange among diffusely emitting and reflecting surfaces. Applications and solutions of the equations of radiant interchange. Radiant interchange through participating media. Combined conduction and radiation. Prerequisites: ME3150.

**ME4202 Compressible and Hypersonic Flow (4-0) As Required**

One-dimensional, compressible flow is reviewed. Two-dimensional and axis-symmetric supersonic of ideal gases. Oblique shocks and expansion waves. General compressible flow equations. Potential supersonic and conical flows. Compressible scaling and transonic area ruling. Effects of very high velocity and low density. Hypersonic flow. Mach number independence and equivalence principles. Newtonian method. Blunt and slender body solutions. Real gas behavior and effect on shock and boundary layers. Applications are presented to satellite parasitic drag and re-entry flows. Prerequisites: ME3201 or consent of instructor.

**ME4211 Applied Hydrodynamics (4-0) As Required**

Fundamental principles of hydrodynamics. Brief review of the equations of motion and types of fluid motion. Standard potential flows: source, sink, doublet, and vortex motion. Flow about two-dimensional bodies. Flow about axisymmetric bodies. Added mass of various bodies and the added-mass moment of inertia. Complex variables approach to flow about two-dimensional bodies. Conformal transformations. Flow about hydro and aerofoils. Special topics such as dynamic response of submerged bodies, hydroelastic oscillations, etc. Course emphasizes the use of various numerical techniques and the relationship between the predictions of hydrodynamics and viscous flow methods. Prerequisites: ME3201.

**ME4220 Viscous Flow (4-0) Fall**

Development of continuity and Navier-Stokes equations. Exact solutions of steady and unsteady viscous flow problems. Development of the boundary-layer equations. Similarity

variables, numerical and integral techniques. Separation, boundary-layer control. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications, and numerical models and CFD. Prerequisites: ME3201 and consent of instructor.

**ME4225 Computational Fluid Dynamics and Heat Transfer (3-2) As Required**

This course presents numerical solution of sets, of partial differential equations, that describe fluid flow and heat transfer. The governing equations for fluid dynamics are reviewed and turbulence modeling is introduced. Discretization techniques are applied to selected model equations and numerical methods are developed for inviscid and viscous, compressible and incompressible flows. Individual term projects include application of CFD to thesis research and to current military problems. Prerequisites: ME3201 or ME3450.

**ME4231 Advanced Turbomachinery (3-2) As Required**

The underlying principles governing flow through and energy exchange in turbomachines are developed to provide a basis for understanding both design and advanced computational methods. Key considerations and procedures followed in the design of new aircraft engine fans, compressors and turbines are introduced. Lectures are coordinated with experimental test experience at the Turbopropulsion Laboratory. Prerequisites: ME3240.

**ME4240 Advanced Topics in Fluid Dynamics (4-0) As Required**

Topics selected in accordance with the current interests of the students and faculty. Examples include fluid-structure interactions, cable strumming, wave forces on structures, free-streamline analysis of jets, wakes, and cavities with emphasis on computational fluid dynamics. Prerequisites: ME4220 and ME4211.

**ME4251 Engine Design and Integration (3-2) As Required**

The conceptual and preliminary component, subsystem, and systems design of military, or military related, airbreathing engines, along with the integration of the engine in a platform, is experienced within student design teams. The course is focused on a team response for a Request-for-Proposal (RFP) for an engine meeting specific requirements. Performance, cost, supportability, deployment, manufacturing, product quality and environmental considerations may be included in the design process. The project draws on all of the mechanical engineering disciplines. Prerequisites: ME3240.

**ME4420 Advanced Power and Propulsion (4-0) Fall**

This course presents an advanced treatment of power and propulsion topics, primarily for naval applications. Thermodynamic analysis of simple, advanced and complex cycles, such as combined and augmented cycles (e.g., RACER and STIG) are presented along with new and direct energy conversion concepts. Design integration of single and multi-type (CODAG, CODOG, etc.) power and propulsion systems with vehicles. Engine installation considerations, including the design of auxiliary equipment and inlet/exhaust systems, are presented. Design and current research topics in fluid mechanics and rotordynamics of turbomachinery are presented. Repair, condition-based maintenance and

machinery operation, including balance techniques, are discussed. Prerequisites: ME3240.

**ME4522 Finite Element Methods in Structural Dynamics (4-0) As Required**

This course provides an introduction to the principles and methods of computational structural dynamics and vibration analysis. Modern computational methods make use of the matrix structural models provided by finite element analysis. Therefore, this course provides an introduction to dynamic analysis using the finite element method, and introduces concepts and methods in the calculation of modal parameters, dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques. Experimental modal identification techniques will be introduced. Prerequisites: ME3521.

**ME4525 Naval Ship Shock Design and Analysis (4-0) As Required**

Characteristics of underwater explosion phenomena, including the shock wave, bubble behavior and bubble pulse loading, and bulk cavitation. Surface ship/submarine bodily response to shock loading. Application of shock spectra to component design. Dynamic Design Analysis Method (DDAM) and applications to shipboard equipment design. Fluid-Structure Interaction (FSI) analysis, including Doubly Asymptotic Approximation (DAA) and surface ship FSI. Current design requirements for shipboard equipment. Prerequisites: ME3521 or equivalent.

**ME4550 Random Vibrations and Spectral Analysis (3-2) As Required**

Engineering application of spectral analysis techniques to characterize system responses under a random vibration environment. Characteristics of physical random data and physical system responses. Application of probability concepts to random data and response analysis. Correlation and spectral density functions. Transmission of random vibration. System responses to single/multiple random excitations. Failure due to random vibration. Supporting laboratory work. Prerequisites: ME3521 or equivalent.

**ME4612 Advanced Mechanics of Solids (4-0) Winter**

Selected topics from advanced mechanics of materials and elasticity. Stress and strain tensors. Governing equations such as equations of equilibrium, constitutive equations, kinematic equations and compatibility equations. Two-dimensional elasticity problems in rectangular and polar coordinate systems. Airy stress function and semi-inverse technique. Energy methods with approximate solution techniques including Rayleigh-Ritz method. Buckling of imperfect columns. Introduction to plate and shell bending theory. Prerequisites: ME3611.

**ME4613 Finite Element Methods (4-0) Fall**

Introduction to the fundamental concepts of the finite element method. Weighted residual methods and weak formulation. Element discretization concept and shape functions. Generation of element matrices and vectors, and their assembly into the matrix equation. Application of boundary and initial conditions. Isoparametric elements and numerical integration techniques. Computer programming and application to engineering problems such as boundary value, initial value and eigenvalue problems. Prerequisites: ME3611, ME3440 or equivalent or consent of instructor.

**ME4620 Theory of Continuous Media (4-0) As Required**

Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. Prerequisites: ME3201 and ME3611.

**ME4700 Weaponneering (3-2) Spring**

This course is meant to describe and quantify the methods commonly used to predict the probability of successfully attacking ground targets. The initial emphasis will be on air launched weapons. These weapons include guided and unguided bombs, air-to-ground missiles, LGBs, rockets and guns. The course will outline the various methodologies used in operational products used widely in the USN, USAF and Marine Corps. Prerequisites: ME2503 or MA2121 or equivalent, ME3410 or OS3104 or equivalent, or consent of instructor.

**ME4702 Engineering Systems Risk Benefit Analysis (3-2) As Required**

This course emphasizes three methodologies, Decision Analysis (DA), Reliability and Probabilistic Risk Assessment (RPRA) and Cost-Benefit Analysis (CBA). The course is designed to give students an understanding of how these diverse topics can be applied to decision making process of product design that must take into consideration significant risk. The course will present and interprets a framework for balancing risks and benefits to applicable situations. Typically these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts from CBA and RPRA are applied for real world problems resulting in decision models that provide insight and understanding, and consequently, leading to improved decisions. Same course as OS4010. Prerequisites: OS3104/EO4021 or equivalent course in probability, or consent of instructor.

**ME4703 Missile Flight and Control (4-1) Spring**

Static and dynamic stability and control; transient modes; configuration determinants; subsonic, transonic, supersonic force and moment data for performance calculations with short and long-range cruciform missiles and cruise missiles; acceleration, climb, ceiling, range and agility in maneuvering trajectories. Principles of missile guidance, including guidance control laws, and six degree-of-freedom motion simulations. Additional topics are selected from the following areas to address the general interests of the class: advanced guidance laws, passive sensors, INS guidance, fire control and tracking systems. Prerequisites: ME3205 and ME2801 or equivalent.

**ME4704 Missile Design (3-2) Fall**

Conceptual missile design methodology centered around a student team design project, focused on a military need defined by a Request-for-Proposal. It stresses the application aerodynamics, propulsion, flight mechanics, cost, supportability, stability and control and provides the student with their application to design. Consideration is given to trade-offs among propulsion requirements, air loads, quality sensors, guidance laws, quality, controls, and structural components. Prerequisites: PREREQUISITE: ME3205, ME4703 or equivalent, AE4452.



**ME4731 Engineering Design Optimization (4-0) As Required**

Application of automated numerical optimization techniques to design of engineering systems. Algorithms for solution of nonlinear constrained design problems. Familiarization with available design optimization programs. State-of-the-art applications. Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques. Prerequisites: ME3450, ME3150, ME3201, ME3611.

**ME4751 Combat Survivability, Reliability, and systems Safety Engineering (4-1) As Required**

This course provides the student with an understanding of the essential elements in the study of survivability, reliability and systems safety engineering for military platforms including submarines, surface ships, fixed-wing and rotary wing aircraft, as well as missiles, unmanned vehicles and satellites. Technologies for increasing survivability and methodologies for assessing the probability of survival in a hostile (non-nuclear) environment from conventional and directed energy weapons will be presented. Several in-depth studies of the survivability various vehicles will give the student practical knowledge in the design of battle-ready platforms and weapons. An introduction to reliability and system safety engineering examines system and subsystem failure in a non-hostile environment. Safety analyses (hazard analysis, fault-tree analysis, and component redundancy design), safety criteria and life cycle considerations are presented with applications to aircraft maintenance, repair and retirement strategies, along with the mathematical foundations of statistical sampling, set theory, probability modeling and probability distribution functions. Prerequisites: Consent of instructor.

**ME4811 Autonomous Systems and Vehicle Control II (3-2) Fall**

Multivariable analysis and control concepts for MIMO systems. State Observers. Disturbances and tracking systems. Linear Optimal Control. The linear Quadratic Gaussian compensator. Introduction to non-linear system analysis. Limit cycle behavior. Prerequisites: ME3801.

**ME4812 Fluid Power Control (3-2) As Required**

Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements, valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability. Prerequisite: ME3801.

**ME4821 Marine Navigation (3-2) Spring**

This course presents the fundamentals of inertial navigation, principles of inertial accelerometers, and gyroscopes. Derivation of gimballed and strapdown navigation equations and corresponding error analysis. Navigation using external navigation aids (navaids): LORAN, TACAN, and GPS. Introduction to Kalman filtering as a means of integrating data from navaids and inertial sensors. Prerequisite: ME3801.

**ME4822 Guidance Navigation and Control of Marine Systems (3-2) Spring**

This course takes students through each stage involved in the design, modeling and testing of a guidance, navigation and control (GNC) system. Students are asked to choose a marine

system such as an AUV, model its dynamics on a nonlinear simulation package such as SIMULINK and then design a GNC system for this system. The design is to be tested on SIMULINK or a similar platform. Course notes and labs cover all the relevant material. Prerequisites: ME4801 or consent of instructor.

**ME4823 Dynamics of Autonomous Vehicles (4-0) Winter**

Development of the nonlinear equations of motion in ship-fixed coordinates. Linear forms. Elements of pathkeeping and stability for ships and submersibles. Maneuverability. Motions in waves. Added mass and damping. Statistical description of the seaway. Sea-keeping considerations in ship design. Prerequisites: ME3201, ME3801.

**ME4825 Marine Propulsion Control (3-2) As Required**

Introduction to dynamic propulsion systems modeling and analysis methods. Control design specifications and design strategies. Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems. Case studies of current naval propulsion control systems. Prerequisites: ME3801, ME3240 (may be taken concurrently), and MA3132.

**ME4902 Advanced Study in Mechanical Engineering (V-V) As Required**

Directed advanced study in Mechanical Engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May be repeated for credit with a different topic. Prerequisites: Consent of Department Chairman. Graded on Pass/Fail basis only.

*MS Courses***MS2201 Introduction to Materials Science and Engineering (3-2) Summer/Winter**

This is a first course in Materials Science and Engineering and emphasizes the basic principles of microstructure-property relationships in materials of engineering and naval relevance. Topics include crystalline structure and bonding, defects, thermodynamics and kinetics of reactions in solids, deformation, strengthening mechanisms and heat treatment. Students will acquire a working vocabulary and conceptual understanding necessary for advance study and for communication with materials experts. Prerequisites: Undergraduate courses in calculus, physics and chemistry.

**MS3202 Properties, Performance and Failure of Engineering Materials (3-2) Fall/Spring**

The purpose of this course is to advance the students' understanding of the fundamentals of materials science, while putting that understanding in the context of the behavior of materials in engineering applications. Contemporary developments in engineering materials such as composites, ceramics and polymers are considered, as well as traditional engineering alloys such as steels and aluminum alloys. Performance and failure histories of materials in service will be studied, as well as conventional textbook subjects. Examples pertinent to Naval, Aero and Combat Systems Science are emphasized. Topics include mechanical properties, fracture, fatigue, failure analysis and corrosion. Prerequisites: MS2201 or equivalent or consent of instructor.

**MS3203 Structural Failure, Fracture and Fatigue (3-2) As Required**

Theories of yield and fracture for aircraft design limit loads and ultimate loads; stress-life and strain-life fatigue theories of crack initiation in aircraft structures subjected to realistic flight load spectra, using Neuber's approximation and incorporating the Miner concept of cumulative damage. Fatigue crack propagation concepts and Navy methods of fleet structural fatigue tracking and monitoring. Prerequisites: MS3202, ME2601.

**MS3214 Intermediate Materials Science and Engineering (4-0) As Required**

The purpose of this course is to provide a bridge between the introductory courses in materials science, MS2201 and MS3202, and the 4000-level elective courses in materials science. The emphasis is on a deepening of understanding of basic principles which govern the behavior of solid materials. Principles of physical metallurgy and the physics of materials will be considered in detail. Topics include thermodynamics of solids, electronic structure of alloys, lattice stability, phase equilibria, diffusion, dislocation theory, deformation mechanisms and an introduction to the kinetics of phase transformations. The course is intended to show how the application of basic principles leads to clearer understanding and control of the behavior and properties of contemporary materials. Prerequisites: MS2201 and MS3202 or equivalent or consent of instructor.

**MS3304 Corrosion and Marine Environmental Deterioration (3-2) Spring**

The fundamentals of corrosion science and the practice of corrosion engineering are discussed. The objectives include an appreciation of the varied causes, mechanisms and effects of corrosion. Fundamental topics such as basic electrochemistry, polarization and passivity are covered. A primary goal of the course is the development of skill in the recognition and prevention of a wide variety of types of corrosion. Standard methods of corrosion control are discussed, including cathodic protection, coatings, alloy selection and inhibitors. Prerequisites: MS2201 or equivalent or consent of instructor.

**MS3606 Introduction to Welding and Joining Metallurgy (3-2) Fall**

Welding and joining are presented from the point of view of metallurgy. Topics include the nature and applications of welding and joining processes; the welding thermal cycle; metallurgical effects of the welding thermal cycle; welding and joining of steels, aluminum alloys, stainless steels and heat-resistant alloys. Also, weldment inspection and quality assurance are introduced. Prerequisites: MS2201 and MS3202 or consent of instructor.

**MS4215 Phase Transformations (3-2) Winter**

The mechanisms and kinetics of structural changes in solid materials are considered in detail. A wide variety of transformation mechanisms are studied, including solidification, recrystallization, precipitation and martensitic transformation. The basic principles which govern these reactions are developed, including principles of nucleation and growth, diffusion and lattice distortion. The relevance of various transformations to practical heat treatment, thermomechanical processing, and technological advances is discussed. Microstructural recognition and methods of monitoring phase transformations are included. Changes in

properties which result from phase transformations are given limited attention. Prerequisites: MS3214 or equivalent or consent of instructor.

**MS4312 Characterization of Advanced Materials (3-2) Spring**

This course is structured to provide an insight into the various tools available for advanced physical examination of engineering materials. Topics covered include X-ray diffraction and optical, scanning, transmission and scanning transmission electron microscopies. Prerequisites: MS3202 or consent of instructor.

**MS4811 Mechanical Behavior of Engineering Materials (4-0) Summer/Fall**

The response of structural materials to stress is discussed, including elastic and plastic deformation and fracture. Topics include elastic response and the modulus of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application to materials development is also considered. Prerequisites: MS3202, and MS3214 or consent of instructor.

**MS4822 The Engineering and Science of Composite Materials (4-0) As Required**

This course focuses on the structure-property correlation in composites utilizing a multi-disciplinary approach, covering the areas of materials science and engineering and solid mechanics. Emphasis is given to the theoretical constitutive behavior at the micro- and macro-levels, as well as on how such behavior can be altered by processing and service variables. The course is divided into three broad parts: (1) Theoretical predictions of composite properties; (2) Materials issues (including processing) complicating accurate performance prediction; and (3) Thermo-mechanical behavior in actual service conditions. Prerequisites: ME3611, MS3202 or equivalent.

**MS4902 Special Topics in Materials Science (V-V) As Required**

Directed advanced study in materials science on a subject of mutual interest to student and staff member after the student has taken most of his or her electives. May be repeated for credit with a different topic. Prerequisites: Consent of Department Chairman. Graded on Pass/Fail basis only.

*TS Courses***TS3000 Electrical Power Engineering (3-2) As Required**

An overview of the principles, concepts and trade-offs which form the foundation for shipboard electric power systems. The composition of electrical power systems for present and future Navy vessels is presented. Theory necessary to understand interactions among shipboard electric power system components is discussed. The interactions between the electric power system and the various types of loads is introduced. Prerequisites: None.

**TS3001 Fundamental Principles of Naval Architecture (3-2) Summer/Winter**

The geometry, hydrostatics and hydrodynamics of monohull and other floating and submerged bodies; Froude similarity; wave and skin friction resistance; powering determination. Longitudinal and transverse stability of floating bodies. Hull girder strength. Introduction to seakeeping and passive

survivability principles. Prerequisites: ME2201, ME2601 or consent of instructor.

### **TS3002 Principles of Ship Design and Case Studies (3-2) As Required**

Systems engineering in the design of complex systems; systems architecture and interface engineering and the Navy design environment. The systems development process, including need identification, requirements, feasibility determination, risk reduction, contract and detailed design. The iterative, multilevel ship design process, with affordability as a fundamental feature; modern ship design and construction methods, systems engineering techniques and tools. Case studies, ship design trends, design exercises and illustrations. Prerequisites: TS3001.

### **TS3003 Naval Combat System Elements (3-2) As Required**

This course will cover combat system detection and engagement elements. This includes radar, ESM, active and passive sonar, infrared, warheads, guns, missiles, torpedoes, fire control and countermeasures. The emphasis will be on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, and their interfaces with the rest of the combat system. Details on specific elements and systems will be limited to those needed to illustrate basic principles and interactions affecting systems engineering. Prerequisites: ME2503, or equivalent or consent of instructor.

### **TS4000 Naval Combat System Engineering (3-2) As Required**

Covers the definition and integration of naval combat systems. The emphasis will be on how the various detection, engagement, and control elements interact with each other and on how to combine them into an efficient and survivable combat system. Also addressed will be topside arrangements, signature reduction, readiness assessment, embedded training, and support system interfaces. Prerequisites: TS3000, TS3003.

### **TS4001 Integration of Naval Engineering Systems (3-2) Spring**

A system-oriented approach to integrating the principles of Naval Architecture and Marine Engineering in the design of ship subsystems. Lectures and projects exploring engineering design tools and analysis methods to meet specified systems requirements are used. Projects on hull, mechanical and electrical ship systems design are emphasized. The impact of systems design on other systems and subsystems and on the ship, including affordability, military effectiveness and survivability at the whole ship level are considered. Prerequisites: TS3000, TS3001, TS3002.

### **TS4002 Ship Design Integration (2-4) Summer**

The ship-impact of requirements/cost/performance tradeoffs within technical and acquisition constraints. Conversion of broad military requirements to mission-based ship requirements and specific tasks resulting from those requirements. Exploration of alternative methods of satisfying requirements, leading to combat systems (payload) definition. Conduct of feasibility studies to investigate whole-ship alternatives which meet requirements. Selection of a best design approach. Design considerations for unusual ship types

and an assessment of future Navy ship and combat systems needs and trends. Prerequisites: TS4001 and TS4000.

### **TS4003 Total Ship Systems Engineering (2-4) Fall**

The design of a Naval vessel as a single engineering system satisfying mission requirements, with emphasis on affordability and survivability. The interaction and interfacing of various subsystems such as hull, propulsion, and combat systems will be explored through a joint ship "preliminary design" project to produce a balanced ship design based on the alternative chosen from feasibility studies conducted in TS4002. Concepts of design optimization within constraints. Prerequisites: TS4002.

## **Naval/Mechanical Engineering - Curriculum 570**

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### **Brief Overview**

The objective of this program is to provide graduate education, primarily in the field of Naval/Mechanical Engineering, to produce graduates with the technical competence to operate and maintain modern warships and naval systems. It establishes a broad background of basic engineering knowledge leading to advanced studies in heat transfer, fluid mechanics, control systems, solid mechanics and vibrations and material science. The graduate will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum.

### **Requirements for Entry**

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 with one quarter refresher). This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to

naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible.

### Entry Date

Naval/Mechanical Engineering is typically an eight-quarter program with preferred entry dates in March or September. Time in residence may be reduced by course validations depending on the officer's specific academic background. If further information is needed, contact the Program Officer or the Academic Associate.

### Degree

Requirements for the Master of Science in Mechanical Engineering degree are met as a milestone en route to satisfying the educational skill requirements of the curricular program.

### Subspecialty

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5601P. The curriculum sponsor is Naval Sea Systems Command. Completion of this curriculum including the Total Ship Systems Engineering option qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5602P. A limited number of particularly well qualified students may be able to further their education beyond the master's degree and seek the degree of Mechanical Engineer and a 5601N or 5602N Subspecialty Codes.

### Typical Subspecialty Jobs

Upon award of the 5601P/5602P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval/Mechanical Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility, SIMA  
 Mechanical Engineering Instructor, USNA  
 Tender Repair Officer (Engineering Duty Officer)  
 Fleet/Type Commander Staff  
 Board of Inspection and Survey  
 Propulsion Examining Board  
 OPNAV/NAVSEA  
 Chief Engineer (Ships and Submarines)

### Typical Course of Study

#### Quarter 1

MA1115	(4-0)	Multivariable Calculus
MA1116	(3-0)	Vector Calculus
MS2201	(3-2)	Materials Science
NW3230	(4-2)	Strategy & Policy

EO2102	(4-2)	Basic Electronics and Electrical Machines
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#### Quarter 2

MA2043	(4-0)	Matrix and Linear Algebra
MA2121	(4-0)	Differential Equations
ME2101	(4-1)	Mechanics of Solids
ME2503	(3-2)	Materials Science
ME2801	(3-2)	System Dynamics

#### Quarter 3

MA3132	(4-0)	Partial Differential Equations
MA3232	(4-1)	Numerical Analysis
ME2601	(4-1)	Mechanics of Solids I
ME3801	(3-2)	Automatic Controls

#### Quarter 4

ME3711	(4-1)	Machine Design
ME2201	(3-2)	Introduction to Fluid Dynamics
MS3202	(3-2)	Failure Analysis and Prevention
ME3611	(4-0)	Mechanics of Solids II

#### Quarter 5

ME3151	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
ME3712	(4-2)	Systems Design
OS3104	(4-0)	Probability and Statistics

#### Quarter 6

MS3304	(3-2)	Corrosion
ME0810	(0-8)	Thesis Research
ME4XXX	(V-V)	Specialization Elective
ME4XXX	(V-V)	Specialization Elective

#### Quarter 7

ME0810	(0-8)	Thesis Research
TS3001	(3-2)	Naval Architecture
ME3521	(3-2)	Mechanical Vibrations
ME3240	(4-2)	Marine Power and Propulsion

#### Quarter 8

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4XXX	(V-V)	Elective

## Total Ship Systems Engineering (Under Department of Mechanical and Astronautical Engineering)

### Program Director

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### Total Ship Systems Engineering

The objective of this program is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system, including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Technology students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590/591 curricula.

### Entry Date

Total Ship Systems Engineering will generally fit as part of an eight-or nine-quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the program officer or academic associate as early as possible.

### Subspecialty

Completion of this program will contribute toward the graduates' subspecialty code within his/her designated curriculum. The student will also receive the 5602P subspecialty code for completion of the TSSE Program.

### Typical Subspecialty Jobs

Upon award of the subspecialty code, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

### Typical Course of Study

#### Quarter 1

ME2101	(4-2)	Thermodynamics
MA2121	(4-0)	Differential Equations

ME2503	(5-0)	Engineering Statics and Dynamics
NW3230	(4-0)	Strategy & Policy
EC1010	(1-1)	MATLAB

#### Quarter 2

MA2043	(4-0)	Matrix and Linear Algebra
ME2601	(4-1)	Mechanics of Solids I
MS2201	(3-2)	Materials Science
OS3104	(4-0)	Probability and Statistics

#### Quarter 3

ME2201	(3-2)	Fluid Mechanics I
ME3611	(4-0)	Mechanics of Solids II
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MA3232	(4-1)	Numerical Analysis

#### Quarter 4

TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3150	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
EO2102	(4-2)	Circuit and Power System Analysis
ME3521	(3-2)	Mechanical Vibrations

#### Quarter 5

TS3000	(3-2)	Electrical Power Engineering
ME2801	(3-2)	System Dynamics
ME3711	(4-1)	Design of Machine Elements
MS3202	(3-2)	Failure Analysis & Prevention

#### Quarter 6

TS3002	(3-2)	Principles of Ship Design and Case Studies
TS3003	(3-2)	Naval Combat System Elements
ME3801	(3-2)	Automatic Controls
ME4XXX	(V-V)	Specialization Elective

#### Quarter 7

TS4000	(3-2)	Naval Combat System Design
TS4001	(2-4)	Design of Naval Engineering Subsystems
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4XXX	(V-V)	Specialization Elective

#### Quarter 8

TS4002	(2-4)	Ship Design Integration
ME3240	(4-2)	Marine Power and Propulsion
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research

#### Quarter 9

TS4003	(2-4)	Total Ship Systems Engineering
MS3606	(3-2)	Introduction to Welding and Joining Metallurgy
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research

**Educational Skill Requirements (ESR)**  
**Naval/Mechanical Engineering - Curriculum**  
**570**  
**Subspecialty Code: 5601P**

Officers entering into the Naval/Mechanical Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET). At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, design, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core program requirements, specialization and thesis research. In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the topics below. It is recognized that all students may not meet all ESRs, depending on individual circumstances determined by the Program Officer and the academic associate. However, each student will be exposed to fundamentals in all ESR areas.

1. **Thermodynamics and Heat Transfer:** Fundamentals of thermodynamics and heat transfer with applications to all marine engineering power cycles, as well as propulsion and auxiliary system cycle analysis and design.
2. **Fluid Mechanics:** Compressible and incompressible flow, both viscous and inviscid, with emphasis on propellers, cavitation, and design of shipboard fluid systems (e.g., fluid machinery, pumps, turbo-machinery).
3. **Dynamics and Control:** Kinematics and dynamics of particle, rigid-body and multi-body mechanical systems. Modeling and simulation of engineering systems with mechanical, electrical and hydraulic components. Feedback control concepts, both frequency response and time domain, with applications to the design of component, platform, and weapon systems. Control of systems with continuous, discrete and combined logic states. Navigation and control for single and network-centric systems. Design of intelligent systems for machinery monitoring and automation, as well as autonomous vehicle operations.
4. **Structural Mechanics and Vibration:** Statically determinant and indeterminate structural analysis, stress/strain analysis, buckling and fatigue. Shock and vibration response of marine structures, including surface ships and submarines.
5. **Materials and Fabrication:** Metallurgical processes and transformations; analytical approach to failure of materials in Naval Engineering use and a basic understanding of the materials technology associated with welding and marine corrosion; an introduction to the developing fields of composites and superconducting materials.
6. **Computers:** A basic understanding of computer system architecture, operating systems (such as UNIX), networking and introduction to engineering software design. Practical experience of structured programming languages (such as FORTRAN, C), and the use of integrated design tools for computational and symbolic manipulation (such as MATLAB and Maple). Use and application of mainframe, workstation and personal computers for the solution of naval engineering design and analysis tasks. Exposure to finite element and finite difference tools and techniques, with application to the thermo-fluid and structural mechanics/dynamics areas, including experience with representative software packages.
7. **Mathematics:** Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.
8. **Design/Synthesis:** Design synthesis and introduction to optimization techniques, with emphasis on the design of mechanical subsystems and their integration into the ship system.
9. **Electrical Engineering:** Electromagnetic and circuit theories, DC circuits, steady-state AC circuits, methods of circuit analysis, including Laplace transforms. Exposure to the construction and operating characteristics of rotating machinery, static converters, and power distribution systems and multiphased circuits.
10. **Naval Architecture:** Fundamentals of naval architecture including the geometry, hydrostatics and hydrodynamics of monohull floating and submerged structures. Wave and skin friction analysis, power requirements of particular designs. Longitudinal and transverse stability of floating and submerged bodies, hull girder strength requirements. Introduction to sea keeping and survivability principles.
11. **Specialization:** Through additional graduate level courses and their associated prerequisites, each officer will also acquire technical competence in one or more of the following areas: thermal/fluid

sciences, solid and structural mechanics, dynamics and controls, material science, or total ship systems engineering.

12. **Joint and Maritime Strategic Planning:** American and world military history and joint and maritime planning, including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
13. **Thesis:** The graduate will demonstrate the ability to conduct independent research in the area of Naval/Mechanical Engineering, and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

## Naval Reactors/Mechanical Engineering Program - Curriculum 571

### Primary Consultant

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### Academic Associate

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### Brief Overview

The objective of this program is to provide both naval officers and civilian employees of Naval Reactors (NR), which is part of the Naval Sea Systems Command (NAVSEA), an advanced education leading to a Master of Science in Engineering Science with major in Mechanical Engineering. This is a non-thesis program for individuals who work as engineers and who wish to pursue a master's degree via Distance

Learning. The program sponsor is NAVSEA and the subject matter expert is SEA-08.

### Requirements for Entry

Entrance into this program is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES). Further requirements include an Academic Profile Code of 121. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors. The nomination to the Director of Admissions must include original transcripts of the student's undergraduate and BRES records. The Director of Admissions will provide copies of all records to the Academic Associate in Mechanical Engineering.

### Entry Date

This Master of Science in Engineering Science (Major in Mechanical Engineering) program may be completed in five academic quarters following completion of BRES, with entry dates normally in either October or April. Students will usually enter this program at the beginning of the academic quarter immediately following completion of the BRES. Application for entry is to be made through the program coordinator and primary consultant for Naval Reactors. The program is also available to civilian employees of Naval Reactors who have completed BRES. For further information, contact the Department Chairman, the Academic Associate, or the Primary Consultant for this program.

### Degree

The student must complete 20 hours of graduate level (ME4XXX) NPS courses. This requirement may be met by completing a sequence of five courses via Distance Learning in a program approved by the Chairman of the Department of Mechanical Engineering.

### Credit for Completion of BRES

The study program is designed to build upon the BRES program and includes 16 hours of credit from the BRES, as well as credit for the BRES Reactor and Power Plant Design Project Report. The following BRES courses are considered as integral to this program and equivalent to 16 credit hours of ME3XXX level NPS courses:

- BRES 200 Mathematics
- BRES 340 Applied Structural Mechanics
- BRES 350 Heat Transfer and Fluid Flow
- BRES 360 Reactor Dynamics, Control and Safeguards

The following course and associated report is also considered integral to this program:

- BRES 370 Reactor and Power Plant Design Project

The NPS transcript will include a listing of these five courses and the student's overall grade point average for the BRES program. The Quality Point Rating (QPR) for NPS courses will be computed based only on the NPS courses completed by the student.

### Subspecialty

Graduates of BRES earn a Navy Subspecialty Code of 5200, which applies to their reactor design training. This Naval Postgraduate School curriculum will not affect that subspecialty code nor provide any additional subspecialty code education or training. No additional subspecialty codes will be earned through this program.

### Typical Course of Study

Upon entry into the program students will typically enroll in one course per quarter, to be taken via Distance Learning. All requirements must be completed within three calendar years from entry. Students will select a program of study from available courses and submit a program for approval by the Chairman of Mechanical Engineering. Typical course offerings in the program include:

ME4161	(4-0)	Conduction Heat Transfer
ME4162	(4-0)	Convection Heat Transfer
ME4220	(4-0)	Viscous Flow
ME4522	(4-0)	Finite Element Methods in Structural Dynamics
ME4525	(4-0)	Ship Shock and Vibration
ME4550	(4-0)	Random Vibrations and Spectral Analysis
ME4612	(4-0)	Advanced Solid Mechanics
ME4613	(4-0)	The Finite Element Method
ME4731	(4-0)	Optimization

### Educational Skill Requirements (ESRs) Reactors/Mechanical Engineering Program - Curriculum 571 Subspecialty Code: 5200

The ESRs required by Naval Reactors are met upon completion of the BRES. This is a degree program only, leading to the Master of Science in Engineering Science with Major in Mechanical Engineering.

## Department of Meteorology

### Chairman

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### Associate Chairman, Research

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### Associate Chairman, Curricular Matters

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**David S. Brown**, Lecturer (2000)\*; M.S., Naval Postgraduate School, 2000.

**Gintautas Buzorius**, Research Assistant Professor (2003); Ph.D., Helsinki University, 2000.

**Hway-Jen Chen**, Research Associate (2000); M.S., University of California - Los Angeles, 1993.

**Chih-Pei Chang**, Distinguished Professor (1972); Ph.D., University of Washington, 1972.

**Kenneth L. Davidson**, Professor (1970); Ph.D., University of Michigan, 1970.

**Philip A. Durkee**, Chair and Professor (1984); Ph.D., Colorado State University, 1984.

**Russell L. Elsberry**, Distinguished Professor (1968); Ph.D., Colorado State University, 1968.

**Paul A. Frederickson**, Research Associate (1999); M.S., University of Maryland, 1989.

**Peter S. Guest**, Research Associate Professor (1992); Ph.D., Naval Postgraduate School, 1992.

**Patrick A. Harr**, Associate Professor (1989); M.S., Colorado State University, 1978; Ph.D. Naval Postgraduate School, 1993.

**Mary S. Jordan**, Research Associate (1999); M.S., Naval Postgraduate School, 1985.

**Michael T. Montgomery**, Professor (2006); Ph.D., Harvard, 1986.

**James T. Murphree**, Senior Lecturer (1991); Ph.D., University of California at Davis, 1989.

**Kurt E. Nielsen**, Research Associate (1999); M.S., University of Oklahoma, 1988.

**Wendell A. Nuss**, Professor and Associate Chair for Curricular Matters (1986); Ph.D., University of Washington, 1986.



**Qing Wang**, Associate Professor and Associate Chair for Research (1995); Ph.D., Pennsylvania State University, 1993.

**Carlyle H. Wash**, Professor (1980); Ph.D., University of Wisconsin, 1978.

### Professors Emeriti:

**George W. Haltiner**, Distinguished Professor Emeritus (1946); Ph.D., University of Wisconsin, 1948.

**Robert L. Haney**, Professor Emeritus (1970); Ph.D., University of California at Los Angeles, 1971.

**Robert J. Renard**, Distinguished Professor Emeritus (1952); Ph.D., Florida State University, 1970.

**Forest Williams**, Senior Lecturer Emeritus (1975); M.S., Naval Postgraduate School, 1962; M.S., Massachusetts Institute of Technology, 1972.

**Roger T. Williams**, Professor (1968); Ph.D., University of California at Los Angeles, 1963.

\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

### Brief Overview

The Department of Meteorology's history dates back to the 1940s when it was part of the Postgraduate Department at the Naval Academy. The department's academic function is interdisciplinary in nature in that it supports separate Master of Science Degree programs: Meteorology, Meteorology and Physical Oceanography, and Oceanography; and, provides courses for the Space Systems, Undersea Warfare, Information/Electronic Warfare, and Joint Command, Control, Communications, Computers and Intelligence (C4I) curricula. Offerings in the Special Operations and Joint Warfare Analysis are under development.

Department academic strengths include air/ocean dynamics and numerical modeling and prediction, structure and dynamics of the atmospheric boundary layer, satellite remote sensing and its applications and synoptic meteorology, including analysis and prediction in tropical, mid-latitude, and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has seventeen faculty (nine tenure track, eight non-tenure track, two military, and five emeritus), with graduate student participation as research-team members through the M.S. thesis and Ph.D. dissertation process. The current areas of research concentration encompass numerical and analytic air/ocean modeling and prediction, tropical meteorology (including monsoon circulations and tropical cyclone dynamics and forecasting), coastal

meteorology and oceanography, climate dynamics, marine boundary layer studies with emphasis on air/sea interactions and electromagnetic/optic propagation, remote sensing/satellite meteorology and a wide range of synoptic studies (e.g., regional studies, maritime cyclogenesis, short range forecasting, and numerical-model verification). The Ph.D. program in the department is active with Navy officers, Air Force officers, DoD civilians and international officers among its recent graduates.

### Degree

A student is able to earn an academic degree listed below while enrolled in Meteorology (Curriculum 372) and METOC (Curriculum 373).

### Master of Science in Meteorology

Entrance to a program leading to a Master of Science in Meteorology degree requires a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics.

The Master of Science in Meteorology degree requires completion of:

1. Necessary prerequisite courses in mathematics (through partial differential equations) and meteorology,
2. The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology,
3. An approved selection of graduate elective courses,
4. An acceptable thesis.

The total number of quarter-hours in (2) and (3) above must be at least 36. These 36 hours must include 18 quarter-hours at the 4000 level in courses other than directed study.

### Master of Science in Meteorology and Physical Oceanography

Direct entrance to a program leading to the Master of Science in Meteorology and Physical Oceanography degree requires a baccalaureate degree in one of the physical sciences, mathematics or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis, and various courses in meteorology and/or oceanography which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event, the program may be lengthened by one or more quarters.

The Master of Science in Meteorology and Physical Oceanography degree requires completion of:

1. Necessary prerequisite courses in mathematics (through partial differential equations), meteorology, and physical oceanography,
2. The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology and oceanography,
3. An approved selection of graduate elective courses in meteorology and oceanography,
4. A significant educational experience at sea on a research vessel.
5. An acceptable thesis on a topic approved by the department.

The total number of quarter-hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study, and they should show an approximate balance between the disciplines of meteorology and oceanography.

### **Dual Degree in Meteorology and Physical Oceanography**

The Meteorology and Oceanography Departments have adopted a policy to not recommend the award of dual master's degrees in Meteorology and Physical Oceanography.

### **Doctor of Philosophy**

The Ph.D. program is offered in the Department of Meteorology in the following areas of study: numerical weather prediction, geophysical fluid dynamics, boundary-layer meteorology, analysis of atmospheric systems and tropical meteorology.

The requirements for the degree are grouped into three categories: course work, research in conjunction with an approved dissertation and examination in both the major and, if elected, a minor field. The minor field is usually in physical oceanography, mathematics or physics.

The Department of Meteorology also may require a preliminary examination to show evidence of acceptability as a doctoral student.

Prospective students should consult with the Chairman of the Department of Meteorology for further guidance regarding doctoral programs.

### **Laboratories**

As described below, the department is served by four major laboratory facilities: An interactive computer lab, a synoptic meteorology lab, a meteorological measurements lab, and a tactical applications lab.

The Interactive Digital Environmental Analysis (IDEA) Laboratory, which is shared with Oceanography, provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology and oceanography programs. The laboratory consists of 32 image analysis and graphics workstations. The laboratory accesses real-time GOES, NOAA, Navy (FNMOC), and DMSP data for use in instruction and research.

The department has developed a modern Synoptic Analysis and Forecasting Laboratory which receives environmental products and observations for instruction on the preparation of real-time weather analyses and forecasts. Fleet Numerical Meteorology and Oceanography Center (FNMOC) and the National Center for Environmental Prediction (NCEP) weather analysis and forecast products are received through a variety of channels that include the Navy Oceanographic Data Distribution System (NODDS), UNIDATA, GOESTAP, PC-based DIFAX facsimile, and the World-Wide Web. UNIX workstations and PC-based systems provide multiple software capabilities for displaying, animating, and visualizing current weather observations, satellite images, radar observations, and numerical model products obtained from FNMOC, NCEP or generated locally.

The Marine Atmospheric Measurements Laboratory utilizes in-situ and remote sensing instrumentation systems for both teaching and research. Instrumentation includes: A 405 MHz and 915 MHz Doppler radar wind profiler with radio acoustic sounding system (RASS); rawinsonde systems with GPS and LORAN navigational aids; a laser ceilometer; and a fully instrumented surface weather station. Access to other instrumentation (measuring turbulent fluxes, aerosols, etc.), measuring platforms (research vessel, buoys, and remotely piloted aircraft) and data from a variety of networked local measurement sites enables the laboratory to provide near "real-time" data from the coastal region.

## **Meteorology Course Descriptions**

### *MR Courses*

### **Meteorology Course Descriptions**

#### **MRR210 Refresher, Introduction to Meteorology/Lab (No Credit) Meets last six weeks of quarter (4-2) As Required**

An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small- and large-scale motions, air masses fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Additionally, laboratory periods are included to illustrate lecture material, including

surface and airways communication codes, pressure and streamline/ isotach analyses, introduction to mid-latitude and tropical analyses by the Navy Operational Global Atmospheric Prediction System (NOGAPS) over oceanic regions, plus satellite interpretation.

**MR0810 Thesis Research (0-8) As Required**

Every student conducting thesis research will enroll in this course.

**MR0999 Seminar in Meteorology (No Credit) (2-0) As Required**

Students present results of thesis or other approved research investigation. Prerequisites: Concurrent preparation of thesis or other acceptable research paper.

**MR2020 Computer Computations in Air-Ocean Sciences (2-2) Spring/Summer**

Introduction to the programming languages, operating systems, and computing facilities which METOC students use in MR and OC courses. Laboratory assignments are elementary problems in oceanography and meteorology. Prerequisites: Calculus and college physics.

**MR2200 Introduction to Meteorology (4-0) As Required**

A introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small-and large-scale motions, air masses, fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Prerequisites: Department approval.

**MR2210 Introduction to Meteorology/Laboratory (4-2) Spring/Summer**

Same course as MR2200 plus laboratory periods illustrating lecture material, including Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis over oceanic areas, plus satellite imagery interpretation. Prerequisites: Department approval.

**MR2230 Meteorology, Oceanography, and Military Operations (4-0) Fall**

This course is an introduction to meteorology and oceanography (METOC) from a military operations perspective. The course examines the basic patterns and processes of the atmosphere and ocean, and their impacts on the planning and conducts of military.

**MR2262 Elements of Weather Forecasting (1-2) Summer**

Survey of subjective and objective methods of atmospheric prognosis. Weather briefings illustrate applications of forecasting principles and use of satellite imagery. Prerequisites: MR3222, MR3230 or consent of instructor.

**MR2416 Meteorology for Electronic Warfare (2-0) Winter**

A survey of environmental factors affecting the propagation and attenuation of electromagnetic waves. Synoptic and climatological conditions associated with anomalous refraction are studied. Ionospheric phenomena associated with longer wavelength (Hf) propagation. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. Prerequisites: Differential and integral calculus (may be taken concurrently).

**MR2520 Survey of Air-Ocean Remote Sensing (3-0) As Required**

Overview of systems for remote sensing of the atmosphere and oceans from space, and operational applications. Prerequisites: Undergraduate physics and calculus or consent of instructor.

**MR3140 Probability and Statistics for Air-Ocean Science (3-2) Spring/Fall**

Basic probability and statistics, in the air-ocean science context with emphasis on techniques of statistical data analysis. Histograms, boxplots, empirical distributions and associated characteristics such as moments and percentiles. Structure of a probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. Prerequisites: Calculus.

**MR3150 Analysis of Air/Ocean Time Series (3-2) As Required**

Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data networks. Laboratory work involves analysis of actual atmospheric and oceanic time series using principles developed in class. Prerequisites: A probability and statistics course.

**MR3212 Polar Meteorology/Oceanography (4-0) Winter**

Operational aspects of arctic and antarctic meteorology. Polar oceanography. Sea-ice: amount, its seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Prerequisites: OC3240, MR3222 or consent of instructor.

**MR3220 Meteorological Analysis (4-0) Spring/Fall**

Techniques of evaluation, interpretation and analysis of pressure, wind, temperature and moisture data, including weather satellite observations, with emphasis on the low and middle troposphere. Synoptic models of extratropical vortices, waves and frontal systems, with emphasis on three-dimensional space structure and time continuity, including isentropic surfaces and vertical cross-section analysis. Introduction to analysis in the troposphere and low stratosphere, including daily exposure to Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis, and satellite imagery interpretation. Prerequisites: MR3420 or MR3480, MR/OC3321.

**MR3222 Meteorological Analysis/Laboratory (4-3) Spring/Fall**

Same as MR3220, plus laboratory sessions in the IDEA lab on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposphere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analyses. Prerequisites: MR3420 or MR3480, MR/OC3321.

**MR3230 Tropospheric and Stratospheric Meteorology (4-0) Summer/Winter**

Development and application of conceptual models of the evolution of various tropospheric and stratospheric circulation systems. Extratropical cyclones, jet streams and fronts are

examined through application of dynamical concepts with particular emphasis on aspects associated with the marine environment. Prerequisites: MR3222, MR4322 (may be taken concurrently).

**MR3234 Tropospheric and Stratospheric Meteorology/Laboratory (4-4) Summer**

Same as MR3230 plus laboratory sessions utilizing the IDEA Lab to facilitate the physical understanding of dynamical relationships inherent to the conceptual models of the various weather systems. Exercises utilize various case studies including material from recent marine cyclogenesis field experiments. Prerequisites: MR3222, MR4322, (may be taken concurrently).

**MR3240 Radar Meteorology (3-0) As Required**

Principles of radar meteorology. Topics covered include radar systems, meteorological radar equation, doppler radar basics, propagation, attenuation, precipitation and velocity estimation, and characteristic echoes. Prerequisites: MR3222 and MR3522.

**MR3250 Tropical Meteorology (3-0) Summer/Winter**

Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, the intertropical convergence zone; structure, development and motion of tropical cyclones; monsoon circulations. Emphasis on analysis and energetics. Prerequisites: MR4322 and MR3230 or MR3234 (may be taken concurrently).

**MR3252 Tropical Meteorology/Laboratory (3-4) Summer/Winter**

Same as MR3250 plus laboratory sessions on analysis of tropical systems emphasizing streamline and isotach analysis and incorporating aircraft and satellite observations. Exercises stress tropical cyclone regimes. Satellite imagery is used as an analysis tool and also in forecasting tropical cyclone intensity. A track forecasting exercise provides an exposure to the use of various dynamic, climatological and statistical forecast models. Prerequisites: MR4322 and MR3230 or MR3234 (may be taken concurrently).

**MR3260 Operational Atmospheric Prediction (3-0) Fall/Winter**

Subjective and objective methods of atmospheric prognosis and techniques for forecasting operationally-important weather elements from surface to 100 mb. Interpretation, use and systematic errors of computer-generated products. Weather satellite briefs and applications of forecasting principles to current situations. Prerequisites: MR3230, or MR3234; MR/OC4323 may be taken concurrently.

**MR3262 Operational Atmospheric Prediction/Laboratory (3-5) Fall/Winter**

Same as MR3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations, and Fleet Numerical Oceanography Center and National Meteorological Center products. Prerequisites: MR3230 or MR3234; MR/OC4323 may be taken concurrently.

**MR3321 Air-Ocean Fluid Dynamics (4-0) Winter**

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations

for rotating stratified fluids are derived from fundamental physical laws. Topics include: the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. Prerequisites: Multivariable calculus and vectors; ordinary differential equations (may be taken concurrently).

**MR3413 Boundary Layer Meteorology (3-0) Spring**

This course covers the basic concepts, description, and quantification of the main features of the atmospheric boundary layer (ABL) and atmospheric dispersion. The characteristics of turbulent flow will be introduced at the beginning of the course followed by a detailed discussion of the flux-profile relationship and the bulk aerodynamics surface flux parameterization for the surface layer. The course also covers the main features and dominant physical processes in the stable, clear, and convective boundary layers and an overview of the surface energy budget over various surface types. For dispersion modeling, the basic concepts of dispersion modeling and the Gaussian plume and puff models will be introduced. During the course, the statistical and dimensional analysis methods, which are the main tools to analyze the ABL observational and numerical modeling data, are introduced and used to reveal the characteristics and structure of the ABL. Prerequisites: MR3222 and MR3480.

**MR3419 Assessment of Atmospheric Factors in EM/EO Propagation (2-1) As Required**

The course addresses atmospheric parameters and their distribution that affect propagation of electromagnetic and Electro-optical (EM/EO) waves and describes their assessment with in situ and satellite borne sensors. It relates propagation phenomena to wavelength-dependent controlling atmospheric influences. Students receive demonstrations of obtaining web-site available atmospheric descriptions. There are demonstrations and exercises with computer-based assessment codes that relate EM/EO propagation to measured and predicted atmospheric properties: PROPHET (HF), AREPS (UHF VHF-SHF), EOTDA&NOVAM (IR). Discussions will occur on display/distribution of global atmospheric and oceanic conditions supporting specific operational systems. Satellite sensor retrieval procedures will be described and demonstrated. Prerequisites: Curricula; Calculus based physics and math through multivariable calculus; Enrollment in International Electronic Warfare and Electronics/Communication.

**MR3420 Atmospheric Thermodynamics (3-0) Spring/Summer/Fall/Winter**

The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air processes; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Prerequisites: Multivariable calculus.

**MR3421 Cloud Physics (3-0) Spring**

Basic principles of cloud and precipitation physics and application to cloud formation and optical properties. Prerequisites: MR3420 or MR3480.

**MR3445 Oceanic and Atmospheric Observational Systems (2-2) As Required**

Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. Prerequisites: OC3230 and MR3420, MR/OC3150 or consent of instructor.

**MR3455 Measurement Systems for the Marine and Coastal Atmospheric Boundary Layer (2-2) As Required**

The course treats a broad spectrum of measurement techniques for atmospheric dynamic and thermodynamic variables. Laboratory sessions provide hands-on experience with various state-of-the-art sensing systems, including NPS' Doppler Radar Wind Profiler. Topics include sensor static and dynamic characteristics; calibration; in situ measurements of wind, pressure, temperature, humidity, aerosols and radiation on the surface, on balloon-borne sounding systems and on aircraft; and surface-based remote sensing systems, including wind profilers, SODAR and LIDAR. Prerequisites: MR3150 and MR3222 or consent of instructor.

**MR3480 Atmospheric Thermodynamics and Radiative Processes (4-1) As Required**

The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air process; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Basic radiative transfer including absorption and scattering by atmospheric constituents; solar and terrestrial radiative heating; radiative energy budgets; climate change; radiative effects of clouds and aerosols; optical phenomena. Prerequisites: Single variable calculus.

**MR3520 Remote Sensing of the Atmosphere and Ocean (4-0) Winter**

Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic properties. Prerequisites: Undergraduate physics and differential/integral calculus, ordinary differential equations and MR3480, or consent of instructor.

**MR3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (SS3525 is used for non air-ocean students) (4-2) Winter**

Same as MR3520 plus laboratory sessions on the concepts considered in the lecture series. Prerequisites: Same as MR3520.

**MR3540 Radiative Processes in the Atmosphere (3-0) Spring/Fall**

Applications of radiation theory to atmospheric energy budgets, general circulation and anthropogenic climate changes. Radiational imbalance at the surface leading to heat fluxes and temperature changes in atmosphere and earth. Upper atmosphere phenomena (ozonosphere and ionosphere). Radiative effects of clouds and aerosols, and optical phenomena. Prerequisites: MR3420, MR3520 or MR3522.

**MR3570 Operational Oceanography and Meteorology (2-4) Spring/Summer**

Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation.

Integration of satellite remote sensing and other operational products with in situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea and post-cruise analysis. Prerequisites: OC3240, MR3220, or consent of instructor.

**MR3610 Modern Climatology (4-0) Summer**

An introduction to physical climatology and its applications. This course examines Earth's climate system, especially major long-term global and regional patterns, and the physical processes that create them, with focus on the application of physical climatology to solve operational DoD problems and analyze and forecast climate variations at intraseasonal and longer time scales. Emphasis placed on support of military operations, past, present and future. Prerequisites: MR2200, MR/OC3321 and MR3480.

**MR4240 Coastal Meteorology (3-1) As Required**

Mesoscale circulations of the coastal atmosphere are examined from theoretical, observational, and model perspectives. Thermally-driven circulations, orographically-driven circulations and mesoscale circulations due to the interaction of synoptic-scale weather systems with coastlines are studied to develop useful conceptual models of coastal meteorological phenomena. Prerequisites: MR4322, MR3234 taken concurrently or consent of instructor.

**MR4241 Mesoscale Meteorology (3-0) Spring/Fall**

Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesoscale convective systems, tornadoes, etc., and their relation to the synoptic-scale environment. Applications to short-range and local-area forecasting utilizing satellite and numerical-model products relevant to mesoscale weather phenomena. Prerequisites: MR3230, MR4322 with consent of instructor.

**MR4242 Advanced Tropical Meteorology (3-0) Summer**

Theories and observations of tropical motion systems. Equatorial wave theory; stratospheric biennial oscillation; tropical intraseasonal oscillations; monsoon circulations; tropospheric biennial oscillation; El Nino and Southern Oscillation; other climate variations. Tropical cyclone dynamics; influence of environmental flow on formation and motion; advanced models and forecasting of tropical motion. Emphases among these topics will depend on the interest of the students. Prerequisites: MR3252 or consent of instructor.

**MR4250 Atmospheric General Circulation (3-0) Spring**

The observed circulation. Zonal mean and eddy motions. Balances of momentum, heat and moisture. Energetics. Maintenance of circulation. Zonally asymmetric circulations. Other selected topics of the general circulation of the atmosphere. Prerequisites: MR4322 and consent of instructor.

**MR4262 Advanced Meteorological Prediction (3-2) Fall**

The course requires previous weather forecast experience and covers advanced forecasting topics. A sample of topics covered include dust forecasting, orographic precipitation, mountain waves and downslope winds, cold-air damming and coastal frontogenesis, marine fog and stratus, ocean wind waves and swell, thunderstorms, and others. The focus is on the mesoscale aspects of forecasting and how to appropriately use observational and model tools for short-range to longer range forecasts of these phenomena. Hands-on practical forecast labs and briefings are used to demonstrate and practice the theory and techniques covered in the lectures. Prerequisites:

Experience equivalent to completion of MR3262, MR3234 and MR3522.

**MR4322 Dynamic Meteorology (4-0) Spring/Fall**

Pressure coordinates, quasi-geostrophic scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. Prerequisites: MR3420, MR/OC3321, calculus and ordinary differential equations.

**MR4323 Numerical Air and Ocean Modeling (4-2) Spring/Fall**

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving hyperbolic, parabolic and elliptic equations, linear and nonlinear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. Prerequisites: MR4322, OC4211, partial differential equation, MA3232 desirable.

**MR4324 Advanced Numerical Weather Prediction (3-0) Winter**

Initialization, boundary conditions; sensible, latent and radiative heat transfer; simulation of sub-grid scale processes such as convection and friction; spectral methods and finite element models; general circulation models. Prerequisites: MR/OC4323 or consent of instructor.

**MR4331 Advanced Geophysical Fluid Dynamics I (3-0) Summer**

Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. Prerequisites: Consent of instructor.

**MR4332 Advanced Geophysical Fluid Dynamics II (3-0) As Required**

Normal mode and baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves; symmetric instability. Prerequisites: Consent of instructor.

**MR4413 Air-Sea Interaction (4-0) Spring**

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer and bulk formula for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers in air-sea interaction. Prerequisites: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

**MR4414 Advanced Air/Sea Interaction (3-0) As Required**

Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. Prerequisites: MR/OC4413 or consent of instructor.

**MR4415 Atmospheric Turbulence (3-0) Spring**

Approaches for defining the structure of the turbulent atmospheric boundary layer. Review of statistical descriptions of atmospheric turbulence; averaging, moments, joint moments, spectral representation. Equations for turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra;

Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. Prerequisites: MR/OC3150 or consent of instructor.

**MR4416 Atmospheric Factors in Electromagnetic and Optical Propagation (3-0) Spring/Fall**

Principles of microwave and optical wave propagation in the atmosphere. Effects of surface and boundary layers on propagation: refraction, scattering, attenuation, ducting, etc. Addresses existing environmental effects assessment models. Prerequisites: MR/OC4413 or MR4415 (may be taken concurrently).

**MR4520 Topics in Satellite Remote Sensing (3-0) Summer**

Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. Prerequisites: MR/OC3522.

**MR4800 Advanced Topics in Meteorology (Variable Credit 1-0 to 4-0) (V-0) As Required**

Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. Prerequisites: Consent of instructor and Department Chairman.

**MR4900 Directed Study in Meteorology (Variable Credit 1-0 to 4-0) Spring/Summer/Fall/Winter**

Directed study of selected areas of meteorology to meet the needs of the individual student. Prerequisites: Consent of instructor and Department Chairman. Graded on Pass/Fail basis only.

**Meteorology and Oceanography (METOC) - Curriculum 373 (Under Department of Meteorology)**

**Program Officer**

Denise Kruse, CDR, USN  
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**Academic Associate**

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**Academic Associate**

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## Brief Overview

This curriculum in meteorology and oceanography involves approximately 120 quarter-hours of classroom lectures, supplemented by an additional 35 quarter-hours of laboratory exercises. This program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
- The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses, and numerical models.
- A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare with particular emphasis on ocean acoustics and electromagnetic/optical propagation.
- An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.
- A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge, and develop analytical ability for practical problem solving.

## Requirements for Entry

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is offered in the Spring or Fall quarter prior to 373 enrollment.

## Entry Date

METOC curriculum is a nine-quarter course of study with entry dates in January and July. If further information is needed, contact the Program Officer.

Academic questions may be referred directly to either of the Academic Associates.

## Degree

Master of Science in Meteorology and Physical Oceanography.

## Subspecialty

Completion of this curriculum qualifies an officer as a METOC Subspecialist with a subspecialty code of 6401P. The Curriculum Sponsor is the Oceanographer of the Navy (CNO N7C).

## Typical Subspecialty Jobs

METOC Officer aboard CV(N)/LHD  
Submarine Group Staff  
Fleet Staff  
CARSTRKGRU/EXSTRKGRU Staff  
OIC Naval Meteorology and Oceanography  
Command Detachment  
NAVMETOCOM Mobile Warfare Teams  
NGA  
Office of Naval Research

## Typical Course of Study - Winter Entry

### Quarter 1 (Winter)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vectors Calculus
MA2121	(4-0)	Ordinary Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

### Quarter 2 (Spring)

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR3222	(4-3)	Meteorological Analysis/Laboratory
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

### Quarter 3 (Summer)

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC3260	(4-0)	Sound in the Ocean
OC/MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3240	(4-2)	Ocean Dynamics I

### Quarter 4 (Fall)

MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
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MR4322 (4-0) Dynamic Meteorology  
 OC4211 (4-0) Ocean Dynamics II  
 OC3902 (3-2) Fundamentals of Mapping,  
 Charting and Geodesy

**Quarter 5 (Winter)**

MR3234 (4-4) Tropospheric and  
 Stratospheric  
 Meteorology/Lab  
 MR/OC4413 (4-0) Air Sea Interaction  
 OC4267 (4-0) Ocean Acoustic Prediction  
 OC4610 (2-2) Wave and Surf Forecasting  
 (or other Coastal Ocean  
 Elective)

**Quarter 6 (Spring)**

MR/OC4323 (4-2) Numerical Air and Ocean  
 Modeling  
 MR4416 (3-0) Atmospheric Factors in  
 Electromagnetic and  
 Optical Propagation  
 MR4240 (3-1) Coastal Meteorology  
 MR/OC4900 (V-0) Directed Study in  
 Meteorology/Oceanograph  
 y

**Quarter 7 (Summer)**

MR3252 (3-4) Tropical  
 Meteorology/Laboratory  
 OC4270 (3-4) Tactical Oceanography  
 MR/OC3570 (2-4) Operational Oceanography  
 and Meteorology  
 MR/OC0810 (0-8) Thesis Research

**Quarter 8 (Fall)**

MR3262 (3-5) Operational Atmospheric  
 Prediction/Laboratory  
 NW3230 (4-2) Strategy and Policy  
 OC4331 (4-0) Mesoscale Ocean  
 Variability  
 MR/OC0810 (0-8) Thesis Research

**Quarter 9 (Winter)**

MR/OCXXXX (4-0) Advanced MR or OC  
 Elective  
 MR/OC0810 (0-8) Thesis Research  
 MR/OC0810 (0-8) Thesis Research  
 MR/OC0999 (2-0) Thesis Presentation

**Typical Course of Study - Summer Entry**

**Quarter 1 (Summer)**

MR/OC2020 (2-2) Computer Computations in  
 Air-Ocean Sciences  
 MA1115 (1<sup>st</sup> 6wks) (4-0) Multi-variable Calculus  
 MA1116 (2<sup>nd</sup> 6wks) (4-0) Vector Calculus  
 MA2121 (4-0) Differential Equations  
 OC3230 (3-1) Descriptive Physical  
 Oceanography

**Quarter 2 (Fall)**

MR3480 (4-1) Atmospheric  
 Thermodynamics and  
 Radiative Processes  
 MA3132 (4-0) Partial Differential  
 Equations and Fourier  
 Analysis  
 MR3222 (4-3) Meteorological  
 Analysis/Laboratory  
 MR/OC3321 (4-0) Air-Ocean Fluid  
 Dynamics

**Quarter 3 (Winter)**

MR/OC3522 (4-2) Remote Sensing of the  
 Atmosphere and  
 Ocean/Laboratory  
 OC3260 (4-0) Sound in the Ocean  
 OC/MR3140 (3-2) Probability and Statistics  
 for Air-Ocean Sciences  
 OC3240 (4-2) Ocean Dynamics I

**Quarter 4 (Spring)**

MR/OC3150 (3-2) Analysis of Air/Ocean  
 Time Series  
 MR4322 (4-0) Dynamic Meteorology  
 OC4211 (4-0) Ocean Dynamics II  
 OC3902 (3-2) Fundamentals of Mapping,  
 Charting and Geodesy

**Quarter 5 (Summer)**

MR3234 (4-4) Tropospheric and  
 Stratospheric  
 Meteorology/Lab  
 MR/OC4413 (4-0) Air Sea Interaction  
 OC4267 (4-0) Ocean Acoustic Prediction  
 OC4331 (4-0) Mesoscale Ocean  
 Variability

**Quarter 6 (Fall)**

MR/OC4323 (4-2) Numerical Air and Ocean  
 Modeling  
 MR4416 (3-0) Atmospheric Factors in  
 Electromagnetic and Optical  
 Propagation  
 MR3252 (3-4) Tropical  
 Meteorology/Laboratory  
 MR/OC4900 (V-0) Directed Study in  
 Meteorology/Oceanography

**Quarter 7 (Winter)**

MR4240 (3-1) Coastal Meteorology  
 OC4270 (3-4) Tactical Oceanography  
 MR/OC3570 (2-4) Operational Oceanography  
 and Meteorology  
 MR/OC0810 (0-8) Thesis Research

**Quarter 8 (Spring)**

NW3230 (4-2) Strategy and Policy  
 MR3262 (3-5) Operational Atmospheric  
 Prediction/Laboratory



OC4213 or OC4220	(4-0)	Nearshore & Wave Processes or Coastal Ocean Circulation
MR/OC0810	(0-8)	Thesis Research

**Quarter 9 (Summer)**

MR/OCXXXX	(4-0)	Advanced MR or OC Elective
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Thesis Presentation

**Educational Skill Requirements (ESR)  
Meteorology & Oceanography (METOC) -  
Curriculum 373**

**Subspecialty Code: 6401P**

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere, and a general understanding of numerical model and numerical model process.
2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis, and numerical models.
3. The officer must have a thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor, and platform performance while conducting and supporting Naval and Joint warfare as described in Joint Vision 2010, and amplified in Joint Vision 2020 and the Navy Vision of "Forward...from the Sea."
4. Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals, and the ways military power may be used to achieve them.
5. The officer must have a thorough understanding of the fundamentals of Global Geospatial Information and Services (GI&S), precise time and time interval (PTTI), and astrometry.
6. The officer must successfully complete all NPS requirements for the Joint Master's Degree in Meteorology and Physical Oceanography.

**Meteorology - Curriculum 372****Program Officer**

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**Academic Associate**

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**Brief Overview**

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the atmosphere.
- The ability to observe, assimilate, analyze, interpret, and predict atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.
- A thorough understanding of the effects of atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting military warfare.
- A meteorological research experience germane to military warfare, culminating in a thesis of professional quality.

**Requirements for Entry**

The master's program is open to International Officers, officers from other services, and DoD civilians. It is open to METOC (1800) officers of the U.S. Navy and officers from other services as a Ph.D. program. Students in the USAF Basic Meteorology Program (BMP) are also listed in this curriculum. The remainder of this section applies to the MS degree program.

For the master's program, a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics is required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is normally offered in the Summer quarter prior to 372 enrollment.

**Entry Date**

Meteorology is a six-quarter course of study with a normal entry date in the Fall quarter. For further information contact the Program Officer. Academic questions may be referred directly to the Academic Associate.

**Degree**

Master of Science in Meteorology.

**Typical Course of Study****Quarter 1**

MA1115 (6wks)	(4-0)	Multi-Variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes

**Quarter 2**

MR2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
PH2514	(3-0)	Physics of the Space Environment (or Elective)
MR3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory

**Quarter 3**

MR4322	(4-0)	Dynamic Meteorology
MR4323	(4-2)	Numerical Air and Ocean Modeling
MR4900	(3-0)	Directed Study in Meteorology
MR3413	(3-0)	Boundary Layer Meteorology (or Elective)

**Quarter 4**

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR3252	(3-4)	Tropical Meteorology/Laboratory
MR3240	(3-0)	Radar Meteorology (or Elective)
MR0810	(0-8)	Thesis Research

**Quarter 5**

MR4262	(3-2)	Advanced Weather Forecasting
MR4241	(3-0)	Mesoscale Meteorology
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

**Quarter 6**

MR4800	(3-0)	Elective in Meteorology
MR0810	(4-0)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Thesis Presentation

**Educational Skill Requirements (ESR)****Meteorology (Masters) - Curriculum 372  
Subspecialty Code: Not Applicable for MS Degree**

*Note -This program primarily supports USAF and International graduate education, thus there is no Navy p-code or subspecialty associated with this master's program, and no official ESRs . This list describes the skills this program will provide students upon successful completion.*

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The program is designed to provide the student with:

1. A thorough understanding of the principles governing the physical and dynamic properties of the atmosphere.
2. The ability to observe, assimilate, analyze, interpret, and predict atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.
3. A thorough understanding of the effects of atmospheric properties and conditions on weapon, sensor and platform performance, while conducting and supporting military warfare.
4. A meteorological research experience germane to military warfare, culminating in a thesis of professional quality.

**Educational Skill Requirements (ESR)****Meteorology (Ph.D.) - Curriculum 372  
Subspecialty Code: 6403D**

The officer must have a thorough theoretical and functional knowledge (obtained at the doctorate level) of the principles of meteorology and its effects on naval warfare and weapons systems.

**Department of Oceanography****Chair**

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**Associate Chairman, Research**

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**Mary Louise Batteen**, Professor and Chair (1985)\*;  
Ph.D., Oregon State University, 1984.

**Ching-Sang Chiu**, Professor (1988); ScD,  
Massachusetts Institute of Technology and Woods  
Hole Oceanographic Institution, 1985.

**Peter C. Chu**, Professor (1986); Ph.D., University of  
Chicago, 1985.

**Curtis Allan Collins**, Professor and Associate Chair for  
Instruction (1987); Ph.D., Oregon State University,  
1967.

**John A. Colosi**, Associate Professor (2005); Ph.D.,  
University of California, Santa Cruz, 1993

**Arlene A. Guest**, Senior Lecturer, (1999); M.S., Florida  
State University, 1981.

**Thomas H.C. Herbers**, Professor and Associate Chair  
for Research (1993); Ph.D., University of California,  
San Diego, 1990.

**Wieslaw Maslowski**, Research Associate Professor  
(1994); Ph.D., University of Alaska-Fairbanks, 1994.

**Jeffrey Dean Paduan**, Associate Professor (1991);  
Ph.D., Oregon State University, 1987.

**Timour Radko**, Assistant Professor (2004); Ph.D.,  
Florida State University, 1997.

**Steven R. Ramp**, Research Professor (1998); Ph.D.,  
University of Rhode Island, 1986.

**D. Benjamin Reeder**, Assistant Professor and Military  
Instructor (2004), Ph.D., Massachusetts Institute of  
Technology and Woods Hole Oceanographic  
Institution (2002).

**Leslie K. Rosenfeld**, Research Associate Professor  
(1989); Ph.D., Woods Hole Oceanographic  
Institution, 1987.

**William J. Shaw**, Research Assistant Professor (2005);  
Ph.D., Woods Hole Oceanographic Institution, 2000.

**Timothy Peter Stanton**, Research Associate Professor  
(1978); M.S., University of Auckland, 1977.

**Rebecca E. Stone**, Permanent Military Professor  
(2004); Ph.D., Naval Postgraduate School, 1999.

**Edward Bennett Thornton**, Distinguished Professor and  
Associate Chair for Instruction, (1969); Ph.D.,  
University of Florida, 1970.

**Robin T. Tokmakian**, Research Associate Professor  
(1997); Ph.D., Naval Postgraduate School, 1997.

**Research Associates:**

**Frederick L. Bahr**, Research Associate (1998); M.S.,  
Oregon State, 1991

**Jaclyn L. Clement**, Research Associate (2002); M.S.,  
University of Tennessee, 2002

**Detalina P. Ivanova**, Research Associate (2001); M.S.,  
Sotia State University, Bulgaria, 1991

**Christopher W. Miller**, Research Associate (1992);  
M.S., Naval Postgraduate School, 1998

**Mark D. Orzech**, Research Associate (2001); M.S.,  
University of Delaware, 1997

**Prasad G. Thoppil**, Research Fellow of Oceanography  
(2002); Ph.D., Hokkaido University, Japan (2001)

**Professors Emeriti:**

**Robert Hathaway Bourke**, Professor Emeritus (1971);  
Ph.D., Oregon State University, 1972.

**Roland William Garwood**, Professor, (1976); Ph.D.,  
University of Washington, 1976.

**Eugene C. Haderlie**, Distinguished Professor Emeritus,  
()Ph.D.; University of California - Berkeley, 1950.

**Glenn Harold Jung**, Professor Emeritus (1958); Ph.D.,  
Texas A & M University, 1955, 1950.

**Albert Julius Semtner, Jr.**, Professor (1986); Ph.D.,  
Princeton University, 1973

**Warren Charles Thompson**, Professor Emeritus (1953);  
Ph.D., Texas A & M University, 1953.

**Eugene Dewees Traganza**, Professor Emeritus (1970);  
Ph.D., University of Miami, 1966.

**Stevens Parrington Tucker**, Professor Emeritus (1968),  
Ph.D., Oregon State University, 1972.

**Joseph John von Schwind**, Professor Emeritus (1967);  
Ph.D., Texas A & M University, 1968.

**Jack H. Wickham**, Professor Emeritus (1951); M.S.,  
Scripps Institution of Oceanography, 1949.

\* The year of joining the Naval Postgraduate School  
faculty is indicated in parentheses.

## Brief Overview

The Oceanography Department supports curricula sponsored by the Oceanographer of the Navy: #372 Meteorology #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography. The department also offers the MS in Physical Oceanography to Undersea Warfare curricula #525 (USN) and #526 (international).

The department focuses primarily on Physical Oceanography, Ocean Acoustics and Acoustical Oceanography, Numerical Modeling, Air-Sea Interactions, and Nearshore and Coastal/Littoral Oceanography, and has strong interests in remote sensing and geospatial information systems.

Topics include ocean dynamics, numerical ocean prediction and simulation, satellite remote sensing of the ocean, air-sea interaction, polar oceanography, upper ocean dynamics and thermodynamics, near-shore processes, wave and surf forecasting, mesoscale dynamics, coastal ocean circulation, tactical oceanography and environmental acoustics. The department also provides core courses for Undersea Warfare and the Space Systems curricula.

## Degree

A student is able to earn an academic degree listed below while enrolled in METOC (Curriculum 373), Operational Oceanography (Curriculum 374), Oceanography (Curriculum 440), and Undersea Warfare (Curriculum 525).

### Master of Science in Physical Oceanography

Entrance to a program leading to the Master of Science in Physical Oceanography degree requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The Master of Science in Physical Oceanography degree requires:

- Completion of at least eight physical oceanography graduate courses with at least four courses in the OC4000 series. The entire sequence of courses selected must be approved by the Department of Oceanography. Significant educational experience at sea on a research vessel is required for the degree. (OC3570 satisfies this requirement).
- Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

### Master of Science in Meteorology and Physical Oceanography

Direct entrance to a program leading to the Master of Science in Meteorology and Physical Oceanography

degree requires a baccalaureate degree in one of the physical sciences, mathematics, or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography, which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event, the program may be lengthened by one or more quarters.

The Master of Science in Meteorology and Physical Oceanography degree requires:

1. Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography.
2. The sequence of core courses in meteorology and oceanography in the fields of dynamical, numerical and physical and synoptic meteorology and oceanography.
3. An approved selection of graduate elective courses in oceanography and meteorology.
4. A significant educational experience at sea on a research vessel.
5. An acceptable thesis on a topic approved by either department.

The total number of quarter-hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of Meteorology and Physical Oceanography.

### Dual Degree in Meteorology and Physical Oceanography

The Meteorology and Oceanography Departments have adopted a policy to not recommend its award of dual master's degrees in Meteorology and Physical Oceanography

### Doctor of Philosophy

Department of Oceanography admission requirements for the Doctor of Philosophy degree include:

A bachelor's degree with a high QPR or a highly successful first graduate year in a master's program, with clear evidence of research ability.

A master's degree may be required before admission to candidacy.

The Ph.D. program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics, nearshore, and coastal/littoral oceanography among others. An

applicant to the Ph.D. program who is not already at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, California 93943-5100.

### **Oceanographic Laboratories**

NPS is a member of UNOLS (University National Oceanography Laboratory System), CENCAL (Central California Cooperative), UCAR (University Corporation for Atmosphere Research), MBCORC (Monterey Bay Crescent Ocean Research Consortium), and CORE (Consortium for Oceanographic Research and Education). UNOLS operates the nation's academic oceanographic research fleet, while CENCAL promotes and coordinates research vessel operations between several academic institutions in central California. The nearby Moss Landing Marine Laboratory operates the NSF-owned, 135-foot R/V POINT SUR for the benefit of CENCAL. Through sponsorship of the Oceanographer of the Navy, NPS is a major user of the R/V POINT SUR, primarily for instructional purposes.

The Rapid Environmental Assessment Laboratory (REAL) consists of moored-equipment in Monterey Bay, the R/V POINT SUR, and the former PT SUR SÓSUS underwater acoustic array provides for instruction in the practical design, deployment and collection of state-of-the-art oceanographic data. Real-time observations of currents, temperature, salinity and sound speed structure in a variety of oceanic regimes are analyzed and modeled, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

The Oceanography Department operates a graphics laboratory that is equipped with networked workstations for the analysis of numerical model output, geospatial information system (GIS) exercises, satellite imagery, acoustical data and other digital fields from REAL. Smart classrooms enable data to be brought into the classroom in real time to demonstrate signal processing, rapid environmental assessment and other state-of-the-art oceanographic and tactical decision aids.

The department is organized around thematic laboratories, each containing faculty, staff and student offices, computing facilities and special laboratory equipment. Thematic laboratories exist for Oceanic Planetary, Polar, Nearshore, Acoustics, Coastal Modeling, Global Modeling, GI&S, Naval Ocean Analysis and Prediction, Ocean Turbulence, Ocean Waves, Radar and Drifter, and Tactical Environmental Support.

## **Oceanography Course Descriptions**

### *OC Courses*

#### **OC0810 Thesis Research (0-8) As Required**

Every student conducting research in oceanography will enroll in this course.

#### **OC0999 Thesis Seminars (No Credit) (2-0) As Required**

Students in the various oceanography curricula present their thesis research. Prerequisites: Preparation of a thesis.

#### **OC2020 Computer Computations in Air-Ocean Sciences**

##### **(2-2) Fall/Winter/Spring/Summer**

Introduction to the programming languages, operating systems, and computing facilities which METOC students use in MR and OC courses. Laboratory assignments are elementary problems in oceanography and meteorology. Prerequisites: Calculus and college physics.

#### **OC2022 Scientific Fortran Programming (2-2) As Required**

Structured Fortran programming as applied to elementary problems including oceanography and meteorology. Prerequisites: Calculus.

#### **OC2902 Fundamentals of Geospatial Information and Services (3-0) Spring/Fall**

This course will give the student an appreciation for the important facts about precision location today, from the true physical shape of the earth to the fusion of geographically labeled data in modern electronic databases. Today's military officer needs to know the fundamentals of precision location systems to operate in the battlespace of the twenty-first century. We have come from precise position being 60 nautical miles in the 1700s to a few meters in the 2000s. We have gone from dead reckoning on paper charts to GPS positions fed to fully automated navigation and weapons systems. The entire process of producing modern geospatially tagged items will be reviewed. This will include the scientific background of the processes and the advantages and limitations of the steps. Prerequisites: Students will need to have a basic understanding of algebra, geometry and trigonometry. A basic course in physics or equivalent that covers vector, conservation of energy and forces is needed. The student needs to be familiar with basic computer skills including the storage of data in arrays (spreadsheets work is sufficient for example).

#### **OC2910 Use of U.S. Navy Operational Ocean Circulation and Tide Models (3-2) Summer**

This course aims to provide Navy users with the information necessary to make informed and intelligent use of the Navy's operational ocean circulation and tide models. The course assumes some familiarity with physical oceanography, and experience working with output from atmospheric and/or oceanographic models. Basic concepts in physical oceanography and numerical modeling will be covered as introduction to more detailed descriptions of each of the Navy operational models and their capabilities. Students will work with output from the Navy models, and perform some model runs themselves. Evaluation of student learning will be in the form of exercises where students will be presented with several hypothetical (or real) operational scenarios and have to choose

which model products to use in preparing a forecast or analysis, justify their choices, and interpret the products.

**OC3030 Oceanographic Computing and Data Display (2-2) As Required**

Course emphasizes the use of the computer as a tool in oceanography problem-solving. Use of various software packages for graphics, scientific visualization, statistics and numerical computation. Prerequisites: OC/MR2020, OC3240 or MR/OC3522, or the consent of instructor. Graded: Pass/Fail.

**OC3120 Biogeochemical Processes in the Ocean (4-3) As Required**

Basic biological, geological, and chemical processes in the ocean. Bioacoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean. Prerequisites: None.

**OC3140 Probability and Statistics for Air-Ocean Science (3-2) As Required**

Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation, and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. Prerequisites: Calculus.

**OC3150 Analysis of Air Ocean Time Series (3-2) Fall/Spring**

Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cross-spectrum. Optimal design of air-ocean data network. Laboratory work involves analysis of actual atmospheric and ocean time series using principles developed in class. Prerequisites: A probability and statistics course.

**OC3210 Polar Oceanography (3-0) As Required**

Covers the ice characteristics and physical oceanography of polar seas. Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models, and remote sensing of ice/snow covered surfaces. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes, and underwater acoustics. Discuss naval and research operations in polar warfare. Prerequisites: OC3240.

**OC3212 Polar Meteorology/Oceanography (4-0) Winter**

Operational aspects of Arctic and Antarctic meteorology, including polar lows, boundary layer and marginal ice zone influences. Polar oceanography. Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes. Prerequisites: MR3222 and OC3240 or consent of instructor.

**OC3230 Descriptive Physical Oceanography (3-1) Fall/Spring**

Physical properties of seawater. Processes influencing the distribution of heat, salt and density in the ocean. Static stability in the ocean. Circulation and water masses in the ocean. Laboratory work involves collection and analysis of actual data using principles developed in class.

**OC3231 Descriptive Regional Oceanography (4-0) As Required**

Overview of basic concepts. Water masses and regional circulation including littoral regions and marginal seas. Recent developments dealing with ocean circulation, sea level, climate, El Nino, ocean resources and pollution, and modern observational techniques. Prerequisites: OC3230 or the equivalent.

**OC3240 Ocean Circulation Analysis (4-2) Summer/Winter**

Application of dynamic concepts of ocean circulation, including conservation of mass, momentum and energy. Oceanic currents without friction: inertial and geostrophic flows. Frictional currents: Reynolds equations, Ekman and wind-driven flows. Vorticity balance: Sverdrup transport, potential vorticity, topographic steering, western intensification and Rossby waves. Thermohaline effects and thermocline theory. Prerequisites: OC3230 and OC3321 or the equivalent.

**OC3260 Fundamentals of Ocean Acoustics (4-0) Fall/Winter/Spring/Summer**

The fundamentals of ocean acoustics, including the acoustic wave equation, ray theory, acoustic arrays and filters, ambient noise, scattering, absorption, an introduction to normal mode theory, and sonar equations. Prerequisites: OC3230, partial differential equations or equivalent.

**OC3321 Air-Ocean Fluid Dynamics (4-0) Spring/Fall**

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluid are derived from fundamental physical laws. Topics include the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. Prerequisites: Multi-variable calculus, vectors, and ordinary differential equations (may be taken concurrently).

**OC3325 Marine Geophysics (3-0) As Required**

Theory and methods of marine geophysics surveys, and emphasis on gravity, magnetism, seismic and acoustic wave propagation; geophysical anomalies associated with major sea floor features; marine geodesy. Prerequisites: OC3120 (may be taken concurrently).

**OC3445 Oceanic and Atmospheric Observational Systems (2-2) As Required**

Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. Prerequisites: OC3230 and MR3420, MR/OC3150 or consent of instructor.

**OC3520 Remote Sensing of the Atmosphere and Ocean (4-0) As Required**

Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry, and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic variability. Prerequisites: Undergraduate physics and differential/integral calculus; ordinary differential equations and MR3480 or consent of instructor.

**OC3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (4-2) Summer**

Same as OC3520 plus laboratory sessions on the concepts considered in the lecture series. Prerequisites: Same as OC3520.

**OC3570 Operational Oceanography and Meteorology (2-4) Winter/Summer**

Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in-situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea, and post-cruise analysis. Prerequisites: OC3240, MR3220, or consent of instructor.

**OC3750 Naval Astronomy and Precise Time (2-0) As Required**

Positional astronomy. Coordinate systems. Solar system dynamics. Astrometry (measurements of positions and motion of stars). Time, earth rotation and atomic clocks. Naval applications of astronomy. Overview of astrophysics and cosmology. Prerequisites: College physics and calculus.

**OC3902 Fundamentals of Mapping, Charting and Geodesy (3-2) Fall/Spring**

Basics of map/chart generation and scientific basis for their accuracy and precision. Ellipsoids, latitudes, longitudes, datums, datum transformations, map projections, geoid and heights. Map/chart generation process including satellite surveying. Use of map/charts with modern navigation systems, including GPS. Digital map characteristics. Prerequisites: Vector analysis, probability and statistics or consent of instructor.

**OC3903 Electronic Surveying and Navigation (3-0) As Required**

Introduction to the theory and practice of electronic navigation including principles of electronics, geometry, and error propagation. Covers ground-based and satellite systems. The global positioning system is covered in detail. Prerequisites: Consent of instructor.

**OC4211 Ocean Waves (4-0) Fall/Spring**

Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. Prerequisites: Partial differential equations and OC3240.

**OC4212 Tides (4-0) As Required**

Development of the theory of tides including the tide-producing forces, equilibrium tides, and the dynamic theory of tides; harmonic analysis and prediction of tides; tidal datum planes and their relationship with geodetic datum planes, short-term and secular changes in sea level. Prerequisites: OC4211.

**OC4213 Nearshore and Wave Processes (3-1) As Required**

Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. Prerequisites: OC4211 or consent of instructor.

**OC4220 Coastal Circulation (4-1) As Required**

Coastal ocean physical processes. Dynamics and models of coastal ocean circulations driven by wind, thermohaline, tidal, boundary currents, and ocean eddy forces. Recent papers on coastal ocean circulation. Laboratory sessions on computing properties of tides, coastal trapped waves and wind-driven motions over the shelf and slope. Prerequisites: OC4211 (may be taken concurrently).

**OC4230 Physical Oceanography of Monterey Bay (3-0) As Required**

Monterey Bay will be used as a case study for various processes affecting the physical oceanography of coastal environments. Topics to include coastal upwelling, flow in and around submarine canyons, internal waves, air-sea interactions, and tides and seiches. Historical, recent, and ongoing studies in and around the bay will be considered. Prerequisites: OC3240 or consent of instructor.

**OC4250 General Circulation of the Atmosphere and Oceans (3-0) As Required**

Selected topics on the general circulation of the atmosphere (e.g. heat, momentum and moisture fluxes; energetics) and ocean (e.g. linear and non-linear theories of the wind-driven ocean circulation); coupled ocean-atmosphere general circulation models. Prerequisites: Consent of instructor.

**OC4262 Theories & Models in Underwater Acoustics (3-0) As Required**

Development of the underlying theories and algorithms of ray, normal mode, and parabolic equation acoustic models for both range independent and dependent environments. Examination of the strengths and weaknesses of and similarities between the various models. Prerequisites: OC3260 and partial differential equations or equivalent.

**OC4267 Ocean Acoustic Variability and Uncertainty (4-0) Summer/Winter**

Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection and scattering from the sea surface and bottom as they affect sound propagation in the ocean. Synoptic prediction techniques for ambient noise and transmission loss are reviewed. Environmental data input and computational approximations for acoustic models are evaluated against observed signal fluctuations and transmission loss. The course is designed for the Air-Ocean Science, Operational Oceanography, and USW Curricula. Prerequisites: OC3230 and OC3260 or equivalent.

**OC4270 Tactical Oceanography (3-4) Winter/Summer**

Course emphasizes the tactical use of the environment and battlespace characterization as a force multiplier in naval operations including acoustic undersea warfare, special operations, amphibious warfare, and mine warfare. Using tailored lectures, students will examine oceanographic conditions and the ability for naval forces to exploit them in nearshore, coastal and deep ocean settings. Current acoustic prediction models, remote sensing, tactical decision aids and Geographic Information Systems (GIS) will be utilized by

students as they explore a broad spectrum of environmental conditions and methods for exploitation by naval forces. Students will also utilize the R/V PT SUR to perform experiments and analyze data relating to acoustic propagation and the ocean. Prerequisites: For METOC students: OC3260 OC4267 (concurrent), or consent of instructor. For USW students: OC3260 and EC4450 (concurrent), or consent of instructor. Classification: SECRET Clearance and U.S. Citizenship is required. Lecture series is UNCLASSIFIED.

**OC4271 Topics in Tactical Oceanography (3-0) Winter/Summer**

Course emphasizes the tactical use of the environment and battlespace characterization as a force multiplier in naval operations, including acoustic undersea warfare, special operations, amphibious warfare, and mine warfare. Using tailored lectures, students will examine oceanographic conditions and the ability for naval forces to exploit them in nearshore, coastal and deep ocean settings. Prerequisites: For International METOC students: OC3260 OC4267 (concurrent), or consent of instructor. For International USW students: OC3260 and EC4450 (concurrent), or consent of instructor.

**OC4323 Numerical Air and Ocean Modeling (4-2) As Required**

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic equations, linear and non-linear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. Prerequisites: MR4322 or OC4211, partial differential equations; numerical analysis desirable.

**OC4324 Advanced Numerical Ocean Modeling (3-0) As Required**

Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer quasi-geostrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. Prerequisites: MR/OC4323.

**OC4331 Ocean Variability (4-0) Fall/Summer**

Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics for observations, theories and models. Prerequisites: OC4211 or equivalent.

**OC4335 Naval Ocean Analysis and Prediction (3-2) By Arrangement**

Advanced knowledge of the U.S. Navy ocean analysis and prediction systems, including the Naval Ocean Modeling Program (NOMP), naval ocean data systems, atmospheric forcing systems, data assimilation systems, Optimal Thermal Interpolation System (OTIS), Thermal Ocean Prediction Systems (TOPS), the global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS), Polar Ice Prediction System (PIPS), and global wave prediction system (WAM). Prerequisites: OC4211 and MR/OC4323 (may be taken concurrently).

**OC4413 Air/Sea Interaction (4-0) As Required**

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. Prerequisites: MR/OC3150, and OC3240 or MR3240 or consent of instructor.

**OC4414 Advanced Air/Sea Interaction (3-0) As Required**

Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. Prerequisites: MR/OC4413 or consent of instructor.

**OC4415 Ocean Turbulence (3-0) As Required**

Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. Prerequisites: MR/OC4413 or consent of instructor.

**OC4490 Ocean Acoustic Tomography (Same as EC4490) (3-0) As Required**

An introduction to Ocean Tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of Ocean Acoustic Tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. Prerequisites: OC3260 or EC3450 or PH4453 or equivalent; linear algebra, partial differential equations or equivalent.

**OC4520 Topics in Satellite Remote Sensing (3-0) As Required**

Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. Prerequisites: MR/OC3522.

**OC4610 Wave and Surf Forecasting (2-2) As Required**

Theory and prediction of wind-generated ocean waves. Spectral transformation of waves from deep to shallow water. Prediction of surf and wave related influences on operations. Prerequisites: OC3150, OC4211.

**OC4800 Advanced Courses in Oceanography (Variable hours 1 - 0 to 4 - 0) As Required**

Advanced courses in various aspects of oceanography. Typically these are advanced topics not covered in regularly offered courses. The course may be repeated for credit as topics change. Prerequisites: Consent of instructor and the Department Chairman.

**OC4900 Directed Study in Oceanography (V-0) As Required**

Independent study of advanced topics in oceanography. Prerequisites: Consent of instructor and the Department Chairman. Graded on Pass/Fail basis only.



## Meteorology and Oceanography (METOC) - Curriculum 373 (Under Department of Oceanography)

### Program Officer

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### Brief Overview

This curriculum in meteorology and oceanography involves approximately 120 quarter-hours of classroom lectures, supplemented by an additional 35 quarter-hours of laboratory exercises. This program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
- The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses, and numerical models.
- A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare, with particular emphasis on ocean acoustics and electromagnetic/optical propagation.
- An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.
- A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge, and develop analytical ability for practical problem solving.

### Requirements for Entry

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is offered in the Spring or Fall quarter prior to 373 enrollment.

### Entry Date

METOC curriculum is a nine-quarter course of study with entry dates in January and July. If further information is needed, contact the Program Officer. Academic questions may be referred directly to either of the Academic Associates.

### Degree

Master of Science in Meteorology and Physical Oceanography.

### Subspecialty

Completion of this curriculum qualifies an officer as a METOC Subspecialist with a subspecialty code of 6401P. The Curriculum Sponsor is the Oceanographer of the Navy (CNO N7C).

### Typical Subspecialty Jobs

METOC Officer aboard CV(N)/LHD  
Submarine Group Staff  
Fleet Staff  
CARSRTKGRU/EXSTRKGRU Staff  
OIC Naval Meteorology and Oceanography  
Command Detachment  
NAVMETOCOM Mobile Warfare Teams  
NGA  
Office of Naval Research

### Typical Course of Study - Winter Entry

#### Quarter 1 (Winter)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1* 6wks)	(4-0)	Multi-variable Calculus

MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vectors Calculus	<b>Quarter 7 (Summer)</b>		
MA2121	(4-0)	Ordinary Differential Equations	MR3252	(3-4)	Tropical Meteorology/Laboratory
OC3230	(3-1)	Descriptive Physical Oceanography	OC4270	(3-4)	Tactical Oceanography
			MR/OC3570	(2-4)	Operational Oceanography and Meteorology
			MR/OC0810	(0-8)	Thesis Research
<b>Quarter 2 (Spring)</b>			<b>Quarter 8 (Fall)</b>		
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes	MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MA3132	(4-0)	Partial Differential Equations and Fourier Analysis	NW3230	(4-2)	Strategy and Policy
MR3222	(4-3)	Meteorological Analysis/Laboratory	OC4331	(4-0)	Ocean Variability
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics	MR/OC0810	(0-8)	Thesis Research
			<b>Quarter 9 (Winter)</b>		
<b>Quarter 3 (Summer)</b>			MR/OCXXXX	(4-0)	Advanced MR or OC Elective
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory	MR/OC0810	(0-8)	Thesis Research
			MR/OC0810	(0-8)	Thesis Research
OC3260	(4-0)	Fundamentals of Ocean Acoustics	MR/OC0999	(2-0)	Thesis Presentation
OC/MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences			
OC3240	(4-2)	Ocean Circulation Analysis	<b>Typical Course of Study - Summer Entry</b>		
			<b>Quarter 1 (Summer)</b>		
<b>Quarter 4 (Fall)</b>			MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series	MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MR4322	(4-0)	Dynamic Meteorology	MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vector Calculus
OC4211	(4-0)	Ocean Waves	MA2121	(4-0)	Differential Equations
OC3902	(3-2)	Fundamentals of Mapping, Charting and Geodesy	OC3230	(3-1)	Descriptive Physical Oceanography
			<b>Quarter 2 (Fall)</b>		
<b>Quarter 5 (Winter)</b>			MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab	MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC4413	(4-0)	Air Sea Interaction	MR3222	(4-3)	Meteorological Analysis/Laboratory
OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty	MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
OC4610	(2-2)	Wave and Surf Forecasting (or other Coastal Ocean Elective)	<b>Quarter 3 (Winter)</b>		
			MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
<b>Quarter 6 (Spring)</b>			OC3260	(4-0)	Fundamentals of Ocean Acoustics
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling	OC/MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MR4416	(3-0)	Atmospheric Factors in Electromagnetic and Optical Propagation	OC3240	(4-2)	Ocean Circulation Analysis
MR4240	(3-1)	Coastal Meteorology	<b>Quarter 4 (Spring)</b>		
MR/OC4900	(V-0)	Directed Study in Meteorology/Oceanography	MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
			MR4322	(4-0)	Dynamic Meteorology
			OC4211	(4-0)	Ocean Dynamics II

OC3902 (3-2) Fundamentals of Mapping, Charting and Geodesy

#### Quarter 5 (Summer)

MR3234 (4-4) Tropospheric and Stratospheric Meteorology/Lab  
 MR/OC4413 (4-0) Air Sea Interaction  
 OC4267 (4-0) Ocean Acoustic Variability and Uncertainty  
 OC4331 (4-0) Ocean Variability

#### Quarter 6 (Fall)

MR/OC4323 (4-2) Numerical Air and Ocean Modeling  
 MR4416 (3-0) Atmospheric Factors in Electromagnetic and Optical Propagation  
 MR3252 (3-4) Tropical Meteorology/Laboratory  
 MR/OC4900 (V-0) Directed Study in Meteorology/Oceanography

#### Quarter 7 (Winter)

MR4240 (3-1) Coastal Meteorology  
 OC4270 (3-4) Tactical Oceanography  
 MR/OC3570 (2-4) Operational Oceanography and Meteorology  
 MR/OC0810 (0-8) Thesis Research

#### Quarter 8 (Spring)

NW3230 (4-2) Strategy and Policy  
 MR3262 (3-5) Operational Atmospheric Prediction/Laboratory  
 OC4213 or OC4220 (4-0) Nearshore & Wave Processes or Coastal Ocean Circulation  
 MR/OC0810 (0-8) Thesis Research

#### Quarter 9 (Summer)

MR/OCXXXX (4-0) Advanced MR or OC Elective  
 MR/OC0810 (0-8) Thesis Research  
 MR/OC0810 (0-8) Thesis Research  
 MR/OC0999 (2-0) Thesis Presentation

### Educational Skill Requirements (ESR) Meteorology & Oceanography (METOC) - Curriculum 373

#### Subspecialty Code: 6401P

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere, and a general understanding of numerical model and numerical model process.

2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.
3. The officer must have a thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval and Joint warfare as described in Joint Vision 2010 and amplified in Joint Vision 2020 and the Navy Vision of "Forward...from the Sea."
4. Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them.
5. The officer must have a thorough understanding of the fundamentals of Global Geospatial Information and Services (GI&S), precise time and time interval (PTTI) and astrometry.
6. The officer must successfully complete all NPS requirements for the Joint Master's Degree in Meteorology and Physical Oceanography.

### Operational Oceanography - Curriculum 374

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#### Brief Overview

This flexible oceanography curriculum involves approximately 100 quarter-hours of classroom lectures, supplemented by an additional 20 quarter-hours of laboratory exercises. This program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the oceans.
- An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational techniques, statistical analyses, and numerical models.
- An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor, and platform performance, while conducting and supporting naval warfare with particular emphasis on ocean acoustics.
- An educationally significant oceanographic experience at sea.
- An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.
- A knowledge of Joint Maritime Strategic Planning.

This curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for Joint PME (as established by the Chairman, Joint Chiefs of Staff) for Intermediate Level Professional Military Education.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base. It is a very flexible program allowing students to examine oceanographic topics relevant to their warfare specialization areas, such as antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare and special warfare. This program is open to Unrestricted Line Officers (1110, 1120, 1310, 1320), officers from other services, International Officers and DoD civilians.

**Requirements for Entry**

A baccalaureate degree in the physical sciences, mathematics or engineering is desirable. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is offered in the Spring or Fall quarter prior to 374 enrollment.

**Entry Date**

Operational Oceanography is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

**Degree**

Master of Science in Physical Oceanography.

**Subspecialty**

Completion of this curriculum qualifies an officer as an Operational Oceanography Subspecialist with a subspecialty code of 6402P. The curriculum sponsor is the Oceanographer of the Navy (CNO N7C).

**Typical Subspecialty Jobs**

- CV ASW Module
- CARGRU Staff
- ASW Operations Center
- Navy Laboratories
- Office of Naval Research
- Patrol Wing Detachments
- Naval Academy Instructor
- NIMA
- Naval Oceanographic Office

**Typical Course of Study - Winter**

**Quarter 1 (Winter)**

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

**Quarter 2 (Spring)**

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
NW3230	(4-2)	Strategy and Policy
NW3285	(3-0)	National Strategy Decision Making

**Quarter 3 (Summer)**

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3240	(4-2)	Ocean Circulation Analysis
NW3275	(2-0)	Joint Maritime Operations (Part 1)
OC3260	(4-0)	Fundamentals of Ocean Acoustics

**Quarter 4 (Fall)**

OC3902	(3-2)	Fundamentals of GI&S
OC4211	(4-0)	Ocean Waves
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3276	(2-0)	Joint Maritime Operations (Part 2)

**Quarter 5 (Winter)**

OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4610	(2-2)	Wave and Surf Forecasting
OC4900	(V-0)	Directed Study in Oceanography

**Quarter 6 (Spring)**

OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
OC0810	(0-8)	Thesis Research

**Quarter 7 (Summer)**

OC4270	(3-4)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC0810	(0-8)	Thesis Research

**Quarter 8 (Fall)**

OC4331	(4-0)	Ocean Variability
MR/OC4323	(4-0)	Numerical Modeling (or elective)
OC0810	(2-0)	Thesis Research
OC0999	(0-8)	Thesis Presentation

**Typical Course of Study - Summer Input****Quarter 1 (Summer)**

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

**Quarter 2 (Fall)**

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
NW3230	(4-2)	Strategy and Policy
NW3285	(3-0)	National Strategy Decision Making

**Quarter 3 (Winter)**

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3240	(4-2)	Ocean Circulation Analysis
NW3275	(2-0)	Joint Maritime Operations (Part 1)
OC3260	(4-0)	Fundamentals of Ocean Acoustics

**Quarter 4 (Spring)**

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
OC4211	(4-0)	Ocean Waves
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3276	(2-0)	Joint Maritime Operations (Part 2)

**Quarter 5 (Summer)**

OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC4900	(V-0)	Directed Study in Oceanography

**Quarter 6 (Fall)**

OC4331	(4-0)	Ocean Variability
MR/OC4323	(4-0)	Numerical Modeling (or elective)
OC3902	(3-2)	Fundamentals of GI&S
OC0810	(0-8)	Thesis Research

**Quarter 7 (Winter)**

OC4270	(3-4)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
OC4610	(2-2)	Wave and Surf Forecasting
OC0810	(0-8)	Thesis Research

**Quarter 8 (Spring)**

OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes
OC0810	(2-0)	Thesis Research
OC0999	(0-8)	Thesis Presentation

**Educational Skill Requirements (ESR)****Operational Oceanography- Curriculum 374  
Subspecialty Code: 6402P**

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere, and a general understanding of numerical model and numerical model process.
2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and littoral water conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.
3. The officer must have a thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor, and platform performance while conducting and

supporting Naval and Joint warfare as described in Joint Vision 2010 and amplified in Joint Vision 2020 and the Navy Vision of "Forward...from the Sea."

4. Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them.
5. The officer must successfully complete all NPS requirements for the master's degree in Physical Oceanography.

## Oceanography - Curriculum 440

### Program Officer

Denise Kruse, CDR, USN  
Code 75, Spanagel Hall, Room 304

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### Academic Associate

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### Brief Overview

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

- Interpret and predict oceanic and air-ocean interface conditions.
- Operate modern oceanographic data management, archival and communications systems.
- Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy-making positions. Students will develop a sound, graduate-level, technical ability based on scientific principles.

### Requirements for Entry

This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers as a Ph.D. program.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry, and is offered in the Spring or Fall quarter prior to 440 enrollment.

### Entry Date

Oceanography is a 6-8 quarter course of study with entry dates in January and July. If further information is needed, contact the Program Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

### Degree

Master of Science in Physical Oceanography.

### Typical Course of Study - Winter

#### Quarter 1 (Winter)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

#### Quarter 2 (Spring)

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
OC3902	(3-2)	Fundamental of GI&S (or Elective)
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes

#### Quarter 3 (Summer)

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3260	(4-0)	Fundamentals of Ocean Acoustics
OC3240	(4-2)	Ocean Circulation Analysis I

#### Quarter 4 (Fall)

OC4211	(4-0)	Ocean Waves
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MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
IT1600	(3-0)	Communication Skills for International Officers (or Elective)
IT1700	(2-0)	Academic Writing for International Officers (or Elective)

**Quarter 5 (Winter)**

OC4900	(V-0)	Directed Study in Oceanography
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
OC4610	(2-2)	Wave and Surf Forecasting

**Quarter 6 (Spring)**

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC0810	(4-0)	Thesis Research
OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes

**Quarter 7 (Summer)**

OC4271	(3-0)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research

**Quarter 8 (Fall)**

OC4331	(3-1)	Ocean Variability
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Presentation
OCXXXX	(4-0)	Elective

**Typical Course of Study - Summer****Quarter 1 (Summer)**

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1 <sup>st</sup> 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2 <sup>nd</sup> 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

**Quarter 2 (Fall)**

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
OC3902	(3-2)	Fundamental of GI&S (or Elective)
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes

**Quarter 3 (Winter)**

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I

**Quarter 4 (Spring)**

OC4211	(4-0)	Ocean Dynamics II
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
OC4220	(4-1)	Coastal Circulation
IT1600	(3-0)	Communication Skills for International Officers (or Elective)

**Quarter 5 (Summer)**

MR/OC4413	(4-0)	Air Sea Interaction
OC4900	(V-0)	Directed Study in Oceanography
OC4267	(4-0)	Ocean Acoustic Prediction
IT1700	(2-0)	Academic Writing for International Officers (or Elective)

**Quarter 6 (Fall)**

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC0810	(4-0)	Thesis Research
OC4331	(3-1)	Mesoscale Ocean Variability
OCXXXX	(4-0)	Elective

**Quarter 7 (Winter)**

OC0810	(0-8)	Thesis Research
OC4271	(3-0)	Tactical Oceanography
OC3570	(2-4)	Operational Oceanography and Meteorology
OC4610	(2-2)	Wave and Surf Forecasting

**Quarter 8 (Spring)**

OC4213	(3-1)	Nearshore and Wave Processes
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Presentation

**Educational Skill Requirements (ESR)  
Oceanography (Masters) - Curriculum 440  
Subspecialty Code: Not Applicable For MS Degree**

*Note – there is no p-code associated with this program, thus there are no official ESRs. This list describes the skills that this program will provide students upon successful completion of the program.*

This curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in

support of all aspects of at-sea operations. The graduate will be able to:

1. Interpret and predict oceanic and air-ocean interface conditions.
2. Operate modern oceanographic data management, archival and communications systems.
3. Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy-making positions. Students will develop a sound, graduate-level, technical ability based on scientific principles.

**Educational Skill Requirements (ESR)  
Oceanography (Ph.D.) - Curriculum 440  
Subspecialty Code: 6402D**

The officer must have a thorough theoretical and functional knowledge (obtained at the doctorate level) of the principles of oceanography and its effects on naval warfare and weapons systems.

## Department of Physics

### Chairman

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### Associate Chairman, Research

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**Robert Louis Armstead**, Associate Professor (1964)\*;  
Ph.D., University of California at Berkeley, 1964.

**Steven Richard Baker**, Associate Professor (1985);  
Ph.D., University of California at Los Angeles, 1985.

**Joseph Blau**, Research Assistant Professor (1989);  
Ph.D., Naval Postgraduate School, 2002.

**Brett Borden**, Associate Professor (2002); Ph.D.,  
University of Texas at Austin, 1986.

**Ronald E. Brown**, Research Professor (2002); Ph.D.,  
University of Southern California, 1972.

**William Boniface Colson**, Distinguished Professor  
(1989); Ph.D., Stanford University, 1977.

**Alfred William Madison Cooper**, Professor (1957);  
Ph.D., The Queen's University of Belfast, 1961.

**Peter P. Crooker**, Senior Lecturer (2001); Ph.D., Naval  
Postgraduate School, 1967.

**David Scott Davis**, Associate Professor (1989); Ph.D.,  
Purdue University, 1976.

**Bruce C. Denardo**, Associate Professor (1998); Ph.D.,  
University of California at Los Angeles, 1990.

**Nancy M. Haegel**, Professor (2003); Ph.D., University  
of California at Berkeley, 1985.

**Richard M. Harkins**, Senior Lecturer and Associate  
Chairman for Administration (2000); MS, Naval  
Postgraduate School, 1988.

**Daphne Kapolka**, Senior Lecturer (2000); Ph.D., Naval  
Postgraduate School, 1997.

**Gamani Karunasiri**, Associate Professor (2000); Ph.D.,  
University of Pittsburgh, 1984.

**Andres Larraza**, Associate Professor (1994); Ph.D.,  
University of California at Los Angeles, 1987.

**James H. Luscombe**, Professor and Chairman (1994);  
Ph.D., University of Chicago, 1983.

**William B. Maier II**, Senior Lecturer (1995); Ph.D.,  
University of Chicago, 1965.

**Xavier K. Maruyama**, Professor (1987); Ph.D.,  
Massachusetts Institute of Technology, 1971.

**Richard Christopher Olsen**, Associate Professor (1987);  
Ph.D., University of California at San Diego, 1980.

**Joseph A. Rice**, Research Chair of Engineering  
Acoustics (2000); MS, University of California at San  
Diego, 1990.

**Craig F. Smith**, LLNL Chair Professor (2004); Ph.D.,  
University of California at Los Angeles, 1975.

**Kevin B. Smith**, Associate Professor and Associate  
Chair for Research (1995); Ph.D., University of  
Miami, 1991.



**David M. Trask**, Col, USAF (Ret.), MASINT Chair (2001); M.B.A., Embry-Riddle University, 1991.

**Philip L. Walker**, Research Associate Professor (1988); Ph.D., University of California Riverside, 1976.

**Donald Lee Walters**, Professor (1983); Ph.D., Kansas State University, 1971.

#### **Professors Emeriti:**

**Fred Raymond Buskirk**, Professor Emeritus (1960); Ph.D., Case Institute of Technology, 1958.

**Eugene Crittenden**, Distinguished Professor Emeritus (1953); Ph.D., Cornell University, 1938.

**Harvey Dahl**, Professor Emeritus (1964); Ph.D., Stanford University, 1963.

**Harry Handler**, Professor Emeritus (1958); Ph.D., University of California at Los Angeles, 1955.

**Otto Heinz**, Professor Emeritus (1962); Ph.D., University of California at Berkeley, 1954.

**Herman Medwin**, Professor Emeritus (1955); Ph.D., University of California at Los Angeles, 1953.

**Richard Reinhardt**, Professor Emeritus (1954); Ph.D., University of California at Berkeley, 1947.

**Wayne Rodeback**, Professor Emeritus (1960); Ph.D., University of Illinois, 1951.

**James Vincent Sanders**, Professor Emeritus (1961); Ph.D., Cornell University, 1961.

**Gordon Everett Schacher**, Professor Emeritus (1964); Ph.D., Rutgers, 1961.

**Fred Schwirzke**, Emeritus Professor (1967); Ph.D., University of Karlsruhe, 1959.

**Oscar Bryan Wilson**, Professor Emeritus (1957); Ph.D., University of California at Los Angeles 1951.

**Karlheinz Edgar Woehler**, Professor Emeritus (1962); Ph.D., University of Munich, 1962.

\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Current expertise in the Department of Physics includes the following specializations:

#### **Specializations**

Optical and Electromagnetic Signal Propagation, Detection and Sensor Systems.

Conventional and Nuclear Weapons and their Effects. Underwater Acoustics.

Free-Electron Laser Physics.

Directed Energy Weapons Physics.

Physical Acoustics.

Condensed-Matter, Device and Sensor Physics.

All of these specializations are of relevance to modern and future weapons technologies. The faculty supports an ongoing research program in these areas and student thesis topics are available in all of them.

#### **Degree Requirements**

The Department of Physics offers the Master of Science and the Ph.D. degrees in Physics and in Applied Physics. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements to the extent allowed by the general Postgraduate School regulations.

#### **Degree**

A student is able to earn an academic degree listed below while enrolled in Combat Systems Science & Technology (Curriculum 533), and Space Systems Engineering (Curriculum 591).

#### **Master of Science in Physics**

A candidate for the Master of Science in Physics degree must satisfactorily complete a program of study that includes a minimum of 30 quarter-hours of physics courses (not including thesis) distributed among courses at the graduate (3000 or 4000) level; of these 30 hours at least 15 hours must be at the 4000 level. Upon approval of the Chairman of the Physics Department, a maximum of 4 hours of courses taken in another department may be applied toward satisfying the above requirements. In lieu of the preceding requirements, students who are qualified to pursue graduate courses in physics when they arrive at the Naval Postgraduate School may complete a minimum of 20 hours entirely of 4000 level physics courses. In addition, all students must satisfy the general Postgraduate School minimum requirements for the master's degree and present an acceptable thesis advised by a member of the Physics Department.

The following specific course requirements (or equivalent) must be successfully completed for a student to earn the Master of Science in Physics degree:

- |    |         |  |
|----|---------|--|
| 1. | PH3152: | Analytical Mechanics                         |
|    | PH3352: | Electromagnetic Waves                        |
|    | PH3991: | Theoretical Physics                          |
|    | PH3782: | Thermodynamics and Statistical Physics.      |
|    | PH4353: | Topics in Advanced Electricity and Magnetism |
|    | PH4656: | Quantum Mechanics                            |

2. In addition to the above, a graduate sequence containing at least two physics courses, at least one of which must be at the 4000 level.

All programs leading to the degree Master of Science in Physics must be approved by the Chairman of the Department of Physics.

### **Master of Science in Applied Physics**

To be awarded the Master of Science in Applied Physics degree, a student must complete a program that includes at least 20 quarter-hours of Physics courses at the graduate level, including 12 at the 4000 level. The total graduate hours in Physics, Mathematics, and Engineering must be at least 32, including 20 at the 4000 level.

The program must include at least one graduate level course in each of the following areas: mechanics, electromagnetism, and quantum physics. Students will demonstrate additional breadth by taking at least one 4000-level physics course outside their concentration area.

In addition to the above required courses, a student's program must include an area of concentration containing a four-course sequence of graduate-level courses, at least two at the 4000 level, in an area related to applied physics and approved by the Chairman of the Department of Physics. A list of courses and concentrations meeting the above requirements is available from the Chairman of the Physics Department.

All programs leading to the Master of Science in Applied Physics degree must satisfy the general Postgraduate School requirements for the master's degree, must include a thesis advised or co-advised by a member of the Physics Department, and must be approved by the Chairman of the Department of Physics.

### **Master of Science in Combat Systems Technology**

A candidate for the Master of Science in Combat Systems Technology degree must complete satisfactorily a program of study that includes a minimum of 32 quarter-hours of graduate work in Physics, Mathematics, and Engineering, with at least 18 quarter-hours at the 4000 level. Included in these hours must be at least 20 quarter-hours of graduate-level physics, including 12 quarter-hours at the 4000 level.

The program must include two approved sequences of courses related to combat systems technology. Each sequence must consist of at least four graduate-level courses with at least two courses at the 4000 level. A list of approved sequences is available from the Chairperson of the Department of Physics.

All programs leading to the Master of Science in Combat Systems Technology degree must satisfy the general Postgraduate School requirements for the master's degree, must include a thesis advised or co-advised by a member of the Physics Department, and must be approved by the Chairperson of the Physics Department.

### **Doctor of Philosophy**

The Department of Physics offers the Ph.D. in several areas of specialization which currently include acoustics, electro-optics, free electron lasers, space physics, and theoretical physics.

Requirements for the degree may be grouped into three categories: courses, dissertation research, and examinations.

The required examinations are outlined under the general school requirements for the Ph.D. In particular, the department requires a preliminary examination to show evidence of acceptability as a doctoral student. This examination may be taken before or after commencement of graduate studies at NPS.

The department offers two options for the Ph.D.: major in Physics or major in Applied Physics. For the major in Physics, a minimum of 40 credit hours of physics courses at the 4000 level is required. The major in Applied Physics also requires 40 credit hours of 4000 level courses, but a portion of these hours may be taken in other departments in technical subjects related to physics.

A more detailed description of departmental requirements for the Ph.D. is contained in the booklet "Doctoral Study in Physics or in Applied Physics at the Naval Postgraduate School," available from the Academic Associate.

An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, California 93943-5100.

### **Total Ship Systems Engineering Program**

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration

procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer Degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that may address system design issues are welcome.

### Physics Laboratories

The physics laboratories are equipped to carry on instruction and research work in acoustics, atomic and molecular physics, electro-optics, spectroscopy, laser physics, computational physics, optical propagation, and sensor physics.

**The Optical Physics and Sensors Laboratory** uses imaging, spectroscopic and sensing systems from far infrared to ultraviolet wavelengths, including instrumentation for seagoing, airborne and ground-based measurements.

**The Acoustics Laboratory** equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in acoustics in air. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the Underwater Acoustics Laboratory. Also available is scale-model shallow-water waveguide. The Physical Acoustics Laboratories are equipped with a variety of modern data collection and processing equipment.

**The Sensor Research Laboratory** is capable of design, packaging and characterization of optical and infrared detectors using I-V measurement, Fourier transform spectroscopy and variable temperature photocurrent spectroscopy. Facilities exist for advanced microcharacterization, including cathodoluminescence, EBIC, X-ray analysis, and transport imaging in a scanning electron microscope with variable temperature capability.

### Physics Course Descriptions

#### PC Courses

#### **PC2013 Introductory Applied Physics Laboratory (3-4) As Required**

This course is an introduction to basic electronic test instrumentation and basic passive and active circuit components, with emphasis on extensive, practical hands-on exposure to laboratory hardware and devices. Included are the measurement and signal processing of analog signals and analog sensors/transducers. Operational amplifiers are introduced as building blocks of analog systems. Passive LRC

filters and active filters are studied with an emphasis on applications. Some background in laboratory instrumentation and simple DC and AC circuit elements is assumed. Prerequisites: College-level basic physics and mathematics, plus simple electrical circuits (e.g., PH1322)

#### **PC2911 Introduction to Computational Physics (3-2) As Required**

An introduction to the role of computation in physics, with emphasis on the programming of current nonlinear physics problems. Assumes no prior programming experience. Includes a tutorial on the C programming language and Matlab, as well as an introduction to numerical integration methods. Computer graphics are used to present the results of physics simulations. Prerequisites: None.

#### **PC3014 Intermediate Applied Physics Laboratory (3-4) Spring/Fall**

This course continues with the instrumentation and signal processing topics begun in PC2013. Included are: controllable oscillators and RF modulation/demodulation techniques, basic electrical noise sources, device damage and failure modes, elementary digital logic gates and ICs. Also included are an overview of relevant microcomputer topics, such as digital encoding schemes, analog and digital interfacing, and serial communications and networking. At the discretion of the instructor, hands-on projects incorporating the course material may be assigned. Typical projects are: in-air sonar systems, radio receivers and transmitters, and opto-electronic communications links. Prerequisites: PC2013 and PC2911 or permission of instructor.

#### **PC3172 Physics of Weapons Systems: Fluid Dynamics of Weapons, Shock Waves, Explosions (4-2) As Required**

This course provides the basic physical principles applicable to air-borne and water-borne missiles, as well as the fluid dynamics of shocks and explosions. Topics include: Elements of thermodynamics, ideal fluid flow, elementary viscous flows, similitude and scaling laws, laminar and turbulent boundary layers, underwater vehicles, classical airfoil theory, supersonic flow, drag and lift of supersonic airfoils with applications to missiles, fluid dynamics of combustion, underwater explosions. Prerequisites: PH2151 and PH3991.

#### **PC3200 Physics of Electromagnetic Sensors and Photonic Devices (4-1) Spring/ Fall**

An introductory survey of the physics of active and passive electromagnetic detection systems, primarily for Combat Systems students who do not elect to follow the Electromagnetic Sensors specialization track. Basic radiometry. Introduction to radar: ranging, pulse rate and range ambiguity, Doppler measurements, radar equation, target cross-sections, antenna beam patterns and phased arrays. Optoelectronic displays: CRTs, LEDs, LCDs, plasma displays. Introduction to lasers: transitions, population inversion, gain, resonators, longitudinal and transverse resonator modes, Q-switching, mode-locking, laser applications. Photodetection basics: noise and its characterization, photovoltaic, photoconductive and photoemissive detectors, image intensifiers, CCDs, night vision systems. Introduction to optical fibers and their applications. Prerequisites: PH2652, PH3292 and PH3352, or equivalent(s), or by permission of instructor.

**PC3400 Survey of Underwater Acoustics (4-2) Spring/  
Fall**

The physics of the generation, propagation, and detection of sound in the ocean. Topics include the acoustic wave equation and its limitations in fluids; plane, cylindrical, and spherical waves; the ray approximation; reflection of plane waves from plane boundaries; radiation of sound from circular piston, continuous line source, and linear array; speed of sound and absorption in the ocean; active and passive sonar equations; transmission-loss and detection-threshold models; normal mode propagation in the ocean; the parabolic equation approximation. Laboratory experiments include surface interference, noise analysis, normal modes, and acoustic waveguides. Prerequisites: PH2151 and PH3991.

**PC3800 Survey of the Effects of Weapons (4-0)  
Summer, Winter**

Physics of high-velocity impact including the dynamical behavior of ductile and brittle materials and shock waves in solids. Physics of projectile penetration at high velocities. Shaped charges. Nuclear weapons effects including blast and shock thermal radiation, X-rays, neutron flux, electromagnetic pulse, and radioactive fallout. Biological and chemical weapons effects, deployment, detection and countermeasures. Directed energy weapons and effects. Prerequisites: PC3172 and PH2652.

**PC4015 Advanced Applied Physics Laboratory (3-4)  
Summer/ Winter**

Students must integrate the material that they learned in the previous two courses (PC2013 and PC3014), along with additional material on embedded microprocessors and controls. A working introduction to control systems theory is provided and incorporated into an autonomous weapon system or "robot." Collaborative and autonomous engagement of the robots will be performed with RF modems and Ethernet communications. The principles of cooperative engagement will be emphasized. For the final exam, teams will compete in 2-on-1 or 2-on-2 engagement contests. These contests will test the students' assimilation of both the formal and the practical aspects of the course material. Prerequisites: PC2911 or other C/C++ programming course, plus PC2013 and PC3014.

**PC4022 Combat Systems Capabilities (3-0) Spring**

An advanced study of the technical capabilities of current acquisition programs within DoD. The course begins with an overview of the Navy acquisition community and the acquisition process. This is followed by weekly presentations by program managers and their technical experts. Overviews of each program are followed by an in-depth analysis of the critical physics and engineering issues, design trade-offs, risk areas, reliability issues, use of simulation and modeling, testing and evaluation rationale, interoperability concerns, software development issues, interfacing issues, etc. Topics of the course are dictated by the availability of program office personnel. Prerequisites: None. Classification: SECRET.

**PC4862 Advanced Weapon Concepts (4-1) Spring/Fall**

This course is a comprehensive overview of the components and underlying technologies of modern missile technologies. The course gives an introduction to missile guidance, missile aerodynamic design considerations, and missile propulsion technologies, followed by an introduction to the physics of modern conventional warhead designs for missile intercept

and lethality and survivability considerations. Prerequisites: PC3172 and good comprehension of all aspects of mechanics and electromagnetics.

*PH Courses***PH0810 Thesis Research (0-8)  
Spring/Summer/Fall/Winter**

Every student conducting thesis research will enroll in this course.

**PH0820 Integrating Project (0-12) Spring/Winter**

The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration. This course is available to students in the Combat Systems Science and Technology Curriculum who are participating in a campus-wide integrated project. Prerequisites: Consent of instructor.

**PH0999 Physics Colloquium (No Credit) (0-1)  
Spring/Summer/Fall/Winter**

Discussion of topics of current interest by NPS and outside guest speakers.

**PH1000 The Nature and Structure of Physics (4-2) As  
Required**

The concepts and laws of physics are explored from the ancient science of Aristotle and Ptolemy through the beginnings of classical physics with Galileo and Newton through the modern quantum and relativity physics of Schrodinger and Einstein to the physics of quarks and neutrino oscillations. Physics concepts are explored and their relevance to every day and military technologies is highlighted. The course is designed for students who will not take a physics based curriculum, but will encounter technologies impacted by physical concepts. The goal in this course is to convey an appreciation for physics as an intellectual endeavor and an understanding of the principles underlying modern technology. Prerequisites: None.

**PH1001 Fundamentals of Physics I (4-2) As Required**

This course meets for twelve hours per week for the first five and one-half weeks of the quarter. Topics covered are the fundamentals of calculus-based mechanics: Kinematics and dynamics of particles, statics of rigid bodies, work, energy, systems of particles, collisions, rotations of rigid bodies, angular momentum and torque, mechanical properties of solids, elasticity, harmonic motion, sound, fluids. Mathematical methods are reviewed as required. Prerequisites: Calculus with a passing grade.

**PH1002 Fundamentals of Physics II (4-2) As Required**

This course meets for twelve hours per week for the second five and one-half weeks of the quarter and covers electromagnetism: electric charge, electric and magnetic fields, forces on charges in fields, electric potential, Gauss' law, Ampere's law, Faraday's law, resistance, capacitance, inductance, DC circuits, magnetic properties of matter, transient currents in circuits, complex AC circuits analysis, Maxwell's equations. Mathematical methods are reviewed as required. Prerequisites: PH1001 or equivalent.

**PH1121 Mechanics (4-2) Summer/Winter**

This course covers the fundamentals of calculus-based mechanics: Kinematics and dynamics of particles, statics of rigid bodies, work, energy, systems of particles, collisions, rotations of rigid bodies, angular momentum and torque, mechanical properties of solids, elasticity, harmonic motion, fluids. Prerequisites: A course in calculus or concurrent registration in a calculus course and consent of instructor.

**PH1322 Electromagnetism (4-2) Spring/Fall**

Basic electromagnetism: electric charge, electric and magnetic fields, forces on charges in fields, electric potential, Gauss's law, Ampere's law, Faraday's law, resistance, capacitance, inductance, DC and AC circuits, magnetic properties of matter, transient currents in circuits, Maxwell's equations, electromagnetic waves. Prerequisites: PH1121 or consent of instructor.

**PH1623 Thermodynamics and Wave Phenomena (4-2) As Required**

An introduction to thermodynamics and wave phenomena. The Laws of Thermodynamics, calorimetry, thermal effects, kinetic theory of gases, heat transfer, the Carnot cycle, heat engine and refrigerator efficiency are studied followed by the general properties of wave phenomena, vibrations, acoustics, and geometrical and physical optics. Prerequisites: PH1121, PH1322 or consent of instructor.

**PH1992-1998 Special Topics in Elementary Physics (V-0) As Required**

Study in one of the fields of elementary physics selected to meet the needs of students without sufficient undergraduate physics to meet the prerequisites of their curriculum. The course may be conducted either as a lecture course or as supervised reading. Prerequisites: Consent of the Department Chairman.

**PH2001 Research Seminar in Physics (1-0) Spring/Fall**

This course will present the research expertise of the physics faculty. The course is designed to support Combat Systems Science and Technology students in their second quarter in the selection of their concentration and area for thesis research. The course is given in the Pass/Fail mode. Prerequisites: CSS&T students in their second quarter or consent of the Academic Associate.

**PH2151 Particle Mechanics (4-1) Spring**

After a review of the fundamental concepts of kinematics and dynamics, this course concentrates on those two areas of dynamics of simple bodies which are most relevant to applications in Combat Systems: vibrations and projectile motion. Topics include: damped and driven oscillations, projectile motion with atmospheric friction, satellite orbits, and rotating coordinate systems. Prerequisites: PH1121 or equivalent; MA2121 or equivalent course in ordinary differential equations (may be taken concurrently).

**PH2203 Topics in Basic Physics: Waves and Optics (4-0) Fall**

A course to provide the physical background to wave motion and optics for students in the Information Warfare and Electronic Warfare curricula, and to provide applications of analytical techniques to physical problems. Areas covered are harmonic motion— differential equations, complex notation, damped vibration and resonance; wave motion—properties of

waves, electromagnetic waves, light waves; geometrical and wave optics. Prerequisites: MA1115, MA1116, MA2121.

**PH2351 Electromagnetism (4-1) Summer/Winter**

Electrostatic fields in vacuum and dielectrics, electrostatic energy and capacitors. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Faraday's law. Magnetic energy. Maxwell's Equations. Prerequisites: PH1322, MA1116, MA2121.

**PH2401 Introduction to the Sonar Equations (3-0) Spring/Fall**

A discussion of each term of the sonar equations, with application to the detection, localization, and classification of underwater vehicles. Topics include ray acoustics, simple transmission loss models, tonals, spectrum and band levels, directivity index, array gain, doppler shift, and detection threshold. This course can be taken on-line as part of the ASW Certificate program. Prerequisites: Precalculus mathematics.

**PH2514 Introduction to the Space Environment (4-0) As Required**

Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field, and the magnetosphere, radiation belts, structure and properties of the earth's upper atmosphere, ionosphere, implications of environmental factors for spacecraft design. Prerequisites: A course in basic electricity and magnetism.

**PH2652 Modern Physics (4-1) Spring/Fall**

An introduction to modern physics. Theory of relativity; blackbody radiation; photoelectric effect; matter waves; atomic spectral lines; Bohr model of the atom; uncertainty relations (position-momentum and time-energy); the Schrödinger equation (time dependent and independent); probability interpretation; infinite, finite and parabolic potential wells; tunneling (single and double barriers); electron spin and exclusion principle; the periodic table; molecular energy levels; quantum statistics (Bose-Einstein, Fermi-Dirac). Prerequisites: PH1623.

**PH2724 Thermodynamics (4-0) Spring/Fall**

Equations of state; the concepts of temperature, heat and work; the first law of thermodynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. Prerequisites: PH1121, PH1322, MA1116.

**PH3002 Non-Acoustic Sensor Systems (4-0) Summer/Winter**

This course covers the physical principles underlying the operation of a number of operational and proposed non-acoustic sensor systems. Geomagnetism, magnetometers and gradiometers, MAD signatures, optical and IR transmission in the atmosphere and in sea water. Image Converter, FLIR and radar systems for USW. Exotic detection schemes. Prerequisites: PH1322.

**PH3052 Physics of Space and Airborne Sensor Systems (4-0) As Required**

This inter-disciplinary course explores the physical principles underlying the sensor systems needed for satellites and tactical aircraft, as well as limitations imposed by the atmosphere and

operating environment on these systems and their communication links. Topics include: satellite orbits, the satellite environment, ionospheric interactions and atmospheric propagation, phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars, noise resources, thermal radiation, principles of semiconductor devices, optical and infrared imaging detector systems, and their resolution limitations and bandwidth requirements. Prerequisites: Basic physics class. Must be familiar with the concepts of energy and wave motion.

#### **PH3119 Oscillation and Waves (4-2) Summer**

An introductory course designed to present mechanics to students studying acoustics. Kinematics, dynamics, and work and energy consideration for the free, damped, and driven oscillators. The wave equation for transverse vibration of a string, ideal and realistic boundary conditions, and normal modes. Longitudinal and transverse waves in bars. Transverse waves on rectangular and circular membranes. Vibrations of plates. Laboratory periods include problem sessions and experiments on introduction to experimental techniques and handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal, and torsional waves on a bar. Prerequisites: PH3991 or equivalent.

#### **PH3152 Analytical Mechanics (4-0) Summer/Winter**

Dynamics of systems of particles, including rockets. Hamilton's principle, Lagrangian dynamics, and the role of physical symmetry. Velocity-dependent potentials. The inertia tensor and rotational dynamics of rigid bodies. Small-amplitude oscillations of systems of particles, and normal modes. Prerequisites: PH2151.

#### **PH3204 Electro-Optic Systems and Countermeasures (3-2) As Required**

This course is designed to provide students in the Information Warfare Curriculum with an understanding of the principles and capabilities of military electro-optic and infrared systems. Topics treated include: Target signatures and backgrounds, laser radiation characteristics, CCD, CID and FLIR,IRST Irlinescan and staring sensors; sensor performance parameters. Laboratory work provides hands-on familiarity with modern infrared devices. Prerequisites: PH2203, MA3139 or equivalent.

#### **PH3280 Introduction to MEMS Design (3-3) As Required**

This is a 4.5 credit hour class introducing the students to Micro Electro Mechanical Systems (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals. Surface, bulk and non-silicon micromachining. Forces and transduction; forces in micro-nano-domains and actuation techniques. Case studies of MEMS based microsensor, microactuator and microfluidic devices. The laboratory work includes computer aided design (CAD) of MEMS devices and small group design project. Prerequisites: basic understanding of electrical and mechanical structures: EC2200 or MS2201 or PH1322 or consent of instructor.

#### **PH3292 Applied Optics (4-2) Spring/Fall**

An intermediate-level course in optics. Review of basic geometric and physical optics concepts. Laws of reflection and refraction at interfaces. Imaging systems and aberrations. Polarization; Jones matrix methods; electro-optical

modulation. Matrix methods for paraxial ray tracing and optical systems analysis. Two-beam and multiple-beam interference; Young's double slit experiment, multiple-slit systems and diffraction gratings; Michelson's interferometer; Fabry-Perot interferometer. Huygens-Fresnel principle; Fraunhofer diffraction; Fresnel diffraction. Prerequisites: PH3352.

#### **PH3352 Electromagnetic Waves (4-0) Spring/Fall**

Maxwell's equations, energy density and Poynting vector, boundary conditions. Polarization. Propagation of uniform plane waves in vacuum, dielectrics, conducting media (with emphasis on sea water) and low-density neutral plasmas. Reflection and refraction at plane dielectric and conducting boundaries, at normal and oblique incidence. Rectangular waveguides. Prerequisites: PH2351.

#### **PH3360 Electromagnetic Wave Propagation (4-1) Fall/Winter**

Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, in dielectrics and conductors, and in the ionosphere. Reflection and refraction at the interface between media. Guided waves. Radiation from a dipole. Prerequisites: MA2121 and a course in basic electricity and magnetism.

#### **PH3451 Fundamental Acoustics (4-2) Fall**

Development of, and solutions to, the acoustic wave equation in fluids; propagation of plane, spherical and cylindrical waves in fluids; sound pressure level, intensity, and specific acoustic impedance; normal and oblique incidence reflection and transmission from plane boundaries; transmission through a layer; image theory and surface interference; sound absorption and dispersion for classical and relaxing fluids; acoustic behavior of sources and arrays, acoustical reciprocity, continuous line source, plane circular piston, radiation impedance, and the steered line array; transducer properties, sensitivities, and calibration. Laboratory experiments include longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, three-element array, speed of sound in water, and absorption in gases. Prerequisites: PH3119 and PH3991 or equivalent.

#### **PH3452 Underwater Acoustics (4-2) Winter**

This course is a continuation of PH3451. Lumped acoustic elements and the resonant bubble; introduction to simple transducers; normal modes in rectangular and cylindrical enclosures; steady-state response of acoustic waveguides of constant cross section, propagating evanescent modes, and group and phase speeds; transmission of sound in the ocean, the Eikonal Equation and necessary space conditions for ray theory, and refraction and ray diagrams; sound propagation in the mixed layer, the convergence zone, and the deep sound channel; passive sonar equation, ambient noise and doppler effect and bandwidth considerations; active sonar equations, target strength and reverberation. Laboratory experiments include Helmholtz resonators, normal modes in rectangular, cylindrical, and spherical enclosures, water-filled waveguide, noise analysis, impedance of a loudspeaker. Prerequisites: PH3451.

#### **PH3458 Noise, Shock and Vibration Control (4-2) As Required**

The application of the principles of acoustics and mechanics to the problems of controlling noise, vibration and mechanical

shock. Topics include linear mechanical vibrations; introduction to vibrations of nonlinear systems; damping mechanisms; vibration and shock isolation; noise generation and control; effects of noise on man; application to problems of naval interest, such as ship quieting and industrial noise control. Prerequisites: A course in acoustics.

**PH3479 Physics of Underwater Weapons (4-0) Spring**

Navier-Stokes Equations and their exact solutions; Reynolds and other numbers and dynamic similarity. Incompressible inviscid hydrodynamics including flow about a circular cylinder and airfoil theory. Prandtl's boundary layer theory: the laminar boundary layer on a flat plate; effects of pressure gradients; separation of a laminar boundary; streamline bodies. Hydrodynamics stability and transition to a turbulent boundary layer; velocity profile in the turbulent boundary layer; drag on a flat plate. Blunt bodies. Drag reduction. Supercavitation. Torpedoes: drag and lift; dynamics of a straight-running torpedo; power plants; propulsors. Review of thermodynamics. Subsonic and supersonic flows. The converging-diverging nozzle. Shock waves: Rankine-Hugoniot equations; stationary normal shocks in air and water. Underwater explosions: detonation; scaling laws for the shock wave; the bubble and its interaction with surfaces. Shaped charges. Prerequisite: MA3139 or equivalent.

**PH3655 Semiconductor Device Physics (4-0) Spring/Fall**

Formation of solids, crystal structure of semiconductors, X-ray diffraction, lattice vibrations, defects, electrical and thermal properties, free electron model, Seebeck effect, thermionic emission, photoemission, effects of periodic potential, formation of energy bands, E-k relation, band structure of Si and GaAs, electrons and holes, doping and impurity levels, mobility, diffusion, continuity equation, Schottky and ohmic contacts, optical properties, Formation of p-n junction, I-V characteristics, bipolar and field effect transistors, fabrication technology, semiconductor alloys, quantum effect devices, fundamental limits to semiconductor device technology. Prerequisites: PH2652.

**PH3782 Thermodynamics and Statistical Physics (4-0) As Required**

Entropy, temperature, Boltzmann factor and Gibbs factor are developed from a quantum point of view. Blackbody radiation, chemical potential, partition function, Gibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerate systems; Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. Prerequisites: PH2724 and PH2652.

**PH3855 Nuclear Physics (4-0) As Required**

This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes, and interaction of high energy particles with matter. Prerequisites: PH3152, PH3360, and PH2652 or equivalents.

**PH3991 Theoretical Physics (4-1) Spring/Fall**

Discussion of heat flow, electromagnetic waves, elastic waves, and quantum-mechanical waves; applications of orthogonal functions to electromagnetic multipoles, angular momentum in quantum mechanics, and to normal modes on acoustic and

electromagnetic systems. Applications of complex analysis to Green Function in quantum mechanics and electromagnetism. Application of Fourier series and transforms to resonant systems. Applications of partial differential equation techniques to equation of physics. Prerequisites: Basic physics, multivariable calculus, vector analysis, Fourier series, complex numbers, and ordinary differential equations.

**PH3992-3998 Special Topics in Intermediate Physics (Variable Hours 1-0 to 4-0.) (V-0) As Required**

Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading in different topics. Prerequisites: A 2000 level course appropriate to the subject to be studied, and consent of the Department Chairman. The course may also be taken on a Pass/Fail basis, provided the student has requested so at the time of enrollment.

**PH4001 Physics Thesis Presentation (1-0) As Required**

This course provides students with the opportunity to develop the ability to deliver a briefing on a technical subject by presenting their thesis to other students and faculty. This course is required of all students working for a degree from the Physics Department and of all Combat Systems students not presenting their thesis in some other department. Prerequisites: At least two quarters of thesis research.

**PH4055 Free Electron Laser Physics (3-0) As Required**

The physical principles describing free electron lasers are explained with applications to ship defense from sea-skimming missiles, and to new radiation sources for scientific research. Theory is applied to experimental facilities around the world. Topics include optical resonator design, general laser concepts, laser beam propagation, relativistic electron dynamics, phase-space analysis, and numerical simulation. Prerequisites: PH4353, E&M.

**PH4056 Radiofrequency Weapons, High Power Microwaves, and Ultrawide Band Systems (4-0) As Required**

This course outlines High-Power Microwave (HPM) and radiofrequency (RF) weapons technology, design, and progress including sources, systems integration, and effects of these emerging capabilities at the SECRET/U.S. ONLY level. Definitions and terminology, and calculations concerning the effects upon electronics, such as burnout and upset; narrowband and wideband modulation; and RF radiation, propagation, and coupling will be presented. The generation of high-power electromagnetic fields in compact sources, testing, EMI/EMC fratricide/suicide issues, and transition to employment as operational systems in a variety of applications will be described. Intelligence concerning the growing RF weapons threat is analyzed with particular attention paid to IW, terrorism, and asymmetrical threat aspects of these developments. Prerequisites: PH3352, EC3600, or EO3602. Classification: SECRET/U.S. only.

**PH4153 Advanced Classical Mechanics I (4-1) As Required**

The first course in a two-course sequence covering classical mechanics at the advanced graduate level. Newtonian mechanics of single-particle and two-body central force systems, including orbital motion and scattering. Constraints,

Lagrangian dynamics and generalized coordinates. Euler's formulation of rigid body mechanics. Small oscillations and systems of coupled oscillators. Prerequisites: PH3152 and PH3991 or equivalents.

**PH4154 Advanced Classical Mechanics II (4-1) As Required**

The second course in a two-course sequence covering classical mechanics at the advanced graduate level. Kinematics and dynamics of relativistic systems from the Lagrangian perspective. Hamilton's equations of motion and conservation laws. Poisson brackets and commutation. Hamilton-Jacobi formulation of mechanics and action-angle variables. Introduction to nonlinear dynamics and chaotic systems. Introduction to classical perturbation theory. Prerequisites: PH4153 or equivalent.

**PH4162 Mechanics of Continua (3-0) As Required**

The foundations of fluid mechanics presented in the tensor formulation. Scalars, vectors, and tensors; tensor differential and integral calculus; the stress tensor and rate of deformation tensor; principal values, deviators, and other invariants; fundamental laws: conservation of mass, linear momentum, angular momentum, and energy; constitutive equations; non-Newtonian fluids; Visco-Plastic materials. Prerequisites: PC3172 or equivalent.

**PH4171 Physics of Explosives (4-0) Summer**

The goals of the course are to provide in-depth and advanced understanding of explosives from theoretical and practical standpoints, to formulate the bases for evaluating competitive and alternative explosive systems, and to provide criteria for crisis management. This course covers advanced topics in explosive physics and chemistry: Molecular energetics of the explosive molecule including molecular orbital and valence bonding and resonance stabilization concepts and practical implications of sensitivity and energy potential, oxygen balance and thermodynamic, reaction rate theory, hot-spot theory, shock physics and detonation theory. Special topics in explosive technology and application as applied to metal driving, mine detection and neutralization, chemical and biological dissemination, and computational modeling are offered per student's interests. Prerequisites: PC3172 and PH2652.

**PH4209 EO/IR Systems and Countermeasures (3-2) As Required**

This unclassified course for students in interdisciplinary curricula treats the military applications of countermeasures to electro-optic systems, including IR and EO seekers and trackers, surveillance and missile and laser warning systems, and laser rangefinders and designators. Scanning FLIR andIRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approaches will be discussed including decoys and active IRCM. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. Prerequisites: PH3204, MA3139, or equivalent.

**PH4253 Sensors, Signals, and Systems (4-2) Spring**

This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals in the EO/IR range. Topics included are: optical modulation, nonlinear optics, acousto-optics; atmospheric molecular absorption characteristics and mechanisms of

detectors for optical and infrared radiation, noise in detectors, cooling systems; image intensifiers, television and FLIR systems; detecting, tracking and homing systems; signal sources, target signatures and backgrounds; laser target designators, laser radars, the range equation. The laboratory will include experiments related to this material as well as to that of the preceding course, PH3252. Prerequisites: PH2652, PH3292, and PH3352 or equivalent.

**PH4254 Thermal Imaging and Surveillance Systems (4-0) As Required**

This course is intended as a capstone course on EO/IR systems for the Combat Systems Science and Technology Curriculum, or the Electronic Warfare Systems Technology curriculum. It addresses the system analysis and technology of infrared imaging (FLIR) and search/track systems (IRST), including the derivation of system performance measures such as Minimum Detectable Temperature Difference (MDT), and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display, and human operator characteristics. Operational Performance Prediction codes and Tactical Decision Aids (TDAs) will be analyzed for current and developmental Forward Looking InfraRed (FLIR) Systems, and comparable codes for IRSTs discussed. Criteria for target detection and transference of contrast will be compared. Integrated Focal Plane Array Technology will be explored for application to second/third generation FLIR and Staring Imager development. Prerequisites: PH4253 or PH4209 or consent of instructor.

**PH4271 Lasers, Optoelectronics and Electro-Optics I (4-1) Fall**

The first course in a comprehensive two-course sequence covering the physics of lasers, optoelectronic and electro-optical devices. Review of Atomic and molecular energy levels, time-dependent perturbation theory, radiative transitions, transition rates. Einstein A and B coefficients for spontaneous and stimulated radiative transitions, blackbody radiation. Optical attenuation and amplification, rate equations. Basic laser theory, gain saturation, homogeneous and inhomogeneous effects. Optical resonators, laser modes, coherence. Q-switching, mode locking, pulse compression, laser pumping and tuning mechanisms. Gaussian beams. Introduction to multiple-mode and single mode optical fibers. Prerequisites: PH3292, PH3352, PH2652, or equivalent(s).

**PH4272 Lasers, Optoelectronics and Electro-Optics II (4-1) Summer**

The second course in a two-course sequence covering the physics of lasers, optoelectronic and electro-optical devices. Physics of optoelectronic detection, noise, detector figures-of-merit. Photovoltaic, photoconductive, bolometric and charge-coupled (CCD) detector families. 1-D and 2-D (focal-pave array) detectors. Image intensifiers and night vision systems. Gaussian beams. Physics of optical fibers and their practical applications. Optical properties of anisotropic media and their applications, electro-optical effects and modulators. Introduction to nonlinear optics, optical harmonic generation, parametric amplification and optical heterodyning. Prerequisites: PH3292, PH3352 and PH2652, or equivalent(s).



**PH4273 Physics of Advanced Imaging Systems (4-2)****Fall**

A course in the physical optics of advanced imaging techniques. Introduction to Fourier optics, spatial frequency, sampling, and transfer function concepts. Beam diffraction from the linear systems/Fourier transform perspective: beam patterns, phased arrays, beam forming and beam steering. Wavefront coherence and its characterization. Optical transfer functions, modulation transfer functions and diffraction limited resolution of optical and RF systems. Performance characterization of imaging systems: NEP, NEFD, MDFD, and MDTD. Introduction to optical information processing: spatial light modulators, optical correlation and pattern recognition, optical tracking. Introduction to atmospheric turbulence and its effects on beam propagation. Introduction to adaptive optics. Prerequisites: PH3292 or equivalent; PH4272 is recommended as a concurrent course.

**PH4274 Physics of Active Electromagnetic Detection and Engagement (4-1) Summer**

A course in the physics of radar and high-power RF/microwave systems. Radiometry and the propagation of electromagnetic energy. Radar equation and its relationship to radiometry. Noise and minimum detection threshold criteria. Range gating, scanning and range ambiguity. Target cross-section and polarization effects. Doppler techniques. Correlation analysis of signals and signal coherence. Synthetic aperture methods. Absorption and scattering of RF/microwave beams by the atmosphere. Modulation and demodulation techniques, pulse compression, chirping and signal recovery. Ultra-wideband and monopulse radars. Tracking and jamming. Propagation of high-power beams and thermal blooming/defocusing in the atmosphere. Introduction to RF/microwave weapons and their effects. Prerequisites: PH2351 and PH3292.

**PH4280 Micro Electro Mechanical Systems (MEMS) Design II (2-4) As Required**

This is the second course in Micro Electro Mechanical Systems (MEMS) Design. This course will expose students to advanced topics on material considerations for MEMS, microfabrication techniques, forces in the micro- and nano-domains, and circuits and systems issues. Case studies of MEMS-based microsensors, microactuators, and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) and characterization of existing MEMS devices. The grades will be based on exams, lab projects, and a group design project. Prerequisites: ME/EC/PH3280 or ME3780 or consent of instructor.

**PH4353 Topics in Advanced Electricity and Magnetism (4-0) As Required**

Topics selected from: Electromagnetic radiation, including radiation from antennas and accelerating particles, and radiation scattering from charged particles. Additional topics may include Cerenkov radiation, free electron lasers, and the relativistic formulation of electrodynamics. Prerequisites: PH3152, PH3352 and PH3991.

**PH4354 Advanced Electromagnetic Radiation (4-0) As Required**

This course gives an in-depth coverage of scattering of electromagnetic radiation in the microwave to optical region, from randomly distributed scatterers in the atmosphere and the propagation of optical radiation in turbulent randomly

fluctuating atmosphere, which has a most significant application in the high energy laser weapon program. Prerequisites: PH3352, PH3991.

**PH4371 Classical Electrodynamics (3-0) Spring**

Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. Prerequisites: PH4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

**PH4410 Advanced Acoustics Laboratory (1-6) As Required**

Advanced laboratory projects in acoustics. Through the performance of experiments drawn from diverse fields of acoustics, the student is introduced to the problems and opportunities of acoustics research. For each experiment, the student is guided through the scientific literature on the subject, the construction of the equipment, the collection and analysis of the data, and the writing of a research report. Prerequisites: PH3451.

**PH4453 Scattering and Fluctuation of Sound in the Ocean (4-0) As Required**

An advanced treatment of the effects of variations of the ocean and its boundaries on ocean noise and the scattering and fluctuation of sound. Topics include: multiple radiation fields and noise sources in the sea, coherence and incoherence, probability density functions, the Hemholtz integral and general scattering formalism, scattering from objects, correlations and frequency spectra of sound scattered from rough boundaries, fluctuations associated with variability in the medium. Prerequisites: PH3452 or consent of instructor.

**PH4454 Sonar Transducer Theory and Design (4-2) Winter**

A treatment of the fundamental phenomena basic to the design of sonar transducers, specific examples of their application and design exercises. Topics include piezoelectric, magnetostrictive and hydro mechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical navy transducers, and a design project. A field trip to visit one or more transducer manufacturers is normally scheduled during the course. Prerequisites: PH3452 (may be taken concurrently).

**PH4455 Sound Propagation in the Ocean (4-0) Spring**

An advanced treatment of the subject. Topics include: reflection of spherical waves from ocean boundaries; normal mode propagation of sound; inhomogeneous wave equation and the point source in cylindrical coordinates; shallow water channel with fluid and solid bottoms; the deep sound channel and the WKB approximation; range-dependent channels; adiabatic normal modes and the parabolic equation; multi-path propagation; application to matched field processing and source localization. Prerequisites: PH3452 or consent of instructor.

**PH4459 Shock Waves and High-Intensity Sound (3-0) As Required**

Nonlinear oscillations and waves on strings; the nonlinear acoustic wave equation and its solution; the parametric array; the physics of shock waves in air and in water. Prerequisites: PH3451.

**PH4656 Quantum Mechanics (4-1) Summer/ Winter**

Free particles and wave packets, the uncertainty principle, Schrodinger equation, eigenstates and eigen functions, stationary and scattering states, identical particles and the exclusion principle, atomic energy levels, quantum theory of angular momentum, hydrogen atom, coupling of angular momentum with spin, the periodic table, nuclear structure and radioactivity; fission and fusion, time independent perturbation theory, time dependent perturbation theory; selection rules for dipole radiation, magnetic effects (MRI, GMR etc.), quantum computing. Prerequisites: PH2652, PH3152, PH3991.

**PH4661 Plasma Physics I (4-0) Summer**

Introduction to plasma physics; single particle dynamics (orbit theory), MHD fluid theory, electromagnetic waves, instability, diffusion, and breakdown in gases. Prerequisites: PH3352 or equivalent.

**PH4662 Plasma Physics II (3-0) As Required**

A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma; classification of plasma instabilities; kinetic theory, the Boltzmann equation and the macroscopic-momentum transport equation; plasma oscillations and Landau damping; nonlinear effects, shock waves, radiations from plasma, sheath theory. Prerequisites: PH4661 or consent of instructor.

**PH4760 Solid State Physics (4-0) Spring**

Fundamental theory dealing with solids: crystals, binding energy, lattice vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semi-conductors and insulators, magnetism. Prerequisites: PH3655, PH3782.

**PH4771 Advanced Statistical Physics (3-0) As Required**

Kinetic theory and the Boltzmann theorem, configuration and phase space, the Liouville theorem, ensemble theory, microcanonical, canonical and grand canonical ensembles, quantum statistics; applications to molecules, Bose-Einstein gases, Fermi-Dirac liquids and irreversible processes. Prerequisites: PH3782.

**PH4857 Physics of High Velocity Impact, Weapon Lethality, and Survivability (4-0) Summer**

This course is the first of a two course sequence on the physics and systems engineering concepts underlying weapon systems and weapon systems integration. Topics include: basics of stress-strain relations in various materials; elastic-plastic waves and shocks in solid materials; explosively driven fragments and materials; physics of fragment and rod-like penetration into solid targets; kill mechanisms; vulnerability, survivability and kill probability considerations; and basics of warhead design. Prerequisites: PC3172, PH3352, PH2151.

**PH4858 Electric Ship Weapon Systems (4-2) Fall**

This is the second of a two course sequence on the physics and systems engineering concepts underlying weapon systems and weapon systems integration. Topics include: the basic laser range equation and estimate of kill requirements; candidate laser systems for weapons applications; laser propagation effects from absorption, turbulence and blooming; laser target interaction by melting and by impulse; high power microwave principles and applications; and railgun theory and critical

issues-power conditioning, barrel design and life, projectile design, cooling. Prerequisites: PH3352.

**PH4911 Simulation of Physical and Weapon Systems (3-2) Winter**

The role of computation physics in modern weapons development and combat simulations is studied. The programming language is C within the UNIX, Apple, or Windows operating systems. Applications emphasize physical principles of weapons development, systems engineering, and the use of graphics. Subject matter includes random number distributions, projectile and fragment dispersion, missile defense, free electron laser simulation, laser beam propagation in a turbulent atmosphere, thermal blooming, diffraction and numerical integration methods. Optional topics include molecular dynamics in solids, liquids, and gases, wave propagation in various media, chaos, and quantum mechanical wave functions. Prerequisites: PO2911.

**PH4984 Advanced Quantum Physics (4-0) As Required**

Quantum mechanics in the Dirac format. Angular momentum, spin, and spin resonance. Additional topics may include group theoretical applications to selection rules and crystal fields, variational principles, self-consistent fields in the many-electron atom, scattering theory, and polyatomic molecules. Prerequisites: PH3152 and PH4656.

**PH4991 Relativity and Cosmology (3-0) As Required**

This course is a graduate level introduction to the current thought on the origin of space, time and matter. Topics covered are: The discovery of the cosmic evolution, Description of space in Newtonian and Einsteinian terminology, Kinematics and Dynamics of the Einstein cosmological models, the thermal history of the universe, the very early universe, the problems of a possible quantum origin of the universe and the possible future of the universe. Prerequisites: Courses in Basic Physics and Differential Equations.

**PH4992/4998 Special Topics in Advanced Physics (Variable Hours 1-0 To 4-0) (V-0) As Required**

Study in one of the fields of advanced physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading. The course carries a letter grade and may be repeated in different topics. Prerequisites: A 3000 level course appropriate to the subject to be studied, and consent of the Department Chairman. It may also be taken on a Pass/Fail basis if the student has requested so at the time of enrollment.

*SE Courses (Under Dept of Physics)***SE4858 Nuclear Warfare Analysis (4-0) As Required**

This final course in the nuclear weapons effects graduate specialization sequence deals with technical aspects of strategic and tactical nuclear war. Effects which nuclear weapons explosion environments have on various defense platforms and systems are considered, together with methods of hardening to reduce system vulnerability in each of the effected areas: blast and shock, thermal radiation, transient effects on electronics. EMP, biological effects from contamination, atmospheric and ionospheric effects on communication, detection and surveillance systems. Prerequisites: PH4171 Classification: SECRET.

**SE4859 Technical Aspects of Weapon Proliferation, Control and Disposal (3-0) As Required**

This course address technical issues of detection of nuclear weapon materials, covert explosions, disposition of weapon grade material and nuclear reactor fuel, control and disposition of chemical and biological weapons, policy issues of arms proliferation and arms control. Prerequisites: Consent of instructor.

**Combat Systems Sciences and Technology - Curriculum 533****Combat Systems Web Page:**

<http://www.nps.edu/CSST>

**Program Officer**

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**Brief Overview**

This program is designed to meet the needs of the military services for an officer having a broad-based advanced technical education applicable to combat systems design, development, test and evaluation, acquisition, operation, and support. The student does not necessarily earn a degree in Combat Systems. The majority of students earn a degree in Physics or Applied Physics. Degrees in Engineering Acoustics, Software Engineering, Mechanical Engineering, Combat Systems Technology, or Electrical Engineering are also available on a space available basis. Included in the core of the program are courses on electromagnetic radiation, applied optics, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, combat simulation, underwater acoustics, semiconductor devices, detection and engagement elements, combat systems integration, and computing resources for advanced combat systems. The officer will also conduct thesis research on a military-relevant technical problem.

**Requirements for Entry**

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required for direct input.

Courses in the physical sciences and engineering are highly desirable. An APC of 334 is required.

**Entry Date**

Standard entry dates are January and July. Other entry dates are possible by special arrangement with the program officer. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

**Degree**

A student can earn one of the following degrees in the Combat Systems Sciences and Technology (Curriculum 533): Master of Science in Physics, Applied Physics, Software Engineering, Engineering Acoustics, Mechanical Engineering, Combat System Technology, or Electrical Engineering. Required classes vary by degree.

**Subspecialty**

The Combat Systems Sciences and Technology Curriculum has options ranging from a four-quarter program for students ready to commence graduate-level courses, to an eight-quarter course of study for students who require a review of undergraduate coursework. Completion of the full eight-quarter curriculum qualifies an officer as a Combat Systems Sciences and Technology Sub-specialist with a subspecialty code of 5700-5707P depending on specialization track. U.S. Navy students entering the Combat Systems Curriculum through the one-year Immediate Graduate Education Program receive a sub-specialty code of 5701-5704I. The curriculum sponsor is Commander, Naval Sea Systems Command.

**Typical Subspecialty Jobs**

AEGIS Tech Rep, Morristown, NJ  
DOE National Nuclear Security Agency,  
Washington, DC  
Defense Threat Reduction Agency, Los Alamos, NM  
Missile Defense Agency, Washington, DC (laser program)  
Naval Sea Systems Command, Washington, DC  
(Battle Force Engineer, Systems Engineering East Coast Battle Group, NATO Sea Sparrow Surface Missile Program)  
Naval Surface Warfare Center White Sands, NM  
(Project Support Officer, Weapons Test Officer)  
Naval Surface Warfare Center Dahlgren, VA  
(Strategic Fire Control)  
Naval Surface Warfare Center Port Hueneme, CA  
(Aegis Ship Qualification Trials, Test and Evaluation Project Officer)

Program Executive Officer Carriers, Washington, DC  
(Deputy Program Manager Combat Systems)  
Supervisor Shipbuilding, Jacksonville, FL (Ship  
Repair Officer)  
Strategic Weapons Facility Atlantic, King's Bay, GA  
(Weapons Technology)  
Strategic Systems Programs, Sunnyvale, CA (Arms  
Control Coordinator, Fire Control and Guidance  
Branch Head)  
Program Executive Officer Strike, Washington, DC  
(Tech Director, Combat Systems, Air Dominance,  
Undersea Domain, Ship Design)  
Space and Naval Warfare Systems Command, San  
Diego, CA (PD-18 Assistant Program Manager for  
Acoustic Sensor Systems)  
United States Naval Academy (Physical Science  
Instructor)

### Typical Course of Study - Applied Physics Option

#### Quarter 1

PH1994 (4-1) Mathematics for Scientists and  
Engineers I  
PH1995 (4-1) Mathematics for Scientists and  
Engineers II  
PH1121 (4-2) Mechanics  
PC2911 (4-3) Introduction to Computational Physics

#### Quarter 2

PH1322 (4-2) Electricity and Magnetism  
PH2151 (4-1) Particle Mechanics  
PH3991 (4-0) Theoretical Physics  
PH2724 (4-0) Thermodynamics  
PH2001 (1-0) Research Seminar in Physics

#### Quarter 3

PH2652 (4-1) Modern Physics  
PH3152 (4-0) Mechanics of Physical Systems  
PH2351 (4-2) Electromagnetism  
PC2013 (4-3) Introductory Applied Physics  
Laboratory  
PH0999 (0-1) Physics Colloquium

#### Quarter 4

PH3292 (4-2) Applied Optics  
PH3655 (4-0) Solid State Physics  
PH3352 (4-0) Electromagnetic Waves  
PC3014 (3-4) Intermediate Applied Physics Laboratory  
PH0999 (0-1) Physics Colloquium

#### Quarter 5

PC3172 (4-1) Physics of Weapon Systems: Fluid  
Dynamics of Weapons, Shock Waves,  
Explosions  
PH4656 (4-0) Quantum Mechanics  
Concentration Course  
PC4015 (4-3) Advanced Applied Physics Laboratory  
PH0999 (0-1) Physics Colloquium

#### Quarter 6

NW3230 (4-2) Strategy and Policy  
PC3400 (4-2) Survey of Underwater Acoustics  
PC4862 (4-0) Advanced Weapon Concepts  
Concentration Course  
PH0810 (0-8) Thesis Research  
PH0999 (0-1) Physics Colloquium

#### Quarter 7

Concentration Course  
Concentration Course  
PC3800 (4-0) Survey of the Effects of Weapons  
PH0810 (0-8) Thesis Research  
PH0999 (0-1) Physics Colloquium

#### Quarter 8

PC3200 (4-1) Physics of Electromagnetic Sensors and  
Photonic Devices  
PC4022 (3-0) Combat Systems Capabilities  
PH0810 (0-8) Thesis Research  
PH0810 (0-8) Thesis Research  
PH4001 (1-0) Physics Thesis Presentation

#### Concentration Areas:

*NOTE: Final approval of an individual student's degree rests  
with the Chairman of the cognizant department.*

#### MS Applied Physics:

##### Electromagnetic Sensor Systems:

PH4271 (4-1) Lasers, Optoelectronics, and Electro-  
Optics I  
PH4272 (4-1) Lasers, Optoelectronics, and Electro-  
Optics II  
PH4273 (4-2) Physics of Advanced Imaging Systems  
PH4274 (4-1) Physics of Active Electromagnetic  
Detection and Engagement

##### Weapons and Effects:

PH4171 (4-1) Physics of Explosives  
PH4857 (4-1) Physics of Directed Energy and  
Conventional Weapons  
PH4858 (4-0) Weapons Lethality and Survivability  
PH4911 (3-2) Simulation of Physical and Weapon  
Systems

##### Underwater Acoustic Systems:

PH3119 (4-2) Oscillations and Waves  
PH3451 (4-2) Fundamental Acoustics  
PH3452 (4-2) Underwater Acoustics  
PH4454 (4-2) Sonar Transducer Theory and Design  
PH4455 (4-0) Sound Propagation in the Ocean

##### Total Ship Systems Engineering:

TS3000 (3-2) Electrical Power Engineering  
TS3001 (3-2) Fundamental Principles of Naval  
Architecture  
TS3002 (3-2) Principles of Ship Design and Case  
Studies  
TS3003 (3-2) Naval Combat System Elements  
TS4000 (3-2) Naval Combat System Engineering

TS4001	(3-2)	Integration of Naval Engineering Systems
TS4002	(2-4)	Ship Design Integration
TS4003	(2-4)	Total Ship System Engineering

**MS Physics Track:**

PH3782	(4-0)	Thermodynamics and Statistical Physics
PH4353	(4-0)	Topics in Advanced Electricity and Magnetism
PH4656	(4-0)	Quantum Mechanics

A two course Physics sequence.

**MS Engineering Acoustics Track:**

PH3119	(4-2)	Oscillations and Waves
PH3451	(4-2)	Fundamental Acoustics
PH3452	(4-2)	Underwater Acoustics
PH4454	(4-2)	Sonar Transducer Theory and Design
PH4455	(4-0)	Sound Propagation in the Ocean
EC3500	(4-0)	Analysis of Random Signals
EC4450	(4-1)	Sonar Systems Engineering

**MS Electrical Engineering Track:**

Program developed upon arrival based on educational background. Available areas are:

- Signal Processing
- Guidance, Control, and Navigation
- Electromagnetic Systems
- Computer Engineering
- Communication Systems
- Microelectronics and Power

This program is limited to students arriving with an ABET accredited BSEE.

**MS Mechanical Engineering Track:**

Program developed upon arrival based on educational background. Available areas are:

- Fluid Mechanics
- Thermal Science
- Solid Mechanics
- Vibrations, Controls, and Materials Engineering

This program is limited to students arriving with an ABET accredited BSME

**MS Software Engineering Track:**

12 software engineering courses including:

SW3460	(3-1)	Software Methodology and SW4500
(3-1)		Introduction to Software Engineering

**Typical Course of Study - 4-Quarter Applied Physics Degree****Quarter 1**

PH3119	(4-2)	Waves and Oscillations
PC3172	(4-1)	Physics of Weapon Systems: Fluid Dynamics of Weapons, Shock Waves, Explosions

4000 level elective

PH0810	(0-8)	Thesis
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**Quarter 2**

PH3991	(4-0)	Theoretical Physics
PH3451	(4-2)	Fundamental Acoustics
PH3655	(4-0)	Solid State Physics
PH3352	(4-0)	Electromagnetic Waves

**Quarter 3**

PH3452	(4-2)	Underwater Acoustics
PH4454	(4-2)	Sonar Transducer Theory and Design
PH4656	(4-1)	Quantum Mechanics
PH0810	(0-8)	Thesis

**Quarter 4**

PH4455	(4-0)	Sound Propagation in the Ocean
4000 level elective		
PH0810	(0-8)	Thesis
PH0810	(0-8)	Thesis

**Educational Skill Requirements (ESR)****Combat Systems Sciences and Technology-Curriculum 533****Subspecialty Code 57xxP****1. Mathematics, Science, and Engineering**

**Fundamentals:** A solid foundation in mathematics, physics, and engineering underpinning combat-systems technology to support the theoretical and experimental aspects of the technical courses in the curriculum.

**2. Acoustic and Electromagnetic Systems:**

A graduate level understanding of acoustic and electromagnetic propagation; physics of solid state, and electro-optic devices; including the principles of radar and sonar systems; and signal analysis, processing, and decision theory.

**3. Communication Systems:**

A graduate level understanding of various communication systems including fiber optics, automatic control systems, and open architecture designs and their implications on integration of computing resources and in advanced combat systems.

**4. Weapons Systems and Applied Fluid Mechanics:**

A graduate-level understanding of the fluid dynamics of subsonic and supersonic weapons, warheads and their effects.

**5. Combat Systems Analysis, Simulation, and Testing:**

Sufficient foundation in Systems Analysis and Simulation to understand the limits of each, and their effect on required combat systems testing.

**6. Combat Systems Engineering:**

An understanding of the principles of design, development, testing and evaluation; and the importance of performance and economic trade-offs in combat systems.

7. **Materials Science:** A familiarity with the concepts of materials science sufficient for an understanding of the mechanical, electrical, and thermal properties of materials important in present and future combat systems.
8. **Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons for future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College course series leading to Service Intermediate level Professional Military Education (PME) and Phase I Joint PME credit.
9. **Technical Specialization:** Each officer will also acquire technical competence in an area related to Combat Systems:
10. **Thesis:** The graduate will demonstrate the ability to conduct independent research in combat systems sciences and technology, and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

## Undersea Warfare - Curriculum 525

### Program Officer

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### Academic Associate

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### Brief Overview

The Undersea Warfare Curriculum educates officers in the engineering fundamentals, physical principles, and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. The USW program is interdisciplinary and integrates many subjects: acoustics, electrical engineering, mathematics, meteorology, oceanography, physics, operations analysis, human factors, computer science, and robotics.

This curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for

Joint Professional Military Education for Intermediate Level Professional Military Education (JPME Phase I) as established by the Chairman, Joint Chiefs of Staff.

### Requirements for Entry

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of refresher math and/or physics as needed.

### Entry Date

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or Program Officer. A four-quarter course of study has been designed for students that are accepted in the Immediate Graduate Education Program (IGEP). IGEP students begin their program in July.

### Degree

This interdisciplinary program divides naturally into five major academic areas, allowing the student to specialize in the area of choice. Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for the various degrees, depending upon academic qualifications, the specialization sequence selected, and the thesis. A student can earn one of the following degrees in the Undersea Warfare (Curriculum 525/526): Master of Science in Engineering Acoustics, Electrical Engineering, Physical Oceanography, and Applied Science. Required classes vary by degree.

### Master of Science in Engineering Acoustics

The Master of Science in Engineering Acoustics degree will be awarded as an interdisciplinary program in accordance with the following degree requirements:

1. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.
2. The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter-hours of course work; at least 20 graduate quarter-

hours must be taken in acoustics and its applications. Three 4000 level courses must be included from any three of the following six areas: wave propagation; transducer theory and design; noise, shock, and vibration control; sonar systems; signal processing; and communications. In addition, these courses must include at least one from each of the sponsoring disciplines (physics and electrical engineering).

3. An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

### **Doctor of Philosophy and Doctor of Engineering**

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the Doctor of Philosophy or Doctor of Engineering degree. Areas of special strength in the departments are physical acoustics, underwater acoustics and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other federal government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctorate degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student

### **Master of Science in Physical Oceanography**

(with emphasis on the prediction of the littoral battlespace environment, ocean acoustics and environmental effects on sonar performance)

### **Master of Science in Electrical Engineering**

(with emphasis on communications or signal processing)

### **Master of Science in Operations Research**

(with emphasis on tactical applications and decision analysis)

### **Master of Science in Mechanical Engineering**

(with emphasis on autonomous systems)

### **Master of Science in Engineering Science**

(with emphasis on autonomous systems)

### **Master of Science in Applied Science**

Students who have limited time for degree completion, or whose technical backgrounds are weak,

may choose to pursue a Master of Science in Applied Science (Signal Processing), (Physical Oceanography), (Acoustics), or (Operations Research) degree.

### **Subspecialty**

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of 6301P. The curriculum sponsors are N77 (Submarine Warfare) and N75 (Expeditionary Warfare).

### **Typical Subspecialty Jobs**

Naval Undersea Warfare Center  
COMINELWARCOM  
Naval Air Warfare Center  
Submarine Development Squadron Twelve  
Program Executive Offices  
Patrol Wing Staffs  
Carrier Group Staffs  
Naval Air Systems Command  
Naval Surface Warfare Development Group  
OPNAV  
Destroyer Squadron Staffs  
Fleet Mine Warfare Training Center  
Operational Test and Evaluation Force

### **Typical Course of Study - Fall Entry**

Notes: Courses indicated by \* are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

#### **Quarter 1**

MA1115(6wks)	(4-0)	Multi-variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Ordinary Differential Equations
PH2401	(3-0)	Introduction to Sonar Equations

#### **Quarter 2**

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography
OS2103	(4-1)	Applied Probability for Systems Technology
NW3230*	(4-2)	Strategy and Policy

#### **Quarter 3**

OC3260	(4-0)	Sound in the Ocean
UW3303	(4-0)	Modeling and Simulation for Undersea Warfare
OS3604	(3-0)	Decision and Data Analysis
NW3285*	(4-0)	National Security Decision Making

**Quarter 4**

EO2402	(4-1)	Introduction to Linear Systems
OA3602	(4-0)	Search Theory and Detection
OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean
OC4270	(3-4)	Tactical Oceanography

**Quarter 5**

EO3402	(3-1)	Signals and Noise
OA4607	(4-0)	Tactical Decision Making
UW3301	(4-0)	Undersea Warfare in the 20 <sup>th</sup> Century
PH3002	(4-0)	Non-Acoustic Sensor and Systems

**Quarter 6**

EC4450	(4-1)	Sonar Systems Engineering
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 7**

MEXXXX	(4-0)	Core Course in Autonomous Systems
UW9999	(4-0)	Specialization Elective
NW3275*	(4-0)	Joint Maritime Operations (Part 1)
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 8**

NW3276*	(2-2)	Joint Military Operations (Part 2)
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research

**Typical Course of Study - Spring Entry**

Notes: Courses indicated by \* are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

**Quarter 1**

MA1115 (6wks)	(4-0)	Multi-variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Ordinary Differential Equations
PH2401	(3-0)	Introduction to Sonar Equations

**Quarter 2**

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography
EO2402	(4-1)	Introduction to Linear Systems
NW3230*	(4-2)	Strategy and Policy

**Quarter 3**

OC3260	(4-0)	Sound in the Ocean
UW3301	(4-0)	Undersea Warfare in the 20 <sup>th</sup> Century
EO3402	(3-1)	Signals and Noise
NW3275*	(4-0)	Joint Maritime Operations (Part 1)

**Quarter 4**

OC4270	(3-4)	Tactical Oceanography
OS2103	(4-1)	Applied Probability for Systems Technology
EC4450	(4-1)	Sonar Systems Engineering
NW3276*	(2-2)	Joint Military Operations (Part 2)

**Quarter 5**

UW3303	(4-0)	Modeling and Simulation for Undersea Warfare
OS3604	(3-0)	Decision and Data Analysis
UW9999	(4-0)	Specialization Elective
MEXXXX	(4-0)	Core Course in Autonomous Systems

**Quarter 6**

OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean
OA3602	(4-0)	Search Theory and Detection
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 7**

PH3002	(4-0)	Non-Acoustic Sensor and Systems
OA4607	(4-0)	Tactical Decision Making
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 8**

NW3285*	(4-0)	National Security Decision Making
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research

**Educational Skill Requirements (ESR)****Undersea Warfare - Curriculum 525****Subspecialty Code: 6301P**

1. **Physics:** The officer will understand physical principles applicable to acoustic, non-acoustic USW systems and underwater weapons systems.
2. **Acoustics:** The officer will understand acoustical phenomena affecting the design, performance, and operation of acoustic USW systems.
3. **Oceanography and Meteorology:** The officer will understand atmospheric and oceanographic processes influencing the performance and tactical use of USW systems.



4. **Signal Processing:** The officer will understand principles of signal processing as they apply to USW systems.
5. **Operations Research and Systems Technology:** The officer will understand computer simulation; search, detection, and localization; and USW modeling. The officer will understand principles of data analysis in the evaluation of USW systems. The officer will understand tactical decision aids for USW systems.
6. **Unmanned Systems:** Understand the fundamental technologies and capabilities of unmanned underwater systems and tactical robotics.
7. **Joint Professional Military Education:** Graduates will develop understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war. Fulfilled by completing the Naval War College three-course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. Suggested for USN and USMC students.)
8. **Problem Solving and Practical Applicability:** The officer will demonstrate the ability to conduct independent analysis in Undersea Warfare, and proficiency in presenting the results in writing and orally.

#### **Curriculum Sponsor and ESR Approval Authority**

Director, Submarine Warfare Division (N77)  
 Director, Expeditionary Warfare Division (N75)  
 September 2000

#### **Undersea Warfare (International) - Curriculum 526**

##### **Chairman**

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A course of study modeled after curriculum 525 is available for international students. Further information is available from the Program Officer or Academic Associate. The international version replaces U.S. PME courses with courses specifically developed for international students.

##### **Brief Overview**

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics and signal processing applied to undersea warfare. Subjects covered include the generation, propagation and reception of sound in the ocean; military applications of underwater sound; and acoustic signal processing. These programs are designed specifically for students in the Combat Systems Sciences and Technology, Undersea Warfare, and Underwater Acoustics curricula, government employees in acoustics-related laboratories and systems commands, and international students.

The academic aspects of the MS program are the responsibility of an academic committee composed of representatives from the Departments of Physics and Electrical and Computer Engineering.

#### **Space Systems Academic Group**

##### **Chairman**

Rudolf Panholzer, Ph.D.  
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**Brij Agrawal\***, Distinguished Professor, Ph.D.,

Syracuse, 1970, MS., McMaster University, 1968

**Kyle Alfriend\***, Visiting Professor, Ph.D., Virginia Tech, 1967

**Thomas Betterton**, RADM, USN (Ret.), Naval Space Technology Chair Professor, EAA-Massachusetts Institute of Technology, 1966

**Dan Boger\***, Professor, Chairman of IS department, Ph.D., University of California Berkeley, 1979

**Joseph Bonometti**, Michael Smith NASA Chair Professor, Ph.D., University of Alabama in Huntsville, 1997

**Alex Bordetsky\***, Associate Professor, Ph.D., Chelyabinsk St Tec University, 1982

**Christopher Brophy\***, Research Assistant Professor, Ph.D., University of Alabama, 1997

**Nancy Ann Budden**, Executive Director for Strategic Development, M.B.A., California Lutheran University, 1982

**Daniel Bursch**, CAPT, USN (Ret.), Astronaut, NRO Chair Professor (2005); M.S, Naval Postgraduate School, 1991

**Don Danielson\***, Professor, Ph.D., Harvard, 1968, M.S., Harvard, 1965

**Phil Durkee\***, Professor, Ph.D., Colorado State University, 1984

**Douglas Fouts\***, Professor, Ph.D., University of California Santa Barbara, 1990

**Ashok Gopinath\***, Associate Professor, Ph.D., UCLA, 1992

**Larry Halbach**, Lt Col, USAF, Military Instructor (2003); M.S., University of Colorado Boulder, 1999, M.S. Naval Postgraduate School, 2000

**James A. Horning**, Research Associate, M.S., Naval Postgraduate School, 1997

**Barry Leonard\***, Visiting Associate Professor, M.S., Stanford, 1961

**Herschel H. Loomis, Jr.\***, Professor, Ph.D., Massachusetts Institute of Technology, 1963

**Sherif Michael\***, Associate Professor, Ph.D., West Virginia University, 1983

**Beny Neta\***, Professor, Ph.D., Carnegie-Mellon University, 1977

**James H. Newman**, Astronaut, NASA Visiting Professor, Ph.D., Rice University, 1984

**Richard C. Olsen\***, Professor, Ph.D., University of California, San Diego, 1980

**Rudy Panholzer**, Professor, Ph.D., Technical University Graz, Austria, 1961, EE., Stanford University, 1957

**Charles M. Racoosin**, NNSOC Chair Professor; M.S., Naval Postgraduate School, 1989

**Mark Rhoades**, CDR, USN (Ret.), Lecturer, M.S., Naval Postgraduate School, 1990

**Marcello Romano**, Assistant Professor, Ph.D., Politecnico di Milano, Italy, 2001

**Alan Ross**, Navy TENCAP Chair Professor, Ph.D., University of California, Davis, 1978

**Michael Ross\***, Associate Professor, Ph.D., Penn State University, 1990

**Dan Sakoda**, Research Associate, M.S., Naval Postgraduate School, 1992

**Alan Scott**, CAPT, USN, Military Instructor; Astronautical Engineer, Naval Postgraduate School, 1996

**David Trask**, MASINT Chair Professor, M.B.A., Embry-Riddle University, 1991

**Donald Wadsworth\***, Senior Lecturer, Ph.D., Massachusetts Institute of Technology, 1958

**Donald Walters\***, Professor, Ph.D., Kansas State University, 1971

**Todd Weatherford\***, Associate Professor, Ph.D., North Carolina State University, 1993

**Joseph Welch\***, CDR, USN (Ret.), Lecturer, M.S., Nova Southeastern University, 2001, M.S. Naval Postgraduate School, 1987

**Lonnie Wilson\***, Research Associate Professor, Ph.D., University of California Los Angeles, 1973

(\* indicates faculty member has a joint appointment to another department at NPS)

### Brief Overview

The Space Systems Academic Group (SSAG) is an interdisciplinary association of faculty and academic chair professors representing eight separate academic disciplines. The SSAG has established six Chair professorships sponsored by the aerospace Corporation/NRO, NASA, Navy TENCAP, Naval Space Technology Program, NNSOC, and the MASINT Chair Professor who supports the SSAG in areas of Measurement and Signature Intelligence (MASINT). The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the group, as well as the following academic departments: Mechanical and Astronautical Engineering, Electrical and Computer Engineering, Mathematics, Meteorology, Operations Research, Physics, Information Operations, and Systems Management. The Space Systems Academic Group approves thesis topics for students in Space Systems Operations. For Space Systems Engineering, the group chairman approves the final thesis in addition to the academic department granting the degree.

## Degree

### *Space Systems Operations*

The Space Systems Operations students are awarded the Master of Science in Space Systems Operations degree. A minimum of 45 quarter-hours of graduate level work is required, of which at least 15 hours must be at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included. There is also a requirement of three courses constituting advanced study in an area of specialization and an experience tour. Each student is required to write a thesis that is space oriented. The Chairman of the Space Systems Academic Group must approve all study programs.

### *Space Systems Engineering*

The Space Systems Engineering students earn a master's degree in one of the following academic areas: Astronautical Engineering, Computer Science, Electrical and Computer Engineering, Mechanical Engineering, or Physics. Refer to the degree requirements in the associated departments.

### Group Facilities

- Open site EMI/EMC facility
- Satellite Ground Station facility
- Space Warfare Computer Laboratory
- FLTSATCOM Satellite Operations
- Simulation and Test Laboratory
- Spacecraft Attitude Dynamics and Control Laboratory
- Spacecraft Environmental Simulation and Test Laboratory
- Radiation Effects Laboratory
- Solar Simulation Facility
- NPS-AFRL Optical Relay Spacecraft Laboratory
- Flash X-ray Facility
- Electron Linear Accelerator
- Small Satellite Test and Development Laboratory
- Smart Structures Laboratory
- Special Compartmented Information Facility for Classified Research and Thesis work
- Rocket Propulsion Laboratory
- Spacecraft Robotics Laboratory

## Space Systems Course Descriptions

### *SS Courses*

#### **SS0810 Thesis Research (0-8)**

#### **Spring/Summer/Fall/Winter**

Every student conducting thesis research enrolls in this course.

#### **SS3001 Military Applications of Space (3-2) Winter**

Space Systems and technologies of interest to the military. Strategic and tactical imagery and SIGINT requirements. Tasking and use of national space systems and ground support elements. Vulnerability considerations and impact of current R&D programs. Prerequisites: SS3500, SS3525 (or PH3052). Classification: Fourier analysis and TOP SECRET clearance with SI/SAO.

#### **SS3011 Space Technology and Applications (3-0) Fall**

An introduction to space mission analysis with an emphasis on those space missions supporting military operations. Topics include space history, doctrine and organizations, orbital mechanics, communication link analysis, space environment, spacecraft technology, and military, civil and commercial space systems. Prerequisites: None.

#### **SS3035 Microprocessors for Space Applications (3-2) As Required**

An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, I/O systems and interfacing, and operating systems. Prerequisites: EC2820.

#### **SS3041 Space Systems and Operations I (4-2) As Required**

Space systems mission analysis and design. Mission characterization, mission evaluation, requirements determination, cost analysis and estimating, cost and operational effectiveness analysis. Prerequisites: SS3011, SS3500, MN3331 and PH3052 (concurrently). Classification: SECRET.

#### **SS3051 Space Systems and Operations II (4-0) As Required**

This course covers joint space doctrine, space policy, and applications of selected military space systems. Topics include the space mission areas of space control and space force enhancement to include space-based navigation, environmental monitoring, and space surveillance systems, along with satellite command and control networks. Additional topics include space threats, tactics, ground application tools and the space annex for an operations plan. Prerequisites: SS3500 and SS3011. Classification: TOP SECRET clearance with SI/SAO.

#### **SS3500 Orbital Mechanics and Launch Systems (4-2) As Required**

Fundamentals: conic sections, coordinate systems and transformations, time. The two-body problem: Newton's laws and their solution, Kepler's equation. Orbital maneuvering. Orbit determination. Perturbations. Mission design. An overview of the performance and selection of launch vehicles. Launch profile and basic terminology (GLOW, mass ratio, injected weight, etc.). Ascent and payload delivery performance. Launch windows, Future launch systems. Prerequisites: None.

#### **SS3525 Air/Ocean Remote Sensing for Interdisciplinary Curricula (3-2) As Required**

Principles of radiative transfer and satellite sensors, and methods used to measure the atmosphere and ocean; visual, infrared and microwave radiometry, and radar systems. Laboratory sessions illustrate lecture concepts using interactive displays of satellite data. Course designed for Space Systems Operations, Space Systems Engineering, Undersea Warfare,

Underwater Acoustics and other interdisciplinary curricula. Prerequisites: Undergraduate physics, and differential/integral calculus and ordinary differential equations, or consent of instructor.

### **SS3613 Military Satellite Communications (3-0) Fall**

MILSATCOM mission analysis, systems design, and applications. This course will cover requirements, tactical employment, system architectures, satellite design and performance, terminal design and performance, associated information systems, link budget calculations, telemetry and control and IO/IW implications. The student will be expected to create SATCOM solutions for Navy and Marine Corps scenarios. Prerequisites: SS3011, or consent of instructor. U.S. Citizen, Classification: SECRET.

### **SS3900 Special Topics in Space Systems (Variable Hours 1-0 to 5-0) (V-0) As Required**

Directed study either experimental or theoretical in nature. Prerequisites: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment. Prerequisites: None.

### **SS4000 Space Systems Seminars and Field Trips (0-1) As Required**

Seminars consist of lectures to provide perspective on Space Systems. Field trips expose the student to various space activities such as industry, NASA and DoD laboratories and commands. Prerequisites: None.

### **SS4051 Military Space Systems and Architectures (3-2) As Required**

This course covers the system level architectural design of selected Space Systems. Emphasis is on a balanced design of all seven components of space systems: space segment, launch segment, ground segment, mission operations, C3 architecture, subject, and orbit and constellation. Prerequisites: SS3001 and SS3051. Prerequisites: None. Classification: TOP SECRET clearance with SI/SAO.

### **SS4900 Advanced Study in Space Systems (Variable Hours 1-0 to 5-0) (V-0) As Required**

Directed graduate study based on journal literature, experimental projects, or other sources. Prerequisites: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment. Prerequisites: None.

## **Space Systems Certificate (SSC) - Curriculum 273**

### **Program Manager**

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### **Brief Overview**

The Space Systems Certificate program is comprised of four courses (SS3011, PH3052, SS3613, and OC2902). Upon successful completion of the course

work, students will be awarded a certificate of accomplishment in keeping with standard practices of the Naval Postgraduate School. The Space Systems Certificate program supports Navy and DoD space educational needs and complements existing resident training by providing cross-disciplinary science and technical education. The Space Systems Certificate program is targeted primarily at the enhancing the education and preparation for the USN Space Cadre personnel. The Navy's Space Cadre represents a distinct body of expertise horizontally integrated within the Navy active duty, reserves, both officer and enlisted, and civilian employee communities organized to operationalize space. Individuals completing the Space Systems certificate will receive an Additional Qualification Designator (AQD) of VS1 and will automatically be considered for designation as a member of the USN Space Cadre.

Two significant events specified the requirement to establish a distance learning program for National Security Space (NSS) personnel in space systems and space applications. First, the DoD-wide space educational requirement was identified by the Undersecretary of the Air Force, as the Executive Agent for Space, as required in the "Commission to Assess United States National Security Space Management and Organization" (2001). Second, the USN Space Cadre Human Capital Strategy was signed by Commander, Naval Network Warfare Command on 25 Jan 2005, stating that completion of NPS Space Systems Certificate satisfied approved entry level space education for Space Cadre personnel.

Based upon these events, the NPS Space Systems Certificate (SSC) was developed, comprised of the following four courses:

- SS3011 Space Technology and Applications
- SS3613 Military Satellite Communications (MILSATCOM)
- PH3052 Physics of Space and Airborne Sensor Systems
- OC2902 Fundamentals of Geospatial Information and Services (GIS)

The original course and academic content for the SSC was vetted and approved by USN space and space training leaders. The Space Systems Certificate is a completely Web-based, asynchronous education program that covers fundamental areas of twenty-first century space enhancement to military operations as validated by NETWARCOM (November 2004). The learning outcomes for the SSC Certificate program directly support the Educational Skill Requirements within the Space Systems Operation (subspecially code 6206P) degree. Evaluation of the Space Systems Certificate occurs in conjunction with the biannual Space Systems curriculum review.

**Requirements for Entry**

A baccalaureate degree with above-average grades. Completion of college level Algebra 2 with a grade of 'C' or better is required.

**Entry Dates**

At the beginning of any quarter throughout an academic year (Jan, Apr, Jul, Oct)

**Program Length**

Four Quarters

**Graduate Certificate Requirements**

Requirements for the certificate in program management are met by successful completion of all four courses. Credit is obtained by maintenance of a 3.0 grade point average on a 4.0 scale.

**Required Courses: Curriculum 273**

SS3011	(3-0)	Space Technology and Applications
SS3613	(3-0)	Military Satellite Communications (MILSATCOM)
PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
OC2902	(3-0)	Fundamentals of Geospatial Information and Services (GIS)

**Space Systems Operations - Curriculum 366****Program Officer**

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**Academic Associate**

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**Brief Overview**

The Space Systems Operations curriculum is designed to provide officers with knowledge of military opportunities and applications in space. Students are provided instruction about the operation, tasking and employment of space surveillance, communications, navigation and atmospheric/oceanographic/environmental sensing systems as well as payload design and integration—specifically for the exploitation of Space and Information products.

The Space Systems Operations curriculum is one of the Information Superiority (IS) curricula, which encompasses several degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core of the Information Superiority (IS) curricula consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the Information Superiority education skill requirements as established by CNO-N6.

**Requirements for Entry**

This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential equations and integral calculus, plus at least one course in calculus-based physics. An APC of 324 is required for direct entry. Students lacking this background may matriculate through the one-quarter Engineering Science program (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students.

**Entry Date**

The Space Systems Operations curriculum is an eight-quarter course of study with a single entry date in October. A summer academic refresher quarter is available as needed. If further information is needed, contact the Academic Associate or Program Officer.

**Degree**

Requirements for the Master of Science in Space Systems Operations degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

**Subspecialty**

Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of 6206P. The curriculum sponsors are OPNAV N6F, Navy Space Systems Division and Naval Network Warfare Command (NETWARCOM). The designated Subject Matter Expert is the Naval Networks and Space Operations Command (NNSOC).

**Typical Subspecialty Jobs**

Project Officer: OPNAV (N6) TENCAP, Arlington, VA

Project Officer: SPAWAR Space Field Activity (SSFA)/NRO, Chantilly, VA

Space Advisor: NAVNETWARCOM, Norfolk, VA  
Detachment OIC: Naval Space Operations Command (NAVSOC), Colorado Springs, CO

Staff Officer, Space and Global Strike: USSTRATCOM, Omaha, NE

Assistant Crew Commander: Space Control Center, Cheyenne Mountain Operations Center, Colorado Springs, CO

**Typical Course of Study - Space Systems Operations-Fall Entry****Quarter 1**

MA1113	(4-0)	Single Variable Calculus
MA1114	(4-0)	Single Variable Calculus II with Matrix Algebra
SS3011	(3-0)	Space Technology and Applications
PH1121	(4-2)	Mechanics
SS4000	(0-1)	Seminar

**Quarter 2**

OS2100	(3-1)	Probability/Stats
PH1322	(4-2)	Electricity and Magnetism
SS3500	(4-2)	Orbital Mechanics and Launch Systems
NW3230	(4-2)	Strategy and Policy (All Navy)
SS4000	(0-1)	Seminar

**Quarter 3**

EO3516	(4-2)	Intro to Communication Systems Engineering
PH2514	(4-0)	Space Environment
AE4830	(3-2)	Spacecraft Systems I
NW3285	(4-0)	National Security Decision Making (Navy URL Only)
SS4000	(0-1)	Seminar

**Quarter 4**

EO4516	(4-2)	Communications Systems Analysis
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
CC3000	(4-0)	Intro to Command, Control, Communication, Computer and Intel Systems (Navy Only)
IS3502	(3-2)	Computer Networks: Wide Area/Local Area (Navy Only)
SS4000	(0-1)	Seminar

**Quarter 5**

PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
SS3041	(4-2)	Space Systems & Operations I (SECRET)

SS3613	(3-0)	MILSATCOM System & Applications (SECRET)
AE4831	(3-2)	Spacecraft Systems II
SS4000	(0-1)	Seminar

**Quarter 6**

SS3001	(3-2)	Military Applications of Space (1st half of quarter) (TS/SI)
SS3051	(4-0)	Space Systems & Operations II(1st half of quarter) (TS/SI)
SS0810	(0-8)	Thesis and Experience Tour (2nd half of quarter)
SS4000	(0-1)	Seminar

**Quarter 7**

SS0810	(0-8)	Thesis
SS4051	(3-2)	Military Space Systems and Architectures (TS/SI)
IW3101	(4-1)	Information Operations (Navy Only)
NW3275	(4-0)	Joint Maritime Operations Part I (Navy URL Only)
SS4000	(0-1)	Seminar

**Quarter 8**

SS0810	(0-8)	Thesis
SS0810	(0-8)	Thesis
OS3307	(4-1)	Modeling Practices for Computing (Navy URL Only)
NW3276	(2-2)	Joint Maritime Operations Part II (Navy URL Only)
SS4000	(0-1)	Seminar

**Educational Skill Requirements (ESR) Information Sciences, Systems, and Operations - Curriculum 366****Subspecialty Code: 6206P**

Graduates of the Space Systems Operations Specialization of the Information Sciences, Systems, and Operations (ISSO) Curriculum shall be able to determine space systems requirements which support the following operational concepts: control of space, global engagement, full force integration, and global partnerships. The graduates shall be able to analyze courses of action for the best employment of available space assets for ongoing and future military operations, and communicate this assessment to shore and afloat staffs and commanders.

Supporting these goals are the following specific requirements.

**1. Joint Strategy and Policy**

- a. Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the

- ways military power may be used to achieve them. This is fulfilled by completion of the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.
- b. Understand current Navy and USMC doctrine (e.g., Sea Power 21, Expeditionary Maneuver Warfare).
2. **Orbital Mechanics, Space Environment, and Remote Sensing:**
    - a. Understand the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks. Understand the design of orbits, how they are achieved, maintained, and controlled including the design of constellations and how spacecraft are maneuvered and repositioned. Understand spacecraft tracking and command/control from a ground station. Understand the various orbital perturbations, including those due to non-spherical earth and due to atmospheric drag. Understand the relationships of orbits to mission requirements, including the advantages and disadvantages of various orbits.
    - b. Understand the natural and induced environment of space, including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere, and their response to natural and artificial disturbances. Understand the impacts to spacecraft parts and materials due to this space environment.
    - c. Understand the principles of active and passive sensors used in current and future spacecraft for sensing through the atmosphere. Understand the effects of the space environment and countermeasures on sensor performance. Understand the tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.
  3. **Military Space Systems**
    - a. Understand the two major components of military space systems: (These systems include MILSATCOM, Commercial systems, GPS, Meteorological systems, space surveillance, national systems, space-based warning, and other nations' systems)
    - b. Military Space Operations: Understand the operational requirements and limitations of current and future space systems used by the DoD for Space Control and Force Application. Understand the roles of the services in the development, operation, and use of these systems. Understand the roles, responsibilities and relationships of national and Joint DoD organizations in establishing policies, priorities, and requirements for these space systems; and in their design, acquisition and operation. Understand the nature of space warfare (theory, history, doctrine, and policy) including space control, assured access, global engagement, and full force integration. Be familiar with Joint Doctrine (e.g., JP 314).
    - c. Warfighter Support Obtained from Space: Understand the capabilities and use of space systems to enable and support joint air, land, and sea military operations (i.e., Force Enhancement). Understand the intelligence collection and analysis process for space systems and how warfighters access information from these sources. Understand doctrine and operational concepts (e.g., USSTRATCOM's "Long Range Plan") and be able to contribute to the development of space tactics that enhance or support military operations.
  4. **Project Management and System Acquisition:**
    - a. Understand project management and DoD system acquisition methods and procedures to include contract management, financial management and control, and the Planning, Programming and Budgeting System (PPBS). Receive an introduction to the Defense Acquisition University and the acquisition courses and qualifications available.
    - b. Understand the system acquisition organizational responsibilities and relationships (e.g. Congress, DoD, Services; Resource Sponsor, Systems Commands, Operating Forces) as they pertain to the acquisition of systems for DoD, Naval, and civilian agency users.
  5. **Communications:**
    - a. Understand the basic principles of communications systems engineering, including the space and ground segments. Understand digital and analog communications architecture design, including frequency reuse, multiple access, link design, repeater architecture, source encoding, waveforms, and propagation media. Understand current and future communications systems used or planned by

- naval operating and joint forces afloat and ashore. Understand how space systems are used to meet joint warfighters' communications requirements.
- b. Be able to articulate from the joint warfighter's perspective the advantages and disadvantages of various frequencies used by DoD for communications across the frequency spectrum. Understand the national and international issues involving use of the frequency spectrum.
  - c. Understand current and future MILSATCOM bandwidth allocation processes.
  - d. Understand the nature of the rapid evolution in commercial satellite communications systems. Be able to articulate potential uses to satisfy Joint DoD Information Operations requirements.
6. **Analysis, Synthesis, and Evaluation:**
- a. Be able to derive, assess, and articulate cost-effective requirements for the operational use of space systems to meet C3I/IO requirements, using modeling and simulation, field and laboratory experiments, and other quantitative and qualitative methods as they pertain to the Federal and DoD Acquisition System.
  - b. Be able to perform business case (economic) and trade-off analyses for commercial and DoD Systems.
  - c. Receive introduction to Naval Warfare Development Command and become familiar with real world exercises (e.g., Fleet Battle Experiments, Millennium Challenge)
7. **Architecting Joint Military Space Missions:**
- a. Understand the basic principles of architecting a complex joint military space mission, the life cycle process by which a space system is conceived, structured, designed, built, tested, certified and operated in a way that ensures its integrity and performance. Be able to formulate a consistent set of principles and techniques to be followed throughout all phases of the architecting process.
  - b. Understand the systems design of a spacecraft that includes its various subsystems: propulsion, structure, thermal, attitude determination and control; electrical power, and telemetry, tracking and command; and their integration. Gain an appreciation of the key interactions between the various subsystems and their effects on performance requirements. Understand the system design criteria from stated performance requirements, and the trade-offs between payloads and other spacecraft subsystems.
- c. Understand the basic principles of launch vehicle performance; launch environment, launch windows, and their role in military operations. Understand the differences between the various classes of current and future launch systems, including the upper stages. Gain an appreciation of the various business issues involved in the selection of the launch vehicle (e.g., pricing, insurance, policy). Be familiar with the issues of integrating a spacecraft with a launch vehicle. Perform a trade-off analysis in the selection of the launch vehicle.
  - d. Understand the application of the principles of systems engineering to a Joint space project from the needs assessment phase to the final operations cycle. Be able to apply the tools of project management (e.g. scheduling, costing, budgeting, planning, resource negotiation, risk management) to a space project. Gain an appreciation of the review process from the systems requirements review to the critical design review. Gain a familiarity with typical spacecraft testing: electromagnetic compatibility tests, vibration and thermal tests, functional tests, deployments tests, alignment tests, inertia determination tests and comprehensive system tests. Understand the necessity to ensure the integrity, workmanship, and performance of the spacecraft.
  - e. Understand the basic elements of joint mission operations: command the spacecraft, manage payloads, resolve anomalies, schedule ground station support, design failure workarounds, plan orbit maneuvers, and link users and operators.
  - f. Be able to develop a concept of operations for a space system. Be able to develop and assess a course of action using the Joint Operational Planning and Evaluation System (JOPES) process for best utilization of space systems. Be able to develop the space systems component of OPLANS.



8. **Advanced Concepts and Technologies In Space Systems:**
- Understand the future of military space requirements stemming from information superiority.
  - Understand the future concepts of operations published by various DoD organizations, based on an understanding of the emerging technologies and their impact on military space.
  - Develop an understanding of the advanced concepts and technologies in military space systems.
9. **Information Superiority:**
- The graduate shall have a broad understanding and ability to innovatively employ information superiority technologies, develop and implement top-level systems and subsystems, and influence applications of the following knowledge domains: Joint C4I, Information Warfare, Space System Operations, Information Technology Management, Computer Science, Modeling and Simulation.

#### **ESR Approval Authority**

Deputy for Command, Control, Communications and Computers (C4), Integration and Policy (OPNAV N6F)  
Nov 2004

### **Space Systems Engineering - Curriculum 591**

#### **Program Officer**

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#### **Brief Overview**

The Space Systems Engineering program provides officers, through graduate education, with a comprehensive scientific and technical knowledge of national security, military and naval space systems.

This curriculum is designed to equip officers with the theoretical and practical skills required to design and integrate national security and military space payloads with other spacecraft subsystems. Graduates will be prepared by their education to design, develop and manage the acquisition of space communications, navigation, surveillance, electronic warfare and environmental sensing systems.

#### **Requirements for Entry**

A baccalaureate degree, or its equivalent, in engineering or the physical sciences is preferred. An APC of 323 is required for direct entry. The Engineering Science program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional required time to complete the Engineering Science program will vary upon the candidate's background. For those wishing to pursue the electrical engineering degree option, the candidate will need to have earned the equivalent of an accredited BSEE. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students.

#### **Entry Date**

Space Systems Engineering is a nine-quarter course of study with an entry date in October. Those requiring the one-quarter Engineering Science curriculum will have their time of arrival adjusted to accommodate it. If further information is needed, contact the Academic Associate or the Program Officer.

#### **Degree**

A student can earn one of the following degrees in the Space Systems Engineering (Curriculum 591): Master of Science in Astronautical Engineering, Electrical Engineering, Mechanical Engineering, Computer Science or Physics. Required classes vary by degree. The placement of these required classes in the course of study shown below is indicated as Degree Specialization Electives.

#### **Subspecialty**

Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of 5500P. The curriculum sponsor is NAVSEA and the designated Subject Matter Expert is the Space and Naval Warfare Systems Command Space Field Activity (SSFA).

#### **Typical Subspecialty Jobs**

Project Officer/Engineer: SPAWAR, San Diego, CA  
Project Officer/Engineer: SPAWAR Space Field Activity/NRO, Chantilly, VA

Satellite Communications Engineer: NAVSOC, Point Mugu, CA  
 Space Advisor: Naval Network Warfare Command, Norfolk, VA  
 Project Officer: Space Warfare Center, USSTRATCOM, Omaha, NE  
 Project Officer/Engineer, C4ISR Programs: SPAWAR Systems Center, San Diego, CA

### Typical Course of Study - RL & URL Officers without JPME

#### Quarter 1

MA2121 (4-0) Differential Equations  
 AE2820 (3-2) Introduction to Spacecraft Structures  
 EC2820 (3-2) Digital Logic Circuits  
 NW3230 (4-2) Strategy and Policy (JPME)  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 2

SS3500 (4-2) Orbital Mechanics and Launch Systems  
 PH2514 (4-0) Introduction to Space Environment  
 MA3046 (4-1) Matrix Analysis  
 EC2300 (3-2) Control Systems  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 3

AE3815 (3-2) Introduction to Spacecraft Dynamics  
 EO2525 (4-1) Analysis of Signals and Communications Systems  
 SS3525 (3-2) Remote Sensing  
 SS9999 (4-0) Degree Specialization Elective  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 4

AE3851 (3-2) Spacecraft Propulsion  
 EO3525 (4-1) Communications Engineering  
 AE3804 (3-0) Thermal Control of Spacecraft  
 SS9999 (4-0) Degree Specialization Elective  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 5

PH3360 (4-1) Electromagnetic Waves Propagation  
 AE3818 (3-2) Spacecraft Attitude, Dynamics & Control  
 SS9999 (4-0) Degree Specialization Elective  
 SS9999 (4-0) Degree Specialization Elective  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 6

AE3870 (2-4) Spacecraft Design Tools  
 SS3051 (4-0) Space Systems and Operations II (TS/SCI)  
 SS3001 (3-2) Military Applications of Space (TS/SCI)  
 SS0810 (0-8) Thesis Research  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 7

AE4870 (4-0) Spacecraft Design and Integration I  
 EC3230 (3-1) Space Power and Radiation Effects  
 SS3035 (3-2) Microprocessors for Space Applications

SS9999 (4-0) Degree Specialization Elective  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 8

AE4871 (2-4) Spacecraft Design & Integration II  
 SS9999 (4-0) Degree Specialization Elective  
 SS9999 (4-0) Degree Specialization Elective  
 SS0810 (0-8) Thesis Research  
 SS4000 (0-1) Space Systems Seminars

#### Quarter 9

MN3331 (5-1) Systems Acquisition and Program Management  
 SS0810 (0-8) Thesis Research  
 SS0810 (0-8) Thesis Research  
 SS9999 (4-0) Degree Specialization Elective  
 SS4000 (0-1) Space Systems Seminars

### Typical Course of Study - URL Officers with JPME (Astronautical Engineering)

#### Quarter 1

MA2121 (4-0) Differential Equations  
 AE2820 (3-2) Introduction to Spacecraft Structures  
 EC2820 (3-2) Digital Logic Circuits  
 NW3230 (4-2) Strategy and Policy (JPME)  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 2

SS3500 (4-2) Orbital Mechanics and Launch Systems  
 PH2514 (4-0) Introduction to Space Environment  
 MA3046 (4-1) Matrix Analysis  
 EC2300 (3-2) Control Systems  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 3

AE3815 (3-2) Introduction to Spacecraft Dynamics  
 EO2525 (4-1) Analysis of Signals and Communications Systems  
 SS3525 (3-2) Remote Sensing  
 AE3830 (3-2) Guidance and Controls  
 AE3811 (2-2) Space Lab  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 4

AE3851 (3-2) Spacecraft Propulsion  
 EO3525 (4-1) Communications Engineering  
 AE3804 (3-0) Thermal Control of Spacecraft  
 ME3521 (3-2) Mechanical Vibrations  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 5

PH3360 (4-1) Electromagnetic Waves Propagation  
 AE3818 (3-2) Spacecraft Attitude, Dynamics & Control  
 AE4850 (3-2) Astrodynamics Optimization  
 AE3820 (3-2) Space Systems Dynamics  
 SS4000 (0-1) Space Systems Seminar

#### Quarter 6

AE3870 (2-4) Spacecraft Design Tools

SS3051	(4-0)	Space Systems and Operations II (TS/SCI)
SS3001	(3-2)	Military Applications of Space (TS/SCI)
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminar

**Quarter 7**

AE4870	(4-0)	Spacecraft Design and Integration I
EC3230	(3-1)	Space Power and Radiation Effects
SS3035	(3-2)	Microprocessors for Space Applications
AE4816	(4-0)	Dynamics and Control of Space Structures
SS4000	(0-1)	Space Systems Seminar

**Quarter 8**

AE4871	(2-4)	Spacecraft Design & Integration II
SS0810	(0-8)	Thesis Research
NW3285	(4-0)	National Security Decision Making (JPME)
NW3275	(4-0)	Joint Maritime Operations, Part I (JPME)
SS4000	(0-1)	Space Systems Seminars

**Quarter 9**

MN3331	(5-1)	Systems Acquisition and Program Management
SS0810	(0-8)	Thesis Research
SS0810	(0-8)	Thesis Research
NW3276	(4-0)	Joint Maritime Operations, Part II (JPME)
SS4000	(0-1)	Space Systems Seminars

**Educational Skill Requirements (ESR)**  
**Space Systems Engineering- Curriculum 591**  
**Subspecialty Code: 5500P**

**1. Joint Strategy and Policy:**

- Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. This is fulfilled by completion of the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.
- Understand current Navy and USMC doctrine (e.g., Sea Power 21, Expeditionary Maneuver Warfare).

**2. Orbital Mechanics, Space Environment and Remote Sensing:**

- Understand the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks.

Understand the design of orbits, how they are achieved, maintained, and controlled including the design of constellations and how spacecraft are maneuvered and repositioned. Understand spacecraft tracking and command/control from a ground station. Understand the various orbital perturbations, including those due to nonspherical earth and due to atmospheric drag. Understand the relationships of orbits to mission requirements, including the advantages and disadvantages of various orbits.

- Understand the natural and induced environment of space, including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances. Understand the impacts to spacecraft parts and materials due to this space environment.
- Understand the principles of active and passive sensors used in current and future spacecraft for sensing through the atmosphere. Understand the effects of the space environment and countermeasures on sensor performance. Understand the tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

**3. Military Space Systems:**

- Understand the two major components of military space systems: (These systems include MILSATCOM, Commercial systems, GPS, Meteorological systems, space surveillance, National systems, space-based warning, and other nations' systems)
- Military Space Operations: Understand the operational requirements and limitations of current and future space systems used by the DoD for Space Control and Force Application. Understand the roles of the Services in the development, operation, and use of these systems. Understand the roles, responsibilities and relationships of national and Joint DoD organizations in establishing policies, priorities, and requirements for these space systems; and in their design, acquisition and operation. Understand the nature of space warfare (theory, history, doctrine, and policy) including space control, assured access, global engagement, and full force integration. Be familiar with Joint Doctrine (e.g., JP 3-14).

- c. Warfighter Support Obtained from Space: Understand the capabilities and use of space systems to enable and support Joint air, land, and sea military operations (i.e., Force Enhancement). Understand the intelligence collection and analysis process for space systems and how warfighters access information from these sources. Understand doctrine and operational concepts (e.g., USSTRATCOM's "Long Range Plan") and be able to contribute to the development of space tactics that enhance or support military operations.
4. **Project Management and System Acquisition:**
    - a. Understand project management and DoD system acquisition methods and procedures to include contract management, financial management and control, and the Planning, Programming and Budgeting System (PPBS). Receive an introduction to the Defense Acquisition University and the acquisition courses and qualifications available.
    - b. Understand the system acquisition organizational responsibilities and relationships (e.g., Congress, DoD, Services; Resource Sponsor, Systems Commands, Operating Forces) as they pertain to the acquisition of systems for DoD, naval, and civilian agency users.
  5. **Spacecraft Communications and Signal Processing:**
    - a. Understand the basic principles of communications systems engineering including the space and ground segments. Understand digital and analog communications architecture design, including frequency reuse, multiple access, link design, repeater architecture, source encoding, waveforms, and propagation media. Understand current and future communications systems used or planned by naval operating and Joint forces afloat and ashore. Understand how space systems are used to meet joint warfighters' communications requirements.
    - b. Understand link budget calculations/analysis, waveforms, and modern SATCOM hardware design. Understand signal processing techniques, both digital and analog, as applied to spacecraft communications, surveillance, signals intelligence, and electronic warfare. Understand spacecraft vulnerabilities in an electronic warfare context.
  6. **Computers: Hardware and Software:**
    - a. Understand the fundamentals of digital logic and digital system design. Design simple digital computer subsystems.
    - b. Gain knowledge of current computer architecture, such as one of the common 16-bit or 32-bit microprocessor systems. Understand the ways in which computers are used in complex systems such as guidance, signal processing, communications and control systems.
    - c. Understand the fundamentals of electronic component design, fabrication, reliability, and testing (to include radiation hardening), with emphasis on parts, materials and processes.
  7. **Spacecraft Dynamics, Guidance and Control:**
    - a. A fundamental understanding of the field of spacecraft guidance and control which includes, linear control, rotational kinematics, rigid body dynamics, single-spin stabilization, stability of dual-spin stabilized spacecraft, active nutation control, gravity-gradient stabilization, disturbance torques: solar, magnetic, gravity gradient, and aerodynamic, attitude sensors, actuators, attitude determination, quaternion feedback control, three-axis-stabilized spacecraft attitude control design, biased momentum, thrusters, magnetic, three reaction wheel system, and control moment gyro system, rapid spacecraft reorientation maneuvers and tracking, and military spacecraft guidance and control.
  8. **Spacecraft Structures and Materials:**
    - a. Understand the engineering of space structures, including simplified sizing calculations and analytical modeling of advanced materials, which can be incorporated in system design and integration. Understand the advanced dynamics and control of these structures.
    - b. Apply reliability and maintainability to testing, evaluation, and manufacturing, which can be used to predict the functional dependability of spacecraft structures
  9. **Propulsion Systems:**
    - a. Understand the operating principles of current and proposed propulsion devices for space applications, including launch, orbit changing and maneuvering engines. Understand the interaction between mission requirements and propulsion requirements.

10. **Spacecraft Thermal Control and Power:**
- Understand the principles of heat transfer on spacecraft, including radiation and conduction. Understand the variations in the radiative properties of surfaces with respect to wavelength and temperature. Understand the design and applications of current active and passive thermal control devices (including heat pipes, louvers, and materials).
  - Understand the sources of heat in space (solar, terrestrial, reflected solar, internal vehicle generation) and their variation as a function of vehicle orbit.
  - Gain knowledge of the major power generating systems for spacecraft and their operating characteristics, including the performance of photovoltaic sources in the natural and artificial radiation environment. Understand the role of energy storage devices in power systems design.
11. **Spacecraft Design and Integration:**
- Understand the principles of space systems design, integration, and systems engineering, and their application to an overall spacecraft/mission. Consideration will be given to life cycle costs, performance, maintainability, reliability, configuration control, and systems integration.
  - Gain an appreciation of system design criteria from stated performance requirements of trade-offs between payload and other spacecraft subsystems, and of test and evaluation procedures.
  - Gain proficiency in CAD, MATLAB, Satellite Tool Kit (STK), or similar programming simulators and analysis tools.
12. **Conduct and Report Independent Research:**
- Conduct independent research on a space systems problem, including resolution of the problem and presentation of the results and analysis in both written and oral form.

### ESR Approval Authority

Commander SPAWAR Space Field Activity  
Nov 2004

## Department of Systems Engineering

### Chairman

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**Matthew G. Boense**, Lecturer (1999); M.S., Naval Postgraduate School, 1988

**J. Jeffrey Crowson**, Research Assistant Professor (2001); Ph.D., University of Kansas, 1997

**Carson K. Eoyang\***, Associate Provost (1983); Ph.D., Stanford University, 1976.

**Raymond "Chip" Franck\***, Senior Lecturer (2000); Ph.D., Harvard University, 1983.

**John "Mike" Green**, Senior Lecturer (2002); M.S., MBA, University of New Haven, 1986 and 1998.

**Tri T. Ha\***, Professor (1987); Ph.D., University of Maryland, 1977.

**Robert C. Harney**, Associate Professor, Associate Chair for Research, and NAVSEA Chair for Total Ship Systems Engineering - Combat Systems (1995); Ph.D., University of California at Davis, 1976.

**Thomas V. Huynh**, Associate Professor (2003); Ph.D., University of California at Los Angeles, 1981.

**Matthew D. Kelleher\***, Professor (1967); Ph.D., University of Notre Dame, 1966.

**Eduoard Kujawski**, Associate Professor (2005); Ph.D., Massachusetts Institute of Technology, 1969.

**Gary O. Langford**, Lecturer (2005); M.S., California State University Hayward (1971)

**Orin E. Marvel\***, Research Associate Professor (1995); Ph.D., University of Illinois, 1970.

**Gregory Miller**, Lecturer (2004); M.S., Naval Postgraduate School (1992).

**Nita L. Miller\***, Visiting Assistant Professor (2000); Ph.D., University of Texas, 1982.

**Gregory K. Mislick\***, LtCol, USMC, Military Instructor (2000); M.S., Naval Postgraduate School, 1988.

**David H. Olwell**, Senior Lecturer and Chair (1998); Ph.D., University of Minnesota, 1996.

**John Osmundson\***, Research Associate Professor (1995); Ph.D., University of Maryland, 1968.

**Fotis A. Papoulias\***, Associate Professor and Academic Associate (1988); Ph.D., University of Michigan, 1987.

**Eugene P. Paulo**, Senior Lecturer (2000); Ph.D., University of Central Florida, 1998.

**David Schrady\***, Distinguished Professor (1965); Ph.D., Case Institute of Technology, 1965

**Paul V. Shebalin**, Senior Lecturer (2003); ScD, George Washington University, 1997.

**Mark R. Stevens**, Lecturer and Academic Associate (2003); M.S., Rensselaer Polytechnic Institute, 1988.

**Ravi Vaidyanathan**, Assistant Professor (2004); Ph.D., Case Western Reserve University, 2001.

**Clifford Whitcomb**, Associate Professor (2005); Ph.D., University of Maryland, 1998.

**E. Roberts Wood\***, Professor (1967); Ph.D., Yale University, 1962.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

(\* indicates faculty member has a joint appointment to another department at NPS)

### Brief Overview

The department of Systems Engineering provides a strong academic program which spans the engineering disciplines and the analytical sciences. These disciplines are blended together with a strong emphasis on naval combat systems engineering applications.

Four degrees are offered by the department. The Master of Science in Systems Engineering degree requires an undergraduate engineering degree or its equivalent. The Master of Science in Systems Engineering Analysis does not require an undergraduate engineering degree. The Master of Science in Product Development and the Master of Science in Systems Engineering Management are offered for graduates of the PD21 (Product Development) curriculum.

A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council.

Any program leading to award of a degree offered by the SE department must be approved by the Chairman of the Department of Systems Engineering at least two quarters before completion. In general, approved programs may require more than minimum degree requirements in order to conform to the needs and objectives of the service or agency sponsoring the student.

### Objectives

The overall educational objective of the Systems Engineering program is to support the NPS mission by producing graduates who have, at an advanced level, knowledge and technical competence in Systems Engineering and an application domain and who can use that knowledge and competence to support national security.

In order to achieve this goal, the specific objectives are to produce graduates who:

Demonstrate the ability to identify, formulate, and solve operational, technical, and engineering problems in Systems Engineering and related disciplines using the techniques, skills, and tools of modern practice, including modeling and simulation. These problems may include issues of research, design, development, procurement, operation, maintenance or disposal of systems and processes for military applications.

Demonstrate proficiency in the systems engineering process, including defining requirements, conducting functional analysis, designing and architecting a system, analyzing it against requirements, allocation of requirements to sub-systems, conducting trade-off studies, determining the cost of the system, integrating human factors into the system, designing logistical supportability, and planning for its testing and evaluation.

Demonstrate proficiency in core skills of systems analysis, to include deterministic and stochastic modeling of systems, optimization, decision analysis, risk analysis, economic models, and lifecycle

supportability analysis. This includes familiarity with combat simulations and combat modeling.

Demonstrate the ability to work as a team member or leader in a large systems engineering project, and to provide leadership in the systems engineering management process. The graduate must be able to interact with personnel from other services, industry, laboratories and academic institutions.

Demonstrate competence in the planning and management of large systems engineering projects.

Demonstrate proficiency in written and oral presentation of technical material.

### **Degree**

#### **Master of Science in Systems Engineering**

A candidate shall have completed work equivalent to the requirements of this department for the Bachelor of Science degree in an engineering discipline. Candidates who have not majored in engineering, or who have experienced significant lapses in continuity with previous academic work, may initially take undergraduate courses in engineering and mathematics to fulfill these requirements in preparation for their graduate program.

The Master of Science in Systems Engineering requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000 level. The course work must include a four-course core consisting of one course each in systems engineering methods.

The candidate must complete a 12-hour equivalent team systems engineering project. This degree is offered both in residence and non-residence. The non-resident programs are described in detail at <http://www.nps.edu/dl/NPSO/index.html>

#### **Master of Science in Product Development**

Candidates do not require an undergraduate engineering background for this degree.

The Master of Science degree in Product Development requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000

level. The course work must include a four-course core in systems engineering methods. Five more courses must be selected from an approved list consisting of additional systems engineering topics.

The candidate must complete an approved thesis.

#### **Master of Science in Systems Engineering Management**

Candidates do not require an undergraduate engineering background for this degree.

The Master of Science degree in Systems Engineering Management requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000 level. The course work must include a four-course core consisting of one course each in systems engineering methods, project management, risk management, and operations analysis. Five more courses must be selected from an approved list consisting of additional systems engineering topics.

The candidate must complete an approved thesis.

### **Laboratories**

#### **Systems Engineering Laboratories**

The first Systems Engineering Laboratory (Family of Systems Integration Lab) will be constructed and integrated into systems engineering education and research by the end of FY06—in partnership with Lockheed-Martin. This laboratory will provide means for conceiving, developing, testing and designing complex, large-scale systems. State-of-the-art technologies and software will also provide the means to identify gaps in future capabilities, excessive redundancies and investment risks. Those capabilities will enhance the student integrating projects (capstones of their educational programs), facilitate research that improves systems engineering methods, and permit effective practice of systems engineering applied to complex DoD problems.

Four other Systems Engineering laboratories are scheduled for completion by 2008. They include a demonstrations laboratory, a projects laboratory, a foundations laboratory, and an applications laboratory.

## Systems Engineering Course Descriptions

### SE Courses

#### SE0811 Thesis in Systems Engineering (0-8)

##### Fall/Winter/Spring/Summer

Thesis course for students pursuing a systems engineering degree. Students are awarded grade of 'T' upon successful completion of their theses.

#### SE1001 Mathematics for SE I (4-2) Summer/Winter

This course provides a brief survey of selected calculus and post-calculus topics—single variable derivatives and integrals, and vector analysis. The course is intended to give students the requisite mathematics needed in SI2003. Prerequisites: Consent of instructor and enrollment in the SEA curriculum.

#### SE1002 Mathematics For SE II (3-1) Spring/Fall

This course provides an introduction to selected pre- and post-calculus topics. Covered will be complex numbers, matrix algebra and differential equations.

#### SE2003 Introduction to Mechanical Systems (4-2)

##### Spring/Winter

The course provides a basic understanding of the physical properties underlying combat systems. It presents calculus based physics covering a broad range of topics in mechanics, heat, and sound. Relevance to military development is discussed. Practical tools are developed to describe motion, Newton's force laws, friction and drag, energy and momentum, rotation, gravitation and orbits, fluids, oscillations, chaos, waves, gases, and thermodynamics. Prerequisites: SE1001, SE1002 and/or consent of instructor.

#### SE2010 Fundamentals of Mechanical Systems (4-2) As Required

This course is the first of three calculus-based fundamental courses covering the basic principles underlying physical systems. The course is a survey of classical mechanics to include Newton's laws of motion, conservation of energy and momentum, kinematics, one and two dimensional collisions, simple harmonic motion, rotational motion, orbital mechanics, simple wave mechanics, and elementary thermodynamics. Subject matter covered also includes mechanical engineering topics such as statics (balancing forces in structures), simple machines and their elaborations into useful mechanisms, mechanical vibrations, and properties of fluids. Prerequisites: SE1001 or equivalent.

#### SE2011 Fundamentals of Electromagnetic Systems (4-2) As Required

This course is the second of three calculus-based fundamental courses covering the basic principles underlying physical systems. The course is a survey of classical electromagnetism to include time-independent electric and magnetic fields, time dependent fields, Maxwell's equations, and electromagnetic oscillations and waves. Subject matter covered also includes electrical engineering topics such as electrical components, analog electrical circuits, and amplifiers and oscillators. Prerequisites: SE1001, SE2010.

#### SE2015 Fundamentals of Material Systems (4-2)

##### Winter

This is an overview course of modern materials science and engineering as applied to the design of complex systems. It describes the structures of materials and the relationship of

structure to material properties. All properties of engineering significance (both mechanical and non-mechanical) will be discussed. The broad variety of materials (including single crystals, alloys, ceramics, glasses, polymers, composites, foams, etc.) available for engineering applications is also discussed. Topics include structure and bonding, mechanical properties of materials, thermal properties of materials, electromagnetic properties of materials, superconductivity, chemical properties of materials (including environmental degradation), characteristics of specific engineering materials (alloys, ceramics, etc.), the selection of materials for specific applications, and the engineering of new materials to fulfill specific requirements. Students will acquire a working vocabulary and conceptual understanding necessary for advanced study, for communication with materials experts, and for the conceptualization of advanced systems. Prerequisites: SE2011.

#### SE2016 Battlespace Environments (4-2) Spring

This course covers the fundamentals of terrestrial science (geology, oceanography, meteorology, and near-earth space science) necessary for any systems engineer to understand how systems interact with and are influenced by their environment. Topics covered include the internal structure of the earth, tectonic processes, rocks and minerals, erosion and weathering, the water cycle, the structure and composition of the oceans, acoustic oceanography, oceanic currents, wave processes, structure of the atmosphere, temperature, pressure and winds, atmospheric water, weather systems, storms, weather forecasting, the extreme upper atmosphere, solar wind and magnetic storms, and the radiation belts. Prerequisites: SE2011.

#### SE2017 Fundamentals of Chemical Systems (4-2) Winter

This course covers the fundamentals of chemistry and chemical processes, necessary for any systems engineer to understand many key technologies affecting systems design. Topics covered include chemical bonding and chemical structure, chemical reactions, chemical equilibrium, reaction kinetics, solutions, and oxidation-reduction reactions. Prerequisites: SE2014, SE2011 or consent.

#### SE2018 Fundamentals of Biological Systems (4-2) Spring

This course covers the fundamentals of biological systems, especially human beings, which are necessary for any systems engineer to understand many key biological/biochemical/biophysical technologies affecting future systems design. Topics covered include basic anatomy and physiology, important biochemicals and biochemical processes, cell structure and cell processes, microbiology, disease and immunity, and bioculture. Prerequisites: SE2017.

#### SE2101 Introduction to Electro-Mechanical Systems (4-2) Summer/Winter

This course provides a basic understanding of the electromagnetic principles underlying combat systems. Relevance to military development is discussed. Practical tools are developed describing electric and magnetic fields, electromagnetic waves, special relativity, atomic energy levels, atomic binding, Schrödinger equation, energy bands in solids, nuclear particles, and radioactive decay. Prerequisites: SE1001, SE2003 and/or consent of instructor.



**SE2114 Information Systems and Operations (3-0)****Summer/Winter**

The impact of the network era through the proliferation of N-Tier applications has significantly transformed organizational processes and provided new strategic capabilities. These new N-tier applications have complex and dynamic components that require technical knowledge to develop and manage. This course provides an understanding of these technologies and demonstrates how networked applications may be used as a mechanism to support DoD transformation initiatives targeted at meeting the information needs of today's military. It combines the study of theory, best practices and hands-on laboratory exercises to improve understanding of how to select, develop and manage N-Tier applications. Prerequisites: None.

**SE3001 Special Topics in Strategic Analysis I (3-0) As Required**

This course develops a realistic understanding of processes and ideas that determine our national security posture and behavior: in short, how we design, develop and acquire our forces, and how we use them to influence international events, hopefully to deter war, and eventually, if necessary, to fight and win. Additionally, this course examines the generation of combat system requirements and the relationships between operational, financial planning, and technical communities in fielding a combat system that fulfills those requirements. Prerequisites: Consent of instructor.

**SE3002 Project Management (3-V) Spring/Fall**

This course examines modern techniques of engineering project management. Specific topics include review of the systems engineering management process, risk analysis and management, scheduling methodologies, the acquisition environment, management of design activities, and project control mechanisms. Case studies are used. During the lab period, the students develop the management plan for the annual campus-wide project. Prerequisites: None.

**SE3011 Engineering Economics and Cost Estimation (3-0) Summer/Winter**

An introduction to the cost aspects of systems engineering, exploring cost from a decision-making perspective. Examines how cost is used to select alternatives and how the cost of systems can be measured. Concepts covered include economic analysis, cost behavior, cost allocation, system cost, life cycle costs, cost over time, cost estimating techniques, cost uncertainty, and cost risk. Prerequisites: OS3180 or equivalent, or consent of instructor.

**SE3014 Fundamentals of Quantum Systems (4-2) As Required**

This course is the third of three calculus-based fundamental courses covering the basic principles underlying physical systems. This course is a survey of introductory quantum theory, atomic and molecular spectroscopy, solid state electronics, and nuclear physics. Subject matter covered also includes engineering topics such as lasers, semiconductors and integrated circuits, digital electronics, and superconducting electrical devices. Prerequisites: SE2011.

**SE3030 Quantitative Methods of Systems Engineering (3-2) Winter**

This course discusses advanced mathematical and computational techniques that find common application in

systems engineering. It also provides an introduction to MATLAB, a computational tool useful in obtaining quantitative answers to engineering problems. Among the topics addressed in this course are vector analysis, complex analysis, integral transforms, special functions, numerical solution of differential equations, and numerical analysis. Prerequisites: SE1002, SE3100 or consent of instructor.

**SE3100 Fundamentals of Systems Engineering (3-2) Spring/Fall**

Introduction to systems thinking and the processes and methods of systems engineering. The course covers fundamentals of systems engineering and system architecting, requirements analysis, functional analysis and allocation, preliminary system architecture, systems analysis, system design, and the basics of test and evaluation. Various perspectives, from frameworks, processes, and standards, such as the DoD Architecture Framework (DoDAF), DoD Joint Capabilities Integration and Development System (JCIDS), EIA 632, ISO 15288, IEEE 1220, IEEE 1471, and the International Council on Systems Engineering (INCOSE) models, are presented. Students analyze case studies. Students also use spreadsheet software for modeling and analyzing requirements and conceptual design alternatives. The course includes the application of fundamental systems engineering processes and methods to an integrative project, as well as development of communication skills through oral presentations and written reports.

**SE3112 Combat Systems Engineering I - Introduction to Sensors (3-0) Spring/Fall**

This is the first course of a survey of military sensor technology. It introduces the student to the nature of physical observables and propagators, the effects of the propagation medium on sensor performance, the relationship between signals and noise, and the characteristics of critical sensor functions (including detection, estimation, imaging, and tracking). It is designed to provide a framework for more detailed analysis of specific sensor systems in the follow-on course SE4112. Prerequisites: SE1002, SE2101 and/or consent of instructor.

**SE3113 Combat Systems Engineering II - Introduction to Weapons (3-0) Spring/Fall**

This is a survey of conventional military weapons technology. It introduces the student to both the effects that conventional weapons (artillery, bombs, and missiles) can produce as well as the technologies needed by weapons systems to create those effects. It is designed to provide familiarization of the student with critical weapons concepts that are necessary for enlightened examination of both technology development and military planning. Prerequisites: SE1002, SE2101 and/or consent of instructor.

**SE3115 Combat Technologies III - USW/ASW (3-0) As Required**

This course surveys the application of sensor, C4I, and weapon technologies to mines/counter-mines and undersea warfare. The course discusses the limitations the technologies place on the tactics of conducting these operations. Prerequisites: SE3112 or consent of instructor.

**SE3121 Introduction to C4ISR (3-0) Summer/Winter**

The study of command and control (C2) information processing and decision making in the context of adaptive

combat organizations and the C4ISR System Infrastructure that support it. Topics include: C2 decision processes [Observe-Orient-Decide-Act Loops, Problem Sensemaking (Identification) - Solution Finding and Implementation Processes], operational architectures, intelligence preparation of the Battlespace (IPB); mission success and organizational fitness. Prerequisites: Consent of instructor.

**SE3122 Naval Weapon Systems Technology - I (3-0) As Required**

This is the first of two courses that introduce the student to the technologies of combat systems. It starts with a brief survey of military sensor technology. It then introduces the student to effects of the propagation medium on sensor performance, the relationship between signals and noise, and the concepts of signature and signature control. The various sensor technologies involved in military applications of all kinds are presented as well as the essentials of C4ISR and the C4ISR Framework. Prerequisites: Consent of instructor.

**SE3123 Naval Weapon Systems Technology - II (3-0) As Required**

The second of a two course sequence, this course introduces the student to both the effects that weapons can produce as well as the technologies needed by weapons systems to create those effects, including the control elements. It is designed to provide an early initial familiarization of the student with critical weapons concepts. Analytic techniques are presented that allow the student to evaluate the interrelationships between the combat systems. Prerequisites: SE3122, or consent of instructor.

**SE3130 Network-Centric Operations and Warfare (3-0) Spring**

The course provides the student with an understanding of the breadth and depth of managing and operating a network-centric enterprise. Both business enterprises and warfighting enterprises are covered. Subject matter includes enterprise management and global operations, the role of information systems and technology, Web-enabled operations and information sharing, and the role of the network-centric systems engineer in developing and improving commercial and military enterprise systems. Prerequisites: None.

**SE3302 Systems Suitability (3-2) Spring/Fall**

This course presents the techniques of system design and assessment for operational feasibility, including reliability, maintainability, usability (including human factors and human performance), supportability, and producibility. Design methods for open architecture of hardware and software are presented. Software integration and management from a systems perspective is presented. Prerequisites: SE3100.

**SE3303 Systems Assessment (3-2) Summer/Winter**

Systems under development must be assessed for cost and effectiveness, and both cost and effectiveness must be managed during systems trades. This course presents a systems engineering perspective for framing such trade decisions. Topics include cost estimation, effectiveness estimation through the test and evaluation process and modeling, techniques for engineering trades, and managing the risk involved. The course applies these fundamental systems assessment processes and methods to an integrative system project, building on work done in SE3100 and SI3400.

Development of communication . Prerequisites: SE3100, SI3400.

**SE3321 Reliability Management and Data Systems (3-2) As Required**

The course focuses on the practical aspects of reliability analysis and management. Reliability aspects and functions are explained and illustrated using examples and calculus-level mathematics. Topics include: basic tools and methods of reliability for developing complex systems including electronic components, mechanical components, and software; data needs for effective reliability analysis and how to design and implement systems to acquire and store that data; and the principles and practices for developing cost-effective dependable (reliability and availability) systems. Case studies are used to illustrate the material. Prerequisites: None.

**SE3322 Reliability Centered Maintenance (3-2) As Required**

The course covers the fundamentals of reliability centered maintenance and current practices following both military and industry standards. It also presents modifications that have been implemented for different applications and explains their suitability. An important aspect of the course is to examine and quantify the role of maintenance on operations, safety, and its economic benefits. Software tools for implementation are presented. The course includes a class project to develop and implement a pilot application of RCM to an identified site need. Prerequisites: SE3321.

**SE3502 Distributed Systems Engineering (3-2) Spring**

This course is designed as part of the Network-Centric Systems Engineering track of the Master of Science in Systems Engineering (MSSE) program. The course provides the student with an understanding of the principles, concepts, and technology that allow a network-centric enterprise to function. Subject matter includes system communications, computer-based processes, naming conventions, process synchronization, consistency, replication, state-of-the-art middleware, and distributed information systems. Prerequisites: CS3010, CS2900 and SE3130, or consent of instructor.

**SE3503 System Performance Evaluation (3-2) Fall**

This course provides the student with the principles, concepts and techniques needed to analyze and plan the capacity of computer systems. The course relies on the use of analytic queuing network models of computer systems. Queuing network modeling is applied to evaluating the performance of centralized, distributed, parallel, client/server, and Web-based systems performance. The course also covers performance measurement tools for various computer operating systems and for large-scale, network-centric systems. Prerequisites: CS3010, CS2900 and SE3501, or consent of instructor.

**SE4000 Systems Engineering Seminar (2-0) Spring/Summer/Fall/Winter**

This weekly seminar provides integrating and reinforcing time to establish continuity for the SEI Project. The goal is to keep the entire project team abreast of refinements and amplifications by bringing new analysis techniques/viewpoints gained during each individual's specialized track. Prerequisites: Consent of instructor.

**SE4001 Systems Engineering and Architecture (4-1)  
Summer/Winter**

This course presents the methodological framework and techniques for designing, implementing, managing and reengineering large-scale systems or processes. Students learn engineering design and engineering management processes and gain an appreciation for future environments and system life cycles. Students analyze case studies and complete a course project. Students also use spreadsheet software (in conjunction with complementary analysis course) for modeling and analyzing design alternatives and develop communication skills through oral presentations and written reports. Corequisite: OS4680.

**SE4003 Systems Software Engineering (3-2)  
Spring/Fall**

This course is designed to teach students the basic concepts of software engineering and methods for requirements definition, design and testing of software. Specific topics include introduction to the software life cycle, basic concepts and principles of software engineering, object-oriented methods for requirements analysis, software design and development. Special emphasis is placed on the integration of software with other components of a larger system. Prerequisites: SE2114, SE3121, or consent of instructor.

**SE4007 Introduction to Systems Engineering (2-1)  
Spring/Summer/Fall/Winter**

This course provides an overview of the art and science of systems engineering and an introduction to the systems approach and methodological framework for designing, implementing, managing, and reengineering large-scale systems and processes. Topics covered include the systems approach, understanding and defining customer (stakeholder) problems, eliciting and defining stakeholder requirements, defining stakeholder-driven value systems, developing alternative system concepts, and functional modeling and analysis of alternatives. Students will carry out projects and assignments both individually and as teams. Prerequisites: SI3400 or equivalent.

**SE4008 Systems Engineering and Integration (2-1) As Required**

Customer requirements modeling and subsequent system functional and architecture modeling, form the basis for engineering and integrating complex technical systems and processes. This course provides the student with the language, terminology, and concepts of system architecting and an introduction to various types of architectures and their interrelationships. Topics covered include organizational systems, architecture modeling (e.g., the Hatley/Hruschka/Pribhai Method, the Rummler-Brache Method), types and relationships of architectures and architectural frameworks (including the C4ISR Framework and the Zachman Framework), human and cultural aspects of architecting, process engineering, information engineering and architectures, and knowledge formation and distribution. Students will carry out projects and assignments both individually and as teams. Upon successful completion of this course, the student will receive a Defense Acquisition University SYS-201 certificate. Prerequisites: SE4007.

**SE4009 Systems Architecture for Systems Engineering (2-1) As Required**

This course provides the student with an understanding of the context and framework for carrying out a systems engineering project and the system-level responsibilities of a systems engineer. Topics covered include systems architecture, systems design and development, system test and evaluation, system reliability, system maintainability, human factors and system design, system producibility and supportability, balancing live cycle cost, schedule, suitability, and performance, and systems engineering project management and control. Types of systems considered will range from small-scale to large-scale and from primarily technical to primarily social-political. Students will work in teams to complete a system engineering project to analyze, design and architect a working prototype system. Upon successful completion of this course, the student will receive a Defense Acquisition University SYS-301 certificate. Prerequisites: SE4008, or equivalent.

**SE4011 Systems Engineering for Acquisition Managers (3-2) Summer/Winter**

Systems engineers flow requirements down to detailed elements, integrate elements, and verify system performance. This course concentrates on the structural and technical elements of system engineering necessary in the product development domain. Multidisciplinary activities leading to requirements analysis, design trades, and integrated product-process development are complemented by current best manufacturing practices and design for cost principles. Structured methods, decision analysis, and quality engineering foundations are emphasized. Case studies from a variety of industrial contexts are presented and discussed. This course is team taught by experts from several disciplines. Prerequisites: None.

**SE4012 Management of Advanced Systems Engineering (4-0) Summer/Winter**

This course provides the student with an understanding of architecting, Object Oriented Systems Engineering, the Unified Modeling Language, and the control of complex projects with many Systems Engineers through the use of metrics. Specific emphasis is placed on exploring the relationship between science, art, deductive processes, inductive processes, systems engineering, and acquisition management. In order to solve today's complex problems, the student will become familiar with heuristic tools. This course is equivalent to DAU SYS 301. Prerequisites: None.

**SE4021 Systems Engineering for Product Development (4-0) Summer/Winter**

Systems engineers flow requirements down to detailed elements, integrate elements, and verify system performance. This course concentrates on the structural and technical elements of system engineering necessary in the product development domain. Multidisciplinary activities leading to requirements analysis, design trades, and integrated product-process development are complemented by current best manufacturing practices and design for cost principles. Structured methods, decision analysis, and quality engineering foundations are emphasized. Case studies from a variety of industrial contexts are presented and discussed. This course is team taught by experts from several disciplines. Prerequisites: None.

**SE4022 Systems Architecture for Product Development (4-0) Summer/Winter**

Systems architects respond to user needs, define and allocate functionality, decompose the system, and define interfaces. This course presents a synthetic view of system architecture: the allocation of functionality and its projection on organizational functionality; the analysis of complexity and methods of decomposition and re-integration; consideration of downstream processes including manufacturing and operations. Physical systems and software systems are discussed. Heuristic and formal methods will be presented. Students are given research assignments that provide opportunities to further learn how systems architecture principles are applied in a variety of application areas. This course provides an integrative forum for PD21 students to stimulate holistic, global, and innovative thinking, and to enable critical evaluation of current modes of architecture. Prerequisites: None.

**SE4112 Combat Systems Engineering III (3-2) Summer/Winter**

This course applies systems engineering principles to the design of combat systems with emphasis on detection, tracking, and identification systems. Sensor technologies covered include radars, ESM, active and passive sonar, infrared, electro-optical, and magnetic/electric/gravity field sensors. The emphasis is on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, trade-offs, and their interfaces with the rest of the combat system. This course builds on the material offered in SE3112 (Intro to Sensors). Prerequisites: SE3112, SE3113.

**SE4113 Combat System Engineering IV (3-2) Spring/Fall**

This course extends the coverage of SE3113 (Conventional Weapons) to include unconventional weapons. Topics include information warfare and weapons (including electronic warfare), directed energy weapons, weapons of mass destruction (nuclear, chemical, biological, and radiological), and nonlethal weapons. It introduces the student to both the effects that unconventional weapons can produce as well as the technologies needed by weapons systems to create those effects. It is designed to provide familiarization of the student with critical weapons concepts that are necessary for enlightened examination of both technology development and military planning. Prerequisites: SE4112.

**SE4115 Combat Systems Integration (3-2) As Required**

This course presents systems engineering techniques for integrating combat systems into a common system, including technology development, system development and integration, network integration, and system of systems integration. Lectures and projects exploring engineering design tools and analysis methods to meet specified systems requirements are used. Topics include engineering analysis of interfaces for power, data, mechanical, and other attributes; engineering change management; advanced collaboration environments; technology readiness levels; and integration risk mitigation. Prerequisites: SE3113 or equivalent.

**SE4321 Reliability Growth and Accelerated Testing (4-1) As Required**

This course covers mathematical and statistical models used in advanced reliability engineering and the art of their

application. Reliability growth models include the AMSSA-Crow, Duane, and Lloyd-Lipow models. Accelerated testing models include the Arrhenius, Eyring, and Inverse-power Law. Statistical and practical issues in model selection and parameter estimation are discussed. Particular emphasis is placed on design of test plans. Prerequisite: OA4302.

**SE4501 Network-Centric Enterprise Design and Engineering (3-2) Spring**

This course provides the concepts, principles, and approaches necessary to understand the enterprise (warfighting force or business organization—private or public) as a functioning system or system of systems. It also introduces a method for enterprise modeling and design and discusses the functions of enterprise engineering. As a result, the student will be given the tools to understand large-scale system (i.e., enterprise) engineering and its relationship with network-centric technologies and components. Prerequisites: CS3010, CS2900 and SE3501, or consent of instructor.

**SE4503 Technology Planning and Replacement (3-2) Spring**

Often, enterprise managers make information resource management decisions based only on costs of acquiring, maintaining, and replacing information technology—the proverbial IT tail wags the business dog. While cost is certainly important, planning and replacement of the IT infrastructure should be driven by a solid business case based on total enterprise needs. This course examines the business-driven approach to information resource management in a network-centric enterprise. Prerequisites: SE3130 or consent of instructor.

**SE4900 Advanced Studies in Systems Engineering and Integration (3-0) Spring/Winter**

This course presents advanced topics in Systems Engineering relevant to in depth, focused graduate research and thesis work. Course may be repeated for credit. Prerequisites: Consent of instructor.

*SI Courses***SI0811 Integrating Project (0-8) Spring/Summer/Fall/Winter**

This course for students pursuing a systems engineering degree. Students are awarded grade of 'T' upon successful completion of their theses.

**SI3400 Fundamentals of Engineering Project Management (3-2) Summer/Winter**

This course examines modern techniques of engineering project management from a systems perspective, including project planning, organization, and control. Specific topics include discussion of the systems engineering management process, risk management, scheduling methodologies, the DoD acquisition environment, management of design activities, PERT, CPM, and project control mechanisms. Case studies are used to examine application of principles. Large-scale system management, mitigation of technical risk, integrated product and process development, quality management, contracting, and the international environment are discussed. Large scale systems management problems are examined using commercial software suites. Covers application of fundamental systems project management processes and methods to an integrative system project.

Development of communication skills is accomplished through oral presentations and written reports. Prerequisites: None.

### **SI3900 Topics in Systems Engineering and Analysis (3-0) Spring**

This course presents topics in systems engineering and analysis that are relevant to the across-campus project or that meet special interests of the students. Prerequisites: Consent of instructor.

## **Systems Engineering and Analysis Program - Curriculum 308**

This curriculum is described under the Systems Engineering and Analysis Curriculum Committee (SEACC) section of this Catalog. The Department of Systems Engineering supports this curriculum with courses and project advisors. Selected students in the 308 curriculum may earn the MS SE degree, awarded by the Department.

## **Systems Engineering (DL) - Curriculum 311**

### **Program Manager**

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### **Brief Overview**

The Master of Science in Systems Engineering DL degree program is designed for DoD organizations involved in a wide range of systems engineering and integration challenges. These commands can partner with NPS to educate and train engineers with tools and technologies relevant to their work, resulting in employees with greater knowledge and expertise to enable them to better meet the needs of their customers.

DoD organizations or sponsors provide the students, and the Department of Systems Engineering provides the instruction, course materials, and hands-on experience. Courses are delivered at the students' local site using a combination of on-site instruction, video conferencing, and Web-enhanced on-line courses. The program can begin any academic quarter, in accordance with the sponsor's needs.

Students take two courses per quarter over a two-year period. There are ten core courses in the 16-course program. The remaining six courses can be tailored to meet the sponsor's need. Students must participate in a capstone design project in lieu of writing a thesis.

Students receive an NPS degree, may receive NPS Systems Engineering certificates of accomplishment, and earn DAU equivalency certificates for all SPRDE Level III training requirements.

The program manager will help establish partnership arrangements with other organizations if desired. Additional information on the program can be found at [www.nps.navy.mil/se/msse](http://www.nps.navy.mil/se/msse)

### **Requirements for Entry**

An entering student must possess a Bachelor of Science degree in an engineering discipline with at least a 2.2 undergraduate grade point average.

### **Entry Dates**

This is an eight-quarter curriculum that may start any quarter chosen by the sponsor.

### **Degree**

#### **Master of Science in Systems Engineering**

To be considered for this degree, a student must enter the curriculum with an ABET accreditable engineering BS degree or establish equivalency with an ABET degree, and complete all the requirements of curriculum #311.

#### **Master of Science in Engineering Science**

Students who enter without an ABET accreditable engineering BS degree and cannot establish equivalency, and who complete all the requirements of curriculum #311, will earn a Master of Science in Engineering Science degree.

### **Typical Course of Study**

The typical course of study for curriculum 311 involves a four-course core systems engineering sequence, a three-course project, prerequisites, and an agreed-upon emphasis or domain track. This track is selected by the sponsor, program manager, and academic associate.

#### **Quarter 1**

MN3221	(3-0)	Principles of Systems Acquisition & Program Management I
SW3460	(3-1)	Software Methodology

#### **Quarter 2**

MN3222	(3-0)	Principles of Systems Acquisition & Program Mgt- II
SE3100	(3-2)	Fundamentals of Systems Engineering

**Quarter 3**

SI3400	(3-2)	Engineering Project Management
OS2100	(3-1)	Statistics for Systems Engineering

**Quarter 4**

SE3302	(4-1)	System Suitability
SE3122	(3-0)	Naval Weapon Systems Technology I

**Quarter 5**

SE3303	(4-2)	Systems Assessment
SE3123	(3-0)	Naval Weapon Systems Technology II

**Quarter 6**

SI0810	(0-8)	Capstone Design Project— Requirements Generation
OS3301	(3-0)	Simulation Modeling & Analysis

**Quarter 7**

SI0810	(0-8)	Capstone Design Project—Synthesis of Alternatives
SW4582	(3-0)	Weapon System Software Safety

**Quarter 8**

SI0810	(0-8)	Capstone Design Project—Concept Definition
OS3401	(3-1)	Human Factors and Safety Systems Engineering

**Systems Engineering - Curriculum 580****Program Officer**

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**Brief Overview**

Systems Engineering at NPS provides a broad education in systems engineering methods and tools, and depth in a particular domain of application. Several domain tracks are offered, including combat systems engineering, ship systems engineering, and network-centric systems engineering. Other tracks are added, based on sponsor and student demand. The tracks consist of eight or more courses to gain depth in the domain area. These tracks complement the standard set of systems engineering courses. The curriculum is interdisciplinary and draws on courses from across campus.

Students come from the uniformed services, civilian members of government, and from foreign military services. Navy Engineering Duty Officers constitute a substantial portion of the students.

**Requirements for Entry**

Students must have an academic profile code of 323, which implies a 2.2 or better undergraduate GPA, a calculus sequence with a C+ or better grade, and a calculus-based physics sequence with a C+ or better grade.

**Entry Dates**

Students may enter this curriculum once a year, in July. Students requiring a refresher quarter to meet entrance requirements will begin in April. For further information, contact the Program Officer or Academic Associate for this curriculum.

**Subspecialty**

Completion of this curriculum qualifies a naval officer as a systems engineering sub-specialist, subspecialty code 5800. The curriculum sponsor is the Commander, Naval Sea Systems Command.

**Typical Course of Study**

Students have a wide set of options for their specialization tracks. Below is a typical course matrix for the ship systems track.

**Quarter 1**

SE1001	(4-2)	Math I for Systems Engineering
SE1002	(2-1)	Math II for Systems Engineering
PH1001	(4-2)	Fundamentals of Physics I
PH1002	(4-2)	Fundamentals of Physics II

**Quarter 2**

SE3100	(3-2)	Fundamentals of Systems Engineering
OS3180	(4-1)	Probability and Statistics for Systems Engineering
NW3230	(4-2)	Strategy and Policy
PH2652		Modern Physics

**Quarter 3**

SI3400	(3-2)	Fundamentals of Engineering Project Management
SE3030	(3-2)	Quantitative Methods in Systems Engineering
SE2017	(4-2)	Fundamentals of Chemical Systems
SE2015	(3-2)	Material Systems

**Quarter 4**

SE3302	(4-1)	System Suitability
OS3380	(3-1)	Combat System Simulation
SE2018	(4-2)	Fundamentals of Biological Systems
SE2016	(4-2)	Battlespace Environments

**Quarter 5**

OA4702	(4-0)	Cost Estimation
SE4003	(3-2)	Computer and Software Systems Engineering
SE3113	(3-1)	Combat Technologies II— Introduction to Weapons
SE3112	(3-0)	Introduction to Sensors

**Quarter 6**

OS3401	(3-1)	Human Factors and Safety
ME4700	(3-2)	Weaponering
SE4113	(3-2)	Combat Systems Engineering
SE4112	(3-2)	Sensor Technologies

**Quarter 7**

OS4680	(4-0)	Systems Analysis
OS4580	(4-0)	Reliability, Maintainability, and Logistics
CC3000	(4-0)	Introduction to C4I Systems in DoD
SI0810	(0-8)	Capstone Systems Engineering Project

**Quarter 8**

ME3750	(4-0)	Platform Survivability
TS4000	(3-2)	Naval Combat Systems Engineering
SE0811		Systems Engineering Thesis
SI0810	(0-8)	Capstone Systems Engineering Project

**Quarter 9**

OA4603	(4-0)	Test and Evaluation
SE0811		Systems Engineering Thesis
SI0810	(0-8)	Capstone Systems Engineering Project
SI0810	(0-8)	Capstone Systems Engineering Project

**Educational Skill Requirements**  
**Systems Engineering Curriculum 580**  
**Subspecialty Code 5800P**

Officers entering the Systems Engineering curriculum will be offered the necessary preparatory-level courses to satisfy the equivalent of a baccalaureate degree in engineering. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET). At the graduate level, the officer will acquire the competence to effectively contribute as a systems engineer to naval systems research, design, development, maintenance and acquisition. The officer will gain the ability to effectively integrate future technological, engineering, and acquisition approaches with existing practice through a combination of core systems engineering courses, specialization studies, and project/thesis research. An officer will meet the below-listed ESRs through the completion of a program of study determined by the officer, the Program Officer, and

the academic associate. Individual programs, and how they support the officer's attainment of the ESRs, will be specifically designed to meet the needs of the Navy and the officer's interests.

- Undergraduate Mathematics and Basic Sciences:** Understand and apply engineering-baccalaureate-equivalent mathematics and basic sciences. For mathematics, this includes single- and multi-variable differential and integral calculus, ordinary differential equations, probability, and statistics. Basic sciences include physics, chemistry, and terrestrial sciences. This can be met by the appropriate undergraduate work.
- System Design:** Understand and apply the system-design process in a naval systems context, including defining requirements, conducting functional analysis, creating a functional system design, designing and architecting a system, evaluating system design against system requirements, allocating requirements to sub-systems, hardware, and software, conducting trade-off studies, estimating the cost of the system, integrating human factors into the system design, designing for reliability, availability, and logistical supportability, and planning for its testing and evaluation. Estimate and mitigate risk. Understand the principles of and apply current industry approaches and technology to manage systems design.
- Systems Architecting:** Construct feasible system architectures that represent a balanced approach to meeting stakeholder expectations, stated system requirements, and suitability objectives, such as being open, modular, extensible, maintainable, and reusable. Develop, analyze, and compare alternative architectures against appropriate, system-level evaluation criteria.
- System Test and Integration:** Apply the core skills of system test and integration, to include integrating relevant technological disciplines that bear on weapons, sensor, and information systems, while being responsive to realistic military requirements, specifications and cost limitations. Design experiments using fractional factorial methods and response surface methodologies. Apply fundamental verification and validation principles to the construction of systems that satisfy customer needs, with emphasis on combat systems. Understand the principles of and apply current industry approaches and technology to manage systems integration.

5. **Systems Analysis:** Understand and apply core qualitative and quantitative skills of systems analysis, to include problem formulation, alternatives development, alternatives modeling and evaluation, alternatives comparison, optimization, decision analysis, risk analysis, and futures analysis. Mathematical techniques include linear programming, integer programming, and probabilistic analysis.
6. **Modeling and Simulation:** Understand and apply modeling and simulation to include deterministic and stochastic modeling of systems, economic models, cost models, and lifecycle supportability analysis. This includes familiarity with large-scale commercial combat simulations as well as the ability to develop original discrete-event and continuous run-time simulations.
7. **Human Systems Integration:** Address human factors during requirements generation, as well as workload, safety, training, operability and ergonomics during design. Evaluate proposed designs for man-machine integration during test and evaluation. Understand biological systems as they apply to man-machine interface.
8. **Operations Analysis:** Know and apply U.S./Allied and potential enemy capabilities, doctrine, tactical and logistical support concepts to emerging systems requirements. Model and analyze military operations and systems using Operations Analysis techniques, and be able to integrate emerging tactical concepts and systems.
9. **Project Management:** Work as a team member or leader in a large-scale or enterprise-level, military, systems engineering project. Demonstrate an understanding of project management principles. Demonstrate competence in the planning and management of complex projects. Understand the principles of and apply current industry approaches and technology to manage large engineering projects.
10. **Specialization:** Demonstrate in-depth understanding at the level of a graduate minor of the technologies and systems used in at least one major specialty area. These areas can be specific warfare areas, such as EW, IW, and undersea warfare, or in a single engineering specialty, such as mechanical, electrical or software engineering. Demonstrate a broad understanding of sensors, weapons, C4I systems, and information systems. Apply that understanding to the design of system components, sub-systems, and interfaces.
11. **Joint and Maritime Strategic Planning:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
12. **Thesis:** Conduct independent analysis and research in the area of Systems Engineering, and show proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

## Systems Engineering Management (MSSEM) /Product Development (DL) - Curriculum 721

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### Brief Overview

The Naval Postgraduate School (NPS), as a partner in the Massachusetts Institute of Technology's (MIT) "Educational Consortium for Product Development Leadership in the 21st Century" (PD21), is delivering a joint executive systems engineering management degree using distance learning methods to military officers, senior enlisted, federal civilians and a limited number of defense contractor civilians. The program's joint focus is on joint services, joint engineering-management and joint government-industry. The joint executive SEM-PD21 degree program is modeled after the prototypic graduate program developed by MIT jointly between their School of Engineering and Sloan School of Management. The executive SEM-PD21 degree is designed to produce a



cadre of change agents skilled in engineering and management to bring about dramatic improvements in the way American corporations and the defense industry develop and build new systems and products.

Participants in this unique program are exposed to state-of-the-art concepts and tools, as well as world-class companies, leaders, and cross-industry best practices. Students acquire the foundation skills and strategic perspective necessary to become future leaders and senior managers responsible for driving product development and business growth through innovation, and become effective change agents at their companies. They develop a mindset receptive to change and continuous improvement, an understanding of the enablers to business success, and an enhanced ability to recognize barriers to success early in the product development cycle when corrective actions are least costly.

The SEM-PD21 curriculum is an eight-quarter distance learning curriculum with entry in the Fall quarter, which begins in late September with an onsite two-week kickoff at NPS in Monterey, CA. After the kickoff, classes are taken at students' sponsoring command locations by video teleconferencing or online. Students are expected to participate in two-three industry trips during the two-year course of study and a graduation ceremony in Monterey at the completion of the program. There will also be occasional Systems Engineering and Product Development seminars for all SEM-PD21 students within their existing course of study.

#### **SEM-PD21 website:**

[http://www.nps.edu/dl/NPSO/degree\\_progs/PD21.html](http://www.nps.edu/dl/NPSO/degree_progs/PD21.html)

#### **Requirements for Entry**

For entry, the student must hold an undergraduate degree in engineering, or a related scientific or technical field, with high academic achievement. The student must be sponsored by an organization committed to supporting the student's full participation and have at least five years of experience directly related to product development (three years if student holds a master's degree). The application requirements can be found at the joint executive SEM-PD21 website at [http://www.nps.edu/dl/NPSO/degree\\_progs/PD21.html](http://www.nps.edu/dl/NPSO/degree_progs/PD21.html)

#### **Entry Dates**

September (Fall quarter)

#### **Program Length**

Eight distance learning quarters (two years).

## **Degree**

### **Master of Science in Systems Engineering Management**

To be considered for this degree a student must enter the curriculum with an ABET accreditable engineering BS degree or establish equivalency with an ABET degree, complete all the requirements of curriculum #721, and have approval of their program by the Chair, Department of Systems Engineering.

### **Master of Science in Product Development**

- Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.
- Completion of an acceptable thesis, with at least one advisor from the Naval Postgraduate School.
- Approval of the candidate's program by the Chair, Department of Systems Engineering

### **Curriculum Sponsors**

Any federal organization or defense contractor can sponsor students into the SEM-PD21 program. In addition to earning a master's degree, the curriculum satisfies the mandatory Defense Acquisition University (DAU) Systems Planning, Research, Development, and Engineering (SPRDE) course requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) through Level III. Students who select the Systems Acquisition elective track also earn mandatory DAU course requirements for Program Management through Level III. Other elective tracks offer additional NPS certificates in Space Systems, Information Systems, Software Engineering or Advanced Systems Engineering. Students who complete the program also earn a MIT certificate of recognition.

### **Typical Course of Study**

#### **Quarter 1**

MN3108	(3-2)	Leadership in Product Development
MN3117	(4-0)	Organizational Processes

#### **Quarter 2**

MN3156	(4-0)	Finance and Managerial Accounting
SE4021	(3-2)	Systems Engineering For Product Development

#### **Quarter 3**

OS4010	(3-2)	Engineering-Risk Benefit Analysis
SE4022	(4-0)	Systems Architecture

**Quarter 4**

MN3392	(4-0)	Systems and Project Management
MN3145	(4-0)	Marketing Management

**Quarter 5**

OS3211	(4-0)	Systems Optimization
Mgmt/Eng	(4-0)	Elective

**Quarter 6**

MN4379	(4-0)	Operations Management
Mgmt/Eng	(4-0)	Elective

**Quarter 7**

SI0810	(0-8)	Thesis Research
Mgmt/Eng	4-0)	Elective

**Quarter 8**

SI0810	(0-8)	Thesis Research
Mgmt/Eng	(4-0)	Elective
MN2304	(0-8)	Systems Engineering and Product Development Seminar

*(Note: Seminar used throughout program but credits given final quarter)*

**Elective Tracks:**

Sponsors and students have great flexibility in designing their elective structure. Currently, there are five advertised elective tracks that, when taken with SEM-PD21 core/fundamental courses, earn participating students additional certifications in Systems Acquisition (DAWIA PMT352), Space Systems, Information Systems, Software Engineering and Advanced Systems Engineering. Other elective tracks can be designed by contacting the academic associate.

**Systems Engineering Certificate - Curriculum 282****Program Officer**

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**Academic Associate**

Cliff Whitcomb, Associate Professor  
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The Department of Systems Engineering offers a four-course academic certificate in Systems Engineering. The four courses are offered online, beginning Spring and Fall quarters.

**Requirements for Entry**

For entry, the officer must have at least a C+ undergraduate grade point average, with at least one calculus course with a C or better and at least one calculus-based physics course with a C or better (APC 334). If an officer is an outstanding performer but lacks the necessary academic preparation, the Naval Postgraduate School offers refresher and transition courses before the program start.

**Typical Course of Study****Quarter 1**

SE3100 (3-2) Fundamentals of Systems Engineering

**Quarter 2**

SI3400 (3-2) Fundamentals of Engineering Project Management

**Quarter 3**

SE3302 (3-2) Systems Suitability

**Quarter 4**

SE3303 (3-2) Systems Assessment

**Undersea Warfare Academic Committee****Chairman**

Donald P. Brutzman  
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**Roger F. Bacon**, VADM, USN (Ret.), Chair Undersea Warfare and Director of Undersea Warfare Research Center (2003)\*; M.S., Naval Postgraduate School, 1969

**Steven Richard Baker**, Associate Professor (1985); Ph.D., University of California at Los Angeles, 1985

**Mary Batteen**, Chairperson and Professor of Oceanography (1985); Ph.D., Oregon State University, 1984

**Ronald E. Brown**, Research Professor, Department of Physics (2002); Ph.D., University of Southern California, 1972

**Donald P. Brutzman**, Undersea Warfare Academic Committee Chair, Associate Professor (1995); Ph.D., Naval Postgraduate School, Monterey, 1994

**Peter C. Chu**, Professor of Oceanography (1986); Ph.D., University of Chicago, 1985

**Roberto Cristi**, Associate Professor (1985); Ph.D., University of Massachusetts, 1983

**Curt Collins**, Professor of Oceanography (1987); Ph.D., Oregon State University, 1967

**James Norfleet Eagle**, II, Chairman and Professor of Operations Research (1983); Ph.D., Stanford University, 1975

**John M. Green**, Senior Lecturer, System Engineering and Integration (2002); M.S., Naval War College, 1982; MA, Salve Regina College, 1984; M.S., University of New Haven, 1986; MBA, University of New Haven, 1998;

**Arlene Guest**, Senior Lecturer, Department of Oceanography, (1999); M.S., Florida State University, 1981

**Anthony Healey**, Distinguished Professor of Mechanical Engineering (1986); Ph.D., Sheffield University, United Kingdom, 1966

**Michaele Lee Huygen**, Reference Librarian, Dudley Knox Library, Naval Postgraduate School (1996); BS, New Mexico Tech 1967, MLS, San Jose State University 1979

**John Joseph**, CDR, USN (Ret.), Research Associate (2006); M.S., Radford University, 1979, M.S., Naval Postgraduate School, 1991

**Daphne Kapolka**, Senior Lecturer, Academic Associate for Undersea Warfare (USW) Curriculum (2003); Ph.D., Applied Physics, Naval Postgraduate School, 1997

**Denise M. Kruse**, Undersea Warfare Program Officer (2006); M.S., Troy State University, 1993; M.S., Naval Postgraduate School, 2000

**Andres Larraza**, Associate Professor of Physics, Academic Associate for Combat Systems Science & Technology Curriculum (1994); Ph.D., University of California at Los Angeles, 1987

**D. Benjamin Reeder**, CDR, USN, Oceanography Department (2004); Ph.D. Massachusetts Institute of Technology (MIT) / Woods Hole Oceanographic Institute (WHOI), 2000

**Joseph Rice**, Research Chair of Engineering Acoustics (2000); M.S., University of California at San Diego, 1990

**Clyde Scandrett**, Chair and Associate Professor of Mathematics (1987); Ph.D., Northwestern University, 1985

**Kevin B. Smith**, Associate Professor (1995); Ph.D., University of Miami, 1991

**Rebecca Stone**, CDR, USN, Oceanography Department (2004); Ph.D., Naval Postgraduate School, 1999

**Edward Thornton**, Distinguished Professor of Oceanography (1969); Ph.D., University of Florida, 1970

**Donald Walters**, Professor of Physics (1983); Ph.D., Kansas State University, 1971

**Alan Washburn**, Emeritus Professor of Operations Research (1970); Ph.D., Carnegie Institute of Technology, 1965

**Richard D. Williams III**, RADM, USN (Ret.), Chair of Mine Warfare, Assistant Director of Undersea Warfare Research Center (2005); M.S., Naval Postgraduate School, 1972

**Lawrence J. Ziomek**, Professor of Electrical and Computer Engineering (1982); Ph.D., Pennsylvania State University, 1981

\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

### Brief Overview

The Undersea Warfare Academic Committee (USWAC) is an interdisciplinary association of faculty and academic professorships providing oversight for multiple Undersea Warfare (UW) degree programs. The USWAC has administrative responsibility for the academic content of the UW program of study. Teaching in this interdisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Oceanography, Operations Research, Mechanical Engineering and Physics. Affiliated with the USWAC is the Undersea Warfare Research Center (USWRC) and the Center for Autonomous Underwater Vehicle (AUV) Research. The Chair, ASWAC approves thesis topics for students in the Undersea Warfare curriculums. The committee chair approves the final thesis in addition to the academic department granting the degree.

### Undersea Warfare Course Descriptions

#### *UW Courses*

**UW0001 Seminar (0-1) Spring/Summer/Fall/Winter**  
Special lectures and discussion of matters related to the USW Program, Prerequisite: Enrollment in the USW Curriculum (for U.S. citizens). Classification: SECRET.

**UW0810 Thesis Research/Group Project (0-8) As Required**

Students in the USW curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

**UW3301 History of Undersea Warfare in the 20th Century (4-0) Fall**

A study of submarine warfare, antisubmarine warfare, and mine warfare during the 20th century. Starting with the development of submarines and mines at the end of the 19th century, the progression of the three warfare areas is tracked through the end of the 20th century. The lessons of this history continue to have implications for the future of naval warfare. Numerous lessons reappear from the Russo-Japanese War of 1905 on through World War I, World War II, the Korean conflict, the Vietnam War, the Cold war, Desert Shield/Desert Storm, and Operation Iraqi Freedom. Technical innovations with significant impact on this historical period are covered as part of this course. Students are required to conduct a 10-page study and presentation on the historical impact of one of these warfare areas during the 20th century.

**UW3303 Modeling and Simulation for Undersea Warfare (4-1) Spring**

Design, implementation and analysis using digital simulation models, with emphasis on physics-based modeling of military systems. Simulation is a discipline that cut across all technical fields complementing both theory and experiment as a component of the scientific method. Course topics include a broad view of analytic simulation, properly designing and structuring simulation problems, extending student programming skills to include the MATLAB language, use of on-line tutorials, and the use of public-domain X3D model archives. This course provides tools, techniques and repeatable methodology that can be used to support thesis work and projects in other classes. Examples and class projects are typically oriented to problems of military or scientific interests.

**Undersea Warfare - Curriculum 525****Program Officer**

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**Brief Overview**

The Undersea Warfare Curriculum educates officers in the engineering fundamentals, physical principles

and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. The USW program is interdisciplinary and integrates many subjects: acoustics, electrical engineering, mathematics, meteorology, oceanography, physics, operations analysis, human factors, computer science, and robotics.

This curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for Joint Professional Military Education for Intermediate Level Professional Military Education (JPME Phase I) as established by the Chairman, Joint Chiefs of Staff.

**Requirements for Entry**

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of refresher math and/or physics as needed.

**Entry Date**

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or Program Officer. A four-quarter course of study has been designed for students that are accepted in the Immediate Graduate Education Program (IGEP). IGEP students begin their program in July.

**Degree**

This interdisciplinary program divides naturally into five major academic areas, allowing the student to specialize in the area of choice. Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for the various degrees, depending upon academic qualifications, the specialization sequence selected, and the thesis. A student can earn one of the following degrees in the Undersea Warfare (Curriculum 525/526): Master of Science in Engineering Acoustics, Electrical Engineering, Physical Oceanography, and Applied Science. Required classes vary by degree.

**Master of Science in Engineering Acoustics**

The degree Master of Science in Engineering Acoustics will be awarded as an interdisciplinary program in accordance with the following degree requirements:

1. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.
2. The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter-hours of course work; at least 20 graduate quarter-hours must be taken in acoustics and its applications. Three 4000 level courses must be included from any three of the following six areas: wave propagation; transducer theory and design; noise, shock, and vibration control; sonar systems; signal processing; and communications. In addition, these courses must include at least one from each of the sponsoring disciplines (physics and electrical engineering).
3. An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

#### **Doctor of Philosophy and Doctor of Engineering**

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the degree Doctor of Philosophy or Doctor of Engineering. Areas of special strength in the departments are physical acoustics, underwater acoustics and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other Federal Government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctor's degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student

#### **Master of Science in Physical Oceanography**

(with emphasis on the prediction of the littoral battlespace environment, ocean acoustics and environmental effects on sonar performance)

#### **Master of Science in Electrical Engineering**

(with emphasis on communications or signal processing)

#### **Master of Science in Operations Research**

(with emphasis on tactical applications and decision analysis)

#### **Master of Science in Mechanical Engineering**

(with emphasis on autonomous systems)

#### **Master of Science in Engineering Science**

(with emphasis on autonomous systems)

#### **Master of Science in Applied Science**

Students who have limited time for degree completion or whose technical backgrounds are weak may choose to pursue a Master of Science in Applied Science (Signal Processing), (Physical Oceanography), (Acoustics), or (Operations Research) degree.

#### **Subspecialty**

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of 6301P. The curriculum sponsors are N77 (Submarine Warfare) and N75 (Expeditionary Warfare).

#### **Typical Subspecialty Jobs**

Naval Undersea Warfare Center  
COMINELWARCOM  
Naval Air Warfare Center  
Submarine Development Squadron Twelve  
Program Executive Offices  
Patrol Wing Staffs  
Carrier Group Staffs  
Naval Air Systems Command  
Naval Surface Warfare Development Group  
OPNAV  
Destroyer Squadron Staffs  
Fleet Mine Warfare Training Center  
Operational Test and Evaluation Force

#### **Typical Course of Study - Fall Entry**

Notes: Courses indicated by \* are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

#### **Quarter 1**

MA2121	(4-0)	Ordinary Differential Equations
PH2401	(3-0)	Introduction to Sonar Equations

#### **Quarter 2**

OS2103	(4-1)	Applied Probability for Systems Technology
NW3230*	(4-2)	Strategy and Policy

**Quarter 3**

OS3604	(3-0)	Decision and Data Analysis
NW3285*	(4-0)	National Security Decision Making

**Quarter 4**

OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean
OC4270	(3-4)	Tactical Oceanography

**Quarter 5**

UW3301	(4-0)	Undersea Warfare in the 20 <sup>th</sup> Century
PH3002	(4-0)	Non-Acoustic Sensor and Systems

**Quarter 6**

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 7**

NW3275*	(4-0)	Joint Maritime Operations (Part 1)
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 8**

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research

**Quarter 4**

EC4450	(4-1)	Sonar Systems Engineering
NW3276*	(2-2)	Joint Military Operations (Part 2)

**Quarter 5**

UW9999	(4-0)	Specialization Elective
MEXXXX	(4-0)	Core Course in Autonomous Systems

**Quarter 6**

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 7**

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

**Quarter 8**

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research

**Educational Skill Requirements (ESR)**

**Undersea Warfare - Curriculum 525**

**Subspecialty Code: 6301P**

1. **Physics:** The officer will understand physical principles applicable to acoustic, non-acoustic USW systems and underwater weapons systems.
2. **Acoustics:** The officer will understand acoustical phenomena affecting the design, performance, and operation of acoustic USW systems.
3. **Oceanography and Meteorology:** The officer will understand atmospheric and oceanographic processes influencing the performance and tactical use of USW systems.
4. **Signal Processing:** The officer will understand principles of signal processing as they apply to USW systems.
5. **Operations Research And Systems Technology:** The officer will understand computer simulation; search, detection, and localization; and USW modeling. The officer will understand principles of data analysis in the evaluation of USW systems. The officer will understand tactical decision aids for USW systems.
6. **Unmanned Systems:** Understand the fundamental technologies and capabilities of unmanned underwater systems and tactical robotics.

**Typical Course of Study - Spring Entry**

Notes: Courses indicated by \* are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

**Quarter 1**

MA2121	(4-0)	Ordinary Differential Equations
PH2401	(3-0)	Introduction to Sonar Equations

**Quarter 2**

EO2402	(4-1)	Introduction to Linear Systems
NW3230*	(4-2)	Strategy and Policy

**Quarter 3**

EO3402	(3-1)	Signals and Noise
NW3275*	(4-0)	Joint Maritime Operations (Part 1)

7. **Joint Professional Military Education:** Graduates will develop understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war. Fulfilled by completing the Naval War College three-course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. Suggested for USN and USMC students.)
8. **Problem Solving And Practical Applicability:** The officer will demonstrate the ability to conduct independent analysis in Undersea Warfare and proficiency in presenting the results in writing and orally.

#### **Curriculum Sponsor and ESR Approval Authority**

Director, Submarine Warfare Division (N77)  
 Director, Expeditionary Warfare Division (N75)  
 September 2000

#### **Undersea Warfare (International Students) - Curriculum 525/526**

##### **Program Officer**

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##### **Academic Associate**

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##### **Brief Overview**

The Undersea Warfare Curriculum educates officers in the engineering fundamentals, physical principles and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. The USW program is interdisciplinary and integrates many subjects: acoustics, electrical and mechanical engineering, mathematics, meteorology, oceanography, physics, operations analysis, human factors, computer science, and robotics.

The 525 curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for

Joint Professional Military Education for Intermediate Level Professional Military Education (JPME Phase I) as established by the Chairman, Joint Chiefs of Staff.

The 526 curriculum, modeled after the 525 curriculum, is available for international students. The international version replaces U.S. PME courses with courses specifically developed for international students.

##### **Requirements for Entry**

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of refresher math and/or physics as needed.

##### **Entry Date**

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or Program Officer. A four-quarter course of study has been designed for students that are accepted in the Immediate Graduate Education Program (IGEP). IGEP students begin their program in July.

##### **Degree**

This interdisciplinary program divides naturally into five major academic areas, allowing the student to specialize in the area of choice. Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for the various degrees, depending upon academic qualifications, the specialization sequence selected, and the thesis. Students typically earn their degree in one of the following areas: Master of Science in Engineering Acoustics, Electrical Engineering-Signal Processing, Physical Oceanography, Operations Research, or Mechanical Engineering-Unmanned Systems. Required classes vary by degree.

##### **Master of Science in Engineering Acoustics**

**Master of Science in Physical Oceanography**  
 (with emphasis on the prediction of the littoral battlespace environment, ocean acoustics and environmental effects on sonar performance)

**Master of Science in Electrical Engineering**  
 (with emphasis on communications or signal processing)

**Master of Science in Operations Research**

(with emphasis on tactical applications and decision analysis)

**Master of Science in Mechanical Engineering**

(with emphasis on autonomous systems)

**Master of Science in Engineering Science**

(with emphasis on autonomous systems)

**Master of Science in Applied Science**

Students who have limited time for degree completion or whose technical backgrounds are weak may choose to pursue a Master of Science in Applied Science (Signal Processing), (Physical Oceanography), (Acoustics), or (Operations Research) degree

**Certificate Program (Anti-Submarine Warfare)**

The Anti-Submarine Warfare Certificate program comprises four courses (OC2930, EC2450, OS3680, and PH2401). Upon successful completion of the coursework, students will be awarded a certificate of accomplishment in keeping with standard practices of the Naval Postgraduate School.

The Anti-Submarine Warfare Certificate program supports Navy ASW needs and complements existing ASW training by providing cross-disciplinary science and engineering education at the graduate level for the four primary technical disciplines involved.

- Physical Oceanography (Introduction to Oceanography for USW)
- ECE Signal Processing (Review of Signals and Systems)
- Operations Research (Search Theory and Detection)
- Engineering Acoustics (Introduction to Sonar Equations)

Since completion of the distance-learning ASW Certificate introduces students to each of the four disciplines in USW and completes the first quarter, it is an excellent way for students to decide on their area of interest. Arriving at NPS for a master's degree with an already-completed ASW certificate can either reduce on-board tour duration or increase thesis-research time at NPS.

**Subspecialty**

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of 6301P. The curriculum sponsors are N77 (Submarine Warfare) and N75 (Expeditionary Warfare).

**Typical Subspecialty Jobs**

- Naval Undersea Warfare Center
- COMINELWARCOM Naval Air Warfare Center
- Submarine Development Squadron Twelve
- Program Executive Offices
- Patrol Wing Staffs
- Carrier Group Staffs
- Naval Air Systems Command
- Naval Surface Warfare Development Group
- OPNAV
- Destroyer Squadron Staffs
- Fleet Mine Warfare Training Center
- Operational Test and Evaluation Force

**Typical Course of Study - Fall Entry**

Notes: Courses indicated by \* are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

**Quarter 1**

MA1115 (6wks)	(4-0)	Multi-variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Ordinary Differential Equations
PH2401	(3-0)	Introduction to Sonar Equations

**Quarter 2**

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography
OS2103	(4-1)	Applied Probability for Systems Technology
NW3230*	(4-2)	Strategy and Policy

**Quarter 3**

OC3260	(4-0)	Sound in the Ocean
UW3303	(4-0)	Modeling and Simulation for Undersea Warfare
OS3604	(3-0)	Decision and Data Analysis
NW3285*	(4-0)	National Security Decision Making

**Quarter 4**

EO2402	(4-1)	Introduction to Linear Systems
OA3602	(4-0)	Search Theory and Detection
OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean
OC4270	(3-4)	Tactical Oceanography

**Quarter 5**

EO3402	(3-1)	Signals and Noise
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5. **Operations Research and Systems Technology:** The officer will understand the principles of USW search, detection, and localization and be able to perform computer modeling and simulation. The officer will understand principles of tactical decision aids and data analysis in the evaluation of USW systems.
6. **Unmanned Systems:** Understand the fundamental technologies and capabilities of unmanned underwater systems and tactical robotics.
7. **Joint Professional Military Education:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. Graduates will also develop an understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war. (Fulfilled by completing the Naval War College three-part series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. Required for USN and USMC students).
8. **Problem Solving and Practical Applicability:** The officer will demonstrate the ability to conduct independent analysis in Undersea Warfare and proficiency in presenting the results in writing and orally.

**Curriculum Sponsor and ESR Approval Authority**

Director, Submarine Warfare Division (N77)  
Director, Expeditionary Warfare Division (N75)  
February 2005

## GRADUATE SCHOOL OF OPERATIONAL AND INFORMATION SCIENCES (GSOIS)

### Website

<http://www.nps.edu/Academics/Navigation/GSOIS.html>

### Dean

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### Associate Dean

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### The Graduate School of Operational and Information Sciences consists of the following Departments:

Computer Science	CS
Defense Analysis	DA
Information Sciences	IS
Operations Research	OR

### Overview

The Graduate School of Operational and Information Sciences includes Graduate Resident Programs consisting of 15 technical curricula and awards Master of Science and Ph.D. degrees across four academic departments. The faculty number approximately 100 and educate approximately 600 military and DoD students annually.

In the domains of education and ideas, staying current in these dynamic times is basic to the Graduate School of Operational and Information Sciences. Unlike a civilian university, at GSOIS we know we are educating our students for military related careers. First we teach them scientific principles and mathematical methods, and then we teach them how to apply them to military objectives when they return to service.

Another university could not tailor a curriculum, adapt to change, or transform its courses as swiftly as do the GSOIS faculty. For example, pedagogically, we have embraced the shift to distance learning, especially in the past five years, as Web-based instruction has become an efficient delivery mode, and we supplement it with Video TeleEducation so that students will benefit in widely dispersed locations, sometimes in ships at sea.

### Mission Statement

To deliver graduate-level education and conduct cutting-edge research in four nontraditional knowledge domains in response to the needs of naval and DoD customers. Our four knowledge domains are:

- Information Science and Technology
- Military Computer Science
- Military Operations Analysis and Research
- Special Operations and Related Defense Analysis

## Department of Computer Sciences

### Chairman

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\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

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**Peter J. Denning**, Chairman, Department of Computer Sciences and Professor (2002); Ph.D., Massachusetts Institute of Technology, 1968.

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**Timothy E. Levin**, Research Associate Professor (2001); B.S., University of California at Santa Cruz, 1991.

**Theodore G. Lewis**, Professor (1993); Ph.D., Washington State University, 1971.

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**Luqi**, Professor (1986); Ph.D., University of Minnesota, 1986.

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**Loren Peitso**, LCDR, USN, Military Instructor (2004); M.S., Naval Postgraduate School, 2002.

**Richard Riehle**, Visiting Professor (2004); M.S., National University, 1971.

**Matthew T. Rose**, Research Associate (2002); B.A., Biola University, 1989.

**Neil C. Rowe**, Professor (1983); Ph.D., Stanford University, 1983.

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**Deborah S. Shifflett**, Research Associate (2000); M.S., Golden Gate University, 1996.

**Man-Tak Shing**, Associate Professor (1988); Ph.D., University of California at San Diego, 1981.

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**T. Owens Walker**, CDR, USN, Military Lecturer (2004); M.S., Naval Postgraduate School, 1995.

**Daniel F. Warren**, Senior Lecturer (1996); M.S., University of California at Santa Cruz, 1986.

**Geoffrey Xie**, Associate Professor (1996); Ph.D., University of Texas at Austin, 1996.

### **Emeritus Professors**

**Robert B. McGhee**, Professor Emeritus (1986); Ph.D., University of Southern California, 1963.

### **Degree**

The Department of Computer Science provides graduate training and education in major areas of computer science; thus, both basic and advanced graduate courses are offered. Course work and

research lead to either the Master of Science or Doctor of Philosophy degree. The requirements to complete either program are rigorous and are comparable to those of other major universities.

### **Master of Science in Computer Science**

### **Master of Science in Computing Technology**

### **Master of Science in Modeling, Virtual Environments, and Simulation**

### **Master of Science in Software Engineering**

### **Doctor of Philosophy in Computer Science**

### **Doctor of Philosophy in Modeling, Virtual Environments, and Simulation**

### **Doctor of Philosophy in Software Engineering**

### **Laboratories**

There are currently ten laboratories:

Computer Science Learning Resource Centers (2)  
Introductory Computer Security Laboratory  
Computer Information Security Research (CISR) Laboratory  
Public Key Infrastructure Laboratory  
Wireless and Mobile Computing Laboratory  
Autonomous Robotics Coordination Laboratory  
Software Engineering Laboratory  
Introductory PC Network Laboratory  
Intermediate Local Area Network Laboratory

### **Computer Science Learning Resource Centers (2)**

These laboratories provide a general purpose, networked, PC desktop environment for a variety of programming languages and software packages. They are used both as teaching labs for a number of courses and as open labs for NPS-wide coursework.

### **Introductory Computer Security Laboratory**

This lab is primarily used by the Center for Information Systems Security Studies and Research. It is an "air-gapped" lab dedicated to studies of network vulnerabilities, intrusion detection, secure system management, and computer forensics, where tools used by administrators and hackers can be freely researched and studied. It is also used in certifying students with NSTISSI 4000 series certifications in Security Professionalism by the Committee of National Security Systems (CNSS), via the National Science Foundation (NSF).

### **Computer Information Security Research (CISR) Laboratory**

This teaching and research computer lab is primarily used by the CISR and is dedicated to studies of

information assurance, computer security, high assurance system architecture, and authentication. This lab facility introduces students to studies in high assurance systems, steganography, public key infrastructure, mandatory access control, viruses, covert channels, and the reference monitor concept.

### **Public Key Infrastructure Laboratory**

This teaching and research computer lab is primarily used by the CISR and is dedicated to studies of network security; secure computer systems; and security policies, modeling, and formal methods. In addition, through the use of a Virtual Private Network (VPN), it is utilized for the Inter-Service Academy Cyber Defense Exercise (CDX). This annual exercise involves NPS, AFIT, and all four U.S. Service Academies; acting as network defenders (Blue teams) against network attackers (Red teams) from NSA and DoD information warfare agencies. This lab also directly supports DoD-funded research on DoD Public Key Infrastructure (PKI).

### **Wireless and Mobile Computing Laboratory**

This laboratory provides the majority of academic computing needs to support the wireless and mobile computing track within the Department of Computer Science. This lab provides students with the opportunity to program and examine security aspects of mobile computing devices ranging from personal digital assistants (PDAs) through cellular phones.

### **Autonomous Robotics Coordination Laboratory**

This teaching and research computer lab supports graduate students and faculty work on sponsored classes/research projects regarding the coordination between multiple autonomous robots to achieve a coordinated result. The lab is equipped with several types of programmable robots and a wide range of intelligent software tools, including programming languages, planners, language processors, image processors, and neural-computing.

### **Software Engineering Laboratory**

This laboratory provides a state-of-the-art engineering systems environment to support graduate students and faculty work on sponsored classes and projects in software automation. The lab provides a test bed for software-intensive systems. Software for embedded/safety-critical systems can also be precisely tested in the lab. Evaluation and assessment on network-based system integration and interoperability, and the risk assessment on systems of systems, can be conducted effectively in the lab. It also provides support for requirements analysis, prototyping, specification, and computer-aided system architecture design.

## **Network Research and Experimentation Laboratories**

### **Introductory PC Network Laboratory**

### **Intermediate Local Area Network Laboratory**

These two labs support the Networks Track and provide students the opportunity to apply network theory in concrete applications. The Introductory PC Network Laboratory enables students to install network hardware and software, learning firsthand the advantages, limitations, and intricacies of various components and operating systems. The Intermediate Local Area Network Laboratory allows students to participate in ongoing Next Generation Internet research, advanced protocol development, future high-speed digital switching systems experimentation, network management, control design, and analysis. These labs also directly support DoD-funded research for the Defense Advanced Research Projects Agency and the National Science Foundation.

## **Computer Science Course Descriptions**

### *CS Refresher Courses*

#### **CSR100 Refresher for Beginning Programming (2-2) Winter/Summer**

(No credit) An introduction to computer algorithms, programs, and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded. Prerequisite: None.

#### **CSR101 Refresher for Laboratory Systems (2-1) As Required**

Intended for Computer Science majors, to provide an introduction to computer science and computing laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CSO100. Not graded. No credit. Prerequisite: None.

### *CS Courses*

#### **CSR100 Refresher for Beginning Programming (2-2) Winter/Summer**

(No credit) An introduction to computer algorithms, programs, and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded. Prerequisite: None.

**CSR101 Refresher for Laboratory Systems (2-1) As Required**

Intended for Computer Science majors, to provide an introduction to computer science and computing laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CSO100. Not graded. No credit. Prerequisite: None.

**CS0001 Colloquium (0-1) As Required**

(No credit) Departmental lecture series. Attendance is required by students in their fourth quarter. Graded on a Pass/Fail basis. Prerequisite: None.

**CS0102 Review for Direct Input Students (2-1) As Required**

(No credit) (Meets entire quarter) An individualized course to cover the topics of CSR100 and CSR101. The course is open only to first-quarter computer science majors who did not take CSR100 and CSR101. This course is not graded. Prerequisite: None.

**CS0810 Thesis Research (0-8) Fall/Winter/Spring/Summer**

Every student conducting thesis research will enroll in this course. Prerequisite: None.

**CS0820 Integrated Project (0-1) Fall/Winter/Spring/Summer**

The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration. This course is available to Computer Science students who are participating in a campus-wide integrated project. Graded on a Pass/Fail basis. Prerequisite: None.

**CS2101 Introduction to the Modern PC (3-1) As Required**

This course is designed to introduce students to modern PC technology. Part one of the class covers the hardware and software design of the PC. This section details the feature of the Windows operating system including the Windows interface, multitasking, memory and device management, and other operating system services. Part two introduces the basic concepts of office automation, multimedia applications, and networking technology. Prerequisite: None.

**CS2900 Introduction to Objects and Programming (4-2) Fall/Spring**

This course teaches the fundamental programming concepts. The course adopts the object-first approach in teaching object-oriented programming. The use of predefined objects is explained before teaching how to define your own classes. Topics covered in the course include control structures, classes, objects, methods, visibility modifiers, strings, arrays, exception handling, simple graphics, and software

development and testing techniques. Although Java is used as the programming language, this course is about objects and programming. Prerequisite: None.

**CS2971 Fundamental Object-Oriented Programming in C++ (4-2) As Required**

This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using C++. The topics covered include: problem-solving, documentation, C++ Integrated Programming Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. Prerequisite: None.

**CS2973 Fundamental Object-Oriented Programming in Java (4-2) As Required**

This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using Java. The topics covered include: problem-solving, documentation, Java Integrated Programming Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. Prerequisite: None.

**CS3000 Great Principles of Computing Technology (4-1) Fall/Spring**

An introduction to computing technology that underlies all of information technology (IT). Offers a holistic view of the computing field and its connections with other fields in science, business, and philosophy. Covers deep principles of information technology in the areas of computation, communication, coordination, storage, and automation. Emphasizes the historical development of these principles, why they have stood the tests of time, how they relate to one another, and how they relate to issues in other fields. Prepares students for graduate study in computing-related fields. Prerequisite: None.

**CS3006 An Introduction to Information System Security (4-0) Fall/Winter/Spring/Summer**

Due to the rapid development and ubiquitous deployment of computer and information systems, and the very nature of insecurities they may hold, professionals involved with the design, development, deployment, and management of these systems now require a familiarity with information assurance (IA) and security. This course will introduce topics relevant to IA and computer security necessary to create a foundation of knowledge for the information management professional. The domains of knowledge to be introduced during the course include: access control systems and methodology; telecommunications and network security; security management practices; application and systems development security; cryptography; security architecture and models; operations security; business continuity and disaster recovery planning; laws, investigations, and ethics; and physical security. This course is meant to introduce the topics and will lay the foundations for further studies in any of the domains listed. Prerequisite: None.

**CS3010 Computing Systems Principles (4-0)****Winter/Summer**

Designed to provide computer science majors with a basic understanding of computer systems hardware. The course includes the following topics: basic computer concepts, number systems and data representation, digital logic and Boolean algebra, storage devices and organization, basic computer organization and control, and instruction formats, addressing modes and the assembler process. No previous background in computer hardware is assumed. Prerequisite: None.

**CS3030 Computer Architecture and Operating Systems (4-0) Fall/Spring**

(For non-CS students.) This course provides an overview of basic computer hardware concepts and operating systems software. The following topics are covered: basic computer concepts; data representation; elements of computer architecture and operation; processor and process management; multiprogramming; memory management; and file management. Future trends in computer hardware and operating systems will be discussed. Prerequisite: CS2900 and CS2971, or consent of the instructor.

**CS3050 Software Development for Combat Systems (3-2) Summer**

This course covers the unique characteristics of software development for mission-critical embedded computer systems. Students will be introduced to real-time systems issues including analysis, design, process scheduling, operating systems, communications, architecture and fault-tolerance. The DoD Standard 2167A life cycle model will be explored, along with analysis, design, programming, and verification methodologies used in developing combat systems software. Students will learn the Ada programming language's real-time tasking and interprocess communication techniques, and be introduced to tools for prototyping, code reuse, and automatic code generation and documentation. The laboratory experience includes work with software analysis, design and programming tools to build a combat-type software system from requirements analysis through verification. Intended for non-CS majors. Prerequisite: CS2900.

**CS3111 Principles of Programming Languages (4-0)****Winter/Summer**

This course is an introduction to the design, evaluation, and implementation of programming languages. Imperative, functional, logic, and concurrent programming methodologies are investigated, with an emphasis on practical issues. Tradeoffs in choosing different programming languages for a given task are discussed and principles on which an objective assessment of programming language design can be made are presented. Prerequisite: CS2900 or consent of instructor.

**CS3113 Introduction to Compiler Writing (3-2)****Fall/Spring**

This course is intended to explore the basics of modern compiler design and construction techniques. The fundamentals of scanning, parsing, and compiler semantics are developed in the framework of modern compiler-compiler and translator-writing systems technology. The laboratory periods will be used to develop a small model compiler/assembler. Prerequisite: CS3902.

**CS3130 Software Design for Mobile Computers (3-2)****As Required**

This course introduces the student to rapid application development environments, programming languages, and operating systems used by commercial off-the-shelf handheld computers running operating systems such as Newton Intelligence, Magic Cap, GEOS, and PalmOS. The course includes a survey of devices, architectures, operating systems, and programming languages. Laboratory programming exercises will be required for at least one PDA-class operating system platform. Prerequisite: CS3901.

**CS3200 Computer Architecture (3-2) Winter/Summer**

This course examines the organization of computer and processor architectures. Instruction set design alternatives, processor implementation, memory system hierarchy, and I/O systems are the main topics of study. A quantitative approach is taken in which different design alternatives are evaluated and compared through analysis and/or experimentation. The course is accompanied by a set of labs which reinforce and extend the lecture subject matter. Prerequisites: CS3010 and either CS2900 or consent of the instructor.

**CS3204 Human-Computer Interaction (3-2)****Winter/Summer**

This course studies the principles of human-computer interaction (HCI) and computing system usability. The design of an interactive system is much different than that of a conventional, noninteractive one. A successful software application depends on how well the designer understands the users of the system and how best to design for their needs and capabilities. In addition, an understanding of system design constraints and operational implementation issues are equally important. The primary focus of the course is to build the knowledge and skills needed to develop an effective and usable human interactive system. All students will participate on a design project that will take them through an entire interactive design process, from problem statement and requirements definition through prototyping and implementation, test, and evaluation. The course material will survey the field of HCI including interaction techniques and styles, design methodologies, evaluation techniques, software development, and input/output devices. The student will learn how to approach design problems from the user's point of view, how to study usability issues, and how to consider the strengths and limitations of the user during the design process. Prerequisite: None.

**CS3310 Artificial Intelligence (4-1) Winter/Summer**

Survey of topics and methods of Artificial Intelligence. Methods include rule-based systems, heuristic search and exploitation of natural constraints, means-ends analysis, semantic networks, and frames. Emphasis is placed on solving problems that seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. Prerequisites: CS3010 and one college-level course in programming.

**CS3320 Database Systems (3-1) As Required**

This course presents an up-to-date introduction to database systems including database system architectures, physical file organizations, data models, query languages, and design of databases. Prerequisite: CS2900 or consent of the instructor.



**CS3450 Operating Systems (3-2) Fall/Spring**

A theoretical and practical treatment of operating concepts. Major course topics include concurrency, ADA tasking, virtual memory including demand paging and segmentation, dynamic linking and loading, file structures, and information security. The laboratory portion of the class will give students the opportunity to write and test components of a modern operating system. Prerequisite: CS2900 and CS3901 and CS3010.

**CS3502 Computer Communications and Networks (4-2) Fall/Spring**

This course covers basic computer networking concepts and technology through the study of protocols at each layer of the Internet architecture. Materials taught in class are reinforced through laboratory projects. Prerequisite: CS3010 and CS3030 and a solid background in Computer Architecture, Algorithm and Data Structures; and programming experience with C/C++ or Java are important for success in this class.

**CS3505 The Internet and the Information Highway (3-2) Winter/Summer**

In this class, the Internet and related technologies are explored. Major objectives are to (1) learn what the Internet and the "information highways" are; (2) learn how to use the Internet for business, academic, and personal uses; and (3) learn what the current and especially future direction the Internet is going. Students will gain experience in exploring the World Wide Web and in creating their own home pages using the language HTML. They will also learn how to use the "big three" Internet tools, which are FTP, E-mail, and Telnet. Some background on how these protocols were developed is also presented. Lectures also discuss the origins of the Internet, and the various physical and software layers which make up the Internet. The class requires a series of laboratory assignments, through which the students become familiar with the concepts in a "hands on" way. The class is intended for all graduate students interested in learning about and using the Internet, so the only prerequisite is graduate standing. Prerequisite: None.

**CS3600 Information Assurance: Introduction to Computer Security (4-2) Fall/Winter/Spring/Summer**

This course provides a comprehensive overview of the terminology, concepts, issues, policies, and technologies associated with the fields of Information and Software Assurance. It covers the notions of threats, vulnerabilities, risks, and safeguards as they pertain to the desired information security properties of confidentiality, integrity, authenticity, and availability for all information that is processed, stored, or transmitted in/by information systems. This is the entry point prerequisite for all other Computer Security Track courses. Prerequisites: CS3010 and CS3030.

**CS3601 Theory of Formal Languages and Automata (4-0) Fall/Spring**

This course will cover the Chomsky hierarchy of Formal Languages (regular sets, context-free languages, context-sensitive languages, and recursively enumerable languages) and the types of grammars and automata associated with each class in the hierarchy. Emphasis is placed on the major results of the theory as they apply to language and compiler design. In addition, the major results involving the concept of decidability are covered. Prerequisite: MA3025.

**CS3640 Analysis of DoD Critical Infrastructure Protection (3-1) Fall/Spring**

The DoD relies on the correct functioning of an extensive information and control infrastructure to accomplish its mission. To assist in ensuring the survivability of assets that comprise this infrastructure, the DoD has formulated a CIP lifecycle, which includes: Analysis and Assessment, Remediation, Indicators and Warnings, Mitigation, Incident Response, and Reconstitution. This course introduces students to this lifecycle, and how the criticality and survivability of mission-critical infrastructures within the DoD are assessed. Prerequisite: CS3600.

**CS3650 Design and Analysis of Algorithms (4-0) Fall/Spring**

This course focuses on the design and analysis of efficient algorithms. Techniques for analyzing algorithms in order to measure their efficiency are presented. Control structure abstractions, such as divide and conquer, greedy, dynamic programming, backtrack (branch and bound), and local search methods are studied. The theory of NP-completeness is presented, along with current approaches to NP-hard problems. Prerequisites: CS3901 and MA3025.

**CS3651 Computability Theory and Complexity (3-1) As Required**

This course covers the concepts needed to argue the decidability and computational complexity of problems. Topics include recursive enumerability, undecidability, diagonalization, computational complexity classes, intractability, Turing reduction, and many-one reducibility. Basic techniques are presented for proving undecidability and for establishing a lower bound on the computational complexity of a problem. Prerequisites: CS3601 and CS3650.

**CS3660 Critical Infrastructure Protection (4-0) Spring**

This course examines the critical infrastructure of the USA. Eight sectors of the critical infrastructure are examined: Banking/Finance; Health Care/Health Affairs; Space/ISR; Power/Energy; Logistics/Postal System; Transportation; Telecommunications and Satellites; and Internet/IA. Each sector and its components are characterized in terms of its vulnerabilities, especially its interdependencies and couplings with other sectors. Finally, the course identifies potential countermeasures that mitigate sector and system vulnerabilities and assesses their costs and benefits. Prerequisite: NS3180.

**CS3670 Information Assurance: Secure Management of Systems (3-2) Fall/Spring**

This course provides students with a security manager's view of the diverse management concerns associated with administering and operating an automated information system facility with minimized risk. Students will examine both the technical and nontechnical security issues associated with managing a computer facility, with emphasis on DoD systems and policies. Students have the opportunity to earn the following CNSS (formerly NSTISSI) certifications: INFOSEC Professional, System Administration in Information Systems Security, and ISSO. Prerequisite: CS3600.

**CS3675 Network Vulnerability Assessment (3-2)  
Winter/Summer**

This course provides a basis for understanding the potential vulnerabilities in networked systems by studying methods to: (1) obtain information about a remote network and (2) to possibly exploit or subvert systems residing on that network. Labs provide practical experience with current network attack and vulnerability assessment tools. Foot printing, scanning, enumeration, and escalation are addressed from the attacker's perspective. A final project that demonstrates skill and knowledge is required. Prerequisite: CS3502.

**CS3690 Network Security (4-2) Winter/Summer**

This course covers the concepts and technologies used to achieve confidentiality, integrity, and authenticity for information processed across networks. Topics include: fundamentals of TCP/IP-based networking, core network security principles, traffic filtering types and methodology, packet-level traffic analysis, employment of cryptography, tunneling/encapsulation, Public Key Infrastructure (PKI), remote authentication protocols, and virtual private networks based on the IPSec, L2TP, and SSL protocols. Prerequisites: CS3600 and CS3502 and IS3502.

**CS3700 Advanced Object-Oriented Programming in C++ (4-2) As Required**

A course in advanced object-oriented programming using C++ for students having intermediate-level experience with C++. Students will learn guidelines for using C++ effectively through general design strategies and language-specific features to make C++ programs and object-oriented designs more efficient, robust, maintainable, and portable. Topics include: Memory management; Constructor and Assignment Operator Issues; Classes and Functions; Inheritance and Object-Oriented Design; Standard Template Library; Exceptions; and Efficiency. Prerequisite: CS3771.

**CS3770 ADA as a Second Language (4-2) As Required**

A first course in ADA for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of ADA. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays, and pointers. The object-oriented topics include: data abstraction and encapsulation, packages, inheritance, polymorphism, and generics. Weekly programming projects will be assigned. Prerequisites: Recent completion of the complete series in another programming language course, or programming experience in another programming language.

**CS3771 C++ as a Second Language (4-2) As Required**

A first course in C++ for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of C++. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays, and pointers. The object-oriented topics include: data abstraction and encapsulation, classes, objects, operator overloading, inheritance, polymorphism, templates, and reusable class libraries. Weekly programming projects provide students the opportunity to implement techniques covered in class. Prerequisites: Recent completion of the complete series in

another programming language course, or programming experience in another programming language.

**CS3773 Java as a Second Language (4-2) As Required**

A first course in Java for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of Java. Topics include: program structures and environment, arrays, exceptions, constructors and finalizers, class extension, visibility and casting, overriding versus overloading, abstract classes and interfaces, files and streams, class loaders, threads, and sockets. Programming projects provide students the opportunity to implement techniques covered in class. Prerequisite: Recent completion of the complete series in another programming language course, or programming experience in another programming language.

**CS3800 Directed Study in Computer Sciences (0-V)  
Fall/Winter/Spring/Summer**

(Variable hours 0-2 to 0-8.) Individual research and study by the student under the supervision of a faculty member. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on a Pass/Fail basis only. Prerequisite: Consent of the instructor.

**CS3901 Introduction to Data Structures and Intermediate Programming (4-2) Winter/Summer**

This is the second course in the programming practice sequence. One of the main goals of this course is the teaching of data structures so the students will be able develop intermediate-level programs. Another goal is the teaching of modern programming techniques such as threads, and advanced-level, object-oriented, programming concepts such as inheritance and polymorphism. Topics covered in the course include event-driven programming, recursion, file input and output, sorting and searching, threads, stacks and queues, lists, binary search trees, balanced binary search trees, and hashing. Prerequisite: CS2900.

**CS3902 Programming Paradigms (4-2) Fall/Spring**

This is the third course in the programming practice sequence. Based on the knowledge of Java, this course introduces students to other programming paradigms. Many concepts are illustrated using C++ and ADA Functional programming using Lisp and Haskell and logic programming using Prolog are also introduced in the course. Prerequisite: CS3901.

**CS3920 Topics in Computer Science (V-V) As Required**

(Variable hours 2-4 to 4-1.) Designed to support subject matter of special interest, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

**CS4112 Distributed Operating Systems (3-2)  
Winter/Summer**

An advanced treatment of operating systems concepts. Major course topics include distributed operating systems, distributed operating system architectures, and concurrent programming. Other topics include secure operating systems and real-time operating systems, as time permits. Prerequisite: CS3450 or equivalent.

**CS4113 Advanced Language Topics (4-0)****Winter/Summer**

This course is designed to explore concepts considered essential to the study of programming languages. These concepts include the lambda calculus, the Church-Rosser Theorem, reduction strategies, continuations, semantics, and recursion. Prerequisites: CS3111 and CS3450.

**CS4130 Wireless Mobile Computing (3-2) Fall/Spring**

This course will focus on a new paradigm in computing: wireless mobile computing. Portable, handheld, computing devices are now being used for many applications previously accomplished by larger desktop computers or dedicated small devices. Some of these devices contain powerful RISC CPUs, user-accessible flash RAM storage, networking and peripheral connectivity, handwriting recognition, and built-in infrared networking capabilities. The goal of this course is to provide a fundamental understanding of the devices, communications, and design and implementation issues in building such mobile networked applications. Students will be required to research, design, and/or implement a project that integrates multiple technologies to solve a real-world problem requiring mobile computing. Prerequisites: CS3502 and CS3901.

**CS4135 Mobile Devices (3-2) Spring**

There are a large number of mobile devices, including cellular phones, personal digital assistants (PDAs), PDA/cellular phone combinations, pagers, badges, and other wearable devices, in use today in a variety of applications. The number and variety of such devices keeps growing at a fast pace as new processing, display, and battery and wireless technologies are invented, and as new applications for these devices are envisioned. This is a practical, hands-on course that covers the architecture, usability, and applications of mobile devices. From an application perspective, this course will discuss mobile devices as tools to support homeland security applications, military applications for capability enhancement, and communications and computing needs of mobile professionals. The study of principles is combined with hands-on laboratory exercises to develop applications on mobile devices. The ultimate objective of the course is to show students how they can exploit the capabilities of mobile devices to implement innovative applications to enhance productivity and effectiveness in a variety of domains. Prerequisite: CS279X.

**CS4137 Wireless Data Services (3-2) Summer**

Tremendous progress has been made in mobile device and wireless networking technologies. Many different PDAs, cell phones, smartphones, and specialized devices have been introduced in the marketplace, and been enthusiastically adopted by millions of people around the world. Wireless networking technology development and adoption has moved even faster! The combination of mobile devices and wireless networking lends itself to data applications that can make a significant difference in a wide variety of application areas. The aim of this course is provide an understanding of the issues, technologies, and applications related to wireless data services. In addition to other topics, this course will cover wireless Internet, SMS, MMS, WAP, iMODE, J2ME, and BREW. Prerequisites: CS4130 and CS4135.

**CS4138 Mobile and Wireless Security (3-1) As Required**

The application of mobile and wireless devices has grown rapidly in military and commercial environments. The functionality and reliability of these devices has grown tremendously. The mobile and wireless nature of these devices raise new and important security challenges not usually present in static environments. This course will address these challenges including the security functionality, protocol, and assurance issues associated with this emerging technology. Prerequisites: CS3600 and CS3690 and CS4137.

**CS4182 Capstones in Computer Science (4-0)****Winter/Summer**

This is the capstone course for the CS curriculum. It surveys the transforming effects of seminal papers on ten subject areas within computer science. Each paper illustrates how the introduction of an organizing framework, a suitable form of analysis, or a set of supporting principles was able to change the way problems within the subject area were approached; a change that led to integrated and lasting solutions. Students will be responsible for reading and evaluating key papers that have helped to shape modern computer science. Prerequisite: CS3000.

**CS4310 Sensory Artificial Intelligence (4-1) As Required**

A study of methods of computational simulation in natural-language processing, computer vision, and sensor networks. Issues in natural-language processing include modeling of syntax, semantics, morphology, discourse, phonetics, and stochastic phenomena. Issues in computer vision include low-level processing, segmentation, shape inference, and object identification. Issues in sensor networks include deployment, local inference, and communications. Prerequisite: CS3310.

**CS4312 Advanced Database Systems (3-1) As Required**

This course is a sequel to CS3320, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, transaction management, recovery, security, and other advanced topics. Topics will be illustrated using both commercial and prototype database systems. Prerequisite: CS3320 or consent of the instructor.

**CS4315 Learning Systems and Data Mining (3-1)****Winter**

A survey of methods by which software and hardware can improve their performance over time. Methods include case-based reasoning, concept learning, neural networks, simulated annealing, and genetic algorithms. Students will do projects with software tools. Prerequisites: CS3000 and one college-level course in programming.

**CS4322 Internet Information Systems Technology (3-2) Summer**

A course exploring the implementation of recent Internet tools for supporting databases, intelligent systems, and information retrieval. Topics include browsers and server technology including servlets, XML, data mining, and data warehousing. Students will do programming to build their own tools. Prerequisites: CS2900 and either CS3310 or CS3320, or consent of the instructor.

**CS4330 Introduction to Computer Vision (3-2)****Fall/Spring**

This course introduces students to the main concepts that allow computers to "see" and understand visual information. It teaches methods and skills in image processing, pattern recognition, statistical analysis, classification, and learning. These are exemplified on applications such as military intelligence, surveillance, object tracking, robotic navigation, human-computer interfaces, and visual effects. Students complete a small class project that demonstrates the use of computer vision for an application of their interest. In laboratory activities, students get hands-on experience with the most important tools for building practical vision systems. Experiments and projects are tightly coupled with the material covered in class. Students must be familiar with a programming language such as C, C++, or Java (CS2900, CS2971, CS3771, CS3773, etc.). Prerequisites: Helpful, but not necessary, is knowledge of basic linear algebra, probability or game theory, and Matlab (EC1010), or consent of the instructor.

**CS4450 Advanced Computer Architecture (4-0)****Summer**

This course covers advanced topics in computer architecture and the application of concepts in computer architecture to the design and use of computers. The topics discussed include classes of computer architecture, application-oriented architecture, and high performance architecture. Prerequisites: CS3010, and CS3200 or equivalent.

**CS4552 Network Design and Programming (3-3)****Fall/Spring**

A hands-on introduction to parallel computing. The course introduces the student to different scientific and engineering applications that can benefit from parallel computing. The performance trade-offs among different ways of parallelizing an application are discussed. With the aid of parallel programming development tools, the students design, implement, debug, and monitor parallel programs for a few of the applications discussed. Every student is required to complete a nontrivial parallel program for solving some problem pertaining to his/her academic fields of study. The course is intended for CS and non-CS majors. Students will be guided to evaluate an emerging networking technology through experiments performed on a real network or using a Java-based network emulator called SAAM. The network protocols covered in this course include: RIP, OSPF, DNS, HTTP, DHCP, TCP, UDP, and VPN. Prerequisites: A Java programming course, CS3502, and CS4550; or equivalent with consent of the instructor.

**CS4554 Network Modeling and Analysis (4-0)****Winter/Summer**

The purpose of this class is to learn to formally specify and analyze network protocols, emphasizing wireless protocols, and in the process acquire a thorough understanding of these protocols. Formal protocol models, such as communicating finite state machines and systems of communicating machines, will be used as a tool for this purpose. Some protocols other than wireless protocols may also be covered. Several research papers from recent years will be assigned reading. Cellular networking, IEEE 802.11, Bluetooth, and wireless local loop networks will be covered as well. The class will study these protocols in the context of the network architectures and

physical environments they are intended to perform in. Students should acquire an increased knowledge of formal tools, experience in protocol and system analysis, and a better understanding of protocols and networks. At the discretion of the instructor, other advanced topics such as simulation and statistical analysis of networks and network protocols may be added and/or substituted for some of the topics above. The emphasis is on application of mathematical rigor to the analysis and description of networking protocols. Prerequisite: CS3502.

**CS4556 Business Economics Network Technology (4-0)****Fall/Spring**

This class teaches a different side of the networking world—the business and economics areas, which necessarily include relevant laws and government policies. The course reviews the history of telecommunications, including the major inventions and the development of the business and resulting regulations. The importance of capital and investment is taught by studying actual decisions of telecom companies and their results in the ensuing years. In this way, the students learn how the telecom industry developed and how the current regulatory structure came about. All of the major telecom laws and court decisions are studied.

Basic business and economics principles are also studied, and numerous real-life examples are given. Students learn to write business plans and to analyze a telecom company or industry. The influence of the stock market on major companies is shown. The results of having either too much capital or too little are examined. The divestiture of AT&T in 1984, the resulting competition, the Telecom Act of 1996, and the telecom boom and bust of 1996-2003 are all examined in detail. Students in this class will gain a thorough understanding of the telecom industry, the major companies, and the effects of government regulation (too much or too little) and capital investment. Prerequisite: None.

**CS4600 Secure Computer Systems (3-2) Fall/Spring**

This course covers the implementation of protection for monolithic and distributed secure computer systems. The problems of subversion and confinement in highly secure components are addressed by life cycle assurance methodologies. Topics include: protection hardware, the implementation of virtual machines through effective memory management techniques, synchronization mechanisms, critical sections, SWE methodologies, and configuration management techniques. Prerequisites: CS3600 and CS3450 and CS3502.

**CS4603 Database Security (3-1) Spring**

Course topics include: policies for information integrity and confidentiality of database (DB) systems, modeling of secure DB systems, security in statistical DBs, security approaches for object-oriented DBs, multitier architecture security issues, privacy, aggregation and inference, military applications of secure DBs, and other important implementation issues, such as atomicity, serialization, and view-based controls. Prerequisites: CS3600 and CS3320 and CS3450.

**CS4605 Security Policies, Models, and Formal Methods (3-1) Winter/Summer**

This course covers the methods used to specify, model, and verify the access control mechanisms of computational systems. The identification of the security policy and its interpretation in terms of a technical policy is covered. Several

security policy and access-control models are explored. Prerequisites: CS3650 and CS3600 and CS3601.

#### **CS4610 Information Ethics (3-0) Fall**

Rapid and revolutionary advances in IT confront society with novel choices and opportunities. This course attempts to identify the kinds of ethical choices that may arise from its use. While a few may be clear choices, most will be between the greater of goods or the lesser of evils. These choices will be difficult because the values are difficult to identify, the right choices are more difficult than the wrong, and their consequences are neither certain nor easily predicted. Prerequisite: None.

#### **CS4614 Advanced Topics in Computer Security (3-1)**

##### **Winter/Summer**

This course applies graduate-level knowledge and reasoning skills in written essays and verbal discussion of current topics in computer security. Students read academic papers regarding information assurance topics, and discuss issues that they derive from the readings. This pedagogical approach is constructivist in encouraging the students to develop their own viewpoints and conclusions. Prerequisites: CS3600 and CS4600 and CS4605, or consent of the instructor.

#### **CS4650 Application of Security Evaluation Criteria for Information and Software Assurance (3-1) Summer**

This course uses the Common Criteria (ISO/IEC 15408) as the framework for an in-depth study of security evaluation philosophies, processes, and issues. Coverage of the Common Criteria include: (1) security requirements taxonomy, (2) requirements derivation methodology, (3) interpretation process, and (4) evaluation methodology performed by evaluators. Examinations of existing Protection Profiles and Security Targets provides insights on domain-specific requirements expression. This course discusses fundamental security principles and disciplines for information and software assurance (e.g., requirements engineering, design principles, formal methods, life cycle management) as applied to security evaluation. Skills and knowledge on the Common Criteria are DoD-relevant regarding the evaluation and validation of IA-enabled components as per DoD Directive 8500.1. Homework reinforces classroom instruction and labs provide practical experience with the use of the Common Criteria from the developer's perspective. Prerequisites: CS3600 and CS4600 or consent of the instructor.

#### **CS4675 Intrusion Detection and Response (3-1)**

##### **Winter/Summer**

This is an introduction to methods of intrusion detection in computer systems and networks and the possible methods of automatic responses to those events. It will cover types of intrusion detection, inference of suspicion, implementation, and management, and will examine at least one specific product. A special focus in response management will be the use of deliberate deception in defense of systems, including the psychology and ethics of deception in general. Prerequisite: CS3600.

#### **CS4677 Computer Forensics (3-2) Fall/Spring**

This course covers the fundamentals of computer forensics in the context of DoN/DoD information operations. Students examine how information is stored and how it may be deliberately hidden and/or subverted. Coverage includes: practical forensic examination and analysis, techniques of

evidence recovery, legal preparation of evidence, common forensic tools, principle of original integrity, disk examination, and logging. Prerequisites: CS3010 and CS3600 and CS3670.

#### **CS4678 Advanced Vulnerability Assessment (4-2)**

##### **Winter/Summer**

This course provides a basis for understanding the potential vulnerabilities in networked systems by applying a problem-solving approach to: (1) obtaining information about a remote network, (2) possibly exploiting or subverting systems residing on that network, (3) understanding the theory of operation of existing tools and libraries, along with how to measure the effectiveness of those tools, and (4) understanding tools and techniques available for vulnerability discovery and mitigation. Labs provide practical experience with current network attack and vulnerability assessment tools as well as development of new tools. Foot printing, scanning, numeration, and escalation are addressed from the attacker's perspective. A final project that demonstrates skill and knowledge is required. Prerequisites: CS3113 and CS3450 and CS3690, or consent of the instructor. Classification: This course is UNCLASSIFIED FOUO, U.S. only.

#### **CS4680 Introduction to Certification and Accreditation (3-0) Fall/Spring**

This course provides an in-depth instruction on the DoD/DoN security certification process. It provides an introduction to the Certification and Accreditation (C&A) process as applied to procurement and life cycle management of federal government information systems, with a focus on the role of the Certifier. Topics include the principal C&A roles, functional components, and output documents of the C&A process. Also included is a comparison of the government C&A process specifications currently in use (DITSCAP/NIACAP, FIPS, DCID 6/3) and the emerging effort aimed at producing a unified specification. Prerequisites: CS3600 and CS3670 and CS3690.

#### **CS4685 System Certification Case Studies (0-2)**

##### **Fall/Spring**

In this course students will do two or three case studies of information systems that have been evaluated under the current and/or federal criteria in preparation for accreditation to carry sensitive information. The students will study each system from concept through final system certification and accreditation. They will look at and evaluate such things as the security policies, system architecture, the system security architecture, design, implementation, deployment, management, evolution, assurances, etc., through available documentation and other evidence, to determine whether the systems were secure enough to handle the classified information at the appropriate levels of assurance. The case studies will be based on the information available on deployed systems. Prerequisite: CS4680.

#### **CS4800 Directed Study in Advanced Computer Science (0-V) Fall/Winter/Spring/Summer**

Advanced group studies in computer science on a subject of mutual interest to students and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on Pass/Fail basis only. Prerequisite: Consent of the instructor.

**CS4900 Technology and Transformation I (0-2)****Winter/Summer**

This is a two-quarter course that supports students in the selection of thesis topics with potential for transformation. The thesis process is a microcosm of transformation processes. Topics include: meaning of transformation and innovation, innovation process, skills of innovation, selection of thesis topic, design of an effective thesis document, and organizing an effective writing process. Frequent faculty guest speakers will discuss different research areas and current problems under study. The emphasis in the first quarter is on the range of possible research, and in the second quarter on the transformation process as it applies to theses. Includes weekly readings and exercises. Prerequisite: None.

**CS4901 Technology and Transformation II (0-2)****Winter/Summer**

This is a two-quarter course that supports students in the selection of thesis topics with potential for transformation. The thesis process is a microcosm of transformation processes. Topics include: meaning of transformation and innovation, innovation process, skills of innovation, selection of a thesis topic, design of an effective thesis document, and organizing an effective writing process. Frequent faculty guest speakers will discuss different research areas and current problems under study. The emphasis in the first quarter is on the range of possible research, and in the second quarter on the transformation process as it applies to theses. Includes weekly readings and exercises. Prerequisite: None.

**CS4902 Practices of Transformation (0-2) As Required**

This course will examine the current and planned research of Computer Science faculty in multiple fields of study. The course is designed to support Computer Science students in their third quarter of study in the selection of an emphasis track and an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. Prerequisite: Computer Science students in third quarter or consent of the department chairman.

**CS4910 Advanced Readings in Computer Science (0-V)****Fall/Winter/Spring/Summer**

(Variable hours 0-2 to 0-8.) Directed readings in computer science on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Prerequisite: Consent of the instructor.

**CS4920 Advanced Topics in Computer Science (3-2)****Fall/Winter/Spring/Summer**

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**CS4921 Advanced Topics in Computer Science I (V-V)****As Required**

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not

covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**CS4922 Advanced Topics in Computer Science II (V-V) As Required**

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**CS4923 Advanced Topics in Computer Science III (V-V) As Required**

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

*MV Courses***MV0810 Thesis Research (0-8) As Required**

MOVES Thesis Research. Prerequisite: None.

**MV1000 Becoming a Master Learner (3-2)****Fall/Winter/Spring/Summer**

This course teaches fundamental skills associated with success in higher education, with a focus on improving learning strategies and self-management skills to help students better organize, prepare, and perform effectively in an academic or work environment. The course teaches students to improve study habits, develop critical thinking skills, use time management principles, hone communication skills, and develop their own individual success strategies. The course helps students understand their own cognitive processes, and what strategies work for best for them in order to improve their learning and lead them to successes academically, personally, and in their careers. This course is graded on a Pass/Fail basis only. Prerequisite: None.

**MV2920 Introductory Topics in Modeling, Virtual Environments, and Simulation (V-V) As Required**

(Variable hours 2-4 to 4-1.) This course is designed to support introductory subject matter of special interest and is dependent on faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture- or lab-oriented, or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**MV2921 Introduction to Modeling, Virtual Environments, and Simulation (2-0) Fall/Spring**

This course is an introduction to the Modeling, Virtual Environments, and Simulation discipline. Topics include Combat Modeling, Networked Visual Simulation, Web-Based Simulation, Agents and Cognitive Modeling, Training Systems, Human Factors, Physically Based Modeling, and

Optimization. This course is graded on a Pass/Fail basis only. Prerequisite: None. Classification: CONFIDENTIAL.

**MV3202 Computer Graphics Programming (3-2) Winter/Summer**

An introduction to the principles of the hardware and the software used in the production of computer-generated images. The objective of the course is to instruct students in 3-D graphics programming. Topics include graphics programming in a Windows environment, basic rendering and color, transformations, font rendering, selection, lighting, and hidden surface elimination. The primary focus of the course is the design and implementation of a major project involving 3-D graphics. Prerequisite: None.

**MV3204 Computer Graphics Modeling Using X3d/Vrml (4-0) Winter/Summer**

This course provides an introduction to the principles of hardware and software used for computer-generated 3-D graphics via the World Wide Web. The focus of the course is authoring interactive 3-D scenes and a major design project. The course is intended for MOVES and Computer Science students working in visual simulation, or students in other majors interested in the basics of 3-D modeling and rendering. Prerequisite: CS2971 and CS2973, or equivalent.

**MV3250 Introduction to Extensible Markup Language (XML) (4-0) Winter**

XML and related technologies provide platform independent representation, description, and validation of data. This is necessary for the data communication among different networks, computers, and applications that is essential for contemporary military and civilian applications. The course will present the benefits of XML and how to use software tools to construct and process XML documents using XML editors, XML parsers, XML Schema for validation, XSLT to transform documents, and DOM, SAX, and JDOM to access and manipulate XML documents within a computer program. Much of the programming code in contemporary computer applications that is used to construct data files, access databases and spreadsheets, check and validate data values, and output data can be replaced by these more general software tools. Prerequisite: None.

**MV3472 Graphical Simulation of Physical Systems in Virtual Worlds (3-2) Winter**

Design and construction of reusable software modules for real-time computer simulation of physical systems in graphical virtual worlds. Rigid body kinematics and dynamics, perspective transformations, and wire-frame graphical models. Time domain and transform domain analysis of linearized dynamic systems. Laboratory is concerned with development and testing of software. Prerequisites: CS2970 or CS2971 or CS2973 or equivalent; MA3042 or consent of the instructor.

**MV3500 Internetwork Communications and Simulation (3-2) As Required**

An introduction to network communications in simulation applications. Topics include an introduction to the TCP/IP protocol stack; TCP/IP socket communications, including TCP, UDP, and multicast; and protocol design issues, with emphasis on Distributed Interactive Simulation and High Level Architecture. The emphasis will be on Windows and Web-browser applications. Prerequisites: CS2971 and CS3773.

**MV3800 Directed Study in Modeling, Virtual Environments, and Simulation (0-V) As Required**

Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on Pass/Fail basis only. Variable hours 0-2 to 0-8. Prerequisite: Consent of the instructor.

**MV3920 Topics in Modeling, Virtual Environments, and Simulation (V-V) As Required**

(Variable hours 2-4 to 4-1.) Designed to support a subject matter of special interest, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

**MV3922 Introduction to Virtual Environmental Technology (2-0) Winter/Summer**

This course is an introduction to the technology used in virtual environments and discusses applications that use virtual environments. It is intended to give the students an introduction to the items they are likely to use throughout the master's degree program in Modeling, Virtual Environments, and Simulation (MOVES). Graded on a Pass/Fail basis only. Prerequisite: MV2921.

**MV3923 Introduction to Research and Modeling, Virtual Environments, and Simulation (0-2) Fall/Spring**

This course will examine the current and planned research of Modeling, Virtual Environments, and Simulation (MOVES) faculty in multiple fields of study. The course is designed to support MOVES students in the selection of emphasis blocks and an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. Graded on a Pass/Fail basis only. Prerequisite: MV3922.

**MV4000 Hamming: Learning to Learn (3-2) Winter**

Richard W. Hamming's original capstone course, EC4000, "Learning to Learn: Future of Science and Engineering" has been fully digitized and placed online. This course presents the distilled career insights of a preeminent thinker. In 1968, Dr. Hamming was the recipient of the Turing Award, the highest honor in computer science, for his work on numerical methods, automatic coding systems, and error-detecting and error-correcting codes. This course is intended to instill a "style of thinking" that will enhance one's ability to function as a problem solver of complex technical issues. With respect, students sometimes called the course "Hamming on Hamming" because he relates many research collaborations, discoveries, inventions, and achievements of his own. This collection of stories and carefully distilled insights relates how those discoveries came about. Most importantly, these presentations provide objective analysis of the thought processes and reasoning that took place as Dr. Hamming, his associates, and other major thinkers in computer science and electronics progressed through the grand challenges of science and engineering in the twentieth century. Prerequisite: None.

**MV4001 Human Factors of Virtual Environments (4-1) Winter**

This course focuses on human factors issues in virtual environments (VEs). While the similarities of VEs to the real world can often make VE interfaces intuitive and easy to use, the differences between VEs and the real world can often be the cause of serious performance problems and physical inability to effectively use a system. The design of effective VE systems depends on an understanding of humans and their interaction with their environment. Only then can a VE system hope to achieve reasonable performance levels and acceptability. This course will survey the VE literature on issues of human performance, perception, cognition, multimodal interfaces, locomotion, wayfinding, object selection and manipulation, visualization, simulator sickness, and performance differences between individuals. Prerequisite: None.

**MV4002 Simulation and Training (4-1) Summer/Winter**

This course focuses on training issues in virtual environments (VEs). VEs have often been considered to be general purpose trainers. However, systems are often built without an understanding of how to build a trainer that can verify that it improves subsequent performance without forming bad habits or other reverse training artifacts. This course will first investigate VE training systems from a theoretical perspective, focusing on learning, memory, and cognition. From this framework, actual training systems will be studied with the focus being on an actual study of training transfer of a real training system. Prerequisite: None.

**MV4015 Agent-Based Autonomous Behavior for Simulations (4-2) Winter/Summer**

Covers the concepts and skills required to apply agent-based programming to models and simulations of complex adaptive systems (CAS). Concepts covered will include: complex systems—especially their properties of path dependence, sensitivity to initial conditions, emergence of self-organized structure, adaptation to a changing environment, and criteria for evaluation model or simulation fidelity; distinctions between agent-based methods and other kinds of programming; goal-directed behavior and decision making; situational reasoning and the elements of rational behavior. The course will survey specific works and key contributors to this subject: John Holland, Complexity Science at the Santa Fe Institute, Artificial Life, Brian Arthur (the El Farol Problem and Bounded Rationality), SWARM, Sugarscape, ISAAC, Daniel Dennett (Intentionality), and Richard Dawkins. Within this conceptual and historical framework, the course will emphasize design, specification, and programming skills that will equip the student to know when and how to apply agent-based methods to models and simulations. The programming skills will involve genetic algorithms, classifier systems, applications of game theory and reinforcement learning, and the treatment of collaboration and defection in groups. Finally, the course will discuss agent-based simulations in the context of distributed, virtual environments. Prerequisite: None.

**MV4025 Cognitive Behavioral Modeling for Simulations (3-2) Summer**

This course focuses on the primary technologies used to model cognition and behavior in order to create agents that represent

human beings in simulations. Topics include the dominant technologies in use, the tools used to support them, and their application to the various capabilities required of an agent. The modeling technologies covered include the production-system approaches common in artificial intelligence/cognitive science/psychology, as well as the finite-state, automata-inspired approaches that are part of engineering practice in computer-generated force simulations and the computer entertainment industry. The full scope of the modeling problem will be addressed, from sensation and perception through situation awareness and action selection, to action execution. Approaches to modeling communication and behavior moderators (e.g., experience, emotion, fatigue) will also be discussed. Prerequisite: CS3310.

**MV4030 Modeling and Simulation in Ocean Environments (3-2) Spring**

This course focuses on modeling and simulation (M&S) issues in ocean environments. While virtual environments (VEs) serve as M&S tools, the design of effective VE systems needs realistic physical environments. This course will cover the basic physics of ocean environments, visualization of the ocean from satellites, visualization of the ocean from Navy METOC model output, METOC information flow in M&S, the impact of the environment on human behavior, and physically-based modeling. Prerequisite: None.

**MV4100 Cognitive Engineering (4-1) Fall**

This course is about a cognitive approach to engineering systems. It is partly about artificial intelligence and agent-based technologies, and partly about human-computer interaction. The objective is to build intelligent interactive systems where we maximize the performance and capabilities of the combined human-machine system. Prerequisite: None. Classification: CONFIDENTIAL.

**MV4205 Advanced 3-D Modeling with X3D/VRML (3-2) Spring**

This course focuses on the primary technologies used to model cognition and behavior in order to create agents that represent human beings in simulations. Topics include the dominant technologies in use, the tools used to support them, and their application to the various capabilities required of an agent. The modeling technologies covered include the production-system approaches common in artificial intelligence/cognitive science/psychology, as well as the finite-state, automata-inspired approaches that are part of engineering practice in computer-generated force simulations and the computer entertainment industry. The full scope of the modeling problem will be addressed, from sensation and perception through situation awareness and action selection, to action execution. Approaches to modeling communication and behavior moderators (e.g., experience, emotion, fatigue) will also be discussed. Prerequisite: None.

**MV4250 Advanced Extensible Markup Language (XML) Authoring and Design (4-0)**

MV4250 presents advanced principles and practices for Web-based document design and authoring using XML data structures, XML applications, and XML-based languages. Examples and class projects are typically oriented to problems of broad Navy, military, or scientific interest. Because this new course deals with principles of all Web-based languages, and since XML authoring tools are becoming more intuitive and accessible, MV4250 will be of interest to many other



departments and curricula. Prerequisites: MV3250 and OA3250 and MV3250, or sufficient background knowledge of XML.

**MV4302 Advanced Discrete Event Simulation Modeling (3-2) Fall**

This course is an in-depth study of modern methods of Discrete Event Simulation (DES) modeling. The focus will be on learning advanced methods for designing and implementing DES models using the most current methodologies, including component-based simulation modeling, listener design patterns, XML and Web-based models. Students will implement a nontrivial DES model of military relevance as a final project. Prerequisite: OA3302.

**MV4460 Management of Modeling and Simulation Development (4-0) Summer**

The purpose of this course is to prepare MOVES students to manage large-scale modeling and simulation projects. The course traces the development life cycle of modeling and simulation systems, including, but not limited to, project management, measurement, life cycle models, requirements, implementation, testing, verification, and deployment of large-scale systems typical of DoD acquisition. Prerequisite: None.

**MV4470 Image Synthesis (3-2) Spring**

This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Topics include illumination, shading, transparency, antialiasing, shadows, raytracing, radiosity, texture mapping, and parametric surfaces. Labs are directed towards providing students with experience working with scene graph architecture. Prerequisites: CS3773 and MV3202, or consent of instructor.

**MV4471 Computer Animation (3-2) Fall**

This course covers advanced topics in state-of-the-art, animated, 3-D, computer models. Computational techniques for real-time animation, motion control, interactive key-frame systems, kinematic methods for figure animation, dynamics for figure animation, soft object animation, procedural animation and other high-level approaches will be examined. Labs utilize state-of-the-art animation software and equipment. Prerequisite: Consent of the instructor.

**MV4472 Physics for Game Developers and Virtual Environments (3-2) Spring**

This course enables you to produce convincing graphical virtual reality representations of the motion of vehicles and human actors or avatars. Basic linear algebra and vector-matrix calculus are explained, and the ANSI Common Lisp programming language is used, in the context of examples. This is a hands-on, project-oriented course. After studying basic topics, each student will focus on developing and presenting an individual project during the second part of the course. Prerequisite: MV3472 or equivalent.

**MV4473 Virtual Worlds and Simulation Systems (3-2) As Required**

This course covers the design and implementation of real-time, visual simulation systems for animating and interacting with virtual environments. The course pays special attention to practical issues involving performance/realism tradeoffs; experience with computer/human interaction, especially novel

input devices and paradigms; and simulating kinematic and dynamic behaviors in real-time. Prerequisite: MV3202 or consent of the instructor.

**MV4474 Virtual Environment Network and Software Architecture (3-2) Spring**

This course covers the design and implementation of network and software architectures for real-time, interactive 3-D virtual environments (VEs). Network architecture topics include a taxonomy for networked virtual environments, distributed interactive simulation protocols (DIS and HLA), virtual reality modeling language (VRML), agent-based network protocols (Java/Telescript), proposed solutions for large-scale networked virtual environments (area of interest managers and object brokers), multicast backbone tools and developments, and virtual reality transfer protocol proposals. Software architecture topics include representative software architectures for VEs (NPSNET, DIVE, MASSIVE, etc.), commercial toolkits for VE development (WorldToolKit, Division's dvs, Performer, etc.), lag in multiprocessor virtual environments, and the HCI implications on VE network and software architectures. Prerequisite: MV3500 or consent of the instructor.

**MV4655 Introduction to Joint Combat Modeling (4-0) As Required**

This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, introduction to aggregated force-on-force modeling (including the basic Lanchester model and some of its derivatives), sensing algorithms, simulation entity decision making, simulating C4ISR processes, terrain and movement algorithms, verification, validation, and accreditation (VV&A), stochastic versus deterministic representations, hierarchies of models, and variable resolution modeling. The primary course objective is for you to understand the enduring fundamentals of how combat models are built and used to support decision making. This will be done, in part, through several small projects that will require students to design, implement, and analyze models. Prerequisites: Probability and Statistics (through third course in the sequence), familiarity with a programming language (Java recommended), Stochastic Models (OA3301), Calculus, and concurrent instruction in computer simulation (e.g., OA3302).

**MV4800 Directed Studies in Advanced Modeling, Virtual Environments, and Simulation (0-V) As Required**

Advanced group studies in modeling, virtual environments, and simulation on a subject of mutual interest to students and faculty member. The primary intent of this course is to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. This course may be repeated for credit with a different topic. Graded on Pass/Fail basis only. The variable credit hours are 0-2 to 0-8. Prerequisite: Consent of the instructor.

**MV4900 Research Seminar in Modeling, Virtual Environments, and Simulation (0-2) As Required**

A seminar series designed to give a broad-brush introduction to MOVES. Presentations include the major areas of MOVES and are presented by subject matter experts within MOVES. Also covered are ongoing research projects within MOVES at NPS and around the world. All first and second quarter MOVES students are required to take this course. Prerequisite: None.

**MV4910 Advanced Readings in Advanced Modeling, Virtual Environments, and Simulation (0-V) As Required**

(Variable credit hours 0-2 to 0-8.) This course is centered on directed readings in modeling, virtual environments, and simulation on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. This course may be repeated for credit with a different topic. The course can be taken either Pass/Fail or graded. Prerequisite: Consent of the instructor.

**MV4920 Advanced Topics in Advanced Modeling, Virtual Environments, and Simulation (V-V) As Required**

(Variable credit hours 2-4 to 4-1.) This course is designed to support the advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**MV4924 Research Seminar in Modeling, Virtual Environments, and Simulation Fall/Winter/Spring/Summer**

The course is designed to provide breadth in MOVES not normally provided by classroom material, as well as focus in major areas of MOVES. Faculty and research staff attend class sessions, providing the opportunity to interact with a broad group once a week, and with a focused group of the student's choosing once a week. Course is expected to be repeated and is required of all MOVES students every quarter starting with their fourth quarter in the curriculum. Graded on a Pass/Fail basis only. Prerequisite: MV3923.

**MV4925 Advanced Rendering Techniques for Visual Simulation (2-3) Summer**

Currently, the number of transistors on a certain consumer-level graphics processing units exceeds the number of transistors on a Pentium IV processor. Until recently, however, programming these powerful units has been done using a limited assembly-like instruction set targeted for a specific vendor's hardware. This has made cinematic effects difficult to program, update, and transport. Recent developments such as High Level Shading Language (HLSL), Nvidia's C for Graphics (CG), and the OpenGL 2.0 specification could revolutionize the process of programming GPUs. This class will provide an overview of current technology and will explore in-depth its application to DoD. Prerequisites: MV4470 and or consent of the instructor.

**MV4930 Advanced Topics in Advanced Modeling, Virtual Environments, and Simulation (0-2) As Required**

This course is part of the seminar series in advanced research topics in MOVES. Topics are drawn from current student

thesis research, funded research projects, proposed research projects, and other research directions within the MOVES Institute. This course is required by all MOVES students in their second quarter and beyond, as well as all CS Graphics Track students. Presentations are made by M.S. and Ph.D. students, as well as by MOVES faculty and researchers. This course may be repeated multiple times. Prerequisite: None.

*SW Courses***SW0810 Thesis Research (0-8) None**

Every student conducting thesis research will enroll in this course.

**SW2920 Introductory Topics in Software Engineering (V-V) None**

(Variable hours 2-4 to 4-1.) Designed to support introductory subject matters of special interest in software engineering, dependent on faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture- or lab-oriented, or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

**SW3460 Software Methodology (3-1) Winter/Summer**

The course is designed to teach students the basic concepts of software engineering and methods for requirements definition, design, and testing of software. Specific topics include introduction to the software life cycle, basic concepts and principles of software engineering, object-oriented methods for requirements analysis, software design, and development. Prerequisite: None.

**SW3800 Directed Study in Software Engineering (0-V) As Required**

(Variable hours 0-2 to 0-8.) Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on Pass/Fail basis only. Prerequisite: Consent of the instructor.

**SW3920 Topics in Software Engineering (V-V) As Required**

(Variable hours 2-4 to 4-1.) Designed to support subject matters of special interest in software engineering, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

**SW4150 Programming Tools and Environments (4-0) Fall**

This course covers the design and implementation of tools to aid software development, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, type checkers, and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented, programming environment. Prerequisite: SW4500.

**SW4500 Introduction to Formal Methods in Software Engineering (3-1) Winter/Summer**

This course covers formal methods for specification and analysis of software systems. The course introduces application of mathematical logic to software design, program verification, and formal specification languages. The laboratory sessions will cover special topics and case studies. Prerequisite: SW3460 or consent of the instructor.

**SW4510 Computer-Aided Prototyping (3-0) Fall**

This course covers the concept and application of computer-aided prototyping to the development and acquisition of DoD software systems. Specific topics include the prototyping software life cycle, system models, design methods, automatic code generation, prototyping languages and tools, and their unique systematic system for increasing productivity, reliability, and portability of software development in comparison with other development methods. Prerequisite: None.

**SW4520 Advanced Software Engineering (3-0) As Required**

This course covers methods for specifying, designing, and analyzing software systems, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. Prerequisite: SW4500 or consent of the instructor.

**SW4530 Software Engineering Research and Development in DoD (3-1) Spring**

This course builds on the material covered in SW4500. Fundamental principles of computer system/network security and distributed computing are covered, along with advanced methods, techniques, and standards aimed at improving the development and acquisition of DoD software systems. Specific topics include: the application of software engineering principles for designing large, secure, embedded real-time computer systems; the application of software engineering principles for the design of distributed systems; automated tools for the specification, design, and generation of code for applications; and existing and emerging standards for software development, security, and acquisition. Prerequisite: SW4500 or consent of the instructor.

**SW4540 Software Testing (3-1) Spring**

This course covers the theory and practice of testing computer software with the intent of preventing, finding, and eliminating bugs in software. Planning and executing software tests are covered, including requirements-based testing, functional testing, static analysis, code reading, symbolic testing, structural testing, and advanced testing techniques. These topics are discussed in the context of a realistic development environment, illustrated using a variety of software testing tools. Prerequisite: SW3460.

**SW4555 Engineering Network Centric Systems (3-1)**

This course covers the concepts, methods, techniques, and tools for engineering the development of network centric systems. Specific topics include the evolution of client/server models to distributed objects, an introduction to and comparison of CORBA/OpenDoc and OLE/COM, intelligent software agents, application development in distributed environments, security issues in network centric

computing, and software system development. Prerequisite: SW4500.

**SW4560 Software Evolution (3-0) Winter**

This course covers the concepts, methods, techniques, and tools for supporting the evolution and maintenance of software systems. Specific topics include the use of formal specifications to support software evolution, design databases, configuration management, software change merging, and software re-engineering. Prerequisite: SW4500.

**SW4570 Software Reuse (3-0) Spring**

This course covers the concepts, methods, techniques, and tools for systematic reuse of software components and systems. Specific topics include design and re-engineering for reuse, mechanisms for enhancing reuse, domain specific reuse and software architectures, reuse of requirements models, specifications and designs, tools for reuse, software library organization, and methods for component search. Prerequisite: SW4500 (can be taken concurrently) or consent of the instructor.

**SW4580 Design of Embedded Real-Time Systems (3-0) Summer**

This course covers the concepts, methods, techniques, and tools for supporting the design of embedded real-time systems. Specific topics include real-time systems and concurrency models, object-oriented methods for real-time system design, real-time scheduling, and programming language support for concurrent and real-time systems. Prerequisite: SW4500 or consent of the instructor.

**SW4581 Software Reliability (3-1) Summer**

This course covers the concepts, methods, and techniques for evaluating and improving the engineering of software reliability. Specific topics include system-level dependability and reliability modeling concepts; software reliability prediction and estimation models and metrics; and techniques for model evaluation, fault/failure forecasting, fault removal, fault prevention, and fault tolerance. Prerequisite: SW4500 taken concurrently or consent of the instructor.

**SW4582 Weapon System Software Safety (3-1) Fall**

This course provides an introduction to software system safety. The course covers the principles and processes of system safety engineering, including the basics of hazard analysis and risk assessment. Emphasis is placed in this course on both planning and managing acquisition programs involving safety-critical software. Concepts and principles are applied to the acquisition of weapon systems. An advanced course in system safety is offered as SW4920. Prerequisite: SW3460.

**SW4583 Principles of Software Design (3-1) Winter**

The course is designed to teach students the role of design in software engineering. Specific topics include the software system design process, design qualities, principles and strategies, design models, design methods, and the use of patterns in the design of object-oriented software systems. Prerequisite: None.

**SW4590 Software Architecture (3-1) Summer**

This course covers both high- and low-level software architectures, including software patterns and pattern-oriented architectures, from the module level through the enterprise

level. Where appropriate, we examine formalisms, and actual software architecture practice. Special attention is given to interoperability of architectural components. Case studies of existing DoD systems are used throughout the course. Prerequisite: SW4500 (can be taken concurrently) or consent of the instructor.

#### **SW4591 Requirements Engineering (3-1) Spring**

This is an in-depth treatment of requirements engineering concepts, methods, and tools. The role of requirements engineering within software engineering is explored, as well as consistency, cost-benefit analysis, resolving multiple viewpoints, dependency tracing, and automated decision support. Topics are reinforced with examples from DoD applications. Prototyping is introduced as a means of assessing requirements early in the design process. Prerequisite: SW4500 taken concurrently or consent of the instructor.

#### **SW4592 Software Risk Assessment in DoD (3-1) Summer**

This course introduces concepts, techniques, and tools for software risk management. The course examines various risks of software practice and evaluates them in terms of mathematical models (e.g., probability theory). Students learn techniques for mitigating, avoiding, and handling risks throughout the software life cycle. The course depends on software metrics; we also look at reliability theory and its application to software risk management. Prerequisite: SW4500.

#### **SW4593 Advanced Logic and Algebra for Software R&D in DoD (3-1) As Required**

The aim of this course is to present fundamentals of advanced logic and algebra for software R&D. Specific topics include equational specifications, algebra, characterization of equation classes, the equation calculus, term rewriting, first and second order logic, temporal logic, model theory, and generalized induction. Prerequisite: SW4500 or consent of the instructor.

#### **SW4594 Formal Models for Software Automation (3-1) As Required**

This course covers the concepts, methods, techniques, and tools for designing and developing systems. Specific topics include the use of knowledge-based tools for software evolution and techniques for specification, methods for program derivation and generation, domain-specific program synthesis techniques, and cognitive and planning approaches to software design. Prerequisite: SW4500.

#### **SW4595 Lightweight Inference Techniques (3-1) As Required**

This course covers the fundamental principles and technologies for automated decision support and automated software evolution with an emphasis on techniques for lightweight inference. Specific topics include: decision support systems, software evolution systems, gaps in existing technology that prevent automation, models and methods for lightweight inference, and state of the art theory and practice. Prerequisite: SW4500 or consent of the instructor.

#### **SW4596 Algorithm Design and Analysis in Software Engineering (3-1) As Required**

This course covers algorithm design and analysis in software engineering. Specific topics include advanced data structures (such as Binomial Heaps and Fibonacci Heaps), graph algorithms (such as minimum spanning trees, maximum flow,

all-pairs shortest paths, and single-source shortest paths), and advanced design and analysis techniques (such as dynamic programming, greedy algorithms, linear programming, and amortized analysis). Prerequisite: SW4500 or consent of the instructor.

#### **SW4597 Robust Generation of Control Software (3-1) As Required**

This course covers the concepts, methods, techniques, and tools needed to methodically generate robust software for system control. Specific topics include specification and analysis of control requirements, hard and soft real-time constraints, embedded software control, code generation, software reliability through software reuse and redundancy, and DoD requirements for control systems. A survey of computer-aided tools that support the generation of robust systems is provided. Prerequisite: SW4500 or consent of the instructor.

#### **SW4598 Software Merging and Slicing Techniques (3-1) As Required**

The fundamental concepts, methods, and tools for software merging and slicing are covered in this course, with applications to software evolution, configuration management, and testing. This is followed by advanced topics including recent advancements in this field. Prerequisite: None.

#### **SW4599 Automated Software/Hardware Integration in DoD (3-1) As Required**

Automated software/hardware integration is a key problem for current software development in DoD. This course covers some important aspects of this field, including software prototyping, interface integration, data integration, and control integration. Automatable decision support methods for software/hardware integration are also discussed. Prerequisite: SW4500 or consent of the instructor.

#### **SW4600 Automata, Formal Specification, and Run-Time Verification (3-1) Fall**

This course focuses on run-time monitoring and verification, a practical software verification technique based on automata and formal specifications. The automata section consists of finite automata (deterministic and nondeterministic), languages, and regular expressions. The formal specification section consists of temporal logics, real-time and time-series constraint specification, statecharts, and TLCharts. The run-time verification section will cover the practical application of formal specifications to monitoring and verification of safety critical systems. The course combines theory, examples, and practical, student-driven projects. After taking this course, students will know how to apply formal specifications and run-time verification to improve the dependability of defense systems. Prerequisites: CS3650 and MA2025.

#### **SW4800 Directed Study in Advanced Software Engineering (0-V) As Required**

(Variable hours 0-2 to 0-8.) Advanced group studies in software engineering on a subject of mutual interest to students and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only. Prerequisite: Consent of the instructor.

**SW4900 Research Seminar in Advanced Software Engineering (0-2) As Required**

This course will examine the current and planned research of software engineering faculty. The course is designed to support software engineering students in the selection of an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. Graded on a Pass/Fail basis only. Prerequisite: None.

**SW4910 Advanced Readings in Software Engineering (0-V) As Required**

(Variable hours 0-2 to 0-8.) Directed readings in software engineering on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Can be taken Pass/Fail or graded. Prerequisite: Consent of the instructor.

**SW4920 Advanced Topics in Software Engineering (V-V) Winter**

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest in software engineering, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

**SW4934 Application of Advanced Concepts in Software Engineering (3-2) As Required**

An advanced seminar designed to assist Ph.D. students to prepare for their written qualifying examination through a combination of lectures and problem-solving sessions. Intended for Software Engineering Ph.D. students. Students may repeat this course for credit. Graded on Pass/Fail basis only. Prerequisite: None.

**SW4935 Software Engineering Dissertation Proposal Preparation (3-0) As Required**

A seminar designed to introduce Ph.D. students to the open problems in software engineering and teach students the skills to identify research topics; find, read and analyze relevant parts of the research literature; and present their findings in the form of research proposals. Intended for Software Engineering Ph.D. students. Prerequisite: SW4934.

**SW4936 Seminar on Solving Software Engineering Research Problems (3-0) Summer**

A seminar designed to assist Ph.D. students in preparing for their oral qualifying examination through a combination of lectures, assigned readings, student presentations, and problem-solving sessions. Intended for Software Engineering Ph.D. students. Prerequisite: SW4934.

**SW4937 Software Engineering Dissertation Research (4-0) As Required**

A seminar designed to provide a forum for Ph.D. students to present work in progress and critique each other's results. Intended for Software Engineering Ph.D. students. Prerequisite: None.

**SW4938 Communicating Research Results in Software Engineering (4-0) As Required**

A seminar designed to provide a forum for Ph.D. students to present their dissertations and critique each other's work. Intended for Software Engineering Ph.D. students. Prerequisite: None.

**Master of Science Computing Technology (MCT) - Curriculum 357****Program Officer and Academic Associate**

Loren Peitso, LCDR, USN  
Code CD/Lp, Spanagel Hall, Room 529A

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MCTDegProg@nps.edu

**Brief Overview**

The MCT degree offers its graduates the knowledge and skills necessary to specify, evaluate, and manage computer system development, as well as the ability to provide technical guidance in the analysis, design, and application of software and firmware used in the Navy. The MCT program consists of 16 courses selected to provide breadth and depth in the latest computing technologies.

Four courses provide a foundation in computer science for those without a CS background. Core courses then develop student expertise in a broad range of topics in the computing field. And a four-course sequence in a specialization area completes the degree. The MCT degree provides a graduate education for those in unique circumstances. State-of-the-art distance learning (DL) technology is used to bring the MCT program straight to the student on duty. With fully Web-based courses, there is no required "class time"—no need to get off the flight schedule, miss any watches, or adjust a duty schedule. MCT offers a seamless transition from duty station to duty station; when you move the program goes with you, even on the road.

The MCT degree is fully accredited and taught by the same faculty that teaches NPS resident courses. It is an excellent fit for those officers and government service (GS) personnel whose career track would not otherwise lend itself to receiving a resident technical graduate education. Available anywhere in the world, at home, on detachment, and at sea.

**Requirements for Entry**

A baccalaureate degree, or the equivalent, with above average grades in mathematics, (including differential and integral calculus) resulting in an academic profile code (APC) of at least 325 is required. Undergraduate degrees in applied science or engineering are highly

desirable. Students lacking these prerequisites may be acceptable for the program, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite. Active/Active Duty Reserve U.S. military and GS personnel are eligible.

### Entry Date

The MCT is a sixteen-quarter (one course per quarter), fully-online curriculum with entry dates in January/July. If further information is needed, contact the Program Officer or the Academic Associate for this curriculum.

### Degree

#### Master of Science in Computing Technology

The Master of Science in Computing Technology program is awarded after the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

- At least 40 quarter-hours of graduate-level work, of which at least 12 quarter-hours must be at the 4000 level.
- Completion of an approved sequence of courses constituting specialization in an area of computing technology.
- Completion of a capstone paper.

### Subspecialty

None currently assigned. DL students desiring a computer science subspecialty code (6203P) may be able to arrange a resident assignment at NPS with their sponsor/community detailer to add a research element to their degree program and complete the ESR requirements for a computer science subspecialty code. Six months of resident study will be required.

If a transition to a MS in Computer Science (MSCS) degree is also desired, the research element must be arranged before the MCT curriculum is finished. A MSCS (in lieu of the MSCT degree) will be granted after completion of the research element and thesis. The MSCS cannot be granted if the MSCT has been awarded for the same coursework.

### Typical Course of Study

#### 1st Year Computer Science Foundations

CS2900	Introduction to Objects and Programming
CS3010	Computing Systems Principles
CS3450	Operating Systems

MA3025 Logic and Discrete Mathematics

#### 2nd Year Computing Technology I

CS3901	Introduction to Data Structures and Intermediate Programming
MV3202	Computer Graphics Programming
CS3600	Information Assurance: Introduction to Computer Security
SW3460	Software Methodology

#### 3rd Year Computing Technology II

CS3320	Database Systems
CS3502	Computer Communications and Networks
CS3000	Great Principles of Computing Technology
CS3310	Artificial Intelligence

#### 4th Year Specializations

Four-course elective sequence, 12 credits at the 4000 level, in one of the three following areas:

- Computer Security and Critical Infrastructure Protection
- Networks
- Software Engineering

### Specialization Options

#### Computer Security and Critical Infrastructure Protection

The Computer Security specialization is designed to provide knowledge in all areas of Information Security (INFOSEC) and to develop the necessary skills for those who will be involved in the development, evolution, or implementation of secure computer systems.

#### Networks

The Computer Networks specialization is designed to provide knowledge of computer architecture, networks, and system software for real-time and multi-computer systems.

#### Software Engineering

The Software Engineering specialization is designed to provide knowledge of all aspects of software development and to develop the skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques.

### Computer Science - Curriculum 368

#### Program Officer

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### **Academic Associate**

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### **Brief Overview**

The Computer Science curriculum is designed to provide the officer with the technical knowledge and skills necessary to specify, evaluate, and manage computer system design; to provide technical guidance in applications ranging from data processing to tactical embedded systems; to educate the officer in the analysis and design methodologies appropriate for hardware, software, and firmware; and provide practical experience in applying modern computer equipment and research techniques to solve military problems.

Ours is the first curriculum in the United States to be organized around the great principles of computing. The principles have two layers: computing mechanics deals with the workings of computations, communications, computers, and memories; design deals with the ways of organizing software systems for simplicity, reliability, performance, security, and value. Our curriculum begins with a unique course in the great principles of computing technology.

Our curriculum also provides for concrete experience in computing practices—the skills and ways of thinking that mark a computing professional. These include programming, engineering of systems, modeling, and innovating. We offer a unique course called Technology, Innovation, and Leadership that teaches the practices and discipline of innovation.

The two dimensions—great principles and practices—define the space in which the core technologies of computing exist and serve application domains: algorithms, architecture, artificial intelligence, database, networking, operating systems, security, and more.

### **Requirements for Entry**

A baccalaureate degree, or the equivalent, with above average grades in mathematics, (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through a six- or twelve-week refresher, provided that their undergraduate records

and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

### **Entry Date**

Computer Science is an eight-quarter course of study with entry dates in March and September. Those requiring the twelve-week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

### **Degree**

#### **Master of Science in Computer Science**

The degree of Master of Science in Computer Science is awarded after the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

- At least 40 quarter-hours of graduate-level work, of which at least 12 quarter-hours must be at the 4000 level.
- At least 28 of the 40 graduate-level credit hours listed above must be CS/MOVES/SW courses.
- Completion of an approved sequence of courses constituting specialization in an area of computer science.
- Completion of an acceptable thesis in addition to the 40 quarter-hours of course work.

Requirements for the Master of Science in Computer Science degree are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

#### **Doctor of Philosophy in Computer Science**

The Department of Computer Science has a program leading to the Doctor of Philosophy degree. A noteworthy feature is that the candidate's research may be conducted off-campus in the candidate's sponsoring laboratory or unit of the federal government. The degree requirements are as outlined under the general school requirements for the doctoral degree.

### **Requirements for Entry**

An applicant should have a master's degree in computer science or a related field. Applicants not meeting this requirement are encouraged to apply to the master's program. Ph.D. applicants should have above average grades in a typical master's degree program and demonstrate the ability to think

creatively and work independently. Other evidence of research or academic ability, such as work experience or publications, is also taken into consideration when evaluating applicants.

### Entry Date

Admitted Ph.D. students may begin in any quarter. The written qualifying examination is administered at least once a year, usually in January. If further information is needed, contact the Program Officer or Academic Associate for this curriculum.

### Typical Course of Study for Doctor of Philosophy in Computer Science

Ph.D. students are expected to complete the following steps:

1. Form a dissertation committee
2. Pass a written qualifying examination
3. Fulfill minor requirements
4. Pass a oral qualifying examination
5. Pass a final dissertation examination
6. Complete a dissertation

Students are expected to complete steps 1 and 2 by the fourth quarter of doctoral study, complete steps 3 and 4 by the sixth quarter, and complete steps 5 and 6 by the twelfth quarter.

### Ph.D. Program Point of Contact

Theodore G. Lewis, Ph.D.  
Professor of Computer Science  
Naval Postgraduate School  
1 University Circle, Watkins Hall, Room 370  
(831) 656-2830, DSN 756-2830, FAX (831) 656-2814  
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### Subspecialty

Completion of this curriculum qualifies an officer as a Computer Science Subspecialist with a subspecialty code of 6203P.

### Typical Subspecialty Jobs

Computer Science Instructor, U.S. Naval Academy  
Preoperational Test and Evaluation, SPAWARS,  
Washington, DC  
Computer Systems Analyst, COMNAVSECGRU,  
Washington, DC  
ADP Systems Director, Naval Security Group,  
Pensacola, FL  
Chief SEID, Joint Staff, Washington, DC  
Operational Test and Evaluation, COMOPTTEVFOR  
ADP System Security, NSA/CSS, Ft. Meade, MD

### Typical Course of Study

#### Quarter 1

CS2900	(4-2)	Introduction to Objects and Programming
CS3010	(4-0)	Computing Systems Principles
MA3025	(5-1)	Logic and Discrete Mathematics
CS3000	(4-1)	Great Principles of Computing Technology
CS4900	(0-2)	Technology and Transformation I

#### Quarter 2

CS3901	(4-2)	Introduction to Data Structures and Intermediate Programming
CS3600	(3-2)	Information Assurance: Introduction to Computer Security
SW3460	(3-1)	Software Methodology
CS3204	(3-2)	Human-Computer Interaction
CS4901	(0-2)	Technology and Transformation II

#### Quarter 3

CS3902	(4-2)	Programming Paradigms
CS3502	(4-0)	Computer Communications and Networks
CS3650	(4-0)	Design and Analysis of Algorithms
CS3320	(3-1)	Database Systems
CS4902	(0-2)	Practices of Transformation

#### Quarter 4

CS3601	(4-0)	Theory of Formal languages and Automata
CS3310	(4-0)	Artificial Intelligence
CS3450	(3-2)	Operating Systems
MV3202	(3-2)	Computer Graphics Programming

#### Quarter 5

CS3113	(3-2)	Introduction to Compiler Writing
OS3307	(4-1)	Modeling Practices for Computing
CSXX	(4-0)	Track Core Requirement*
CSXX	(4-0)	Track Core Requirement*

#### Quarter 6

CSXX	(4-0)	Track Core Requirement*
CSXX	(4-0)	Track Specialization Requirement*
CSXX	(4-0)	Track Specialization Requirement*
NW3230	(4-2)	Strategy and Policy: The American Experience

#### Quarter 7

CSXX	(4-0)	Track Core Requirement*
CSXX	(4-0)	Track Specialization Requirement*



XXXX	(4-0)	Service Required Course or Elective
CS0810	(0-8)	Thesis Research

**Quarter 8**

CS4182	(4-0)	Capstones in Computer Science
XXXX	(4-0)	Service Required Course or Elective
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

*\* Note: Track Core Requirement courses will be determined by the selection of one of the following specialization track options: Computer Security Track, Computer Networks Track, Database and Knowledge Engineering Track, Computer Graphics and Visual Simulation, Wireless and Mobile Devices Track, Agents and Cognitive Systems Track, Software Engineering Track.*

**Specialization Track Options**

- **Computer Security Track** - provides knowledge in all areas of Information Security (INFOSEC) and develops the necessary skills for those who will be involved in development, evolution, or implementation of secure computer systems.
- **Computer Networks Track** - provides knowledge of computer architecture, networks, and system software for real-time and multi-computer systems.
- **Database and Knowledge Engineering Track** - provides an understanding of data retrieval and processing using the best available database system management and operating system techniques and concepts.
- **Computer Graphics and Visual Simulation Track** - provides an understanding of the methodologies and techniques required in real-time, three-dimensional, interactive, visual simulations for military applications.
- **Wireless and Mobile Devices Track** - provides fundamental and advanced knowledge in the rapidly growing areas of wireless networking, mobile devices, and related topics, including mobile computing and wireless security.
- **Agents and Cognitive Systems Track** - provides an understanding of artificial intelligence and human factors techniques for creating highly capable software agents that interact effectively with human users.
- **Software Engineering Track** - provides knowledge of all aspects of software development and develops skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques.

**Educational Skill Requirements (ESR)  
Computer Science - Curriculum 368  
Subspecialty Code: 6203P**

All officers with graduate education in computer science must be competent in computer science core subjects including advanced expertise in a specific computer science functional area. These competencies will enable graduates to serve in positions that design, acquire, operate, or secure military networks and systems and/or deny potential adversaries the effective use of their own. The skills and competencies are detailed below.

1. **Mathematics:** The officer will have a thorough knowledge of mathematical tools and concepts that are intrinsic to Computer Science, including, but not limited to, logic, discrete math, combinatorics, and modeling and simulation.
2. **Networking:** The officer will have a sound understanding of networking theory and practical application as it pertains to the design and operation of military Information Systems and Computer Network Operations (CNO) within Information Warfare. This includes structure, architecture, protocols, communications and security in modern networks, network engineering, and distributed networks. The officer will also be introduced to the fundamental hardware and software components of networks.
3. **Programming and Systems:** The officer will be proficient in programming and programming languages, and in analyzing large software-intensive systems. The officer will demonstrate advanced knowledge and understanding of programming practices and programming paradigms and be familiar with assembly languages. The officer will demonstrate advanced knowledge and understanding of system modules, interfaces, risk factors, and project management.
4. **Practices and Foundational Principles:** Officers will have competence in computer science practices and principles including design and mechanics of computing and their applications to military needs. They will be proficient in core technologies including algorithms, architectures, operating systems, data structures, compilers, databases, software engineering, intelligent systems, and human-computer interactions.
5. **Computer Science Specialization:** Each officer will complete a specialization track that integrates computer science in DoD systems, software, and operations. The major area specializations will include: (a) Network Operations; (b) Information

Security and Assurance; and (c) Software Engineering and Architecture. These specializations require further emphasis in minor areas of study through sequences of courses. The specialization will include a thesis project in a framework that exercises the practice of innovation, problem solving, systems-thinking, and real-world applicability.

## Software Engineering - Curriculum 369

### Program Officer

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### Brief Overview

The defense community, through a NATO-sponsored workshop in 1968, strongly recommended making the developing and maintenance of software-intensive systems a true engineering endeavor. The participants at that workshop coined the term “software crisis” to describe the poor track record the defense community had at that time: Systems were being delivered behind schedule or not at all, the system development and maintenance efforts were usually over budget, and those systems that were delivered typically were missing functionality or even had unwanted or incorrect functionality. Since that time, software development and maintenance has slowly emerged from an ad hoc practice to an engineering discipline that is based on scientific knowledge from computer science. While computer science provides good models and theories to analyze problems and synthesize solutions, it fails to package the results for operational use, leading to the criticism sometimes made by software producers that computer science is irrelevant to practical software.

The software engineering curriculum is designed to address the seemingly never-ending “software crisis” within the defense community. It builds on the student's knowledge of both computer science and engineering sciences, in addition to leveraging the student's real-world, problem-solving experience

working with software-intensive systems. The curriculum introduces students to a set of engineering practices that enable acquisition professionals to procure highly dependable, trustworthy software-intensive systems on schedule, within budget, and with the correct functionality. The curriculum introduces the students to the theory, principles, and practices of software engineering.

The program offers both M.S. and Ph.D. degrees in Software Engineering. The Master of Science in Software Engineering (MSSE) program comes with a one-year, full-time option and a two-year, part-time distance learning option. Students not enrolled in the MSSE degree program may also enroll in individual courses and receive NPS credit after successful course completion.

### Requirements for Entry

An accredited bachelor's degree in computer science, computer engineering, or related field, with above average grades in mathematics, resulting in an APC of at least 325, and at least two years of software development or maintenance experience are required for entry.

### Entry Date

The MSSE is a four-quarter curriculum with entry dates in October, January, and July. If further information is needed, contact the Program Officer or the Academic Associate for this curriculum.

Requirements for the MSSE degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

### Degree

#### Master of Science in Software Engineering (MSSE)

The MSSE program is intended for DoD software practitioners with a bachelor's degree in computer science/engineering (or equivalent) and at least two years of software development experience. Students enrolled in the program typically complete the program in two years on a part-time basis, completing a total of 12 graduate-level Software Engineering courses, which are taught at NPS and televised to the distant site, and an acceptable thesis, in addition to the required course work.

#### Doctor of Philosophy in Software Engineering

The Ph.D. program in Software Engineering is designed for DoD software practitioners who want to acquire the skill and knowledge to perform state-of-the-art research on issues related to the development and evolution of large, complex, software systems, and to intelligently manage the research of other software practitioners. It offers the software professionals a

unique program of study and advances software engineering principles and technology vital to DoD researchers and program managers. Students typically take three years to complete the doctoral program.

The first milestone in the Ph.D. program is the Written Qualifying Examination. This provides early feedback to students and faculty so that a course of study that leads to the successful completion of all the requirements can be determined.

### Requirements for Entry

An applicant should have an MSSE or a related field. Applicants not meeting this requirement are encouraged to apply to the master's program. Ph.D. applicants should have above average grades in a typical master's degree program and demonstrate the ability to think creatively and work independently. Other evidence of research or academic ability, such as work experience or publications, is also taken into consideration when evaluating applicants.

### Entry Date

Admitted Ph.D. students may begin in any quarter. The written qualifying examination is administered at least once a year, usually in January. If further information is needed, contact the Program Officer or Academic Associate for this curriculum.

### Typical Course of Study for Doctor of Philosophy in Software Engineering

Ph.D. students are expected to complete the following steps:

1. Form a dissertation committee
2. Pass a written qualifying examination
3. Fulfill minor requirements
4. Pass an oral qualifying examination
5. Pass a final dissertation examination
6. Complete a dissertation

Students are expected to complete steps 1 and 2 by the fourth quarter of doctoral study, complete steps 3 and 4 by the sixth quarter, and complete steps 5 and 6 by the twelfth quarter.

### Ph.D. Program Point of Contact

Man-Tak Shing, Ph.D.  
 Chairman, Software Engineering Ph.D. Committee  
 Naval Postgraduate School  
 1 University Circle, Spanagel Hall, Room 544B  
 (831) 656-2634, DSN 756-2634, FAX (831) 656-2814  
 shing@nps.edu

### Typical Subspecialty Jobs

Students who graduate from the M.S./Ph.D. Software Engineering programs typically hold senior technical and acquisition positions, such as chief system engineer, technical director, and program/project manager.

### Typical Course of Study

*(Full-Time MSSE Program)*

#### Quarter 1

SW3460 (3-1) Software Methodology

IS4300 (3-2) Software Engineering and Management

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

#### Quarter 2

SW4500 (3-1) Introduction to Formal Methods in Software Engineering

SW4583 (3-0) Principles of Software Design

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

#### Quarter 3

SW4591 (3-0) Requirements Engineering

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

SW0810 (0-8) Thesis Research

SW0810 (0-8) Thesis Research

#### Quarter 4

SW4592 (3-0) Software Risk Assessment in DoD

Elective: SWxxxx course or one of EO4011, IS3301, IS4031, MN3309, or MN3331 (software system acquisition courses)

SW0810 (0-8) Thesis Research

SW0810 (0-8) Thesis Research

### Typical Course of Study

*(Part-Time MSSE Distance Learning Program)*

#### Quarter 1

SW3460 (3-1) Software Methodology

IS4300 (3-2) Software Engineering and Management

**Quarter 2**

SW4500 (3-1) Introduction to Formal Methods  
in Software Engineering

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

**Quarter 3**

SW4591 (3-0) Requirements Engineering

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

**Quarter 4**

SW4592 (3-0) Software Risk Assessment in  
DoD

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

**Quarter 5**

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

**Quarter 6**

SW4583 (3-0) Principles of Software Design

Elective: SWxxxx course or one of EO4011, IS3301,  
IS4031, MN3309, or MN3331 (software system  
acquisition courses)

**Quarter 7**

SW0810 (0-8) Thesis Research

SW0810 (0-8) Thesis Research

**Quarter 8**

SW0810 (0-8) Thesis Research

SW0810 (0-8) Thesis Research

### **Educational Skill Requirements (ESR) Software Engineering - Curriculum 369**

All officers with advanced degree education in Software Engineering must possess skills and competencies in software design, development processes, and related software technology applicable to large-scale military systems. The skills and competencies are detailed below.

1. **Software Design:** The officer must have a thorough knowledge of software system design to include:
  - a. System analysis and design theory encompassing the basics of requirements engineering and specification, system modeling and software architecture, and its application to automation of military processes.

- b. An understanding of the design issues related to digital data processing, interfacing to hardware systems, real-time command and control, distributed computation, and end-to-end systems integration. An understanding of the design issues related to software system interoperability, system reengineering, design rationales, system architecture, and software reuse.
  - c. The ability to design systems that are readily adaptable to changing military needs.
  - d. An understanding of system reliability issues and quality assurance methods for achieving high software reliability.
  - e. The ability to understand, diagnose, and recover from software failures.
2. **Development Processes:** The officer must have a thorough knowledge of software development processes to include:
  - a. An understanding of the software development process, including requirements determination, feasibility assessment, design, configuration management, implementation, quality assurance, and system evolution.
  - b. The ability to perform feasibility assessments of complex, computer-based systems via prototyping, simulation, and static analysis.
  - c. The ability to plan, evaluate, and manage major software projects, choose appropriate design automation tools, and develop appropriate documentation.
  - d. The ability to assess software development risks and improve software development processes to reduce costs and produce more reliable systems.
  - e. An understanding of the development process issues related to improving maintainability and upgradeability of software in integrated systems.
3. **Software Technology:** The officer must have a thorough knowledge of software technology that includes:
  - a. Methods for efficiently representing data and techniques for efficiently operating on data structures.
  - b. The structure, control, and design of software systems involving multiprocessing, distributed processing, and network-centric computing.
  - c. Representations and automatable methods for design and analysis of software systems.
  - d. Tools and techniques for simulation and modeling of systems.

- e. Engineering automation capabilities for design and assessment of software systems, program generation, and computer-aided software design tools.
4. **Problem Solving and Military Applicability:** The officer shall possess skills that enable a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to military concerns such as information warfare and command and control. This includes:
    - a. Completing a significant project applying software engineering skills to Navy and/or relevant problems.
    - b. Exercising skills in problem formulation, criteria specification, analysis, design, and evaluation of results as they relate to military requirements.
    - c. Clearly communicating the results of a project orally and in writing.
  5. **Strategy and Policy:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals, and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required for USN and USMC students only.)

## Modeling, Virtual Environments, and Simulation (MOVES) - Curriculum 399

### Program Officer

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### Academic Associate

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darken@nps.edu

### Brief Overview

The MOVES (Modeling, Virtual Environments, and Simulation) academic program of the Naval Postgraduate School provides the M.S. and Ph.D. student with both fundamental and specialized courses in applied visual simulation technology and the application of quantitative analyses to human-computer interaction in simulation technology.

The M.S. program is a two-year, eight-quarter core program covering the fundamentals of computer science, human-computer interaction, and data analysis. These topics include object-oriented programming, artificial intelligence, computer communications and networks, computer graphics, virtual worlds and simulation systems, probability, statistics, stochastic modeling, data analysis, human-performance evaluation, and human-behavior modeling.

Specialization by the M.S. student is accomplished by completing course blocks providing depth in a selected area. There are seven blocks available, of which the student must select three.

Once the MOVES core courses have been taken, and while the specialization courses are underway, the final step in the M.S. degree process is the completion of a written thesis. This thesis is usually conducted on a research problem specified by a MOVES faculty thesis advisor.

Areas of special strength in the group are networked virtual environments, adaptable software agents, and human factors in virtual environments, physically based modeling for virtual environments, modeling human and organizational behavior, discrete-event systems modeling, data and model visualization, and combat modeling.

### Requirements for Entry

A baccalaureate degree, or the equivalent, with above average grades in mathematics (including differential and integral calculus), resulting in an APC of at least 325 is required for entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through the six-week technical refresher or twelve-week Engineering Science program, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in modeling, virtual environments, and simulation is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

**Entry Date**

MOVES is an eight-quarter course of study with entry dates in April and October. Those requiring the six-week refresher or twelve-week Engineering Science program will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

**Degree**

Requirements for the Master of Science in Modeling, Virtual Environments, and Simulation are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

**Master of Science in Modeling, Virtual Environments, and Simulation**

The degree of Master of Science in Modeling, Virtual Environments, and Simulation is awarded after satisfactory completion of a program, approved by the Chairman of the MOVES Academic Committee, which satisfies, as a minimum, the following degree requirements:

- At least 40 quarter-hours of graduate-level work, of which at least 12 quarter-hours must be at the 4000 level.
- Completion of an approved sequence of courses constituting specialization in an area of Modeling, Virtual Environments, and Simulation.
- Completion of an acceptable thesis in addition to the required course work.

**Doctorate in Modeling, Virtual Environments, and Simulation**

The Ph.D. degree requires the equivalent of at least three academic years of study beyond the baccalaureate level (some of which may be for another post-baccalaureate degree), with at least one academic year (or its equivalent) being spent in residence at NPS.

The student must complete, in order, the following steps, which are detailed at [www.nps.navy.mil/moves/PhD.htm](http://www.nps.navy.mil/moves/PhD.htm).

1. Form a dissertation committee
2. Pass a written qualifying examination
3. Declare a secondary specialization
4. Pass an oral qualifying examination
5. Pass a final examination
6. Complete a dissertation

No courses are required for the Ph.D. degree besides the secondary specialization unless the student's doctoral committee so stipulates.

**Requirements for the Ph.D. Minor**

A Ph.D. minor in Modeling, Virtual Environments, and Simulation consists of:

1. Three courses at the 4000 level that form a coherent sequence relating to Modeling, Virtual Environments, and Simulation.
2. The courses must be from at least two departments or academic groups.
3. The head of the MOVES Ph.D. program will write a letter attesting that the student has fulfilled the requirements upon request of the student.

**Subspecialty**

Completion of this curriculum qualifies an officer as a modeling, virtual environments, and simulation subspecialist with a subspecialty code of 6202P.

**Typical Subspecialty Jobs**

TBD

**Typical Course of Study**

*(MOVES (399) Core Matrix, All Students)*

**Refresher (Summer/Winter)**

CSR101	(2-1)	Refresher for Laboratory Systems
MA1042	(2-0)	Matrix Algebra
MA1113	(5-2)	Single Variable Calculus
MA1025	(4-0)	Introduction to Finite Math

**Quarter 1 (Fall/Spring)**

CS2900	(4-2)	Introduction to Objects and Programming
CS3010	(4-2)	Computing Systems Principles
OS3111	(4-1)	Probability and Statistics
OA3401	(3-1)	Human Factors and System Design
MV4921	(2-0)	Introduction to MOVES

**Quarter 2 (Winter/Summer)**

CS3900	(4-2)	Introduction to Data Structures and Intermediate Programming
MV3204	(3-2)	Computer Graphics Modeling Using X3d/Vrml
OS3112	(4-1)	Statistics and Design of Experiments
MV4002	(4-1)	Simulation and Training
MV3922	(2-0)	Introduction to Virtual Environmental Technology

**Quarter 3 (Spring/Fall)**

CS3771	(4-2)	C++ as a Second Language
CS3502	(4-2)	Computer Communications and Networks

OS3113	(4-1)	Advanced Data Analysis
OS3311	(4-0)	Stochastic Models and Military Applications
MV3923	(2-0)	Introduction to Research and Modeling, Virtual Environments, and Simulation

**Quarter 4 (Summer/Winter)**

MV3202	(3-2)	Computer-Graphics Programming
CS3310	(4-1)	Artificial Intelligence
OA3302	(4-0)	System Simulation I
OA/MV4655	(4-0)	Introduction to Combat Modeling
MV4924	(2-0)	Research Seminar in Modeling, Virtual Environments, and Simulation

**Typical Course of Study**

(MOVES (399) 2nd Year Core Matrix, All Students)

**Quarter 5 (Fall/Spring)**

Four block requirements

MV4924	(2-0)	Research Seminar in Modeling, Virtual Environments, and Simulation
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**Quarter 6 (Winter/Spring)**

Four block requirements

MV4924	(2-0)	Research Seminar in Modeling, Virtual Environments, and Simulation
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**Quarter 7 (Spring/Fall)**

MV0810		Thesis Research
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Three block requirements

OA4659	(2-0)	Survey of Combat Models
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**Quarter 8 (Summer/Winter)**

MV0810		Thesis Research
MV0810		Thesis Research
MV4460	(4-0)	Management of Modeling and Simulation Development

Block requirement

OA4659	(2-0)	Survey of Combat Models
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**Blocks** (Select three. All courses in the block must be taken.)

**Block 1. Combat Modeling**

OA4655		Introduction to Combat Modeling (core)
OA4656		Advanced Combat Models
OA4604		Wargaming
OA4602		Joint Campaign Analysis

**Block 2. Networked Visual Simulation**

MV3202		Computer Graphics Programming (core)
MV3500		Internetwork Communications and Simulation
MV4470		Image Synthesis
MV4471		Computer Animation

**Block 3. Web-Based Simulation**

MV3204		Computer Graphics Modeling Using X3d/VRML (core)
MV4205		Advanced Computer Graphics Modeling
MV3250		Introduction to Extensible Markup Language Programming
MV4250		Extensible markup Language (XML) Authoring and Design

**Block 4. Agents and Cognitive Modeling**

CS3310		Artificial Intelligence (core)
MV4015		Agent-Based Autonomous Behavior for Simulations
MV4025		Cognitive Behavioral Modeling for Simulations
MV4100		Cognitive Engineering

**Block 5. Human Factors and Training Systems**

*Note: To complete the Human Factors and Training Systems block, students must take MV4002, OA3401, and three other block courses.*

MV4002		Simulation and Training (core)
OA3401		Human Factors in System Design (core)
MV4001		Human Factors of Virtual Environments
OA3402		Research Methods for Performance Assessment
OA4401		Individual Performance: Sensation, Perception, and Cognition
OA4402		Skilled Operator Performance
OA4408		Team Performance and Decision Making

**Block 6. Physically Based Modeling**

MV3472		Graphical Simulation of Physical Systems in Virtual Worlds
MV4472		Physics for Game Developers and Virtual Environments
MV4471		Computer Animation

**Block 7. Optimization**

OA3201		Linear Programming
OA4201		Nonlinear Programming
OA4202		Networks
MN3371		Contracts Management and Administration
MN3155		Financial Management for Acquisition Managers

**JPME (Required for Navy URL)**

NW3230	Strategy and Policy
NW3275	Joint Maritime Operations, Part 1
NW3276	Joint Maritime Operations, Part 2
NW3285	National Security Decision-Making

**Electives**

MV4203	Interactive Computation Systems
MV3460	Principles of Software Development
MV4000	Hamming: Learning to Learn
MV4030	Modeling and Simulation of Ocean Environments
MV4474	Virtual Environment Network and Software Architecture
OS3040	Research Methods, Planning, and Execution
OA4001	Human Anthropometric Modeling
OA4333	Simulation Methodology
OS3211	Introduction to Optimization (PD21)
MN4119	Manpower Requirements Determination
MN4112	Personnel and Testing
MN4106	Manpower Policy Analysis

*Note: Any course from a non-chosen block may be used as an elective.*

**Seminars (required)**

MV4921	Introduction to Modeling, Virtual Environments, and Simulation
MV4922	Introduction to Virtual Environment Technology
MV4923	Current Research in MOVES
MV4924	Research Seminar in Modeling, Virtual Environments, and Simulation
OA4658	Survey of Combat Models

**Educational Skill Requirements (ESR)  
Modeling, Virtual Environments, and Simulation  
(MOVES) - Curriculum 399  
Subspecialty Code: 6202P**

All officers with advanced degree education in Modeling, Virtual Environments, and Simulation (MOVES) must possess skills and competencies in the fundamentals of modeling and simulation (M&S) (including visual simulation), human-computer interaction, statistics, and data analysis. Topics in this curriculum include: object-oriented programming, artificial intelligence, computer communications and networks, computer graphics, human-computer interaction, virtual world and simulation systems, physically based modeling, virtual environment network and software architectures, probability, statistics, stochastic modeling, data analysis, human performance measurement and evaluation, and combat modeling. The skills and competencies are detailed below.

1. **Joint and Maritime Strategic Planning:** The officer must understand the application and evaluation of modeling and simulation tools in joint and maritime strategic planning. This applies to development and execution of military strategy; “what-if” analytical evaluation of proposed tactics and strategy; analysis of alternative courses of action; and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization. In view of the increasing emphasis on joint training, joint planning, and joint analysis in support of system procurement decisions, the officer must understand and be able to employ M&S in distributed simulation networks—joining a variety of M&S tools developed and operated by other service agencies.
2. **Software Development:** The officer must have a thorough knowledge of modern software development to include: an understanding of the software development process; the ability to plan and implement a major programming project and develop the appropriate documentation; and the ability to utilize object-oriented techniques in system design, and to use modern software development tools in the construction of modeling, virtual environment, and simulation systems.
3. **Software Technology:** The officer must have a thorough knowledge of software technology to include: properties of object-oriented languages; programming techniques for parallel and distributed applications; the structure of storage media; methods useful in representing structured data in storage; techniques of operating on data structures; computer systems organization, from the operating systems level down to the computer architecture level; memory management; file system design and management; object-oriented operating environments; artificial intelligence techniques including heuristic search, artificial intelligence languages, knowledge representation, expert systems, and means-end analysis; rapid prototyping for object-oriented design; and use of tools.
4. **Computer Systems Design:** The officer must have a thorough knowledge of computer system design to include: empirical and analytical methods for determining the efficiency and performance of computer systems; modeling of processes; and an understanding of the design issues of



- hardware/software compatibility, operating systems compatibility, information systems requirements, and interoperability, especially via networks.
5. **Computer Architecture:** The officer must have a thorough knowledge of computer architecture to include: basic components of computer systems and their patterns of configuration and communication, including large-scale mainframes, microcomputers, supercomputers, parallel processors, and networks of workstations; and the organization, logic design, and components of digital computing systems relating to multiprocessing, parallel processing, distributed processing, networking, communication, multimedia, and peripheral devices.
  6. **Analytical Skills:** The graduate must possess the skills in higher mathematics required to support graduate study in modeling, virtual environments, and simulation. The graduate must understand the use of M&S in design of experiments, including selection of the most appropriate models for specific requirements. The graduate must also gain proficiency in the development of software, and in the employment of software of special importance for modeling, virtual environments, and simulation.
  7. **Data Analysis and Stochastic Modeling:** The graduate must have the ability to apply probability, statistics, and exploratory data analysis as appropriate, and to formulate and execute analyses involving uncertainty, including analyses of military operations. The graduate will be proficient in the principles of probability and statistics and the use of one or more statistical graphics programs, and be able to apply interactively a variety of methods to actual data. The graduate will be able to analyze a variety of DoD data sets to answer specific operational questions utilizing modeling, virtual environment, and simulation systems. The graduate will be able to formulate and solve problems involving processes with uncertainty over time, including the ability to apply the theory to warfare and tactical decision analyses.
  8. **Virtual Environments and Human-Performance Engineering:** The graduate will be knowledgeable with the development of networked virtual environment and simulation systems, and will be able to implement such systems or manage a team capable of developing such systems. Topics of study include: computer-human interfaces and networking; real-time, 3-D, computer graphics and human-computer interaction, virtual worlds, distributed interactive simulation, virtual environment network and software architectures; intelligent displays and computer-mediated autonomous systems; use of video, audio, haptic, and other sensory I/O to coordinate human-machine activities via remote access; and physically based modeling.
  9. **Problem Solving and Real World Applicability:** The officer shall possess skills that permit a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to the real world in a naval organization. This includes: completing a significant project applying academic skills outside of the classroom; exercising skills in problem formulation, criteria specification, analysis, and evaluation and presentation of results; and clearly communicating the project in writing and verbally.
  10. **Strategy and Policy:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)

### Curriculum Sponsor and ESR Approval Authority

Deputy Chief of Naval Operations for Warfare Requirements and Programs (N6/N7); CNO Executive Agent for Modeling and Simulation.

### Information Assurance Certificates

#### Program Manager

Cynthia Irvine, Ph.D.  
Code CS/Ic, Spanagel Hall, Room 512

(831) 656-2461, DSN 756-2461  
irvine@nps.edu

#### Brief Overview

The NPS Computer Science Department is authorized to award five Committee on National Security Systems (CNSS) Information Assurance Certificates. The certificates are awarded to students

who successfully complete specified sets of Computer Science and Information Assurance courses.

The certificates are based on training and education standards that were established by the National Security Telecommunications and Information Systems Security Committee (NSTISSC).

The standards address duties and responsibilities of Information System Security Professionals, Senior System Managers, System Administrators, Information Systems Security Officers, and System Certifiers.

### Certificate Sponsor

Committee on National Security Systems (CNSS),  
www.cnss.gov

### Certificates Awarded

- NSTISSI 4011 - Information Systems Security Professionals
- CNSS 4012 - Senior System Managers
- CNSS 4013 - System Administrators
- CNSS 4014 - Information System Security Officers
- NSTISSI 4015 - System Certifiers

### Required Courses

#### NSTISSI 4011 - Information Systems Security Professionals

- CS3030 or CS3010 (Basic Computer Architecture)
- IS3502 or CS3502 (Basic Computer Networks)
- CS3600 Information Assurance: Introduction to Computer Security
- CS3670 Information Assurance: Secure Management of Systems

#### CNNS 4012 - Senior System Managers

- CS4680 Introduction to Certification and Accreditation
- CS4685 System Certification Case Studies

#### CNNS 4013 - System Administrators

- CS3030 or CS3010 (Basic Computer Architecture)
- IS3502 or CS3502 (Basic Computer Networks)
- CS3600 Information Assurance: Introduction to Computer Security
- CS3670 Information Assurance: Secure Management of Systems

#### CNNS 4014 - Information System Security Officers

- CS3030 or CS3010 (Basic Computer Architecture)
- IS3502 or CS3502 (Basic Computer Networks)

- CS3600 Information Assurance: Introduction to Computer Security
- CS3670 Information Assurance: Secure Management of Systems

### NSTISSI 4015 - System Certifiers

- CS4680 Introduction to Certification and Accreditation
- CS4685 System Certification Case Studies

## Software Engineering Certificates

### Program Manager

Man-Tak Shing, Ph.D.  
Code CS, Spanagel Hall, Room 544B

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shing@nps.edu

### Brief Overview

The Naval Postgraduate School offers programs of study in specialized areas of software engineering, with the aim of providing DoD personnel with both knowledge and problem-solving skills needed for acquiring software-intensive, large-scale systems. Each certificate requires completion of four graduate-level courses in a specialty area of software engineering. The certificate programs are tailored by NPS to meet the needs of the DoD sponsor and the required courses are specified accordingly. Upon completion of the four courses in a specialty area, the student receives a certificate of completion. A student may apply three certificates in partial fulfillment of the requirements for a master's degree in software engineering. Courses are offered online, by VTC, or in person, depending on the arrangements made with the student's sponsoring organization. Requirements for entry into the certificate programs are the same as those for the M.S. in Software Engineering.

### Certificates Awarded

Certificates are offered as requested and tailored to the individual needs of the sponsor.

As an example, these two certificates were offered in FY06:

- DoD Software Engineering Certificate
- Weapon Systems Software Development Certificate

### Required Courses

The FY06 offering of the DoD Software Engineering Certificate required completion of the following courses:

- IS4300 (Software Engineering and Project Management)
- SW3460 (Software Methodology)
- SW4591 (Requirements Engineering)
- SW4592 (Software Risk Assessment in DoD)

The FY06 offering of the Weapon Systems Software Development Certificate required completion of the following courses:

- IS4300 (Software Engineering and Project Management)
- SW4540 (Software Testing)
- SW4590 (Software Architecture)
- SW4582 (Weapon System Software Safety)

## Department of Defense Analysis

### Chairman

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### Associate Chairman, Instruction

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### Associate Chairman, Operations

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### Associate Chairman, Research

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\* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

**John Arquilla**, Associate Professor (1993); Ph.D., Stanford University, 1991.

**Douglas Borer**, Associate Professor (2004); Ph.D., Boston University, 1993.

**Dorothy Denning**, Professor (2002); Ph.D., Purdue University, 1975.

**Jennifer J. Duncan**, Program and Research Manager (1992); M.S., City University of New York, 1985.

**Michael Freeman**, Assistant Professor (2005); Ph.D., University of Chicago, 2001.

**Frank Giordano**, Professor (2002); Ph.D., University of Arkansas, 1975.

**Peter Gustaitis**, Senior Lecturer (2002); M.S., Columbia University, 1989.

**Erik Jansen**, Senior Lecturer (1994); Ph.D., University of Southern California, 1987.

**George Lober**, Senior Lecturer (1998); M.S., California State University at Fresno, 1986.

**Gordon H. McCormick**, Chairman, Defense Analysis Department and Professor (1992); Ph.D., Johns Hopkins University, 1986.

**Guillermo Owen**, Professor (1983); Ph.D., Princeton University, 1962.

**Robert O'Connell**, Visiting Professor (2004); Ph.D., University of Virginia, 1976.

**Glenn Robinson**, Associate Professor (1991); Ph.D., University of California at Berkeley, 1992.

**Hy Rothstein**, Senior Lecturer (2002); Ph.D., Tufts University, 2003.

**Kalev (Gunner) Sepp**, Assistant Professor (2003); Ph.D., Harvard University, 1992.

**Anna Simons**, Associate Professor (1998); Ph.D., Harvard University, 1992.

**Kristen Tsolis**, Research Associate (1999); M.S., Monterey Institute of International Studies, 1999.

**David Tucker**, Associate Professor (1998); Ph.D., Claremont Graduate School, 1981.

**Brian Greenshields**, Col, USAF, Chair of Special Operations (2005); M.S., Naval Postgraduate School, 1989.

### Brief Overview

The Department of Defense Analysis is an interdisciplinary association of faculty, representing a wide range of academic and operational specialties. The Department has two curricula: the Special Operations curriculum and the Joint Information Operations curriculum.

The Special Operations curriculum provides a focused course of instruction in irregular warfare, sub-state conflict, terrorism and counterterrorism, information operations, and other "high leverage" operations in U.S. defense and foreign policy. The core program also provides every student with a strong background in strategic analysis, decision modeling, organization theory, and formal analytical methods. The student's program is built around a common set of core courses and a selected specialty track. The individual student, depending on his or her interests and academic background, chooses the specialty track. In selected cases, students are also able to develop a tailored area of specialization to satisfy a particular interest or requirement. Graduates are awarded a Master of Science in Defense Analysis, with their specialty track so specified.

While the Special Operations curriculum is sponsored by U.S. Special Operations Command, the curriculum actively solicits student participation from across the services, regardless of branch. International students are an important element of the program. Students are encouraged to apply for the Winter or Summer Quarter, permitting them to take maximum advantage of the program's sequenced course of instruction. Exceptions are approved by the Academic Associate. The program is 18 months long and requires a completed thesis.

The Joint Information Operations curriculum educates military personnel and civilian officials in the strategic and operational dimensions of information relative to the use of force as an instrument of statecraft. Graduates will be able to develop information strategies to support military action by taking advantage of information technology, exploiting the growing worldwide dependence on automated information systems, and capitalizing on near real time global dissemination of information to affect adversary decision cycles with the goal of achieving information superiority. This capability will be possible only after students develop a thorough understanding of the enduring nature of war.

The curriculum is designed for both the specialist who will be assigned to an information operations position and the generalist who will be assigned to an operations directorate. The curriculum includes a core of military art and operations, the human dimension of warfare (psycho-social), analytical methods, and a technical sequence customized for each student. Additionally, each student will have an elective sequence designed to further develop an in-depth understanding of joint information operations. Graduates are awarded a Master of Science in Information Operations. The program is 18 months long and requires a completed thesis.

## Degree

Master of Science in Defense Analysis

Master of Science in Information Operations

## Defense Analysis Course Descriptions

### DA Courses

#### **DA3104 Computer Network Attack and Defense (4-1) Winter**

This course introduces the basic principles of attacking and defending computer networks. On the attack side, it covers system intrusions, denial of service attacks, viruses, worms, and Trojan horses. On the defense side, it covers security policies and objectives, access control, authentication, firewalls, intrusion detection, cryptography, security management, and incident response. Basic networking concepts, including TCP/IP, are also covered. No background in computer science or networking is required. The course includes some hands-on work with hacking and security technologies. Prerequisite: SO3101.

#### **DA3120 Jihadi Information Operations (4-0) Spring**

This course traces the rise and evolution of the Jihadi movement since its birth in the 1960s; analyzes the symbols, discourses, and media that Jihadis use in their own information operations, primarily vis-à-vis the larger Muslim community; and examines the impacts on and receptiveness of the broader Muslim community to these information operations. The focus of the course is on the transnational Jihadi movement, but some examples of local Jihadism will be discussed as well. Prerequisite: None.

#### **DA3202 International Perspectives on U.S. Special Operations (4-0) Fall**

This seminar-style course is designed for international officers assigned to the Department of Defense Analysis Special Operations (699) curriculum. Designed as an unclassified version of SO 3201 (Strategic Decision Making for Irregular Warfare). Students examine the unique relationships and associated risks between strategic, operational, and tactical decision makers during the conduct of special operations. The course begins by surveying popular models and theories of U.S. Government decision making and bureaucracy, while using selected case studies to improve the student's diagnostic skills. Roles and relationships between key stakeholders in this decision-making process are examined to better understand the practical environment. Lastly, students will develop alternative methods of high risk/high payoff decision making based on the course subject matter. Prerequisite: Must be an international student assigned to the Department of Defense Analysis or consent of the instructor.

#### **DA3211 The Unconventional Threat in Homeland Defense (4-0) Winter**

The purpose of this class is to provide an introduction to some of the debates over the causes of terrorism and strategies to defeat it. The causes of terrorism will be grouped into individual motivations, group strategies, motivating ideologies, and underlying social, economic, and political factors. Over the course of the class, several terrorist groups will be used as case studies, including Al-Qaeda, the IRA, and others. This class will also explore some possible strategies in response to

terrorism, including the spread of democracy, intelligence, legal measures, negotiations, and the use of military force. By the end of the course, students should be able to design effective measures for countering and responding to terrorism, based on an understanding of its organizational and operational dynamics. Prerequisite: None.

**DA4120 Seminar on Jihadi Information Operations (4-0) Winter/Summer**

This advanced seminar is designed as a follow-on course to DA 3120 for students pursuing theses or advanced research projects relevant to the field of Jihadi information operations. Course material will provide a more robust examination of the nature and types of IO campaigns used by both local and transnational Jihadi groups, but will also allow students to pursue and present specialized research on the topic. Prerequisites: DA 3120 and a one-page statement of research.

**DA4600 Dark Networks (4-0) Winter**

This course focuses on dark networks—covert and illegal networks, such as drug-trafficking and terror networks. The course's first objective is to teach students how to identify and describe these networks and their dynamics. We use various software packages (e.g., Inflow, Analyst Notebook) to aid in the identification and description effort. The second objective is to design intervention strategies to disrupt, destabilize, and possibly destroy dark networks once they have been identified and described. Students are expected to focus their interventions at the tactical and operational levels, although some attention is given to the strategic and policy levels as well. Prerequisite: SO2410 or consent of the instructor.

**DA4601 Terrorist Financing (4-0) Summer**

This course will examine how terrorists fund their activities and how they can be tracked and thwarted through their financial networks and footprints. It will cover sources and methods of terrorist financing, including the role of charities, legitimate businesses, and crime; the use of both formal banking systems and informal hawala systems to transfer funds; and money laundering. It will also cover national and international structures, regulations, tools, and efforts to identify, track, capture, and eliminate terrorists and their financial support through their financial transactions. Concepts will be illustrated with case studies of terrorist groups and regions where terrorism is present. Prerequisite: SO3801.

**DA4810 Countering International Terrorism (4-0) Winter**

A sequel to SO3801, Countering International Terrorism examines the U.S. government's response to international terrorism. It examines policy, strategy, bureaucracy, the role of intelligence, and the media and information campaigns, as well as specific responses to terrorism, such as military force, covert operations, policing, economic sanctions, and diplomacy. The purpose of the course is to provide students a sound basis for developing and evaluating responses to terrorism. Prerequisites: None.

*SO Courses*

**S00810 Thesis Research (0-8)**

**Fall/Winter/Spring/Summer**

This is a thesis research block. Prerequisite: None.

**S02010 Technical Writing and English Composition (4-0) Winter**

This course provides a review of the rhetorical and grammatical principles necessary for successful academic writing. Course content emphasizes standard English grammar and syntax, as well as mastery of two rhetorical modes: comparison and contrast; and persuasion. Emphasis is also placed on the correct use of both parenthetical and traditional footnote notation and documentation for traditional and electronic sources. Prerequisite: None.

**S02410 Modeling for Military Decision Making, I (4-0) Winter/Summer**

This course introduces mathematical modeling processes and concepts. Deterministic models in a graphical setting will be emphasized, including experimental modeling, curve fitting, and optimization. Applications include arms race models, Lanchester combat models, exponential growth and decay models, the Logistic model for social diffusion, supply/demand economic models, and inventory models. The computer is used as a tool with emphasis on the Excel spreadsheet package. Prerequisite: College algebra.

**S03010 Technical Writing and English Composition II (4-0) Fall**

This course provides an in-depth analysis of the rhetorical principles applied in effective academic writing. Course content emphasizes rhetorical analysis, research, formal academic documentation, and a further review of English grammar and syntax. This course is writing intensive and intended to further the principles introduced in SO2010. Prerequisite: SO2010.

**S03101 Warfare in the Information Age (4-0) Fall/Winter**

Given that the emerging Information Age heralds stark changes in future military and security policy, this course begins with a survey of the literature on the current revolution in military affairs (RMA), as well as studies of similar periods earlier in history. While significant attention is focused on information technologies, the principle emphasis in this course lies in an endeavor to understand the ways in which new technologies affect military strategy, doctrine, and organization. In particular, the rise of networked organizations, nonlinear military operations, and the further blurring of the line between war and peace are examined. Prerequisite: None.

**S03102 Psychological Operations and Deception (4-0) Summer/Fall**

This course surveys current theories of behavior, cognition, and perceptual bias, linking them to applied military issues across the spectrum of conflict, from irregular to high-intensity warfare. The effects of increased information flows on the prospects for accurate assessments in crisis and war are also considered in detail. Case studies and experimentation complement the theoretical framework initially advanced, with students working in teams during this portion of the course. Prerequisite: None.

**S03103 Conflict and Cyberspace (4-1) Winter**

This course examines how cyberspace, particularly the Internet, can serve as a tool, target, and source of conflict for both state and nonstate actors. Topics include: characteristics of cyberspace, technology trends, power in cyberspace, cyber-

based information operations (IO), cyber surveillance, domestic and international laws governing cyber operations, cyber crime, cyber activism and hacktivism, cyber terrorism, cyber warfare, and cyber defense. Prerequisite: None.

**SO3201 Strategic Decision Making for Irregular Warfare (4-0) Winter/Summer**

This course examines the unique relationships and associated risks between strategic, operational, and tactical decision makers during the conduct of unconventional warfare (with emphasis on military special operations). In a classified environment using focal point control system information, the course begins by surveying popular models and theories of U.S. Government decision making and bureaucracy, while using selected case studies to improve the student's diagnostic skills. Roles and relationships between key strategic and political stakeholders in this decision-making process are examined to better understand the practical environment. Lastly, students will develop alternative methods of high risk/high payoff decision making based on the course subject matter. Prerequisite: MN3121 or consent of the instructor. Classification: Secret/Focal Point.

**SO3210 The Unconventional Threat to Homeland Security (4-0) Spring**

The purpose of this course is to provide an introduction to the operational and organizational dynamics of terrorism. It considers those who act as individuals, in small groups, or in large organizations; it considers indigenous actors, as well as those who come to the United States to raise money, recruit, or commit their acts of violence. In every instance, its focus is on violent clandestine activity that, whatever its motivation, has a political purpose or effect. The course addresses such specific topics as suicide terrorism, the role of the media, innovation and technology acquisition, the decline of terrorism, and ways of measuring the effect of counterterrorism policies and strategies. The course also looks briefly at sabotage. By the end of the course, students should be able to design effective measures for countering and responding to terrorism based on an understanding of its organizational and operational dynamics. Prerequisite: None.

**SO3250 Anatomy of Intelligence (4-0) Spring**

This course will be devoted to providing students with an improved understanding of the structure, capabilities, and shortcomings of U.S. intelligence, with particular emphasis being placed on Special Operations (SO) and Information Operations (IO). In general, the course approach will be from the general to the specific—beginning with an orientation aimed at familiarizing students with the basic nature of the U.S. Intelligence Community (IC), followed by a closer look at the issues surrounding the provision of intelligence to SO and IO. Prerequisite: None.

**SO3410 Modeling for Military Decision Making, II (4-0) Summer/Fall**

This course continues the mathematical modeling process and concepts introduced in SO2410. Models will now entail the use of probability to find solutions. Introductory probabilistic models will be discussed, along with rudimentary statistical concepts needed to analyze data generated from those models. The course will also introduce simulation modeling. Decision modeling includes decision making under both risk and uncertainty. Use of Excel and the Minitab statistical package continues from SO2410. Prerequisite: SO2410.

**SO3701 Choice, Chance, and Consequence (4-0) Fall**

This course examines the dynamic relationship that exists between Choice, Chance, and Consequence. Specifically, this course examines many of the influential factors associated with effective decision making in stochastic environments, and explores the reasons why choices made in such environments often produce a host of unintended consequences. Incorporating Molton's Theory of The Unanticipated Consequences of Purposive Action, Machiavelli's The Prince, and Kahneman and Tversky's Prospect Theory, the course draws on case studies and examples from ancient Western literature, philosophy, American history, modern literature, and biography. Prerequisite: None.

**SO3750 Anthropology of Conflict (4-0) Fall/Spring**

The focus of this course is cross-cultural conflict and violent confrontation with a view to considering how anthropology might be better used to study modern warfare and large-scale ethnic conflict. For instance, military historians, political scientists, and foreign policy analysts increasingly refer to "culture" and religion, identity politics, and ideology to help explain the new world disorder. From an anthropological perspective, are they using these social science concepts correctly? This course is designed to not only expose students to anthropological concepts useful for understanding the motivations of combatants from other cultures and the nature of warfare as fought by different people(s), but the extent to which cross-cultural miscommunication can complicate the role of U.S. military personnel abroad. Prerequisite: None.

**SO3760 The Soul of the Sword: the History of Weapons (4-0) Fall/Spring**

This course examines the evolution of weapons primarily from a cultural and anthropological perspective: the aim being to provide military professionals with a more basic insight into how and why arms are and were chosen; how the use of weaponry and the concept of courage have manifested themselves over time, and the manner in which the institution of war has been influenced by the nature of the armaments extant at the time conflict took place. The course will place special emphasis on not only the roots of weaponry very early in human existence, but also the characteristics and use of "weapons" (i.e., teeth, claws, antlers, etc.) by other species. This course will cover a vast sweep of history; expect to cover rocks and rockets, along with everything in between. Prerequisite: None.

**SO3800 Theory and Practice of Social Revolution (4-0) As Required**

This course provides an overview of insurgency and counterinsurgency. It reviews the theoretical literature and offers an operational focus on social revolution by examining the alternative models of insurgency provided by the doctrine of "people's war," "foco theory," and the urban guerrilla. The course goes on to examine the development of U.S. counterinsurgency doctrine, the difference between the "hearts and minds" and "systems" prescriptions of counterinsurgency, and alternative British, French, and Russian concepts of counterinsurgency. Prerequisite: None.

**SO3801 International Terrorism (4-0) Summer/Fall**

This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the

sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. Prerequisite: None.

**S03802 Seminar in Guerrilla Warfare (4-0)  
Winter/Summer**

Have you ever wanted to seize state power from below? Have you ever been responsible for keeping others from doing so? This reading seminar is designed to examine the strategy and operational art of substate conflict. It examines the problems of social mobilization; underground organization, command and control, and security; alternate strategies of internal war, and competing theories of counterinsurgency. These and related issues are examined analytically and historically. Comparative cases are discussed and evaluated. Throughout the course, attention is also given to the manner in which such wars are conducted in the future. Prerequisite: None.

**S03880 History of Special Operations (4-0)  
Summer/Fall**

What constitutes a "special" operation? This course considers special operations in a historical context, with emphasis given to their impact on war outcomes, the necessary conditions for their success, and the patterns of civil-military relations that emerge when elite forces are formed. Successes and failures in air, ground, and naval actions are equally considered. Historical studies from World War II to the present will provide the principle means of analysis to gain insights into the theory, practice, and effects of special operations and irregular warfare. Prerequisite: None.

**S03882 Deterrence, Compellance, and Crisis  
Management (4-0) Summer/Winter**

This course surveys current theories of deterrence and coercive diplomacy, relating them to a variety of applied problems in crisis management. Special attention is given to political psychological factors, crisis communication styles, extended deterrence, and the implications of proliferation of weapons of mass destruction for conventional deterrence. Prerequisite: None.

**S03883 The Rise and Fall of the Nation-State (4-0)  
Spring**

This course provides students with a broad overview of the rise, proliferation, and possible fall of the major international organizing tool of the modern era: the nation-state. The course examines the rise of the nation-state in Europe, focusing on the specific political and economic factors that shaped the nation-state; the adoption of the nation-state system around the world, where it did not emerge organically; and the possible decline of the nation-state in the age of globalization. Does globalization mean the end of the nation-state, and if so, what kinds of organizational arrangements are likely to compete with and perhaps replace the nation-state? Prerequisite: None.

**S03900 Directed Studies in Special Operations and  
Low-Intensity Conflict (4-0)  
Fall/Winter/Spring/Summer**

Supervised study in selected areas of special operations and low-intensity conflict to meet the needs of individual students. Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers, projects, and/or examinations. May be repeated for credit if course content changes. Variable 1.0 - 4.0. Prerequisite: Consent of the instructor.

**S04101 Concepts in Information Operations (4-0) As  
Required**

The emergence of information operations (IO) signaled a broadening of the original concept of information warfare (IW) beyond its early emphasis on electronic warfare and/or cyberspace-based attack and defense, to also include such notions as managing others' perceptions, public diplomacy, and the media. This broadening implied a new emphasis on content-based concepts of information operations as opposed to conduit-oriented issues of attack and defense of communications. This course surveys the entire scope of IO, keeping in mind the critical importance of IW, but also emphasizing the more conceptual issues having to do with strategy, doctrine, and organization. Applied issues are also examined, including such topics as the methods for sharing sensitive data with semitrust allies, and the impact of information attack and defense on the future of force projection. Prerequisite: SO3101 or SO3103.

**S04102 Special Information Operations (4-0) Summer**

This course serves as a project-oriented culmination of the studies of those specializing in the SOLIC "IO track." Students are given a specific, real-world problem and challenged to find the place for IO in developing solutions. The goal is both to mobilize the knowledge amassed from previous study and to use practical experience to gain insight into the issues of how IO can support special operations, and how special operations can support IO. Another key element of the course is the requirement that the students work as a team, employing either organizational concepts they have learned about or developing new ones that may be most suitable to the particular problem at hand. The course concludes with briefings to the sponsors of the given project undertaken. Prerequisite: None. Classification: The course is conducted at a Top Secret level.

**S04104 Militaries and Technological Change (4-0)  
Summer**

Technological advances have always influenced developments in military affairs, particularly fighting doctrines and forms of organization. This course surveys the major technological changes that accompanied industrialization: including advances in weapons, transportation, and communications systems; and examines the ways in which professional militaries adapted to these developments. Special attention is given to advances in information systems, as the goal of the course is to derive insights into how militaries might respond, doctrinally and organizationally, to an extended period of information-technology-driven changes in military affairs. Prerequisite: SO3101 or consent of the instructor.

**S04105 Special Topics in Information Operations (4-0) As Required**

This course will focus on special topics in information and special operations. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisite: None.

**S04106 Trust, Influence, and Networks (4-0) Summer**

This course examines the underlying nature of trust and influence, especially as they shape and are shaped by social networks. Students will acquire a theoretical foundation for these concepts and how they apply to a broad spectrum of activity, including work processes, military operations, underground movements, information and intelligence operations, governance, and the media; how trust and influence are established, maintained, exploited, and lost; and the functions they serve for individuals, organizations, and societies. Concepts will be illustrated with examples drawn from a variety of contexts. The course is aimed especially at students concerned with unconventional warfare, information operations, network-centric warfare, nation building, civil and military affairs, public affairs, terrorism, and intelligence. Prerequisite: None.

**S04107 Public Diplomacy to Psychological Operations (4-0) Fall**

A nation uses various tools to minimize its weaknesses and limitations, and to maximize its strengths and capabilities in the international arena. This course aims to stimulate serious thought about a forgotten aspect of strategy and lay the groundwork for a revival of political-psychological planning and operations within a larger framework of U.S. national security strategy. Topics include: a historical overview of the sources of American diplomacy and values; strategic public diplomacy and the war of ideas; military public affairs and the media; and the power and utility of psychological operations. Case studies will be used throughout the course to reinforce important concepts. Prerequisite: None.

**S04108 Deception, Denial, Surprise, and Counterdeception (4-0) Summer/Fall**

An impression about the threats a nation faces shapes its policies and actions in both war and peacetime. Consequently, information has a vital role in understanding threats and creating impressions. At the same time, it is uncertain whether the proliferation of communications technologies and the dissemination of vast amounts of information will keep senior leaders better informed or simply create more confusion. This course aims to stimulate serious thought about how deception, denial, and counterdeception can influence the outcome of a war or contribute to the favorable resolution of an international crisis. Topics include: the theory and process of deception; the role of intelligence; the process of protecting information that could be used by opponents to uncover some truth; and detecting deception. Case studies will be used throughout the course to reinforce important concepts. Prerequisite: None.

**S04200 Intelligence Challenges 2020 (4-0) As Required**

This seminar will familiarize students with the evolution and contemporary status of forecasting methodologies, along with some of the theories on which they are based. In addition,

major emphasis will be placed on the formulation of a broad range of plausible global futures (approximately 12) for the year 2020. The seminar is being planned to include talks by a number of futurists and relevant subject matter experts, and will seek to incorporate insights from NPS' Proteus project, the National Intelligence Council's "Global Trends 2015," along with aspects of the changing nature of IC tradecraft (i.e., Revolution in Intelligence Affairs). Because of the specialized nature of the seminar, enrollment will be limited. Participation by foreign students and those with an intelligence background will be encouraged. Prerequisite: None.

**S04301 American Approaches to Small Wars (4-0) Spring**

How do the United States Government and its armed forces engage in undeclared wars, expeditions, and conflicts below the threshold of wars for the survival of the United States? This course examines those elements of American strategic culture that affect the United States' capacity to fight these "savage wars of peace." Historical studies from the American colonial period to the present will enable students to determine the defining aspects of the American approaches to small wars. Prerequisite: None.

**S04410 Models of Conflict (4-0) Summer/Winter**

This course deals with the problems faced by a rational decision maker, trying to maximize some payoff in a social setting. A distinction will be made between Type I behavior (optimization in a game against nature), Type II (optimization when faced with agents who react against the decision maker's perceived behavior), Type III (optimizations against strategic agents), and Type IV (cooperation with other agents). Applications include arms race models, treaty inspections problems, monopolistic behavior, coalition formation, and pursuit games. The computer is used as a modeling tool. Prerequisites: SO2410 and SO3410.

**S04450 Analytical Methods (4-0) Summer/Winter**

This course will provide a basic understanding of social science research methodology. The emphasis will be on qualitative research methods to balance the analytical course sequence (including SO2410 and SO3410). The course will also discuss the key concepts of theory, law, and hypotheses. Finally, paying particular attention to case study methodology, we will focus on how theories should be tested. In the end, students will learn how to develop an argument; how to marshal evidence to support your argument; how to test your hypotheses; and how to anticipate and address counterarguments. Prerequisite: SO2410.

**S04500 Special Topics in Special Operations and Low-Intensity Conflict (4-0) As Required**

This course will focus on special topics in special operations and low-intensity conflict. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisite: SO3801.

**S04710 Critical Thinking and Ethical Decision Making (4-0) Fall**

This course explores both the contemporary and classical Western frameworks used to define effective ethical leadership and decision making. Emphasis is placed on the development of critical thinking and decision-making skills, the recognition



of logical fallacies, the analysis of both civilian and military case studies, and the exploration of current ethical issues. Readings for this course span classical selections from such writers as Plato, Rousseau, Kant, and Mill through contemporary papers from the Joint Services Conferences on Professional Ethics. Prerequisite: None.

**S04760 The Military Advisor (4-0) As Required**

This course examines the many roles of the military advisor—as leader, trainer, liaison—in a wide variety of settings, among very different groups of people, and under significantly different conditions. Lessons will be drawn from first-person accounts. What field craft lessons can be learned from past endeavors? What challenges might advisors expect to encounter in the future? This course is open to Department of Defense Analysis students only or by consent of the instructor. Prerequisite: Consent of the instructor.

**S04770 Ethnic Conflict (4-0) As Required**

This course poses a series of questions, such as “what is a state?” and “what is a nation?”, in order to better understand when and why ethnic conflict erupts and persists. Often cited as the most prevalent form of warfare today, “ethnic conflict” as a term may conceal more than it reveals. For instance, strife in Northern Ireland and in Israel is often explained away as ethno-nationalist and ethno-religious in nature. On the face of it, both cases would seem to have much in common. However, once local histories and regional politics are considered, the two represent radically different models of (and for) ethnic conflict. This course will examine a series of such examples in order to better understand the origins, trajectory, and virulence of ethnic conflict. Prerequisite: SO3750.

**S04780 Political Anthropology: Methods of Social Control (4-0) Winter**

The aim of this course is to examine in greater detail a variety of methods of controlling: social interactions, resources, societies, states, liberties... whatever it is that humans feel a need to—or discover they can—control. Questions that will lurk throughout the course are: Why does control matter? To whom does it matter most? Can we draw any generalizations cross-culturally? And to what extent might control differ across societies, strata, time, and space? The course is designed to be comparative and will draw on a series of case studies. Prerequisite: SO3750.

**S04820 Regional Seminar in Low-Intensity Conflict: Africa (4-0) Winter**

This course teaches students how to analyze the nature of conflict in sub-Saharan Africa—who is likely to fight, where, why, and when, with special attention paid to the significance of regional complexities and local particularities. Eight cases are presented with two aims: to present a history of post-colonial conflict and to achieve regional balance. Students are specifically taught how to compare and contrast among different sets of factors that tend to feed conflict in Africa. Students also learn about sources of information to which they can turn in the future should conflict flare up in places with which they are unfamiliar. Prerequisite: Student must have completed at least two quarters of instruction in the Defense Analysis Department or NSA or consent of the instructor.

**S04830 Regional Seminar in Low-Intensity Conflict: Middle East (4-0) Spring**

As part of the regional seminar series, this course examines political violence in the Middle East. The course focuses on the major systemic causes of violence in the Middle East at both the state and nonstate levels. At the state level, sources of violence include the consolidation of state power in fragmented societies, survival strategies by weak states, and competition for scarce regional resources. Violence by nonstate actors is also examined, including violence associated with the Jihadist movement and with the conflict over Palestine. Prerequisite: None.

**S04840 Regional Seminar in Low-Intensity Conflict: Europe and the Transcaucasus (4-0) Spring**

As part of the regional seminar series, this course examines low-intensity conflict issues in Europe and the Caucasus. The seminar reviews the theoretical literature on political violence and analyzes the recent history of European and Caucasus-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Europe and the Caucasus. Prerequisite: None.

**S04850 Regional Seminar in Low-Intensity Conflict: Latin America (4-0) Spring**

As part of the regional seminar series, this course examines insurgencies in Latin America. The seminar reviews the history of the continent and the Caribbean from colonial times to the present; examines theoretical literature on political violence; and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed historical case studies of insurgent organizations and conflicts. Prerequisite: None.

**S04860 Regional Seminar in Low-Intensity Conflict: Far East (4-0) Spring**

As part of the regional seminar series, this course examines low-intensity conflict issues in the Far East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Asian-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Far East. Prerequisite: None.

**S04900 Advanced Directed Studies in Special Operations and Low-Intensity Conflict (4-0) Fall/Winter/Spring/Summer**

(Variable hours 1.0 - 4.0.) Supervised study in selected areas of special operations and low-intensity conflict to meet the needs of individual students. Format and content may vary. Normally involves individual research under the direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. May be repeated for credit if course content changes. Prerequisite: Consent of the instructor.

**Joint Information Operations - Curriculum 698**

**Program Manager**

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**Brief Overview**

The goal of this curriculum is to educate military personnel and civilian officials of the United States in the strategic and operational dimensions of information and the use of force as an instrument of statecraft.

Graduates will be able to employ information in support of full-spectrum dominance by taking advantage of information technology, exploiting the growing worldwide dependence on automated information systems, and capitalizing on near real time global dissemination of information to affect adversary decision cycles, with the goal of achieving information superiority for the United States. This capability will be possible only after students develop a thorough understanding of the enduring nature of war.

The curriculum is designed for both the specialist who will be assigned to an information operations position and the generalist who will be assigned to an operations directorate. The curriculum includes a core of military art and operations, the human dimension of warfare (psycho-social), analytical methods, and a technical sequence customized for each student. Additionally, each student will have an elective sequence designed to further develop an in-depth understanding of joint information operations. Finally, each student will write a thesis relevant to the field of information operations.

**Requirements for Entry**

The Joint Information Operations curriculum is open to officers and civilian employees of the U.S. Government and other countries. U.S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the last five years. A baccalaureate degree earned with above average academic performance and a minimum APC of 365 is required.

**Entry Date**

The Joint Information Operations curriculum is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the

Academic Associate or the Program Officer for this curriculum.

**Degree**

Requirements for the degree of Master of Science in Information Operations are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

**Master of Science in Information Operations**

The Master of Science in Information Operations degree will be awarded in accordance with the following degree requirements:

- This degree requires 45 quarter-hours of graduate-level work, of which 15 hours must represent courses at the 4000 level.
- Completion of an acceptable thesis.
- The Chairman of the Defense Analysis Department and the Academic Associate of the Joint Information Operations curriculum approve each individual program.

**Subspecialty**

Completion of the 698 curriculum qualifies an officer as an Information Operations Subspecialist. The curriculum sponsor is the U.S. Strategic Command.

**Typical Subspecialty Jobs**

Command Positions at the LTC/CDR level and above  
 Staff Officer, Plans or Operations: Joint Headquarters  
 Information Operations Officer at the LTC/CDR level and above on service staffs, JTFS, and combatant commands

**Typical Course of Study**

**Quarter 1**

SO3882	(4-0)	Deterrence, Compellence, and Crisis Management
SO2010	(4-0)	Technical Writing and English Composition
MN3121	(4-0)	Organizational Design
SO2410	(4-0)	Modeling for Military Decision Making, I

**Quarter 2**

SO3101	(4-0)	Warfare in the Information Age
SO3250	(4-0)	Anatomy of Intelligence
DA3600	(4-0)	Computer Network Operations
SO3410	(4-0)	Modeling for Military Decision Making, II

**Quarter 3**

SO4107	(4-0)	Public Diplomacy to Psychological Operations
SO4106	(4-0)	Trust, Influence, and Networks

SO4450	(4-0)	Analytical Methods
SO3883	(4-0)	The Rise and Fall of the Nation-State
<b>Quarter 4</b>		
EO3700	(3-2)	Network Centric Electronic Warfare
SO4108	(4-0)	Deception, Denial, Surprise and Counterdeception
SO3802	(4-0)	Seminar in Guerrilla Warfare
DA3120	(4-0)	Jihadi Information Operations

**Quarter 5**

IO4300	(4-0)	Information Operations and Planning
CS3670	(4-0)	Information Assurance: Secure Management of Systems
XXXXXX	(4-0)	Emphasis Elective
SO0810	(0-8)	Thesis Research

**Quarter 6**

XXXXXX	(4-0)	Emphasis Elective
SO4104	(4-0)	Militaries and Technological Change
SO0810	(0-8)	Thesis Research
SO0810	(0-8)	Thesis Research

**Educational Skill Requirements (ESR)****Joint Information Operations - Curriculum 698****Subspecialty Code: None**

- Military Art and Operations:** Graduates will understand the organization, formulation, and execution of national security strategy and national military strategy; the effects of technical developments on warfare; the capabilities and roles of military forces throughout the entire spectrum of conflict; and current defense issues.
- Emerging Security Challenges:** Graduates will explore major security issues among states and between states and nonstate actors, with emphasis placed on examining the sources of instability and violence including ethnic conflict, insurgency, and terrorism.
- Information Operations (IO):** Graduates will understand the role of information in winning wars. An important aspect of this requirement is to examine the principles of information operations, to include psychological operations, military deception, computer network operations, electronic warfare, public affairs and command and control warfare, and how the proper integration of IO can contribute to U.S. information dominance of the twenty-first century battlefield. Additionally, graduates will understand the role of physical (kinetic) attack

and civil-military operations (CMO) in support of DoD informational objectives.

- Analytical Methods and Applications:** Graduates will have a foundation in analytical methods and their application to military modeling, simulations, and gaming. Close attention will be given to the ways in which such analytical techniques can be used in heuristic and decision-making tools for strategic and operational planning. Attention will be given to both historical and contemporary military applications with particular focus on the ways in which such techniques can be used to address issues of interest to the joint information operations community.
- Information Systems:** Graduates will have a systems-level understanding of information systems and their vulnerabilities as well as capabilities.
- Intelligence Processes and Applications:** Graduates will know intelligence processes and their applications to joint warfare through the national level, with particular emphasis given to the role of intelligence in planning, executing, and terminating information operations.
- Thesis:** Graduates will demonstrate their ability to conduct independent research and analysis, and demonstrate proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

**Special Operations - Curriculum 699****Program Manager**

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**Brief Overview**

The Special Operations curriculum is designed to provide a focused course of study of the conflict spectrum below general conventional war. Graduates of this curriculum will possess a thorough knowledge

of the broad range of factors involved in the planning and conduct of these forms of conflict and a detailed understanding of the role of special operations and related forces in U.S. foreign and defense policy. The curriculum examines the sources and dynamics of inter-state and intra-state conflict; the challenge these forms of conflict have posed and are likely to increasingly pose for U.S. security planning; the doctrinal and institutional evolution of the U.S. special operations community; the recent history of political violence and "small wars"; the history of irregular warfare; and contemporary perspectives on low-intensity conflict resolution. The curriculum provides the graduate with a strong background in the areas of strategic analysis, decision making, organization theory, the technological revolution in military affairs, and advanced analytical methods.

**Requirements for Entry**

The Special Operations curriculum is open to officers and civilian employees of the U.S. Government and other countries. U.S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the last five years. A baccalaureate degree earned with above average academic performance and a minimum academic profile code (APC) of 365 is required.

**Entry Date**

The Special Operations curriculum is a six-quarter course of study with entry dates in January and June. If further information is needed, contact the Academic Associate or the Program Manager/Officer for this curriculum.

**Degree**

Requirements for the Master of Science in Defense Analysis degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. The program currently offers eight specialty tracks. Other specialty tracks can be tailored to meet student interests. The current tracks include Irregular Warfare, Information Operations, Operations Analysis, C4I Systems, Combat Systems, Financial Management, National Security Affairs, and Terrorist Operations and Financing.

**Master of Science in Defense Analysis**

The Master of Science in Defense Analysis degree will be awarded in accordance with the following degree requirements:

- This degree requires 45 quarter-hours of graduate-level work, of which 15 hours must represent courses at the 4000 level in at least two disciplines. Within the course program there must

be a specialization sequence consisting of at least six courses.

- In addition to the 45 hours of course credit, an acceptable thesis must be completed.
- The Department of Defense offers the Special Operations curriculum 699 and the Information Operations curriculum 698.

The Chairman of the Defense Analysis Department approves each individual program.

**Subspecialty**

Completion of the 699 curriculum qualifies an officer as a Special Operations Subspecialist with a subspecialty code of 2500P. The curriculum sponsor is the Commanding General, Special Operations Command.

**Typical Subspecialty Jobs**

Command Positions at the LTC/CDR level  
 Assistant Operations Officer, U.S. Army Special Forces Group  
 Staff Officer, Plans or Operations: USSOCOM  
 Action Officer, Counterterrorism Directorate, ASD (SO/LIC)  
 Staff Officer, Plans or Operations: Theater Special Operations Commands  
 Special Warfare Plans:  
 CINCLANT/CINCPAC/NAVEUR  
 Chief, Intelligence/Plans:  
 COMNAVSPECWARCOM  
 Joint Plans/Doctrine: COMNAVSPECWARCOM  
 Joint Staff Action Officer: J-3, Special Operations Directorate (J-3, DDSO)

**Typical Course of Study**

*(Irregular Warfare Track)*

**Quarter 1**

SO3802	(4-0)	Seminar in Guerrilla Warfare
SO3201	(4-0)	Strategic Decision Making for Irregular Warfare
MN3121	(4-0)	Organizational Design for Special Operations
SO2410	(4-0)	Modeling for Military Decision Making , I

**Quarter 2**

SO3882	(4-0)	Deterrence, Compellance, and Crisis Management
SO3410	(4-0)	Modeling for Military Decision Making, II
SO3880	(4-0)	History of Special Operations
SO3101	(4-0)	Warfare in the Information Age

**Quarter 3**

SO4450	(4-0)	Analytical Methods
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SO3750	(4-0)	Anthropology of Conflict
SO4410	(4-0)	Models of Conflict
SO48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (1st)*

**Quarter 4**

SO3801	(4-0)	International Terrorism
SO3102	(4-0)	Psychological Operations and Deception
SO3883	(4-0)	Rise and Fall of the Nation-State
DA4835	(4-0)	Islamic Insurgencies

**Quarter 5**

SO4760	(4-0)	The Military Advisor
SO4500	(4-0)	Special Topics in Special Operations and Low-Intensity Conflict
SO4106	(4-0)	Trust, Influence, and Networks
SO0810	(0-8)	Thesis Research

**Quarter 6**

SO4710	(4-0)	Critical Thinking and Ethical Decision Making
SO48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (2nd)*
XXXXXX	(4-0)	Emphasis Elective
SO0810	(0-8)	Thesis Research

\* Five courses in Low-Intensity Conflict covering different regions of the world will be offered; students will select two of the three.

**Educational Skill Requirements (ESR)**  
**Special Operations - Curriculum 699**  
**Subspecialty Code: 2500P**

- 1. Strategy and Policy:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)
- 2. The Dynamics of Inter-State and Intra-State Conflict:** Students will have an understanding of the political, ethnic, and cultural dynamics that explain the outbreak of war between and within modern states. Particular attention should be given to the issues of intra-state conflict; unconventional forms of inter-state military rivalry; the integrated role of force and diplomacy in crisis management operations short of war;

problems of escalation in a crisis environment; military alliance behavior; the dynamic differences between zero-sum and nonzero-sum conflicts; the special problems associated with suppressing and resolving zero-sum engagements; and military and nonmilitary approaches to conflict resolution. Students must have a close understanding of the prevailing analytical literature on these and related subjects and be able to apply this literature to a broad range of contemporary and historical cases.

- 3. Terrorism, Social Revolution, and Unconventional Warfare:** Graduates will have a detailed understanding of the problems of domestic and international terrorism, social revolution, and other forms of irregular conflict. Close attention must be given to problems of both threat and response. The student must have a close knowledge of the prominent contending theoretical perspectives on the problems of terrorism and social revolution; a detailed knowledge of the operational and organizational dynamics underlying each of these forms of conflict; and a strong working understanding of the ways in which these and similar forms of irregular conflict have been countered historically. Where appropriate, the courses designed to satisfy this requirement should survey the U.S. experience in irregular warfare as well as that of other states that have been prominently engaged in such actions in the past, such as Great Britain, France, Israel, and the former Soviet Union.
- 4. Historical and Comparative Perspectives on Special Operations:** Students will have a close understanding of the historical use of special operations forces, to include how these and similar forces have been organized, trained, equipped, directed, and employed. Attention should be given not only to the U.S. experience, but to other national experiences as well, such as those of Great Britain, Germany, Italy, and the former Soviet Union. Similarly, this examination should not be restricted to contemporary history alone, but should extend back into the historical record to examine the ways in which special operations and related forces have been employed creatively to support state objectives in the more distant past. Throughout this inquiry, attention should be given to the contemporary lessons that can be drawn from historic experience.
- 5. Special Operations Doctrine, Concepts, and Institutions:** Graduates will have a detailed and conceptual understanding of the development of

doctrine for special operations. Work in this area should focus, first, on the defining events and experiences that have stimulated doctrinal and institutional innovations in SO and, second, on the forms these innovations have taken. This examination should cover the period from the end of World War II through the post-Cold War era. These and related issues should be explored creatively in an effort to uncover the appropriate roles, missions, strengths, and limitations of military power in the emerging multipolar environment.

6. **Crisis Management and the Contingent Use of Military Power:** Students will have an understanding of the political role played by military power in operations short of war, the problem of military crisis management, and the contingent use of force in support of local U.S. policy objectives. Attention should be given to the "signaling" role that can be played by military force, the special problems of deterrence and coercion in a crisis environment, and the military consequences of deterrence failure. The student should have a close knowledge of the historical record of "armed diplomacy" throughout the post-war period. This should include knowledge of the individual cases of U.S. military intervention in the Third World, from Lebanon (1958) to Somalia (1993). Attention should be given to both the theoretical and empirical literature on these subjects to provide the student with an understanding of the special political and operational issues associated with operating in a crisis environment.
7. **Comparative Cases of and Responses to Regional Conflict:** Graduates will have a close knowledge of historical and contemporary "small wars" and other forms of low-intensity conflict in Latin America, Asia, and the Middle East. The courses that satisfy this requirement should examine the pertinent theoretical literature on political violence in the region in question, review the recent history of regionally-based terrorism, insurgency, and communal conflict, the regional and international implications of these conflicts, and any functional issues that are of particular interest or concern in the particular area under investigation, such as the religious or communal sources of political violence or the relationship between narcotics and insurgency.
8. **Special Operations and the Revolution in Military Affairs:** Students will have an understanding of the

ways in which the proliferation of new and emerging technologies is changing the shape of modern warfare. An important aspect of this requirement is to examine the likely impact of these developments on the dynamics and characteristics of twenty-first century warfare within both the inter-state and intra-state arena. The student must have a working knowledge of the major technological developments and trends in this area (both lethal and non-lethal) and their conflict implications.

9. **Special Operations and Information Warfare:** Graduates will have an understanding of the likely and potential implications of information warfare on future special operations. An important aspect of this requirement is to examine the principles of information warfare and examine the ways in which SOF can contribute to U.S. information dominance on the twenty-first century battlefield. This examination should address the problem of information dominance at the inter-state and intra-state level of war.
10. **Weapons of Mass Destruction (WMD) Proliferation and Counter-Proliferation:** Students will have an understanding of the developing problem of WMD proliferation and counter-proliferation. Students may have a technical or operational perspective on WMD. The student must have an understanding of the political dynamics of WMD proliferation and an understanding of recent and possible future trends in these areas. Close attention should also be given to the problem of counter-proliferation and the ways in which SOF might approach this task. Students having a technical focus should have a working knowledge of nuclear and non-nuclear WMD technologies.
11. **Analytical Methods and Applications:** Each student will receive grounding in analytical methods and their application to military modeling, simulations, and gaming. Close attention will be given to the ways in which such analytical techniques can be used as heuristic and decision-making tools for strategic and operational planning. Attention will be given to both historical and contemporary military applications, with particular focus on the ways in which such techniques can be used to address issues of interest to the special operations community.
12. **Strategic and Operational Complexity:** Special Operations (SO) is a style of warfare. No traditional single academic discipline can adequately address the educational requirements

of the SO community, so an interdisciplinary approach is required. Each student will develop a course of study that permits him or her to pursue a disciplinary orientation that best suits their particular academic background and interests within the substantive limits of the other ESRs.

## Department of Information Sciences

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**Wolfgang Baer**, Research Associate Professor (1994); Ph.D., University of California at Berkeley, 1972.

**Edgar Bates**, Research Associate (2005); Ph.D., Touro University International, 2005.

**Richard Bergin**, Visiting Assistant Professor (2002); M.S., Marshall School of Business, 1998.

**Mark Bergman**, Assistant Professor (2004); Ph.D., University of California at Irvine, 2003.

**Dan C. Boger**, Chairman, Department of Information Sciences and Professor (1979); Ph.D., University of California at Berkeley, 1979.

**Alexander Bordetsky**, Associate Professor (2000); Ph.D., Chelyabinsk State Technical University of Russia, 1982.

**Eugene Bourakov**, Research Associate (2002); MSEE, Chelyabinsk State Technical University of Russia, 1974.

**Donald Brutzman**, Associate Professor (1994); Ph.D., Naval Postgraduate School, 1994.

**Rex A. Buddenberg**, Senior Lecturer (1993); M.S., Naval Postgraduate School, 1986.

**Raymond J. Buettner, Jr.**, Associate Professor (1999); Ph.D., Stanford University, 2003.

**Stan Bush**, LCDR, USN, Lecturer (2004); M.S., Old Dominion University, 2003.

**Glenn R. Cook**, Lecturer (2000); M.S., Naval Postgraduate School, 1994.

**Dale M. Courtney**, Lecturer (2000); M.S., Naval Postgraduate School, 1996.

**Daniel R. Dolk**, Professor (1982); Ph.D., University of Arizona, 1982.

**James Ehlert**, Research Associate (2004); M.S., Naval Postgraduate School, 1995.

**Raymond Elliott**, Lt Col, USAF, Lecturer (2001); MBA, Golden Gate University, 2001.

**Edward Fisher**, Lecturer (2005); M.A., California State University, 1989.

**Shelley P. Gallup**, Research Associate Professor (1999); Ph.D., Old Dominion University, 1998.

**Richard Hayes-Roth**, Professor (2002); Ph.D., University of Michigan, 1974.

**Susan Higgins**, Lecturer (1999); M.S., Naval Postgraduate School, 1988.

**Thomas J. Housel**, Professor (2001); Ph.D., University of Utah, 1980.

**Susan Hutchins**, Research Associate Professor (1994); M.S., San Diego State University, 1983.

**Steven J. Iatrou**, Lecturer (1999); M.S., Naval Postgraduate School, 1992.

**Nelson J. Irvine**, Research Assistant Professor (2003); Ph.D., Case Western Reserve University, 1973.

**Erik Jansen**, Senior Lecturer (1994); Ph.D., University of Southern California, 1987.

**Magdi N. Kamel**, Associate Professor (1988); Ph.D., University of Pennsylvania, 1988.

**William G. Kemple**, Associate Professor (1990); Ph.D., University of California at Riverside, 1991.

**Anthony Kendall**, Lecturer (1999); M.S., Naval Postgraduate School, 1980.

**Richard Kimmel**, Research Associate (1999); M.S., Naval Postgraduate School, 1999.

**David Kleinman**, Research Professor (1994); Ph.D., Massachusetts Institute of Technology, 1967.

**Orin E. Marvel**, Research Associate Professor (1994); Ph.D., University of Illinois, 1970.

**Randall Maule**, Visiting Associate Professor (2003); Ph.D., University of Florida, 1987.

**Brian McClain**, Research Associate (2000); B.S., California State University, 2000.

**Mark Nissen**, Associate Professor in Acquisition Management (1996); Ph.D., University of Southern California, 1996.

**Carl Oros**, Maj, USMC, Lecturer (2004); M.S., Naval Postgraduate School, 2004.

**John Osmundson**, Research Associate Professor (1995); Ph.D., University of Maryland, 1968.

**Karl D. Pfeiffer**, Lt Col, USAF, Assistant Professor (2004); Ph.D., North Carolina State University, 2001.

**Mark Rhoades**, Lecturer (2005); M.S., Naval Postgraduate School, 1990.

**William Roeting**, Research Associate (2005); M.S., Naval Postgraduate School, 1984.

**Norman F. Schneidewind**, Professor (1971); DBA, University of Southern California, 1966.

**Kishore C. Sengupta**, Associate Professor (1989); Ph.D., Case Western Reserve University, 1990.

**Brian J. Steckler**, Lecturer (2002); M.S., Naval Postgraduate School, 1994.

**John Van Hise**, Research Associate (2001); M.S., Naval Postgraduate School, 1979.

**John Vitalich**, Lecturer (2003); M.S., Naval Postgraduate School, 1997.

**William J. Welch**, Lecturer (2000); M.S., Naval Postgraduate School, 1987.

**Reese Zomar**, LCDR, USN, Director, IPCOE and Lecturer (2005); M.S., Rensselaer Polytechnic Institute, 1991.

### **Emeritus Professors**

**Carl R. Jones**, Professor Emeritus (1965); Ph.D., Claremont Graduate School, 1965.

**Michael G. Sovereign**, Professor Emeritus (1970); Ph.D., Purdue University, 1965.

### **Brief Overview**

The Department of Information Sciences provides in-residence graduate education, as well as a continuum of career-long learning opportunities, in support of defense requirements in the areas of information sciences, systems, and operations. The Department maintains an internationally respected research program in selected areas of information sciences, systems, and operations, and has the capability of developing research programs in additional areas of information sciences that are required to support graduate education.

### **Degree**

The Department provides the following degree programs:

#### **Master of Science in Information Technology Management**

The degree of Master of Science in Information Technology Management will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 370. The Master of Science in Information Technology Management requires:

- Completion or validation of core courses in each of the following disciplines: Information Systems, Computer Science, Electrical and Computer Engineering, and Systems Management.
- Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.
- Completion of an acceptable thesis.
- Approval of the candidate's program by the Chairman, Information Sciences Department.



### Master of Science in Systems Engineering

The degree of Master of Science in Systems Engineering will be awarded at the completion of a multidisciplinary program in Curricula 595 and 596. The Master of Science in Systems Engineering requires:

- Completion of a minimum of 45 quarter-hours of graduate-level work, of which at least 15 hours must represent courses at the 4000 level.
- Graduate courses in at least four different academic disciplines must be included and a course at the 4000 level must be included in two disciplines.
- An approved sequence of at least three courses, constituting advanced specialization in one area, must be included.
- In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.
- The candidate's program must be approved by the Chairman, Information Sciences Department.

### Master of Science in Systems Technology

The degree of Master of Science in Systems Technology (Command, Control, and Communications) will be awarded at the completion of the Joint Command, Control, Communications, Computers, and Intelligence (C4I) interdisciplinary program, Curriculum 365, carried out in accordance with the following degree requirements:

- Completion of a minimum of 45 quarter-hours of graduate-level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines.
- Within the course program there must be a specialization sequence consisting of at least three courses.
- In addition to the 45 hours of course credit, an acceptable thesis must be completed.
- The program must be approved by the Chairman, Information Sciences Department.

### Master of Science in Information Systems and Operations

The degree of Master of Science in Information Systems and Operations will be awarded at the completion of the Information Systems and Operations interdisciplinary program, Curriculum 356, in accordance with the following degree requirements:

- Completion of 40 quarter-hours of graduate course work, of which 15 hours must be at 4000 level.

- An acceptable thesis or project approved by the Chairman, Information Sciences Department.
- Individual student programs to be approved by the Chairman, Information Sciences Department.

### Doctor of Philosophy in Information Sciences

The Department offers the Ph.D. degree in Information Sciences. The program begins with advanced course work guided by the Departmental Ph.D. Committee, which leads to qualifying examinations. The primary emphasis then shifts to the student's research program, culminating in the Ph.D. dissertation. Three areas of primary concentration within the field of information sciences are available: information systems, command and control, and information operations/warfare. Interested potential students may obtain further details by contacting the Information Sciences Ph.D. Program Director, Code IS, 589 Dyer Road, Room 200A, Naval Postgraduate School, Monterey, CA 93943-5100. An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, CA 93943-5100. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases, the student must fulfill the general school requirements for the doctoral degree. Residency for this program generally requires three years beyond completion of a master's degree.

### Information Sciences Course Descriptions

#### CC Courses

#### **CC0001 Seminar Series in C4I (0-2) As Required**

Seminars (consisting of guest lectures, video teleconferences, and field trips) are scheduled to provide background information on specific Joint C4I systems and activities. Prerequisite: None.

#### **CC0810 Thesis Research for C4I Students (0-8) As Required**

Thesis research time for JC4I students. Prerequisite: None.

#### **CC3000 Introduction to Command and Control (4-0) As Required**

Knowledge of current C4I systems and practice is introduced. A basic framework for understanding C4I is provided. Case studies are used as well as lessons learned from crises, field exercises, and war-gaming. Prerequisites: Enrollment in the Joint C4I Systems curriculum, OS2103 concurrently. Classification: SECRET.

#### **CC3102 Introduction to Combat Modeling and Analysis for C4I (3-2) As Required**

Emphasis is on the use of mathematical models such as those for search, attack, and combat adjudication on land and sea to

help operational and tactical commanders solve wartime problems or improve the effectiveness of their forces. Includes a hands-on introduction to the Systems Technology Battle Lab and selected applications. The course is the basis for later study of models of the command and control process, wargaming and simulation, and C4I systems engineering. A required course for the 365 curriculum. Prerequisites: CC3000 and OS3104 (may be concurrent). Classification: U.S. Only, SECRET.

**CC3900 Special Topics in C4ISR (V-V) As Required**

Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Consent of the Academic Associate.

**CC4101 Systems Engineering for Joint C4I (4-2) Summer**

Provide an introduction to systems engineering by performing systems engineering activities, using the tools that a systems engineer uses, analyzing the procedures a systems engineer follows, and performing an actual systems design on a joint C4I system element. The course will use practical examples to explain the fundamental principles, while maximizing the hands-on practical systems design activities. A required course for the 365 curriculum. Prerequisites: CC3000 and OS3604. Classification: TOP SECRET.

**CC4103 Joint C4I Systems Evaluation (2-4) As Required**

Experiments in determining C4I system effectiveness using wargaming and simulation. Design of experiments. Survey of current C4I systems evaluation techniques. Prerequisites: CC4101 and U.S. citizenship. Classification TOP SECRET with Eligibility for SI/SAO.

**CC4221 Joint C4ISR Systems (4-0) As Required**

Synthesis course that deals with adaptation of Internet technology to military situations including security, quality of service, survivability, and reach to mobile platforms (radio-WAN) issues. Course deals with general interoperability issues in Information Systems, including communications interoperability, modularity and coupling, and related issues. The course also deals with what the next generation of information technology training requirements are likely to be and how to prepare for them. Prerequisite: None.

**CC4900 Advanced Study in C4ISR (V-V) As Required**

Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. Graded on a Pass/Fail basis only. Prerequisite: Consent of the Academic Associate.

**CC4913 Policies and Problems in Joint C4I (4-0) As Required**

Study of the fundamental role C4 systems fulfill in operational military situations, including crisis warning and crisis management. Analysis of the changing role of intermediate-level headquarters and its impact on C4I system requirement and design. Consideration of the complexities imposed on C4I systems as the force structure becomes more heterogeneous, as in the case of NATO. Case study of selected incidents and systems. This course is specifically for

students in the 365 curriculum. Prerequisite: CC4103. Classification: CONFIDENTIAL.

*IO Courses*

**IO0001 Seminar Series in IO Topics (0-2) As Required**

Seminar lectures in Information Operations. Prerequisite: None.

**IO0810 Thesis Research for IO (0-8) As Required**

Information Operations thesis research. Prerequisite: None.

**IO3100 Introduction to Information Operations (4-0)**

**Fall/Spring**

This course, available in the classroom or through asynchronous Internet-based education, provides a survey of Information Operations (IO) along the time line of peace, to conflict, and back to the cessation of hostilities. Students study the specific methods and elements of IO and how they integrate with other elements of national power to meet national security objectives. Prerequisite: None.

**IO4300 Information Operations Planning and Targeting Spring/Summer**

This course refines the students' ability to develop and analyze IO plans. Students learn to integrate seemingly disparate disciplines (national security affairs, information warfare/operations, computer science, physics (kinetic warfare), and operations analysis) into a cogent operations plan as an integral part of a theater campaign plan. Prerequisites: NW3230 and IW3101 and OS3000 (or equivalent Operations Analysis course). Classification: SECRET.

*IS Courses*

**IS0001 Seminar Sessions (0-2) As Required**

Seminar Sessions in Information Systems for IST Students. Prerequisite: None.

**IS0810 Thesis Research (0-8) As Required**

Thesis research time for IST Students. Prerequisite: None.

**IS2000 Introduction to Information Technology (3-1) As Required**

Provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager. Offered as part of the E-FIST certificate for distance learning only. Prerequisite: None.

**IS2010 Introduction to Information Technology (1-2)**

**Fall/Winter/Spring/Summer**

This course provides an overview of the technology used to implement modern information systems. Extensive use of hands-on laboratories and demonstrations provide students with a thorough introduction to microcomputer architecture and design, the Internet and Web page development, local area network (LAN) operation and administration, databases, management information systems, and computer security. The strong emphasis on hardware and software technical issues in this course establishes the foundation necessary for studying IT management issues during the follow-on course. Prerequisite: None.

**IS2020 Introduction to Object-Oriented Programming Using Visual Basic (2-3) As Required**

A first course in computer programming using VB, DoN's IT21 mandated standard, as a high-level, event-driven, object-oriented, programming language. Course emphasis will be on planning, program development, graphical user interfaces, rapid prototyping, program construction, data types, operations, control flow, arrays, records, file I/O, database access, random number generators, and event-driven OOP structures. Prerequisite: None.

**IS2025 Fundamentals of Networks (3-2) Spring**

Undergraduate level Network fundamentals class for the E-FIST program. Security Clearance: Confidential.

**IS3001 Computer and Software Technology (4-2) Fall**

This course provides an overview of the technology used to create modern strategic information systems. Hardware architecture, operating systems, programming, software engineering, and project design are introduced. Use of hands-on laboratories and demonstrations provide students with an opportunity to learn how these systems work together. Common Operating Environment (COE), Command and Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), and Joint Technical Architecture are all covered in this course. Prerequisite: None.

**IS3181 Integrating and Leveraging Information Technologies (3-0) As Required**

The attributes of information technology are studied in conjunction with the management aspects of developing and maintaining systems in support of DoN and the joint services. This course is heavily project- and case-study oriented. Minicases force the student to apply theory from reading to realistic DoN settings. These case studies will force trade-offs, resource allocation decisions, development of strategy for specific problems, etc. Prerequisite: Lead program students only.

**IS3200 Fundamentals of Systems Analysis and Design (3-2) Fall/Spring**

This survey course covers the basic concepts, models, and processes used by systems analysts to determine: 1) what is the current situation of an organization that desires to improve itself; 2) what are the problems and opportunities in this situation; and 3) what plans and specifications can be formed to feasibly address these problems or opportunities. The course covers how system analysis is performed to successfully cover these three areas of inquiry and how it connects to system design. Then, the fundamentals of information system design are discussed and applied. The class stops at the point of detailed design, e.g., complete specifications of an Internet Web interface or database application. This topic is covered in subsequent Information Systems classes. When the course is finished, it is expected that the students understand the system development life cycle, system analysis and design methodologies, and have applied them in a team project within the class. Prerequisite: None.

**IS3201 Fundamentals of Database Management Systems (4-2) Winter/Summer**

Introduction to database technology provides the basic knowledge, language, and experience to manage data electronically. Students will learn the essential activities of how

to store, retrieve, manage, and control data using a relational database management system. They not only will learn how to build a database application using Microsoft Access, and but also how to deploy database technology in a larger, organizational context to support problem solving. Further, by the time students have completed the course, they will know the major steps required to manage a complex database project. Prerequisite: None.

**IS3202 Web-Enabled Database Management Development (4-2) Winter/Summer**

This course is designed to familiarize students with the different approaches for developing database-driven, interactive, dynamic Web sites. These approaches include client-side scripting using Java scripts; server-side scripting using Active Server Pages; and Extensible Markup Language (XML) technologies. An integrated development environment is used throughout the course to demonstrate the application of these approaches. Students are expected to develop a fully functional, dynamic Web site using the approaches/technologies learned in class. Prerequisites: IS3200 and IS3201, or consent of the instructor.

**IS3210 Information and Knowledge Management Issues in Defense (4-0) Spring**

This elective course on defense knowledge and information management integrates theory with practice to help prepare current and future leaders to leverage knowledge and knowing for competitive advantage in learning organizations. Knowing refers to knowledge in action and is concerned with activities (e.g., decisions, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand: how knowledge is both critical and unique; how it builds and depends on information; and how to design effective work processes, organizations, and technologies around dynamic knowledge and information. Using application cases for group critique, the problem-based learning part of the course examines a diverse set of knowledge-based processes and organizations in operation today, and it offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational knowledge-based processes for evaluation, and work individually as consultants to assess and redesign them around knowledge flows. Prerequisite: None.

**IS3301 Fundamentals of Decision Support Systems (3-2) Fall/Spring**

This course introduces the principles for designing, implementing, and using computer systems that support a variety of decision-making situations. Surveys or analytical techniques for decision making in complex environments, involving single or multiple criteria made under certainty and uncertainty, and techniques for automated inference are examined. The latest computer-based systems, and exemplary applications in DoD, that support or involve the use of formal decision-making methods and tools are covered. Group projects will supplement and reinforce learning objectives. Prerequisites: IS3200 and IS3201.

**IS3302 Fundamentals of Database and Decision Support Systems (3-2) Fall/Summer**

Database management systems and decision support systems constitute essential components of information-driven organizations. These systems are employed in a wide array of

activities, ranging from combat support to logistics and administration. The course proposed here covers the essential aspects of database management and decision support systems. The course has a “how to” flavor, i.e., in addition to conveying the essential concepts and methods, we seek to familiarize students with the tools and processes. Prerequisite: None.

### **IS3333 Introduction to Thesis Research (0-2)**

#### **Fall/Spring**

Introduction to the thesis research process and requirements for IS Department students. Prerequisite: None.

### **IS3502 Fundamentals of Networks: LAN/WAN (4-2)**

#### **Winter/Summer**

This course is targeted to the analysis and design of computer and telecommunication networks in close relationship with the emerging environment of Global Information Grid (GIG). The fundamental concepts of Internet and LAN/WAN building blocks for wired, satellite, and mobile wireless communication segments of GIG are in the kernel of the course. A four-step network design decision framework is in the center of the classroom, seminar, and project teamwork. This is complemented by analysis of emerging trends in high-speed terrestrial, wireless, and satellite communications. The study includes two research projects. The objective for both projects is to allow students to get hands-on experience with the analysis and design of emerging information networks. The Midterm Project is targeted to the “bottom-up” study of emerging networking technologies and their implementation within the GIG to enable command and control and sensor-decision maker networking operations. The Final Project is focused on the “top-down” design of a business proposal for selected GIG networking segments enabling command and control, humanitarian, ISR, UAV, METOC, and other operations. Both projects are tied to the NPS research activities with SOCOM, DHS, ONR, Foundry Networks, and the Internet 2 community. The course combines on-line study with modeling exercises in the OPNET IT Guru simulation modeling system. The on-line environment is comprised of the Blackboard system, interactive Agent-Evaluator for homework exercises and tests, and the optional Groove client for students' collaboration with the instructor. Prerequisite: None.

### **IS3504 Modern Network Operating Systems: Windows 2003 Server (3-2) As Required**

This course focuses on the planning, design, installation, configuration, and management of network operating systems used throughout DoD and private industry. Network operating systems are compared with single-user operating systems to understand differences and similarities. Popular client/server and peer-to-peer systems are examined to provide a thorough understanding of the correct applications of each. Network labs provide in-depth analysis of such topics as file server configuration and administration, multilevel network security procedures, and global file server synchronization processes. Prerequisite: IS3502.

### **IS4010 Technology in Homeland Security (4-0)**

#### **Fall/Winter/Spring**

Government agencies in today's Information Age are more dependent than ever on technology and information sharing. This course provides students involved in homeland security with a broad overview of homeland security technology, information systems, sensors, networks, knowledge

management, and information security. The course focuses on technology as a tool to support homeland security personnel regardless of functional specialty. The study of principles and theory is combined with homeland security examples and cases. The student will gain a perspective on the important role of senior management in enterprise-level computing and their personal role as change agents. The knowledge and skills acquired will make the students more effective technology users and help them recognize opportunities where the application of technology solutions can provide a strategic advantage and therefore make a contribution to homeland security. The ultimate objectives are to show students how homeland security professionals can exploit technology and not be exploited by it, and to wisely use technology in the most efficient and productive manner. This course is open to students in the Homeland Security Program only. Prerequisite: None.

### **IS4031 Information Systems Economics (4-0)**

#### **Fall/Spring**

The objectives of this course are to provide the student with the tools and methodologies that will allow for the objective evaluation of information systems from a business perspective. The course will focus on the alignment of IT investment to strategic goals and productivity, the methods of obtaining IT services through outsourcing and ASPs, and the importance of managing to the needs of the customer. This course also incorporates the concepts of e-commerce, with an emphasis on case-study analysis. Prerequisite: None.

### **IS4182 Information Systems Management (4-0)**

#### **Winter/Summer**

Information Systems Strategy and Policy: How to Be an Effective CIO or IT Strategist. This course aims to make students fluent in architecture-based decision making for IT systems strategy and policy. Students should become capable of significantly enhancing the prospects of an organization through effective, strategic use of IT architecture. The student should be capable of suggesting significant improvements in existing or proposed architectures, demonstrating both analysis and synthesis skills. Topics include: the enterprise and extended enterprise; information processing for competitive superiority; technology evolution and adaptive stresses; the role of the CIO; information systems architecture and enterprise architecture; architecting; U.S. Government architecture efforts; DoD imperatives; information superiority; network-centric warfare; and architecture synthesis and evaluation. Prerequisite: None.

### **IS4188 Collaborative Technologies (3-2) As Required**

Collaborative technologies and multiple-agent, decision-support architectures become the central application elements of emerging GIG, FORCEnet, DARPA NICCI, and other sensor/decision maker networking initiatives. The first part of the course is based on the analysis of collaboration in different human organizations and the requirements of agent-based, decision-support architecture. The second part of the course is focused on studies of intelligent agents and multiple-agent architecture. From the beginning of the course, students are involved in hands-on practice with wireless collaborative environments including GPS units, pocket PCs, laptops, and other devices. We start with using the peer-to-peer Groove collaborative tool and NPS agents-facilitators. We later move on to several demonstrations, including the client-server GENOA system implementation for Homeland Security and

PACOM POST virtual meetings via the Lotus Same Place System. Prerequisite: None.

**IS4201 Enterprise Data Management (4-2) As Required**

An elective course that will focus on the technological infrastructure, as well as the management processes, related to the operations and maintenance of enterprise data management systems. Prerequisite: IS3201.

**IS4210 Knowledge Superiority (3-0) As Required**

This elective course on knowledge superiority integrates theory with practice to help prepare current and future leaders to leverage knowledge and knowing for competitive advantage in learning organizations. Knowing refers to knowledge in action, and is concerned with activities (e.g., decision, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand how knowledge is both critical and unique, and equips them to design effective work processes, organizations, and technologies around knowledge flows. Using real-time cases for group critique, the problem-based learning part of the course examines a diverse set of knowledge-based processes and organizations in operation today, and offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational knowledge-based processes for evaluation, and work individually as consultants to assess and redesign them around knowledge flows. Prerequisites: IS3201 and IS3301, or IS3302, or equivalent with consent of the instructor.

**IS4220 Business Process Reengineering with E-Business Technologies (3-2) Winter/Summer**

The focus of this class is on practical application of Business Process Reengineering (BPR) principles and the use of information technology to enable innovative redesigns of core defense processes. BPR principles are a set of heuristics, "rules-of-thumb" that help the analyst accomplish the transformational goals required in dramatically changing core processes to create greater value. The course makes use of process analysis and measurement methodologies to ensure productivity increases as a result of the process redesigns. Prerequisites: IS3200 and IS4031, or consent of the instructor.

**IS4300 Software Engineering and Project Management (3-2) Fall/Spring**

The objective of this course is to educate the student in areas of great concern to the DoD in the fields of software engineering and management. The course examines both the technological tools of software production as well as the software engineering techniques for software project management. Software testing, metrics, and reliability are also covered. DoD software standards and metrics programs are included. Prerequisites: CS3030 and IS3200 and IS3171 and OS3004.

**IS4301 Data Warehousing, Data Mining, and Visualization (4-2) Winter**

This elective course is designed to provide students with the basic concepts of data warehousing, data mining, and visualization. The course emphasizes both technical and managerial issues and the implications of these emerging technologies on those issues. The course has a distinctly "real-world" and DoD orientation that emphasizes application and implementation over design and development. A state-of-the-

art system/tool will be used to help students understand and apply the concepts presented in the class. Prerequisites: IS3201 and IS3301 and IS3200, or consent of the instructor.

**IS4505 Wireless Networking (3-2) Winter/Summer**

This course provides students with wireless networking fundamentals essential to design, install, administer, and support IEEE 802.11-compliant wireless networks. The course content and format is aligned with the Planet3 Wireless Certified Wireless Network Administrator (CWNA) Official Study Guide. Students who successfully complete this course will be prepared to take the CWNA certification exam. Prerequisites: IS3502 or CS3502 and EO3502, or consent of the instructor.

**IS4520 Systems Thinking and Modeling for a Complex World (4-0) Spring**

This course introduces system dynamics modeling for the analysis of organizational policy and strategy. Students will learn to visualize an organization in terms of the structures and policies that create dynamics and regulate performance. The goal is to use the analysis and modeling techniques of system dynamics to improve their understanding of how complex organizational structures drive organizational performance, and then to use that understanding to design high-leverage interventions to achieve organizational goals. We use computer-based simulations to model long-term side effects of decisions, systematically explore new strategies, and develop our understanding of complex systems (analogous to the "flight simulators" that pilots use to learn about the dynamics of flying an aircraft). Prerequisite: None.

**IS4550 Internet Appliances and Me-Centric Computing (3-2) Winter**

In the next decade, computing as we know it will be radically transformed around highly personalized devices that know their users, know how to get work done, and can interact with billions of devices and services over the Internet. Computing empires built up on traditional OSI 7-level stacks will lose their preeminence. In the emerging new world of Internet appliances, the center of the universe will become the individual and products will be built around knowledge of how to serve that user. Billions more people will gain access to computing power this way, and our daily experience will shift from endless efforts to tame incomprehensible software products to being masters of a universe of appliances and services that aim to please. This transition is inevitable, because hyper-complex technology isn't welcomed or assimilated fast enough, and pressures exist to find better paths to market. The clear path for powerful technology is to reach many more customers through a radical simplification of what customers must do to employ it. This revolution is underway now, and it will fundamentally alter the landscape for IT, IT management, and strategic uses of technology. The course will look into various technologies including personalization, Web services, wireless communications, Internet (including IP v. 6), and identity services that are driving the changes. Student projects will create Me-Centric innovations pertinent to their domains of interest. Prerequisite: None.

**IS4700 Introduction to the Philosophy of Science (3-2) Winter**

This course is designed to help prepare the prospective Ph.D. in Information Sciences candidate to engage in original

research. The focus will be on understanding the underpinnings of doing science by studying the work of modern philosophers of science. The course will review the epistemologies (economic, behavioral, physics-based, and general systems-based) serving as a scaffolding for the development of original theory development in the field of IS. The characteristic features of the received view, hypothetico-deductive formalism will be reviewed, along with the modern challenges to this framework. The distinction between the instrumental-realist positions will be examined in light of its implications for theory development in IS. Students should understand the requirements for theory generation in terms of the underlying assumptions of given epistemic perspectives as a result of taking this course. Prerequisite: None.

**IS4710 Qualitative Methods for Research (3-2) Winter**

Qualitative Methods for research will be explored in this course. Quantitative research methods are powerful, but not all research questions and settings are amenable to such methods. In particular, early stage exploratory research (e.g., "how" and "why" questions), studies in which the phenomena of interest are intertwined with their contexts (e.g., where people, technology, and organizations interact), investigations of individual and small-group behaviors (e.g., leaders, project teams, user groups), understanding rare and idiosyncratic events (e.g., catastrophes, new technology introductions, organizational changes), and research in which potential sample sizes are small, or measures cannot be operationalized practically, are all candidates for qualitative research methods. Additionally, combining qualitative and quantitative methods represents a compelling tactic for triangulation through data analysis. In this course, students learn to appreciate when qualitative research methods are appropriate, and they gain both theoretical and experiential knowledge about how to employ such methods. Prerequisite: None.

**IS4720 Quantitative Methods for Research (3-2) Summer**

This course equips IS doctoral students with the quantitative methods necessary to support dissertation research, using real-world project data and case studies. Topics include: defining research objectives, formulating and testing hypotheses, designing experiments, developing analytic and simulation models, collecting data, analyzing data, validating models, using quantitative software tools, and presenting results in written and oral reports. Prerequisite: None.

**IS4730 Design of Experiments for Research (3-2) Fall**

Design of experiments for Ph.D. students. Prerequisites: IS4700 and IS4710 and IS4720.

**IS4790 Research Seminar for Ph.D. Students (0-3) Fall/Winter/Spring/Summer**

Research seminar for students in the IS Ph.D. program. Prerequisite: None.

**IS4925 Special Topics in Information Systems (V-V) Summer**

Special topics courses are first-run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

**IS4926 Network Operating Centers (4-0) Winter**

The course provides analytical background for implementing telecommunications management systems and integrating

management infrastructure into the information grid design. It targets operations support for GIG, terrestrial, satellite, and mobile wireless network operation centers. The course combines classroom activities with research and design experience in telecommunication networks configuration, fault, and performance management. In the center of analytical work is the project-based study of management functions and information models for SNMP MIBs, TMN, and architectures. The advanced study issues include an introduction to knowledge-based management and intelligent agent technology. The applications target the needs of GIG operations, C4ISR networks management, Joint Experimentation, Fusion Centers, and Network Operation Centers environment. They employ features of LAN/WAN networks, ATM networks, PCS networks, satellite/wireless networks, UAV, HALO, and other platforms. During the course work, students will gain basic knowledge of several commercial telecommunications management systems used by the NOCs: Spectrum, HP Open View, Tivoli, Unicenter TNG, Micro Muse, etc. The classroom, studies, and projects teamwork are facilitated by the on-line distributed learning and shared electronic workspace environment. Prerequisite: None.

**IS4927 Special Topics in Information Systems II (V-V) Fall/Winter/Spring/Summer**

Special topics courses are first run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

*IW Courses*

**IW0001 Seminar Series for IW Students (0-2) As Required**

Seminar series for IW students. Prerequisite: None.

**IW0810 Thesis Research for IW Students (0-8) As Required**

Thesis research work for IW students. Prerequisite: None.

**IW3101 Introduction to Information Warfare (4-1) As Required**

This course provides a survey of IO along the time line of peace, to conflict, and back to cessation of hostilities in the joint/coalition environment. All of the elements associated with IO, known as "core capabilities," and previously known as "The Pillars of IO," are covered including PSYOP, Military Deception, Operational Security (OPSEC), Computer Network Operations (Computer Network Attack/Defense/Exploitation), and Electronic Warfare (EW). An introduction to the fields of study that form the foundation of IO are provided. Foundation topics include military-civilian relationships, human cognition and decision making, the OODA loop, command and control structures, legal issues and considerations in IO, computer and network attack/defense, the joint planning process, and intelligence support to IO. Prerequisite: None. Classification: Secret; U.S. Citizenship.

**IW3301 IW Influence Modeling (3-2) As Required**

This course explores influence models and analysis in support of military requirements. Students will learn the strengths and weaknesses of modeling techniques as applied to information operations, how to determine whether an influence model is

appropriate for use, and how to evaluate the utility of various models and modeling techniques. The student will become familiar with the process of designing, constructing, and applying influence models within the context of information operations. Prerequisites: OS3104 (or equivalent) and IW3101 (or IO3100).

**IW3900 Signals Intelligence (3-0) Winter (Security Clearance: Top Secret)**

This course focuses on both national and tactical signals intelligence (SIGINT) systems, their capabilities and limitations, and the applications for which each is best suited. Topics covered include SIGINT tasking, collection, processing, exploitation, reporting, dissemination, and fusion with other intelligence products. The course also provides an overview of the missions, roles, and interrelationships of the member elements of the U.S. SIGINT system. Prerequisite: None.

**IW3920 Information Warfare Targeting (3-2) Spring**

This course describes the joint targeting process as it applies to information warfare attack. Network node attack, time critical targeting, weapon system characteristics, C2W attack, attack damage assessment, and directed energy weapons are discussed. Hard kill versus Soft kill methods are compared. Prerequisite: None. Classification: Secret.

**IW3921 IO Targeting I (2-0) As Required**

This course describes the joint targeting process as it applies to information warfare. Targeting will be discussed in reference to the core competencies of information warfare as well as supporting and ancillary competencies. Specific areas of discussions will include: the joint planning process, network centric warfare, links and nodes analysis for target selection, effects-based targeting, time-critical targeting, information warfare systems characteristics, intelligence requirements for analysis and damage/effects assessment, and lethal versus non-lethal options. This course is conducted at the unclassified level utilizing open-source information. Prerequisite: IW3101 or IO3100 or consent of the instructor.

**IW3922 IO Targeting II (2-0) As Required**

This course is taught in conjunction with IW 3921 and explores the practical application of IW targeting concepts as described for IW3921 through lecture and laboratory work. Prerequisite: IW3101 or IO3100 or by consent of the instructor; Concurrently: IW3921. Classification: This course is conducted at the SECRET level.

**IW4301 Advanced Topics in Influence Modeling (4-0) Summer**

This course provides students with the opportunity to develop an Influence Model and to use this model to conduct analysis in support of actual military requirements. Students will design, construct, and analyze Influence Models in collaboration with fellow students. Work completed as part of this course may be included in one or more Naval Postgraduate School Technical Reports. Each project may be briefed to appropriate senior DoD leadership as well, if deemed suitable for such briefings by the instructor. Students must have access to a United States Government computer network and have access to "For Official Use Only" (FOUO) data. SECRET-level work may be conducted as well by special arrangement with the instructor. Prerequisite: IW3301.

**IW4800 Directed Study for IW Students (V-V) As Required**

Directed Study for IW/EW students. Credit hours are variable and must be chosen on a case-by-case basis. Prerequisite: None.

**IW4900 Special Topics in IO (V-V) As Required**

Special Topics in Information Operations. Credit hours are variable and will be assigned on a case-by-case basis. Prerequisite: None.

**IW4925 Special Topics in Information Warfare (V-V) Summer**

Special topics courses are first-run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

**IW4950 Advanced Information Warfare Systems (3-2) Fall**

This course examines the use of modern EW systems in support of information warfare operations. Modern EW systems studied include IDECM, Towed FO decoys, AIEWS, MAWS, ASPJ, Advanced Standoff Jammers, Stand-in Jamming, DECM, and Situational Awareness. Advanced topics, including stealth, directed energy weapons, modern threats, GPS jamming, Hard kill/Soft kill interactions, MASINT, and DRFM systems, are discussed. The laboratory includes visits to EW manufacturers and invited lecturers on advanced topics. Prerequisite: None. Classification: SECRET.

**IW4960 Advanced Information Warfare Systems (3-2) Winter**

The characteristics and performance of modern EW systems are discussed. Course topics include: the Advanced Radar Threat, Architecture and Technology of EA systems, EA against modern radar systems, Noise and DECM EA systems, DDS and DRFMs, characteristics of modern ES systems, Expendables and Towed Decoys, directed energy systems, and stealth principles. Prerequisite: EO4612 or consent of the instructor.

**Information Systems and Operations (ISO) Academic Certificate in Information Systems and Operations - Curriculum 271**

**Program Manager**

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**Brief Overview**

The Information Systems and Operations (ISO) academic certificate program is designed to provide DoD personnel with an opportunity to obtain advanced education in the operational arts supporting Information Operations via asynchronous Web-based media. The four courses in the ISO program represent

the foundation on which modern warfare is built: Command and Control, Space Operations, Network Operations, and Information Operations. This four-course sequence is also the bedrock of all operations-oriented, NETWARCOM-sponsored curricula at the Naval Postgraduate School: Information Systems and Operations; Information Warfare; Information Systems and Technology; Joint Command, Control, Communications, Computers, and Intelligence; Computer Science; and Space Systems Operations.

These curricula exist because our armed forces must be prepared to fight and win the nation's wars across the full range of military operations in any part of the world, to operate with multinational forces, and to coordinate military operations, as necessary, with government agencies and international organizations. This requires a Total Force composed of well-educated, motivated, and competent people who can adapt to the many demands of future joint missions. The transformation of the joint force to reach this full spectrum dominance rests on information superiority as a key enabler and our capacity for innovation.

The ISO academic certificate provides the fundamental education needed to achieve information superiority, thus enabling full spectrum dominance. The actions associated with information operations are wide-ranging—from physical destruction to psychological operations to computer network defense. The task of integrating information operations with other joint force operations is complicated by the need to understand the many variables involved and integrating these variables across the spectrum of conflict—whether facing an adversary during a conflict or engaged in humanitarian relief operations. Achieving this aspect of JV 2020 will require exceptional personnel, well versed in Information Operations and its integration with national security and national military objectives.

The ISO academic certificate is provided through asynchronous Web-based media (i.e., the Internet) because DoD recognizes that this education should be available to their personnel regardless of geographic limitations. So, if students have access to the Internet, they have access to tools necessary to help meet U.S. national security objectives in the information battlespace.

All courses in the ISO academic certificate are graduate-level courses carrying full NPS academic credit. They provide the baseline for advanced education in operationally essential disciplines. As such, they do not carry graduate prerequisite requirements; however, you must have demonstrated academic proficiency through completion of a baccalaureate degree program.

## Requirements for Entry

Applicants must have earned a baccalaureate degree to be considered for admission.

## Entry Date

At the beginning of any quarter in the academic year (January, April, July, October). These courses may be taken in any sequence and they need not be taken all in the same academic year.

## Program Length

Four quarters.

## ISO Academic Certificate Requirements

To earn the ISO academic certificate you must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

## Program Sponsors/Advisors

Naval Network Warfare Command (NETWARCOM), Navy Information Operations Command (NIOC), Naval Education and Training Command (NETC)

## Required Courses

### Quarter 1

CC3000 (4-0) Introduction to Command and Control

### Quarter 2

IS3502 (4-0) Fundamentals of Networks: LAN/WAN

### Quarter 3

IO3100 (4-0) Introduction to: Information Operations

### Quarter 4

SS3011 (3-0) Space Technology and Applications

## Information Systems Technology (IST) - Academic Certificate in Information Systems Technology - Curriculum 272

### Program Manager

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### Brief Overview

The IST academic certificate provides education in the fundamentals of information systems technology. This education is essential to helping the U.S. military reach information superiority in the battlespace. It also offers advanced education in areas essential to enabling global networked communications, including: databases, systems analysis and design, decision support systems, and network security.

The IST academic certificate is provided through asynchronous Web-based media (i.e., the Internet) because DoD recognizes that this education should be available to their personnel regardless of geographic limitations. If you have access to the Internet, you have access to tools necessary to help meet U.S. national security objectives in the information battlespace.

All courses in the IST academic certificate are graduate-level courses carrying full NPS academic credit. They provide the baseline for advanced education in essential disciplines in information technology. As such, they do not carry graduate prerequisite requirements; however, you must have demonstrated academic proficiency through completion of a baccalaureate degree program.

### Requirements for Entry

Applicants must have earned a baccalaureate degree to be considered for admission.

### Entry Date

Program entry dates are at the beginning of any quarter in the academic year (January, April, July, October). These courses may be taken in any sequence.

### Program Length

Four quarters.

### ISO Academic Certificate Requirements

To earn the IST academic certificate students must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

### Program Sponsors/Advisors

Naval Network Warfare Command  
 (NETWARCOM), Navy Information Professional

Center of Excellence (IPCOE), Naval Education and Training Command (NETC)

### Required Courses

#### Quarter 1

CS3006 (4-0) An Introduction to Information System Security

#### Quarter 2

IS3200 (3-2) Fundamentals of Systems Analysis and Design

#### Quarter 3

IS3201 (3-2) Fundamentals of Decision Support Systems

#### Quarter 4

IS3301 (3-2) Fundamentals of Database and Decision Support Systems

## Fundamentals in Information Systems Technology (Electronically Delivered) (EFIST) - Curriculum 276

### Program Manager

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### Brief Overview

This program has been designed to enhance students' knowledge of and productivity in the Navy's information technology fields. The courses are Web-based and will be delivered entirely online. They provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager.

The programming course meets DoN's IT21 mandated standard, as a high-level, event-driven, object-oriented, programming language. Course emphasis is on planning, program development, graphical user interfaces, rapid prototyping, program construction, data types, operations, control flow, arrays, records, file I/O, database access, and event-driven OOP structures.

A fundamentals course focused on the basics of computer networking is included. Since networking is an underpinning to our technology-driven society, understanding the basics of computer networking is important to any technology professional interested in

building a solid technology understanding, and is especially important as a precursor to other courses in the Information Systems and Information Technology arenas.

Academic credit will be awarded for each course. All credits are transferable. These courses are taught by experienced NPS faculty and are available anywhere in the world: at home, on detachment, or at sea. A transcript of your grades and courses will be available from the Naval Postgraduate School upon completion.

### Requirements for Entry

A bachelor's degree is not required. There are no prerequisites.

### Entry Date

Contact the Program Manager.

### Program Sponsors/Advisors

Naval Network Warfare Command (NETWARCOM), Navy Information Professional Center of Excellence (IPCOE), Naval Education and Training Command (NETC) The curriculum consists of the following courses:

IS2000	(3-1)	Introduction to Information Technology
IS2020	(4-1)	Introduction to Object-Oriented Programming using Microsoft Visual Basic
IS2502	(3-2)	Network Fundamentals

## Information Systems and Operations - Curriculum 356

### Academic Associate and Program Manager

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### Brief Overview

Our armed forces must be prepared to “win” across the full range of military operations in any part of the world, to operate with multinational forces, and to coordinate military operations, as necessary, with government agencies and international organizations. This requires a Total Force composed of well-educated, motivated, and competent people who can adapt to the many demands of future joint missions. The transformation of the joint force to reach this full spectrum of dominance rests on information superiority as a key enabler, and our capacity for innovation.

Information operations are essential to achieving information superiority, thus enabling full spectrum dominance. The actions associated with information operations are wide-ranging—from physical destruction to psychological operations to computer network defense. The task of integrating information operations with other joint force operations is complicated by the need to understand the many variables involved, and integrate these variables across the spectrum of conflict, whether facing an adversary during a conflict or engaged in humanitarian relief operations. Achieving this aspect of JV 2020 will require exceptional officers, well versed in information operations and its integration with national security and national military objectives.

Technological innovation must be accompanied by intellectual innovation leading to changes in organization and doctrine. Only then can we reach the full potential of the joint force—decisive capabilities across the full range of military operations. The Naval Postgraduate School graduate studies program in Information Systems and Operations (ISO) provides the education necessary to meet the Chairman's vision and answer the call for officers capable of conducting experimentation, analysis, and conceptual thought in the arena of information operations.

All of the curricular programs at the Naval Postgraduate School take you far beyond the level of proficiency achieved in standardized training programs. NPS educates individuals and enables them to take the U.S. Armed Forces far beyond present capabilities, and ensures domination in all dimensions of the present and future battlespace.

Be advised: The ISO curriculum is not for everyone. The ISO matrix of courses is designed to provide the United States with officers capable of exploiting all elements of national power to reach our national security objectives: officers capable of operating in all dimensions of the battlespace, including: physical, virtual, and psychological. This is an 18-month curriculum balancing operational and technical courses and the full series of JPME Phase I courses—it is intense and will require the students' highest level of commitment to succeed.

### Requirements for Entry

A baccalaureate degree or the equivalent resulting in an academic profile code (APC) of at least 334 is required for acceptance into the program. Eligibility for TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is also required.

### Entry Date

Information Systems and Operations is a six-quarter course of study with an entry date in September.

There is no refresher instruction available for this curriculum. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

### Degree

Requirements for the Master of Science in Information Systems and Operations degree are met en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program. These requirements are met by completing the approved matrix of courses and phase I JPME.

### Master of Science in Information Systems and Operations

The Master of Science in Information Systems and Operations degree will be awarded at the completion of the appropriate interdisciplinary program in accordance with the following degree requirements:

- Completion of 40 quarter-hours of graduate course work, of which 15 hours must be at the 4000 level.
- An acceptable thesis approved by the Chairman, Information Sciences Department.
- Individual student programs to be approved by the Chairman, Information Sciences Department.

### Subspecialty

Completion of this curriculum qualifies a Navy officer as an Information Systems and Operations Subspecialist with a subspecialty code of 6100P. Other services have analogous coding. The curriculum sponsor is COMNAVNETWARCOM.

### Typical Subspecialty Jobs

CO/XO, Naval Computer and Telecommunication Station/Master Station  
 Staff/Fleet Communications Officer, Numbered Fleets  
 Operations Officer (CG/DDG)  
 ADP Plans Readiness Assessment Officer  
 Systems Officer, Director Strategic Systems Procedure  
 Systems Officer, SPAWARSYSCOM  
 Chief Information Officer, Numbered Fleets  
 Staff Officer  
 Information Assessment Officer, Defense Agencies

### Typical Course of Study

#### Quarter 1

IS3001 Computer and Software Technology  
 IW3101 Introduction to Information Warfare  
 MO1901 Mathematics for Information Sciences, Systems and Operations  
 NW3230 Strategy and Policy (JPME)

#### Quarter 2

EO3502 Telecommunications and Systems Engineering  
 IS3502 Fundamentals of Networks: LAN/WAN  
 SO2410 Modeling for Special Operations I  
 SO3101 Warfare in the Information Age  
 NW3275 Joint Maritime Operations I (JPME)

#### Quarter 3

CC3000 Introduction to Command and Control  
 IS3302 Fundamentals of Database and Decision Support Systems  
 IW3920 Information Warfare Targeting  
 SO3410 Modeling for Special Operations II  
 NW3276 Joint Maritime Operations II (JPME)

#### Quarter 4

CS3600 Information Assurance: Introduction to Computer Security  
 IO4300 Information Operations Planning and Targeting  
 SO4450 Analytical Methods  
 IO0810 Thesis Research  
 NW3285 National Security Decision Making (JPME)

#### Quarter 5

CC4221 Joint C4ISR Systems  
 SO3011 Space Technology and Applications  
 SO4104 Militaries and Technological Change  
 IO0810 Thesis Research for IO  
 NW3221 Joint Maritime Operations II (JPME)

#### Quarter 6

IO4500 Information Operations Strategies  
 OS3602 Simulation and Wargaming  
 IO0810 Thesis Research for IO  
 IO0810 Thesis Research for IO

*Note: Due to the time constraints of this program, there are no elective tracks offered.*

### Educational Skill Requirements Information Systems and Operations - Curriculum 356 Subspecialty Code: 6100P

1. **Science and Technology:** The graduate shall understand the terminology, methods, application and effect of the following information sciences and technologies: communications, computer systems, databases, information assurance, sensors, signal processing, space systems, networks, simulation and gaming.
2. **Strategy, Policy, and Doctrine:** The graduate shall understand the terminology and processes; analyze and formulate; and synthesize strategy, policy and doctrine as it is affected by information operations utilizing the concepts found in the theories of conflict in the information age, network-centric

warfare, and the requirements found in policy and doctrine planning, national directives, and rules of engagement.

3. **Organization and Systems:** The graduate shall understand the terminology, processes, and structures; analyze and develop organizational elements and agile organizations utilizing the best current practices found in Command and Control, complex systems, cybernetics, networks and grids, and operational architecture theories.
4. **Methods and Elements:** The graduate shall understand the terminology and processes associated with all aspects of Information Superiority and Warfare to include: deception, psychological operations, operational security, military intelligence, electronic warfare, C4ISR, special operations, and military operations in space.
5. **Strategy and Policy:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)
6. **Joint Professional Military Education (JPME):** Graduates will develop understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war. This requirement is fulfilled by completing the Naval War College three-course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.
7. **Problem Solving and Real World Applicability:** The officer shall possess skills that permit a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to the real of Information Operations. This includes:
  - Completing a significant project applying academic skills outside of the classroom.

- Exercising skills in problem formulation, synthesis, criteria specification, analysis, and evaluation and presentation of results.
- Clearly communicating the project in writing and verbally.

#### **Curriculum Sponsor and ESR Approval Authority**

Commander, Naval Network Warfare Command, April 2004.

#### **Joint Command, Control, Communications, Computers, and Intelligence (C4I) Systems - Curriculum 365**

##### **Program Officer**

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##### **Academic Associate**

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##### **Brief Overview**

The Joint C4I curriculum is designed to meet broad educational objectives endorsed by the Joint Chiefs of Staff. The overall objective is to provide officers and DoD civilian equivalents, through graduate education, with a comprehensive operational and technical understanding of the field of C4I systems as applied to joint and combined military operations at the national and unified command levels. The program is designed with the following goals: enable individuals to develop an understanding of the role C4I systems play in the use of military power and the ability to interpret the impact of C4I on operating philosophy; provide adequate background knowledge in basic technology, human capabilities, and joint military operations and how these factors are exploited in current C4I systems; and provide the framework whereby students can perform requirement and planning studies of new C4I systems and contribute to crisis management.

These officers should be able to undertake a wide range of assignments in C4I (both joint and intra-service) over the full span of their careers.

## Requirements for Entry

The Joint C4I curriculum is open to all U.S. military services and selected civilian employees of the U.S. Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. Eligibility for a TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required. An academic profile code (APC) of 334 is required for direct entry. Officers not meeting the APC may be admitted based on transcript reviews by the registrar's office and the Program Officer.

## Entry Date

Joint C4I Systems is a seven-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Program Officer.

## Degree

Requirements for the Master of Science in Systems Technology (Joint Command, Control, and Communications (C3)) degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

## Master of Science in Systems Technology

The Master of Science in Systems Technology (Joint C3) degree will be awarded at the completion of the appropriate interdisciplinary program carried out in accordance with the following degree requirements:

- Completion of a minimum of 45 quarter-hours of graduate-level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines.
- Within the course program there must be a specialization sequence consisting of at least three courses.
- In addition to the 45 hours of course credit, an acceptable thesis must be completed.
- The program must be approved by the Chairman, Information Sciences Department.

## Subspecialty

Completion of this curriculum qualifies an officer as a Joint C4I Systems Subspecialist with a subspecialty code of 6204 for U.S. Naval officers. U.S. Army graduates are awarded the 3K Special Skill Identifier. U.S. Air Force graduates fill OYTA coded billets. U.S. Marine Corps graduates are awarded the 9658 Special Skill Identifier. The curriculum sponsor is the Director for Command, Control, Computer, and Communications Systems (J6), Joint Staff.

## Typical Subspecialty Jobs

Staff Command and Control Officer: Commander in Chief, Pacific Fleet  
 Surface Systems Officer: Naval Ocean Systems Center  
 Staff Planning and Programming Officer: OPNAV/N62  
 Staff Operations Plans Officer: Headquarters, European Command  
 Staff Operations and Plans Officer: Commander, 7th Fleet  
 Program Manager: Naval Space and Warfare Systems Command  
 C3 Staff Officer: Headquarters, U.S. Space Command

## Typical Course of Study

### Quarter 1

CC3000	(4-0)	Introduction to Command and Control
IS3001	(4-1)	Computer and Software Technology
NW3230	(4-2)	Strategy and Policy
MO1901	(3-0)	Mathematics

### Quarter 2

CC3101	(4-0)	Combat Analysis for C4I
IS3502	(3-2)	Fundamentals of Networks: LAN/WAN
OS3105	(4-0)	Statistics for Technical Management
CS3600	(3-2)	Computer Security
EO2513	(3-2)	Introduction to Communication Systems Engineering

### Quarter 3

IW3101	(4-1)	Introduction to Information Warfare
OS3008	(4-0)	Analytical Planning Methodology
PH3052	(3-0)	Sensors
EO3513	(4-2)	Communication Systems Engineering

### Quarter 4

CC4101	(4-2)	Systems Engineering for Joint C4I
SS3011	(3-2)	Space Systems
IS3302	(3-0)	Fundamentals of Database and Decision Support Systems
EO4513	(4-2)	Communication Systems Analysis

### Quarter 5

CC4221	(3-2)	C4ISR Systems
SS3613	(3-0)	Military Satellite Communications
CC0810	(0-4)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

**Quarter 6**

CC4103	(2-4)	Joint C4I Systems
MN3331	(5-0)	Acquisition and Program Management
CC0810	(0-4)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

**Quarter 7**

CC4913	(4-0)	Policies and Problems in Joint C4I
CC0810	(0-8)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

**Educational Skill Requirements (ESR)  
Joint Command, Control, Communications,  
Computers, and Intelligence (C4I) Systems  
Curriculum - 365  
Subspecialty Code: 6204P**

The graduate shall be able to:

1. **Technologies:** Analyze and synthesize communications, computer, and information systems, including digital and analog communications systems, computer architectures, networks, databases, decision support systems, sensors, information security techniques, user-network interface, and system tradeoff analyses.
2. **Systems Engineering and Analysis:** Perform systems engineering studies, develop architectures, and integrate systems, including mission requirements determination: operational, technical, and systems architectures; data analysis, modeling and simulation, and experimental design and analysis; evaluation of human-in-the-loop C4I systems; technical analysis of selected C4I systems and architectures; interoperability of hardware and software within and across systems of systems; and standard and alternative acquisition process.
3. **Joint C4I:** Understand joint C4I systems, including national and DoD C2 and intelligence concepts, policies, doctrine, processes, and organizations; joint C4I systems and architectures; information warfare and C2 warfare environments; effects of combined operations; and future concepts and current issues.
4. **Strategy and Policy:** Develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College course series

leading to service intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

5. **Practice:** Demonstrate the ability to conduct independent analysis of joint C4I systems, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing.

**Curriculum Sponsor and ESR Approval Authority**

Director, C4 Systems (J6); Director, Space and Electronic Warfare (N6); June 1997.

**Information Systems and Technology -  
Curriculum 370**

**Program Officer**

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**Brief Overview**

The Information Systems Technology curriculum is part of the larger Information Sciences, Systems, and Operations (ISSO) discipline. The ISSO curricula consist of the Professional Practice Core and seven degree tracks: Computer Sciences; Joint C4I Systems; Information Systems and Technology; Information Warfare; Intelligence Information Management; Modeling, Virtual Environments, and Simulation; and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology; Command and Control; C4ISR Systems; Acquisition; C4ISR System Evaluation; Information Operations/Warfare; and Enterprise Policy, Strategy, and Change. This specialization satisfies the ISSO Educational Skill Requirements as established by CNO-N61.

This curriculum provides officers with knowledge of information systems technology to include computer and telecommunications systems, software engineering, networked and distributed applications, database management systems, and decision support systems in the military services. Students will also gain

proficiency in information systems, economics, and management necessary for the critical management decisions needed in the development and utilization of complex and evolving computer-based military systems.

Information Systems Technology is an interdisciplinary, graduate-level, master's program integrating mathematics, accounting, economics, statistics, computer science, information systems, communications engineering, networks, and management disciplines.

### Requirements for Entry

A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus) resulting in an academic profile code (APC) of at least 325 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program, through a six- or twelve-week refresher, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT), indicate a capability for graduate-level work. A minimum Test of English as a Foreign Language (TOEFL) score of 207 (173-207 with supplemental language training) is required for international students. While previous computer, communications, or information systems experience is certainly helpful, it is not essential.

### Entry Date

Information Systems Technology is an eight-quarter course of study with entry dates in March and September (Spring and Fall Quarters). Those requiring the six- or twelve-week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

### Degree

Requirements for the Master of Science in Information Technology Management degree are met as a milestone en route to satisfying the Educational Skill Requirements established by the curricular program's sponsor.

### Master of Science in Information Technology Management

The Master of Science in Information Technology Management degree will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 370. The Master of Science in Information Technology Management requires:

- Completion or validation of core courses in each of the following disciplines:
  - Information Systems

- Computer Science
- Electrical and Computer Engineering
- Systems Management
- Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.
- Completion of an acceptable thesis.
- Approval of the candidate's program by the Chairman, Information Sciences Department.

### Subspecialty

Completion of this curriculum qualifies a Navy officer as an Information Technology Management Subspecialist with a subspecialty code of 6201P. Other services have analogous coding. The curriculum sponsor is the Commander, Naval Network Warfare Command.

### Typical Subspecialty Jobs

CO/XO, Naval Computer and Telecommunication Station/Master Station  
 Staff Comm/Fleet Communications Officer, Numbered Fleets  
 Information Systems Officer, USS George Washington  
 ADP Plans Readiness Assessment Officer, COMNAVSURFLANT  
 ADP Systems Officer, Director Strategic Systems Procedure  
 SNAP System Officer, SPAWARSSYSCOM  
 OIC, NAVMEDINFORMGMTCENDET  
 Data Base Management Officer, Naval Security Group  
 Plans and Programs, COMNAVCOMTELCOM

### Typical Course of Study

#### Quarter 1

CS3030	(4-0)	Computer Architecture and Operating Systems
IS2020	(2-3)	Introduction to Object-Oriented Programming Using Visual Basic
IS3200	(3-2)	Systems Analysis and Design
OS3105	(4-1)	Statistical Analysis for Management I

#### Quarter 2

CC3000	(4-0)	Introduction to Command and Control
IS3201	(3-2)	Fundamentals of Database Management Systems
IS3502	(3-2)	Fundamentals of networks: LAN/WAN
OS3004	(5-0)	Operations Research

**Quarter 3**

CS3600	(4-0)	Introduction to Computer Security
IS3200	(3-2)	Fundamentals of Systems Analysis and Design
IS4300	(3-2)	Software Engineering and Project Management
MN4125	(4-0)	Managing Planned Change in Complex Organizations
IW3101	(4-1)	Introduction to Information Operations

**Quarter 4**

IS3202	(3-2)	Web-Enabled Database Management Development
IS3333	(0-2)	Introduction to Thesis Research
MO1901	(3-0)	Mathematics for ISSO and ISO

**Track Specialization Course 1****Quarter 5**

EO3502	(3-0)	Communication Systems Technology and Applications
IS3301	(3-2)	Fundamentals of Decision Support Systems
IS3333	(0-2)	Introduction to Thesis Research
IS4031	(4-0)	Information Systems Economics

**Track Specialization Course 2****Quarter 6**

IS0810	(0-8)	Thesis Research
IS4182	(4-0)	Information Systems Management
IS4220	(3-2)	Business Process Reengineering with E-Business Technologies
SS3613	(4-0)	Military Satellite Communications (USMC only)

**Track Specialization Course 3****Quarter 7**

CC4221	(4-0)	Joint C4ISR Systems
IS0810	(0-8)	Thesis Research
NW3230	(4-2)	Strategy and Policy
SS3011	(3-0)	Space Technology and Applications

**Quarter 8**

GB3510	(3-0)	Financial Management in the Armed Services
IS0810	(0-8)	Thesis Research
IS0810	(0-8)	Thesis Research
MN3331	(4-0)	Acquisition and Project Management

Each student in the Information Systems and Technology Curriculum will choose a specialization track no later than the start of the third quarter of study. Current track specializations offered by the Information Sciences Department are:

**Network Management Track****Prerequisite**

IS3502	Fundamentals of Networks: LAN/WAN
CS3502	Computer Communications and Networks

**Network Track Courses (Choose 3)**

CS3690	Network Security
IS4926	Network Operating Centers
IS4188	Collaborative Technologies
IS4925	Special Topics in Information Systems

**Other Supporting Courses**

CC4221	Joint C4ISR Systems
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**Information Assurance Track****Prerequisite**

CS3600	Information Assurance: Introduction to Computer Security
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**Information Assurance Track Courses (Choose 3)**

CS3670	Information Assurance: Secure Management of Systems
CS3675	Internet Security Resources and Policy
CS3690	Network Security
CS4603	Database Security
CS4605	Security Policies, Models, and Formal Methods

**Communications Systems Engineering Track**

This track is a requirement for USMC Communications Specialists, USN Information Professionals and USN URL.

**Prerequisite**

MO1901	Mathematics for ISSO
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**Communications Systems Engineering Track Courses**

EO2513	Introduction to Communications Systems Engineering
EO3513	Communications Systems Engineering II
EO4513	Communications Systems Analysis

**Other Requirements**

Remove from Matrix:

EO3502	Telecommunications Systems Engineering
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Add to Matrix:

PH3052	Physics of Space and Airborne Sensor Systems (USN) or
SS3613	Military Satellite Communications (USMC)



## Software Engineering Track

### Prerequisite

IS2020	Introduction to Visual Basic
IS4300	Software Engineering/ Project Management

### Software Engineering Track Courses

#### (Choose 3)

SW3460	Software Methodology
SW4500	Introduction to Software Engineering
SW4530	Software Engineering R&D in DoD
SW4591	Requirements Engineering

Students with a strong educational or experience background in information systems or computer science may be eligible to validate certain requirements. Students who have validated certain courses will be required to substitute additional courses into their educational plan. These courses may include additional courses of study within their specialization track or other courses offered within the Information Sciences Department or other related fields of study. The Academic Associate and the Program Officer must approve all changes to the matrix.

### Educational Skill Requirements (ESR)

#### Information Systems Technology - Curriculum 370

#### Subspecialty Code: 6201P - (Previously XX89P)

The Information Systems Technology graduate shall have the knowledge, skills, and competencies to engineer information systems afloat and ashore; manage information systems, centers, and commands afloat and ashore; and solve information systems engineering and management problems individually and in teams. These general Educational Skill Requirements are supported by the following topical Educational Skill Requirements.

1. **Strategy and Policy:** Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)
2. **Space, Information Warfare and Command and Control Professional Practices:** The officer shall possess skills in the ISSO core subject areas of Science and Technology (Information Technology, Communications, Space, and

Sensors), Analysis and Evaluation (Statistics, Operations Analysis, and System Evaluation), Operations Information Management and Systems (C2, C4ISR, Information Operations, and Acquisition Management).

3. **Software Development:** The officer must have a thorough knowledge of modern software development to include: an understanding of the software development process; the ability to plan and implement a major programming project and develop the appropriate documentation; the ability to utilize object-oriented techniques in system design; and the ability to use modern software development tools in the construction of modeling, virtual environment, and simulation systems.
4. **Information Systems Technology:** The officer must have a thorough knowledge of information systems technology to include: computer system components, computer networks, communication systems and networks, software engineering, database management systems, decision support and expert systems.
5. **Information Systems Analysis and Management:** The officer must master the following concepts to effectively manage information system assets: managerial concepts, evaluation of information systems, systems analysis and design, management of information systems, adapting to technological, organizational, and economic changes, and military use of commercial telecommunications systems.
6. **Military Applications:** The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include: DoD decision-making process on information systems, information technology acquisition management, DoD computer and telecommunications, C4ISR, and C2W.
7. **Independent Research:** The graduate will demonstrate the ability to conduct independent research analysis, and proficiency in communicating the results in writing and orally by means of a thesis and a command-oriented briefing. The research in information technology and its management will include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis, and evaluation.

### **Curriculum Sponsor and ESR Approval Authority**

Director, Space, Information Warfare, Command and Control Directorate, OPNAV (N6), March 2000.

### **Doctor of Philosophy in Information Sciences - Curriculum 470**

#### **Program Manager**

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#### **Brief Overview**

The Department of Information Sciences at the Naval Postgraduate School will award the Doctor of Philosophy in Information Sciences degree as a result of meritorious and scholarly achievement in a particular field of information sciences (IS). This program includes course work, written and oral examinations, research, and a written dissertation. A candidate must exhibit scholarly application to the entire course of study, achieve a high level of scientific advancement, and establish ability for original investigation leading to the advancement of fundamental knowledge.

IS broadly encompass the design, use, and evaluation of information and communication systems and processes supporting organizational functions and decision making. It includes areas of concentration in information systems, information technology, information warfare, information operations, and command and control.

The study of IS is multidisciplinary, and no single theory or perspective dominates the field. In general, the field can be divided into technical and behavioral approaches. The technical approach to IS emphasizes mathematically based, normative models to study capabilities of systems and processes.

A growing part of the IS field is concerned with behavioral problems of system utilization, implementation, and creative design that cannot be expressed with normative models. The behavioral approach does not ignore technology; indeed,

technology is often the stimulus for a behavioral problem or issue. The focus, however, is generally not on technical solutions, but rather on the social, group, and organizational impacts and uses of systems, the political impacts and uses of information, individual response to system realities, and cognitive models of human reasoning and decision making.

The Ph.D. in Information Sciences prepares scholars who have a firm understanding of the technical and organizational aspects of computer-based systems supporting organizations and individuals, as well as the analytical and empirical skills with which to contribute to basic knowledge in the discipline.

#### **Requirements for Entry**

U.S. military officers, foreign military officers, U.S. Government civilians, and employees of foreign governments may apply. The application should include certified transcripts of all courses taken at the university level, including both undergraduate and graduate courses. Students who have not graduated from the Naval Postgraduate School (NPS) within five years must include the results of a recent Graduate Record Examination (GRE) general test. Foreign students who are not native speakers of English must provide scores from the Test of English as a Foreign Language (TOEFL) examination. Applicants are also required to submit a written Statement of Purpose to explain the nature of their interest in Information Sciences, their specific area of interest (IW, EW, ISO, IS, or CC) and their reasons for wanting to study at NPS. Additionally, three letters of recommendation, with a specific assessment of their promise for success in the NPS IS Ph.D. program, is required.

An applicant should have a master's degree in any Information Sciences Department program or in a closely related field from another NPS school or civilian institution. Generally, an acceptable Ph.D. applicant must have above-average grades (GPA > 3.5) in a typical master's degree program. The Ph.D. Committee will also take other evidence of research or academic ability into account in making a recommendation as to whether to admit an applicant. Final acceptance will be based on the professional discretion of the Chairman, Ph.D. Committee.

#### **Entry Date**

The Ph.D. Program Committee will evaluate each applicant to gauge the minimum amount of time the applicant will need to complete the program (normal time is three years). The Information Sciences Department may impose the condition that the applicant obtain authorization for at least four years to complete the Ph.D. Admitted Ph.D. students may begin in any quarter, but the Department recommends that the student start in either the Fall Quarter

(beginning in October) or the Spring Quarter (beginning in April) due to the requirements and timing of the Written Qualifying Examination.

### Program of Study

Each student's Doctoral Committee will guide the student in designing a program suitable for his/her special interests and background, alert them to opportunities both within the Department of Information Sciences and other departments at NPS, and monitor the student's progress.

The doctoral program is based on a core of courses designed to provide the student with the broad knowledge and analytic skills necessary for advanced course work and dissertation research. Additional course work in application areas may be required and is based on the discretion of the student's primary advisor.

### Core Courses

IS4700	(4-0):	Introduction to the Philosophy of Sciences
IS4710	(3-2):	Qualitative Methods for Research
IS4720	(3-2):	Quantitative Methods for Research
IS4730	(3-2):	Design of Experiments for Research
IS4790	(0-3):	Research Seminar for Ph.D. Students

Students who have taken the equivalent of these courses may waive one or more of these core requirements by the Departmental Ph.D. Committee.

### Sample Ph.D. Program in Information Sciences

**First Year:** Remove any deficiencies in meeting the core program requirements for the Ph.D. program. Take any additional information sciences (IS) courses. Have doctoral committee appointed.

At the end of the first year, a diagnostic review is conducted by members of the academic unit in the student's major field. The review considers such indicators of scholastic achievement as performance in research courses and doctoral courses deemed appropriate by the examining faculty. The review culminates in a formal report to the Chairman of the Departmental Ph.D. Committee and includes a recommendation as to whether the student should continue in the program and, if so, make recommendations regarding how the student can improve his or her performance. A faculty member from the student's chosen academic unit then discusses the report with the individual, making a careful assessment of their demonstrated strengths and weaknesses in order to help the student to progress more effectively.

**Second Year:** Finish minor requirements and select a dissertation supervisor. Prepare for the qualifying examination. Take the qualifying examination near the middle of the second year. Upon completion, the student will advance to candidacy.

**Third Year:** Concentrate primarily on dissertation research, with perhaps a course or two related to the dissertation.

The dissertation culminates the student's academic endeavors. Working closely with faculty members from their committee during all phases of preparation, the student is expected to present a dissertation of substantial magnitude. The dissertation should make a significant contribution to the advancement of knowledge in the IS field. It should be of sufficient originality and quality to merit publication, either whole or in part, in a professional journal.

The dissertation is defended at a final oral examination. It must be completed and accepted within five years of advancement to candidacy. The dissertation defense is held before an examination committee. The committee is composed of at least two IS faculty members and two from other areas related to the dissertation topic. While any interested faculty member may attend the examination and participate in the discussion, only those individuals who are members of the examination committee may vote on the dissertation's approval or disapproval.

## Information Warfare - Curriculum 595

### Program Officer

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### Brief Overview

Graduates of this curriculum are thoroughly knowledgeable in information operations (IO) and information warfare (IW). They receive a Master of Science in Systems Engineering degree that provides the services with officers who are well versed in the technical, theoretical, and operational aspects of interdisciplinary IO/IW as they relate to joint mission

objectives. This curriculum is cosponsored by the Joint Staff (J39) and Commander, Naval Security Group (NAVSECGRU).

### Requirements for Entry

A baccalaureate degree with above-average grades with courses in mathematics (through integral calculus) is required for entry consideration. Additionally, applicants must have a minimum academic profile code (APC) of 324. Eligibility for TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required. Applicants not meeting the mathematics requirements may be considered for entry via the Engineering Science Program (Curriculum 460).

### Entry Date

The Information Warfare curriculum is an eight-quarter course of study with a single entry date in October. For further information, contact the Program Officer or Academic Associate for this curriculum.

### Degree

Requirements for the Master of Science in Systems Engineering degree are met en route to satisfying the Educational Skill Requirements of the curricular program.

### Master of Science in Systems Engineering

The Master in Science in Systems Engineering degree will be awarded at the completion of a multidisciplinary program in Curricula 595 and 596. The Master of Science in Systems Engineering requires:

- Completion of a minimum of 45 quarter-hours of graduate-level work, of which at least 15 hours must represent courses at the 4000 level.
- Graduate courses in at least four different academic disciplines must be included, and in two disciplines, a course at the 4000 level must be included.
- An approved sequence of at least three courses constituting advanced specialization in one area must be included.
- In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.
- The candidate's program must be approved by the Chairman, Information Sciences Department.

### Subspecialty

Graduates are designated Information Warfare Subspecialists with a XX46P code.

### Typical Subspecialty Jobs

Joint, Combined, Fleet and Group Staffs  
Systems Commands  
Navy Information Warfare Activity (NIWA)  
Fleet Information Warfare Centers (FIWC)  
The Joint Staff  
Joint Command and Control Warfare Center (JC2WC)

### Typical Course of Study

#### Quarter 1

MA2121	(4-0)	Differential Equations
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
IW3101	(4-1)	Introduction to Information Warfare
NW3230	(4-2)	Strategy and Policy

#### Quarter 2

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OS3104	(4-0)	Statistics for Science and Engineering
CS3030	(4-0)	Computer Architecture and Operating Systems
EO2652	(4-1)	Field, Waves, and Electromagnetic Engineering

#### Quarter 3

OS3003	(4-0)	Operations Research for Information Warfare
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO3602	(4-2)	Electromagnetic Radiation, Scattering, and Propagation
IW3920	(4-0)	Information Warfare Targeting

#### Quarter 4

EO4612	(4-2)	Microwave Devices and Radar
CS3600	(4-2)	Computer Security
EO3512	(3-2)	Communication and Countermeasures I
PH2203	(4-0)	Waves and Optics

#### Quarter 5

EO3911	(3-2)	Fiber Optics Systems
EO4512	(3-2)	Communication and Countermeasures II
EC3750	(3-2)	SIGINT Systems
IW4950	(3-3)	Advanced Information Warfare Systems

#### Quarter 6

OS3403	(4-0)	Human Factors in Information Warfare
EC3760	(3-2)	Information Operations Systems
SO3102	(4-0)	Psychological Operations
IW0810	(0-8)	Thesis Research for IO

**Quarter 7**

IW4500	(3-2)	Information Warfare Systems Engineering
	(4-0)	Elective I
	(4-0)	Elective II
IW0810	(0-8)	Thesis Research for IO

**Quarter 8**

IO4300	(3-2)	Information Operations Planning and Targeting
	(3-2)	Elective III
IW0810	(0-8)	Thesis Research for IO
IW0810	(0-8)	Thesis Research for IO

**Educational Skill Requirements (ESR)  
Information Warfare - Curriculum 595  
Subspecialty Code: XX46P**

- Information Warfare:** The officer will have an in-depth understanding of IW/C2W and the disciplines needed to support them.
- Communications/Computer/Information Networks:** The officer will have an in-depth understanding of the capabilities, limitations, design, and operation of communications, computers, and information networks.
- Information Systems:** The officer will have a systems-level understanding of information systems and their vulnerabilities as well as capabilities.
- Organizational Processes and Structure:** The officer will understand the organizational decision process as well as the structure and other processes of organizations, with emphasis on their vulnerabilities and capabilities.
- Intelligence:** The officer will understand the concepts, principles, methods, and capabilities of joint operational intelligence, with emphasis on the operational requirements levied on the intelligence community to support IW/C2W.
- IW Integration:** The officer will understand the integration of IW as a weapon and its role in modern warfare; understand the integral roles of EW, psychological operations, military deception, OPSEC, and physical destruction; understand INFOSEC and nodal attack in this warfare area; employ real-time intelligence, tactics, and EW systems; understand the physical principles of generation, transmission, propagation, reception, processing, and suppression of detection and surveillance information.
- Problem Solving and Practical Applicability:** The officer will demonstrate the ability to conduct independent analysis in IW/C2W, and proficiency in presenting the results in writing and

orally by means of a thesis and command-oriented briefings.

- Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

**Curriculum Sponsor and ESR Approval Authority**

Commander, Naval Security Group, October 1995.

**Electronic Warfare (International)  
Curriculum - 596**

**Program Officer**

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**Brief Overview**

The curriculum provides international services with officers that are thoroughly knowledgeable in the technical and operational aspects of the role of electronic warfare as an integral part of modern warfare. It is designed to provide an understanding of the principles underlying the broad field of electronic warfare.

**Requirements for Entry**

International students must meet the academic profile code (APC) requirements and receive approval by the Director of Admissions at the Naval Postgraduate School. The procedures for application are contained under the Admissions heading in this catalog. A minimum Test of English as a Foreign Language (TOEFL) score of 207 (173-207 with supplemental language training) is required for international students.

**Entry Date**

The Electronic Warfare curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Program Officer or Academic Associate.

**Typical Course of Study****Quarter 1**

MA2129	(5-0)	Multivariable Calculus
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
CS2971	(4-2)	Fundamental Object-Oriented Programming in C++

**Quarter 2**

OS2103	(4-1)	Applied Probability for Systems Technology
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO2652	(4-1)	Fields, Waves, and Electromagnetic Engineering
EO2410	(4-1)	Signals and Systems

**Quarter 3**

OS3003	(4-0)	Operations Research for Information Warfare
EO3602	(4-2)	Electromagnetic Radiation, Scattering, and Propagation
CS3030	(4-0)	Computer Architecture and Operating Systems
IT1500	(4-0)	Information Program Seminar for International Officers

**Quarter 4**

EO4612	(4-2)	Microwave Devices and Radar
EO3400	(3-1)	Digital Signal Processing
IS3502	(3-2)	Fundamentals of Networks: LAN/WAN
EO3512	(3-2)	Communications and Countermeasures

**Quarter 5**

CS3600	(3-2)	Introduction to Computer Security
OS3604	(4-0)	Decision and Data Analysis
EC3700	(3-2)	Introduction to Joint Services Electronic Warfare
IW9999	(3-2)	Approved Elective

**Quarter 6**

IW9999	(3-2)	Approved Elective
MR3419	(3-2)	Atmospheric Factors in EM and EO for Interdisciplinary Students
IW0810	(0-8)	Thesis Research for IO Students
IW9999	(3-2)	Approved Elective

**Quarter 7**

PH3204	(3-2)	Electro-Optic Systems and Countermeasures
IW9999	(3-2)	Approved Elective
OS4601	(4-0)	Test and Evaluation
IW0810	(0-8)	Thesis Research/Group Project

**Quarter 8**

EC4690	(3-3)	Radar Electronic Warfare Techniques and Systems for International Students
PH4209	(3-2)	EO/IR Systems and Countermeasures
IW0810	(0-8)	Thesis Research for IO Students
IW0810	(0-8)	Thesis Research for IO Students

**Department of Operations Research****Chairman**

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**David Annis**, Assistant Professor (2004); Ph.D., Purdue University, 2003.

**Laura Barton**, LCDR, USN, Assistant Professor (2003); Ph.D., University of Denver, 2002.

**Gordon H. Bradley**, Professor (1973); Ph.D., Northwestern University, 1967.

**Gerald G. Brown**, Distinguished Professor (1973); Ph.D., University of California at Los Angeles, 1974.

**Samuel E. Buttrey**, Associate Professor (1996); Ph.D., University of California at Berkeley, 1996.

**W. Matthew Carlyle**, Associate Professor (2002); Ph.D., Stanford University, 1997.

**George Conner**, Senior Lecturer (1991); M.S., Naval Postgraduate School, 1982.

**Robert F. Dell**, Associate Professor (1990); Ph.D., State University of New York at Buffalo, 1990.

**James N. Eagle**, Chairman, Department of Operations Research and Professor (1982); Ph.D., Stanford University, 1975.

**Paul Lee Ewing**, MAJ, USA, Assistant Professor (2005); Ph.D., Colorado School of Mines, 2002.

**Ronald D. Fricker, Jr.**, Associate Professor (2005); Ph.D., Yale University, 1997.

**Donald P. Gaver, Jr.**, Distinguished Professor (1970); Ph.D., Princeton University, 1956.

**Thomas E. Halwachs**, Senior Lecturer and Director of Information Technology (1988); M.S., Naval Postgraduate School, 1976.

**Alejandro S. Hernandez**, LTC, USA, Military Instructor (2005); M.S., Naval Postgraduate School, 1992.

**Thomas H. Hoivik**, Senior Lecturer (1983); M.S., Naval Postgraduate School, 1973.

**Gilbert T. Howard**, Associate Professor and Director of Academic Planning (1967); Ph.D., Johns Hopkins University, 1967.

**Wayne P. Hughes, Jr.**, Senior Lecturer (1979); M.S., Naval Postgraduate School, 1964.

**Patricia A. Jacobs**, Professor (1978); Ph.D., Northwestern University, 1973.

**Jeffrey E. Kline**, Senior Lecturer (2005); M.S., Naval Postgraduate School, 1991.

**Robert A. Koyak**, Associate Professor (1998); Ph.D., University of California at Berkeley, 1985.

**Moshe Kress**, Professor (2003); Ph.D., University of Texas at Austin, 1981.

**Kyle Y. Lin**, Assistant Professor (2004); University of California at Berkeley, 2000.

**Glenn Lintz**, CDR, USN, Military Instructor (2003); M.S., Naval Postgraduate School, 2001.

**Thomas W. Lucas**, Associate Professor (1998); Ph.D., University of California at Riverside, 1991.

**Michael E. McCauley**, Research Professor (2002); Ph.D., University of California at Santa Barbara, 1979.

**David W. Meyer**, LCDR, USN, Military Instructor (2004); M.S., Naval Postgraduate School, 1994.

**Nita Lewis Miller**, Associate Professor (2000); Ph.D., University of Texas, 1982.

**Gregory K. Mislick**, Lecturer (2005); M.S., Naval Postgraduate School, 1988.

**Gordon R. Nakagawa**, Adjunct Professor (1986); M.S., Naval Postgraduate School, 1966.

**Daniel A. Nussbaum**, Visiting Professor (2004); Ph.D., Michigan State University, 1971.

**David H. Olwell**, Senior Lecturer (1998); Ph.D., University of Minnesota, 1996.

**Sergio Posadas**, LtCol, USMC, Military Instructor (2005); M.S., Naval Postgraduate School, 2001.

**Steven E. Pilnick**, CAPT, USN (Ret.), Senior Lecturer (2005); Ph.D., Naval Postgraduate School, 1999.

**Peter Purdue**, Dean of the Graduate School of Operational and Information Sciences and Professor (1986); Ph.D., Purdue University, 1972.

**Richard E. Rosenthal**, Professor (1985); Ph.D., Georgia Institute of Technology, 1975.

**Johannes O. Royset**, Research Assistant Professor (2003); Ph.D., University of California at Berkeley (2002).

**Anton Rowe**, Research Associate (1999); M.S., Stanford University, 1997.

**Javier Salmeron**, Associate Professor (2000); Ph.D., Universidad Politecnica de Madrid, 1998.

**Paul J. Sanchez**, Senior Lecturer (1999); Ph.D., Cornell University, 1986.

**Susan M. Sanchez**, Professor (2000); Ph.D., Cornell University, 1986.

**Lawrence G. Shattuck**, Senior Lecturer (2005); Ph.D., The Ohio State University, 1995.

**Roberto Szechtman**, Assistant Professor (2003); Ph.D., Stanford University, 2001.

**William J. Tarantino**, COL, USA, Associate Dean of the Graduate School of Operational and Information Sciences and Assistant Professor (2005); Ph.D., Colorado School of Mines, 1999.

**Lyn R. Whitaker**, Associate Professor (1988); Ph.D., University of California at Davis, 1985.

**Daniel Widdis**, LCDR, USN, Military Instructor (2005); M.S., Naval Postgraduate School, 1995.

**R. Kevin Wood**, Professor (1982); Ph.D., University of California at Berkeley, 1982.

#### **Emeritus Professors**

**Harold J. Larson**, Professor Emeritus (1962); Ph.D., Iowa State University, 1960.

**Peter A. W. Lewis**, Distinguished Professor Emeritus (1971); Ph.D., University of London, 1964.

**Kneale T. Marshall**, Distinguished Professor Emeritus (1968); Ph.D., University of California at Berkeley, 1966.

**Paul R. Milch**, Professor Emeritus (1963); Ph.D., Stanford University, 1966.

**Robert R. Read**, Professor Emeritus (1971); Ph.D., University of California at Berkeley, 1958.

**David A. Schrad**, Distinguished Professor Emeritus (1965); Ph.D., Case Institute of Technology, 1965.

**Michael G. Sovereign**, Professor Emeritus (1970); Ph.D., Purdue University, 1965.

**James G. Taylor**, Professor Emeritus (1968); Ph.D., Stanford University, 1966.

**Alan R. Washburn**, Distinguished Professor Emeritus (1970); Ph.D., Carnegie Institute of Technology, 1965.

#### **Brief Overview**

Operations Research (OR) originated during World War II as a response to tactical problems relating to the effective and efficient optimal operation of weapon systems, and to operational problems relating to the

deployment and employment of military forces. Since then, OR has evolved into a full-scale, scientific discipline that is practiced widely by analysts in industry, government, and the military.

OR is the science of helping people and organizations make better decisions. More formally, it is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning, and common sense to the understanding and improvement of real-world operations. Improvement can be measured by the minimization of cost, maximization of efficiency, or optimization of other relevant measures of effectiveness.

The military uses OR at the strategic, operational, and tactical levels. OR improves decision making and facilitates insights into the phenomena of combat. OR applications cover the gamut of military activities including: national policy analysis, resource allocation, force composition and modernization, logistics, human resources (recruiting, retention, promotion, training, and personnel assignment), battle planning, flight operations scheduling, intelligence, command and control, weapon selection (weapon system effectiveness, cost, compatibility, and operability), engagement tactics (fire control, maneuver, target selection, and battle damage assessment), maintenance and replenishment, and search and rescue.

The Naval Postgraduate School's Operations Research Department offers M.S. and Ph.D. degrees. In 2001, it celebrated the 50th anniversary of its curriculum, which was the first educational program in OR in the United States. It is one of the oldest, largest, and highest-ranking OR departments in the country. It is without peer in terms of the extent to which graduate education is integrated with a commitment to solving real military problems. Our students and faculty use the latest mathematical modeling ideas and computing technology to penetrate deeply into the analysis of important real-world problems. Analysis is a key word; NPS operations researchers frequently influence decisions and serve as agents for change.

For further information, see the OR Department Web site: <http://www.nps.navy.mil/or>

#### **Degree**

**Master of Science in Operations Research**

**Doctor of Philosophy in Operations Research**

**Master of Science in Applied Science (Operations Research)**

**Master of Science in Human Systems Integration**

**Master of Systems Analysis**



## Operations Research Course Descriptions

### OA Refresher Courses

#### **OA100 Introduction to Computational Methods for Operations Research (2-2) As Required**

(NO CREDIT) (Meets first 6 weeks of quarter.) Introduction to the Naval Postgraduate School computer laboratories and software. Windows operating system, files, Internet, editing, word processing, spreadsheets, data analysis, and presentation graphics. Review of selected topics in differential and integral calculus. Integration of functions of a single variable. Constrained and unconstrained optimization of functions of a single variable.

#### **OA160 Introduction of Operations Analysis II (2-2) As Required**

(NO CREDIT) This course is the second half of OA1600.

#### **OA200 Introduction to Visual Basic for Operations Research (2-2) As Required**

(NO CREDIT) (Meets last 6 weeks of quarter.) A first course in computer programming using Visual Basic as a high-level programming language. Primary emphasis will be on the planning, structuring, and debugging of computer programs for solving Operations Research problems. Prerequisite: None.

#### **OA100 Introduction to Computational Methods for Operations Research (2-2) As Required**

(No Credit) (Meets first six weeks of quarter.) Introduction to the Naval Postgraduate School computer laboratories and software. Windows operating system, files, Internet, editing, word processing, spreadsheets, data analysis, and presentation graphics. Review of selected topics in differential and integral calculus. Integration of functions of a single variable. Constrained and unconstrained optimization of functions of a single variable.

#### **OA160 Introduction of Operations Analysis II (2-2) As Required**

(No Credit) This course is the second half of OA1600.

#### **OA200 Introduction to Visual Basic for Operations Research (2-2) As Required**

(No Credit) (Meets last six weeks of quarter.) A first course in computer programming using Visual Basic as a high-level programming language. Primary emphasis will be on the planning, structuring, and debugging of computer programs for solving operations research problems. Prerequisite: None.

### OA Courses

#### **OA0001 Seminar for Operations Analysis Students (0-2) As Required**

(No credit) Guest lecturers. Review of experience tours. Thesis and research presentations. Prerequisite: None.

#### **OA0810 Thesis Research for Operations Analysis Students (0-8) As Required**

Every student conducting thesis research will enroll in this course. Prerequisite: None.

#### **OA0820 Integrated Project (0-12) Fall/Winter/Spring/Summer**

The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary

projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration and to lend OR-specific expertise to these projects. This course is available to Operations Research students who are participating in a campus-wide integrated project. Course is graded on a Pass/Fail basis. Prerequisite: None. Classification: Security Clearance Required.

#### **OA1600 Introduction to Operations Analysis I (2-2) As Required**

(No credit) A first course in Operations Analysis, covering its origins in World War II to current practices. Introduces concepts, tools, and methods of analysis, with tactical examples. Emphasis on measuring combat effectiveness and developing better tactics. Prerequisite: None.

#### **OA2200 Computational Methods for Operations Research (3-1) Fall/Spring**

An introductory course in Java with an emphasis on software design and on computational methods particularly appropriate to Operations Research. Assigned projects include developing Operations Research applications. The laboratory has weekly programming assignments. Prerequisite: None.

#### **OA2900 Workshop in Operations Research/Systems Analysis (V-0) Fall/Winter/Spring/Summer**

This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisites: Department approval and a background in Operations Research.

#### **OA2910 Selected Topics in Operations Analysis (V-4) Winter**

(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisite: A background in Operations Research.

#### **OA3101 Probability (4-1) Fall/Spring**

Introduction to data entry, manipulation, and graphing using spreadsheets and statistical packages. Graphical and tabular methods in descriptive statistics, measures of location and variability. Probability axioms, counting techniques, conditional probability. Discrete and continuous probability distributions: binomial, hypergeometric, negative binomial, Poisson, normal, exponential, gamma, and others. Joint probability distributions, conditional distributions and conditional expectation, linear functions. Random samples, probability plots. Prerequisites: Knowledge of single-variable calculus and MA1115 (may be taken concurrently).

#### **OA3102 Statistics (4-2) Winter/Summer**

Point estimation, method of moments, maximum likelihood, least squares. Confidence intervals, tests of hypotheses for one- and two-sample problems. Analysis of variance, multiple comparisons, interaction, simple design cases. Goodness of fit and contingency tables, sign tests, Wilcoxon-Mann-Whitney test. Prerequisites: OA3101 and MA1115 and MA3110 (taken concurrently).

#### **OA3103 Data Analysis (4-1) Fall/Spring**

Techniques for analyzing, summarizing, and comparing sets of real data with several variables. Computations are done in a statistical package and a common spreadsheet program.

Model building and verification, graphical methods of exploration. Least squares regression, logistic and Poisson regression, introduction to categorical data analysis, principal components and/or classification. Prerequisite: None.

**OA3105 Nonparametric Statistics (4-0) Winter**

Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one-sample tests, two-sample tests, and tests for independence based on ranks and scores; nonparametric analysis of variance and regression. Applications will illustrate the techniques. Prerequisite: A course in statistical inference.

**OA3200 Computational Methods for Operations Research II (4-1) As Required**

An advanced course in software design and computational methods in Java particularly appropriate for military Operations Research. Introduction to and projects for: Monte Carlo simulation, time-step simulation, relational databases, network optimization, and geographic information systems. Prerequisite: None.

**OA3201 Linear Programming (4-0) Spring**

(Same as MA3301) Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. Prerequisite: None.

**OA3250 Introduction to Extensible Markup Language (XML) Spring**

XML and related technologies provide platform-independent representation, description, and validation of data. This is necessary for the data communication among different networks, computers, and applications that is essential for contemporary military and civilian applications. The course will present the benefits of XML and how to use software tools to construct and process XML documents using XML editors, XML parsers, XML Schema for validation, XSLT to transform documents, and DOM, SAX, and JDOM to access and manipulate XML documents within a computer program. Much of the programming code in contemporary computer applications that is used to construct data files, access databases and spreadsheets, check and validate data values, and output data can be replaced by these more general software tools. XML is based on open source standards that have been embraced by DoD. The course will look at existing, emerging, and potential military applications including: incorporating XML into a revised U.S. Message Text Format (USMTF) for military messages; representing command and control information in an XML implementation of Generic Hub; using XML in operations orders to auto generate planning products (e.g., map-based planning products, 3-D graphics, optimization data); and creating scenarios for simulations and war games (e.g., input to COMBAT XXI). Prerequisite: None.

**OA3301 Stochastic Models I (4-0) Fall/Spring**

Course objectives are to provide an introduction to stochastic modeling. Topics include the homogeneous Poisson process and its generalizations and discrete and continuous time Markov chains and their applications in modeling random

phenomena in civilian and military problems. Prerequisite: OA3101 or consent of the instructor.

**OA3302 Simulation Modeling (4-0) Winter/Summer**

Discrete event digital simulation methodology. Monte Carlo techniques and use of simulation languages. Variance reduction techniques, design of simulation experiments, and analysis of results. Prerequisite: None.

**OA3304 Decision Theory (4-0) Winter/Summer**

This course provides an introduction to modern theory and methods for decision making in both single and multiple person decision-making situations. Bayesian methods are emphasized in the single-person case, including decision trees, Bayesian networks, influence diagrams, and multicriterion decision making. Multiperson situations covered include two-person zero-sum games, voting, Nash bargaining, and the Shapley value. Applications are mainly to military problems. Prerequisite: None.

**OA3401 Human Factors in Systems Design (3-1) Fall/Spring**

This course will provide an introduction to the field of human factors with an emphasis on military systems. Humans are the most important element of any military system. Consequently, the design of effective systems must take into account human strengths and limitations as well as considerations of human variability. The course surveys human factors and human-centered design and system effectiveness and safety. Topics include human cognition and performance as they are influenced by physiological, anthropometric, and environmental considerations. Prerequisite: None.

**OA3402 Research Methods for Performance Assessment (3-1) Winter/Summer**

Well-constructed research is invaluable; informing and enabling decision makers to make better choices. This course covers the research process from beginning to end and explores the types of research conducted in a variety of laboratory and field settings. Topics include institutional approval and ethical use of human subjects; research reliability and validity; formulation of the research question; research designs ranging from experimentation to systematic observational techniques and subjective surveys; database management considerations; analytical approaches; and writing and presenting the research paper. Prerequisite: None.

**OA3501 Inventory I (4-0) As Required**

A study of deterministic and approximate stochastic inventory models. Deterministic economic lot size models with infinite production rate, constraints, quantity discounts. An approximate lot size-reorder point model with stochastic demand. An approximate stochastic periodic review model. Single period stochastic models. Applications to Navy supply systems. Prerequisite: OA3101 or consent of the instructor.

**OA3601 Combat Models and Games (4-0) Fall/Spring**

This course provides a discussion of measures of effectiveness and a quantitative introduction to dynamic programming, target coverage models, Kalman filters, Lanchester Systems, and two-person zero-sum games. Prerequisite: None.

**OA3602 Search Theory and Detection (4-0) Winter/Summer**

Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths

and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking, and trailing. Prerequisite: OS2103 or OA3101.

**OA3610 Introduction to Naval Logistics (4-0) As Required**

Presentation of the fundamental purposes, history, and components of the naval logistics system. Logistics is introduced as a command function necessary for sustaining combat operations. This concept is developed by looking at logistics resources and processes, unit and battle group logistics, in-theater support, strategic lift, and CONUS/system support. Prerequisite: None. Classification: SECRET.

**OA3900 Workshop in Operations Research/Systems Analysis (V-0) As Required**

(Variable hours 2-0 to 5-0.) This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Departmental approval.

**OA3910 Selected Topics in Operations Research/Systems Analysis (V-0) As Required**

(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisite: A background of advanced work in operations research and consent of the instructor.

**OA4101 Design of Experiments (3-1) Fall/Spring**

(Same as MA4302.) Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments; traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. Prerequisite: OA3103 or equivalent.

**OA4102 Regressions Analysis (4-0) Winter**

(Same as MA4303.) Construction, analysis, and testing of regression models. An in-depth study of regression and its application in operations research, economics, and the social sciences. Prerequisites: OA3102 and OA3103.

**OA4103 Advanced Probability (3-0) As Required**

Probability spaces, random variables as measurable functions, expectation using the Lebesgue-Stieltjes integral, and abstract integration. Modes of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. Prerequisite: MA3605 or departmental approval.

**OA4104 Advanced Statistics (3-0) As Required**

Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher and Kullback information, asymptotic methods, sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. Prerequisites: OA3103 and consent of the instructor.

**OA4105 Nonparametric Statistics (4-0) Fall/Summer**

Inference based on the binomial distribution, including hypothesis tests, confidence intervals for percentiles, and tolerance intervals. Kaplan-Meier estimation with censored failure data. Analysis of contingency tables, including tests for

goodness-of-fit and independence. Permutation tests and tests based on ranks and scores in a variety of applications. Goodness-of-fit testing for continuous distributions and families. Application of techniques to data using computing software will be emphasized. Prerequisite: OA3103 and of consent of the instructor.

**OA4106 Advanced Data Analysis (3-1) As Required**

The course features the blending of sophisticated statistical software and data from recent DoD applications. The manipulation of multivariate data and statistical graphics are emphasized. Methodologies presented can include survival analysis, classification and discrimination, categorical data analysis, and sample survey methods. Prerequisite: OA3103.

**OA4107 Categorical Data Analysis (3-1) As Required**

Contingency tables in two, three, and higher dimensions. Exact procedures for small tables. The course will feature case studies and treat log-linear models, expanded logistic analysis, ordinal variables multinomial response methods. Poisson regression and the problems of sparse data sets. Applications and DoD case studies appear in the laboratory exercises. Prerequisite: OA3103.

**OA4108 Data Mining (2-2) Spring**

The art and science of finding real patterns in (usually very large) data sets as seen from a statistical perspective. Introduction to some of the techniques used in data mining and discussion of their implementation, their strengths and weaknesses, and some common and specific pitfalls. Algorithms for classification and regression include trees and neural networks as well as the a priori algorithm for rule generation. Techniques for clustering and visualization include hierarchical and k-means clustering and XGobi and lattice-type graphics. The Clementine and S-Plus software packages are used. Real datasets used in the past have included fraud detection data from the Defense Finance and Accounting Service. Prerequisite: None.

**OA4109 Survey Research Methods (4-2) Winter/Summer**

The course will cover the basic principles of survey research methods. It will provide students with a practical grounding in all aspects of survey methodology, from survey instrument design, to sample design, to modes of data collection, to methods for survey data analysis. Students will be able to immediately apply course work to their theses and other real-world applications, including a class capstone project in which students will design, field, and analyze a survey on behalf of a DoD organization. Prerequisite: OA3103 and OS3101 or equivalent, or consent of the instructor.

**OA4201 Nonlinear Programming (4-0) Winter/Summer**

(Same as MA4301.) Convex sets, convex functions, and conditions for local and global optimality. Elements and convergence of algorithms for solving constrained and unconstrained optimization problems. Introduction to algebraic modeling languages. Many applications of integer and nonlinear programming to military and civilian problems, such as weapons assignments, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment, and resource allocation. Prerequisite: OA3201.

**OA4202 Network Flows and Graphs (4-0) Fall/Spring**

Introduction to formulation and solution of problems involving networks, such as maximum flow, shortest route,

minimum cost flows, and PERT/CPM. Elements of graph theory, data structure, algorithms, and computational complexity. Applications to production and inventory, routing, scheduling, network interdiction, and personnel management. Prerequisite: OA3201.

**OA4203 Mathematical Programming (4-0) Spring**

Advanced topics in linear programming, large-scale systems, the decomposition principle, additional algorithms, bounded variable techniques, linear fractional programming, formulation and solution procedures for problems in integer variables. Applications to capital budgeting, large-scale distribution systems, weapon systems allocation, and others. Prerequisite: OA3201.

**OA4204 Games of Strategy (4-0) Summer**

Mathematical models of conflict situations, emphasizing the theory of decision making against a completely opposed enemy. Topics include matrix games, Blotto games, stochastic games, and the Shapley value. Applications to combat, resource allocation, cost sharing, etc. Prerequisite: None.

**OA4205 Advanced Nonlinear Programming (4-0) As Required**

Continuation of OA4201. Advanced topics in nonlinear programming, including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in nonlinear programming. Prerequisite: OA4201.

**OA4301 Stochastic Models II (4-0) Winter/Summer**

Course objectives are to discuss methods of stochastic modeling beyond those presented in OA3301 and give students the opportunity to apply the methods. Topics include conditioning; renewal processes; renewal reward processes; length-biased sampling, semi-Markov models, and novel queuing, reliability and maintenance models. The topics are illustrated by DoD applications. Prerequisite: None.

**OA4302 Reliability and Weapons System Effectiveness Measurement (4-0) Winter/Summer**

Component and system reliability functions and other reliability descriptors of system effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. Prerequisite: OA3301.

**OA4303 Sample Inspection and Quality Assurance (4-0) Winter/Summer**

Attribute and variables sampling plans. Military Standard sampling plans with modifications. Multilevel continuous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. Prerequisite: OA3101 or consent of the instructor.

**OA4305 Stochastic Models III (4-0) As Required**

Lecture topics include nonstationary behavior of Markov processes, point process models, regenerative processes, Markovian queuing network models, and non-Markovian systems. Applications include reliability, computer system modeling, combat modeling, and manpower systems. Students are given exercises entailing data analysis, formulation of probability models, and application of models to answer specific questions concerning particular phenomena. Prerequisite: None.

**OA4308 Time Series Analysis (4-0) As Required**

(Same as MA4304.) Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. Prerequisites: OA3103 and OA3301.

**OA4321 Decision Support Systems (3-1) Winter**

An introduction to the topic; includes an overview of organizational decision making, discussion of Operations Research techniques integral to Decision Support Systems, relationships to artificial intelligence and expert systems, specialized computer languages, and nontraditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. Prerequisite: None.

**OA4333 Simulation Analysis (4-0) As Required**

Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on the interests of the students and instructor. Prerequisite: OA3302.

**OA4401 Individual Performance: Sensation, Perception, and Cognition (3-1) Winter/Summer**

This course provides the methods, theories, and applications of psychophysics and the physiological bases for sensory processes. The theoretical and empirical foundations for perception will be addressed, along with perceptual learning and adaptation. Cognition, decision making, and motor output will also be covered. An overview will be given of the relationship between sensory/perceptual processes and display technology including augmented displays, human-in-the-loop simulators, virtual environments, and more traditional system displays. Military applications will be a consistent referent. Prerequisite: None.

**OA4402 Skilled Operator Performance and Training Systems (3-2) Winter/Summer**

The theoretical foundations of skilled performance will be covered, including the principles of skill acquisition, the specificity or transferability of skills, individual differences, and the prediction of skilled operator performance. The second half of the course will be devoted to advances in training systems and instructional design for promoting the efficient acquisition of military-related skills, knowledge, and abilities. Cross-listed as MV4002. Prerequisite: None.

**OA4406 Survivability, Habitability, Environmental Safety, and Occupational Health (4-0) Fall/Spring**

This course will provide an overview of personnel survivability methodology in safety, health hazards, and occupational health concepts. The evaluation of new and modified military systems and equipment for safety and potential health hazards will be addressed through reviewing models, methods, and processes available to help identify and mitigate the potential harm from accidents and hostile environments. Occupational health concerns will be addressed and methods of alleviating or minimizing workplace hazards will be analyzed. Risk analysis and mitigation models also will be examined for their contribution to increased safety and operational effectiveness. Prerequisite: None.

**OA4407 Human Anthropometry and Biomechanics (3-1) Spring**

This course will cover current techniques for combining anthropometric and biomechanical data to model the relationships among people, tasks, equipment, and the workplace. The historical development of anthropometric databases and human engineering models will be reviewed and current techniques and multivariate models will be introduced. Both military and commercial guidelines for ergonomic design will be covered and emphasis will be given to software tools for 3-D modeling, visualization, and workstation design. Prerequisite: None.

**OA4408 Team Performance and Decision Making (3-1) Winter/Summer**

This course addresses current topics and advances in the understanding of team performance, decision-making, socio-technical issues, and team performance measurement. Key issues will be covered such as verbal and nonverbal communications, shared mental models, dynamic task allocation, team training, action coordination, teamwork breakdowns, and team organizational structure. Prerequisite: None.

**OA4501 Seminar in Supply Systems (3-0) Summer**

A survey of the supply system for the U.S. Navy. Topics include inventory models at all levels for consumables and repairables, budget formulation and execution, provisioning and allowance lists, planned program requirements, transaction item reporting, and current topics of research such as stock migration and material distribution studies. Prerequisite: OA3501.

**OA4600 Information in Warfare (4-0) As Required**

Quantitative approaches to measuring and assessing the value of information in warfare, with emphasis on tradeoffs between information and firepower. Major components are on information as precision (Bayesian filtering, data association, and fusion), and information as a guide to decision making (decision theory, Markov policies, optimization). Prerequisite: None.

**OA4601 Models for Decision Making (4-0) As Required**

The objective is to be able to formulate and analyze operational and executive decision problems, where a lack of clear problem definition and data, sequential timing of decisions, uncertainty, and conflicting objectives, are all normal features of such problems. Understanding and applying influence diagrams and decision trees form the core part of the course. Emphasis is on building models and determining data requirements. Specific areas include the use of policy space analysis in sensitivity. Prerequisite: None.

**OA4602 Joint Campaign Analysis (4-0) Winter/Summer**

This course studies the development, use, and recent applications of campaign analysis in actual procurement, force structure, and operations planning. Emphasis is on formulating the problem, choosing assumptions, structuring the analysis, and measuring effectiveness. Interpreting and communicating results in speech and writing is an important part of the course. In the last three weeks, students conduct a broad gauge, quick reaction campaign analysis as team members. Prerequisites: A course in basic probability and statistics theory, and operational experience in military environments.

**OA4603 Test Evaluation (4-0) Winter/Summer**

This course is designed to cover Developmental and Operational Test and Evaluation and Military Experimentation, including statistical concepts and methods frequently used in weapon system testing and experimentation environments. The course is taught from the perspective of the Program Manager, Test Project Officer, Test Engineer, Test Analyst, and Statistician. A number of actual military cases are used for examples. Topics include the Role of Test and Evaluation in Systems Engineering and Acquisition Management, Test Planning and Design, Development of Measures of Effectiveness and Measures of Performance, Conduct of Tests, Data Analysis, and Reporting of Test Results. A detailed group test planning project and design exercise are included. Upon successful completion of this course, students receive DAWIA Level II and Level III Intermediate and Advanced Test and Evaluation certification. Prerequisite: A previous course in probability and statistics, or consent of the instructor.

**OA4604 Wargaming Applications (4-0) Winter/Summer**

War-game techniques, design, and construction for application in manual, computer and interactive gaming. Emphasis is on wargaming as a means to assess aspects of current and future operations in joint warfare. Introduction and use of current joint simulation tools are integral to course goals. Prerequisite: None.

**OA4605 Operations Research Problems in Naval Warfare (3-0) Winter**

Analysis of fleet exercises. Changes in tactics and force disposition arising from the introduction of nuclear weapons and missiles. Relationship of air defense to strike capability and USW. Current radar, sonar, communications, and ECM problems. Prerequisite: None.

**OA4607 Tactical Decision Making (4-0) Spring**

This course deals with computer-aided decision making. Topics include the human-computer interface, the construction of effective graphics, verification/validation, and theoretical frameworks for competitive and noncompetitive decision making. Kalman filters are introduced as an important fusion and tracking tool. The primary classroom application areas are information fusion, search/track, and mine warfare. A project is required. Prerequisites: OS2103 and OS3604 or OA3101 and OA3102 and OA3103, and a working knowledge of a programming language such as MATLAB, C++, Java, or Visual Basic.

**OA4608 Foreign Military Operations Research (4-0) Spring**

This course considers military operations research of foreign countries that are of current concern to DoD. Because many of these have been military clients of the former Soviet Union, the course will take Soviet military operations research as a point of departure for study. Asymmetries between Soviet and American military operations research are emphasized. Exploitation of such information is discussed. Prerequisites: Consent of the instructor.

**OA4610 Mobilization (4-0) As Required**

Introduction to the military and civilian systems for mobilization, linear programming, and simulation formulations of strategic mobility and munitions scheduling. Planning and controls of the logistics systems, including

planning factors and joint operations planning. Integration of mobilization with Navy operational logistics. Prerequisite: None.

**OA4611 Joint and Combined Logistics (4-0) As Required**

Presentation of the role of logistics and logisticians in war planning and strategy development, with emphasis on jointness. Introduction to JCS, unified, and Navy command and staff structures, and participation in deliberate and crisis action-planning process. Emphasis on the transition to war, mobilization, strategic lift, and the weapon system acquisition process as related to logistics planning. Prerequisite: None.

**OA4612 Logistics Models (4-0) As Required**

Mathematical modeling of most of the processes in unit/battle group or battle force logistics. Computation of fuel consumption, underway replenishment scheduling, shuttle ship requirements, measures of effectiveness, formations and their supportability, sustainability, engagement models, and ordnance prediction, and implementation of such models in microprocessor-based logistics decision aids. Also ordnance programming models. Only for U.S. students enrolled in curricula 360 or 361. Prerequisite: Consent of the instructor.

**OA4655 Introduction to Joint Combat Modeling (4-0) Winter/Summer**

(Same as MV4655.) This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, and introduction to aggregated force modeling. Prerequisite: None.

**OA4656 Advanced Combat Modeling (4-1) As Required**

The objective of this course is to educate and train model-builders (as opposed to model-users). The phenomena and situations that are modeled in this course range from fundamental shooting processes to force-on-force engagements, and from minefields to air-defense systems. Special attention is given to contemporary issues such as the effect of information in the presence of precision-guided weapons and UAVs, and the war against terror. The focus of the course is on analytic models that are based on probability and optimization techniques. Prerequisites: OA4655 and OA3301 (or OS3311).

**OA4658 Survey of Joint Combat Models (1-0) Winter/Summer/Fall/Spring**

The purpose of the course is to introduce the student to a wide variety of models that are being used throughout DoD. A broad cross section of models are envisioned to be taught—characteristics of the models will include both large and small models; analytical models as well as those for experimentation and/or training; theater-level as well as strategic- and tactical-level models; ground as well as air models. Prerequisite: None.

**OA4701 Econometrics (4-0) Winter**

Construction and testing of econometric models, analysis of economic time series, and the use of multivariate statistical analysis in the study of economic behavior. Prerequisite: OA3103.

**OA4702 Cost Estimation (4-0) Winter/Summer**

This course provides a broad-based understanding of the cost analysis activities involved in the acquisition and support of DoD weapon systems. In addition, it introduces operations research techniques fundamental to the field of cost estimation. The course covers the defense systems acquisition process, time value of money, and economic analysis; it develops, uses, and analyzes estimating techniques commonly encountered in both the DoD and industry, including statistical and nonstatistical cost estimating relationships, inflation indices, cost improvement curves, time phasing, and uncertainty analysis. Prerequisite: None.

**OA4703 Defense Expenditure and Policy Analysis (4-0) As Required**

A presentation of the major components of defense budgeting and policy formulation, from the standpoint of the three major institutions involved—the agency, executive, and congress. The use of quantitative models of institutional behavior is emphasized when examining both individual institutions and the interaction between them. Prerequisite: OA3103.

**OA4704 Operations Research Techniques in Manpower Modeling (4-0) Fall/Spring**

The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements, and validation. Application in the form of current military models are included. Prerequisite: OA3103 or consent of the instructor.

**OA4801 Spreadsheet Modeling for Military Operations Research (3-2) As Required**

Implementation of a wide variety of military operations research topics on software accessible in any typical Department of Defense (Fleet) environment. This course highlights military spreadsheet applications of operations research methods (e.g., discrete event simulation, optimization, queuing, Markov chains), discusses limitations, and demonstrates methods to supplement and customize spreadsheet analytical functions. Prerequisite: None.

**OA4910 Selected Topics in Operations Analysis (V-0) As Required**

(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisites: A background of advanced work in operations research and departmental approval.

**OA4930 Readings in Operations Analysis (V-0) As Required**

(Variable hours 2-0 to 5-0.) This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Departmental approval.

*OS Courses*

**OS2080 Fundamentals for Naval Analysis (4-2) Fall/Spring**

Fundamentals of probability and statistics useful in military modeling. Modeling aspects of distributions, random number generation using inverse cumulative distribution functions, confidence intervals, first order differential equations for modeling combat, and general modeling skills. Introduction to

Bayes' Theorem and the following distributions: exponential, lognormal, binomial, normal, geometric, and Poisson. Particular attention is paid to the binomial distribution and to conditional probability. Simple linear regression is introduced. Prerequisite: Single variable calculus.

**OS2100 Probability and Statistics (3-1) As Required**

An introduction. Topics include probability laws and calculation methods, conditional probability, discrete and continuous random variables, common probability distributions, introduction to modeling, expectation, variance, covariance, and rudiments of discrete time processes. Confidence intervals, hypothesis testing, and regression. Emphasis is on understanding uncertainty and developing computational skills. Prerequisite: Single variable calculus.

**OS2101 Analysis of Experimental Data (4-0) As Required**

Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representation. Populations and sampling. Principle of least squares, estimation of mean and standard deviation. Curve fitting and regression, propagation of errors. Confidence intervals, tests and contingency tables. Elementary ANOVA. Relevant probabilistic concepts introduced as needed. Prerequisite: None.

**OS2103 Applied Probability for Systems Technology (4-1) Fall/Winter/Summer**

A first course in probability for students in operational curricula. Topics include probability laws and calculation methods, discrete and continuous random variables, common probability distributions, introduction to modeling, expectation, variance, covariance, and rudiments of discrete time processes. Emphasis is on understanding uncertainty and developing computational skills in probability. Prerequisites: Single variable differentiation and integration at the MA1113 level and multiple integration at the MA1115 level.

**OS3000 Introduction to Management Science (3-0) As Required**

A survey of techniques for making decisions quantitatively. Utility theory, linear programming, decision trees, networks and graphs, games, simulation, and waiting lines. Prerequisite: None.

**OS3002 Operations Research for Naval Intelligence (4-0) Fall**

This course provides an introduction to the approach and methods of operations research, with special emphasis on military applications of interest to intelligence. It focuses on the mathematical modeling of combat operations and considers intelligence aspects. Students develop basic skills in such modeling. Topics include: operational definitions, measurement of combat effectiveness, model validation/verification, and models versus modeling. Also included are modeling of processes of target acquisition, fire assessment (kill probabilities and target coverage), tactical decision making, and games. Prerequisites: None.

**OS3003 Operations Research for Information Warfare (4-0) Summer**

This course deals with applications of quantitative models to operational electronic warfare problems, with the underlying idea being to make decisions by optimizing some measure of effectiveness. Topics covered include ESM, ECM/ECCM,

strike warfare, ASMD, and cost-effectiveness tradeoffs. Prerequisite: None.

**OS3004 Operations Research for Computer Systems Managers (4-1) Fall/Spring**

A one-quarter survey of operations research techniques of particular interest to students in computer systems management. Topics covered include: optimization, network flow models, simulation, queuing, forecasting techniques, Markov chains, decision analysis, reliability, and project management techniques. Spreadsheet models and analysis tools are an integral part of the course. Prerequisite: None.

**OS3006 Operations Research for Management (4-1) Fall/Winter/Spring/Summer**

A survey of problem-solving techniques for operations research. Topics include decision theory, linear programming, models, project scheduling, inventory, queuing, and simulation. Prerequisite: None.

**OS3008 Analytical Planning Methodology (4-0) Spring**

A one-quarter survey of operations research techniques of particular interest to students in the C4I curriculum, with emphasis on model formation. Topics include linear and nonlinear programming, integer programming, networks, shop flow and project scheduling, decision analysis, queuing, and simulation. Prerequisite: MA2300.

**OS3030 Surveys in Analysis for the Warfare Commander (3-0) As Required**

TBD

**OS3031 Analytical Tools for the Warfare Commander (3-0) As Required**

TBD

**OS3032 Applying Analysis to Warfare (3-0) As Required**

TBD

**OS3080 Fundamentals for Naval Analysis II (3-0) Summer/Winter**

Additional topics in probability and statistics for systems analysis, including conditional probability and conditional expectation, basic analytical process models, graphical data analysis, simple and multiple regression, and basic time-series analysis. This course is a follow-on to OS2080 for Master of Systems Analysis students. Prerequisite: OS2080.

**OS3081 Systems Analysis Cases I (3-0) Summer/Winter**

This is the first course in a three-course sequence in systems analysis practice. This course focuses on learning from real defense systems analysis case histories through readings, discussion, and writing point papers. Emphasis is on understanding the pitfalls of analysis, highlighting critical assumptions, and recognition of the strengths and weaknesses of applied analytical methodologies. Case histories include actual defense studies conducted with large-scale warfare simulations, seminar wargaming, and other methodologies common in DoD studies and analysis. Prerequisites: Graduate standing in Systems Analysis, Operations Research, or Systems Engineering; completion of courses in probability, statistics, simulation, uncertainty modeling, cost-benefit, decision analysis, and optimization.

**OS3082 Systems Analysis Cases II (3-0) Spring/Fall**

This is the second course in a three-course sequence in systems analysis practice. This course focuses on learning from

participating in class discussion of decision and analysis problem cases and writing concise systems analysis proposals. Cases are drawn from scenarios in defense planning, programming, and budgeting of weapons systems and forces. Emphasis is on systems analysis problem formulation, identification of objectives, measures of effectiveness, articulation of critical assumptions, and outlining of appropriate analytical methodologies. Special emphasis is placed on cases that are typical of quick turn-around, limited-resources Pentagon programming analysis and budget drills. Prerequisite: OS3081.

**OS3101 Statistical Analysis for Management (4-1)  
Winter/Summer**

A specialized course covering the basic methods of probability and statistics with emphasis on managerial applications. The course includes applications of probability models, statistical inference, and regression analysis. Computation for these applications are carried out on a computer, using commercial software packages. Topics in probability include the binomial, geometric, Poisson, and normal distributions, risk, and expected value. Parametric statistical techniques include significance testing and confidence intervals, together with point estimation of model parameters. Regression analysis includes simple linear regression and multiple regression, with estimation of parameters and tests of hypothesis and confidence intervals for regression coefficients and the variance of the error term. Prerequisite: College algebra.

**OS3104 Statistics for Science and Engineering (4-0)  
Fall/Winter/Spring/Summer**

Acquaint the engineering student with the techniques of statistical data analysis with examples from quality control, life testing, reliability, and sampling inspection. Histograms and empirical distributions and random variables are introduced, along with their probability distributions and associated characteristics such as moments and percentiles. Following a brief introduction to decision making, standard tests of hypotheses and confidence intervals for both one- and two-parameter situations are treated. Regression analysis is related to least squares estimation and associated tests of hypotheses and confidence intervals are treated. Prerequisite: Calculus.

**OS3105 Statistics for Technical Management (4-1)  
Fall/Spring**

The course emphasizes management applications of probability models, statistical inference, and regression analysis. Those aspects of probability germane to distributions such as the binomial and normal are covered. Statistical inference for one and two variables is introduced in the settings of both hypothesis testing and confidence interval estimation. Students develop problem solving and numerical computation skills during laboratory periods using commercial software packages. Prerequisite: None.

**OS3111 Probability and Statistics for HSI and MOVES  
(4-0) Fall/Spring**

Noncalculus-based introduction in the context. Descriptive statistics and graphical techniques. Probability rules including Bayes Rule and independence. Discrete and continuous probability distributions, expected values, quantiles, variance, covariance, correlation, expected values, and variance of linear combinations of random variables, notably the sample mean. Fundamentals of statistics in one-sample setting including the ideas of estimation, confidence intervals, and hypothesis

testing. Use and comparison of parametric and nonparametric approaches. Prerequisite: None.

**OS3112 Statistics and Design of Experiments (4-2)  
Winter/Summer**

This course reviews the basic concepts of data collection, data description, and graphical displays. It covers fundamentals of experimental design and analysis of categorical data. Students will learn how to set and analyze experiments using basic experimental design starting with two-sample methods and advancing to designs such as factorials, fractional factorials, and randomized block designs. Designs appropriate for human research (such as repeated measure designs) and/or large-scale simulation experiments (such as Latin hypercube designs) are included. Parametric and nonparametric approaches are compared and contrasted. Methods for analyzing categorical data are introduced: one- and two-sample inference for proportions, and contingency tables. Datasets and motivational examples are drawn from recent research relevant to HSI and/or MOVES. Prerequisites: College algebra and OS3111.

**OS3113 Data Analysis for HSI and MOVES (4-1) Winter**

Regression techniques using hands-on experience. Emphasis throughout is on real problems and real data. Topics covered include Simple Linear Regression, Multiple Regression, and Logistic and Loglinear Regression. Special topics include regression trees, principle components, and factor analysis. Prerequisite: None.

**OS3180 Probability and Statistics for Systems  
Engineering (4-1) Winter/Summer**

This course introduces the systems engineering and analysis student to probability, descriptive statistics, inferential statistics, and regression. The modeling and analysis of the stochastic behavior of systems provides the context for the course. Topical coverage includes the normal, binomial, Poisson, exponential, and lognormal distributions; probabilistic measures of system performance; graphical and numerical data summaries; confidence intervals and hypothesis tests based on one or two samples; regression with one or more predictors; and single factor analysis of variance. The lab portion of the class uses spreadsheets to support the modeling and analyses. The course is delivered in block format. Prerequisite: SE1001 or equivalent.

**OS3211 Systems Optimization (4-0) Fall**

This course is an application-oriented introduction to optimization. It introduces models (linear, integer, and nonlinear programs), modeling tools (sensitivity and post-optimality analysis), and optimization software and solution techniques (including heuristics). It presents many military and private sector optimization applications in production planning and scheduling, inventory planning, personnel scheduling, project scheduling, distribution systems planning, facility sizing and capacity expansion, communication systems design, and product development. Prerequisite: None.

**OS3301 Simulation Modeling and Analysis (3-0) As  
Required**

OS3301 is a simulation and analytical course that provides students with a foundation in simulation theory and process modeling, random number generation concepts, basic queuing theory in process modeling, applied data analysis, an introduction into experimental design, hypothesis testing, and



hands-on system simulation. Students will use these concepts in class projects to simulate systems, evaluate system performance, and compare alternative systems. Prerequisites: OS2080.

**OS3302 Quality Assurance and Reliability (4-0)  
Winter/Summer**

This course is a technical treatment of a contractor's quality assurance program with attention to Sampling Inspection, Statistical Process Control, and Reliability. Topics include attribute and variables sampling plans, MILSTD/ANSI/ASQC and sequential sampling plans, quality control chart development and utilization, and manufacturing process capability estimation. Process management analytical tools are introduced using Minitab Quality Control software applications. Structure and implementation of quality assurance programs and quality improvement measures are discussed. Fundamentals of reliability modeling, life testing, reliability growth, estimation, and assessment are presented. Time and failure censored life-testing methods for Exponential and Weibull reliability models and Bayesian reliability estimation techniques are introduced. Best Management Practices and Program Managers Workstation are reviewed. Prerequisite: A previous course in probability and statistics.

**OS3303 Computer Simulation (4-1) Fall/Spring**

Design, implementation and use of digital simulation models will be covered with special emphasis on features common to USW problems. Wargaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. Prerequisites: OS2103 and OS3604, or equivalent.

**OS3307 Modeling Practices for Computing (4-1)  
Winter/Summer**

An applied course in modeling and understanding systems where randomness plays a significant role. Topics include basic probability and statistics, queuing models, Monte Carlo and discrete-event simulation, least squares curve fitting, and elements of statistical design of experiments. The focus will be on applications of these techniques in a computer science context. Prerequisites: Discrete Math and Introductory Programming.

**OS3311 Probability Models for Military Applications (4-0) Fall/Spring**

An intermediate course in probability modeling focused on military systems and combat situations. Following a review of random variables, probability distributions, expected values and variance, we will present a selection of probability models that range from elementary models that describe static and simple dynamic military (mostly combat) related situations, to Markov models that represent more complex combat situations (e.g., tactical battle) and processes (e.g., surveillance and employment of UAVs). Prerequisite: None.

**OS3380 Combat Systems Simulation (3-1) Fall/Spring**

This course provides an introduction to discrete and continuous time modeling of systems, especially combat

systems. Students learn the fundamentals of simulation modeling and analysis, and construct increasingly sophisticated models of combat behavior. Students are introduced to Lanchester equations and other abstract models, as well as JANUS and other high-resolution, commercial combat simulation programs. Students reinforce and extend statistical skills by learning the principles for design and analysis of simulation experiments for estimation and comparison. The primary course objective is for the student to understand the enduring fundamentals of how combat models are built and used to support decision making. Prerequisites: SE1002 and OS3180.

**OS3401 Human Factors in Information Warfare (3-1)  
Summer/Winter**

This course will provide the student with the ability to evaluate and predict human performance in specified operational environments. The effects of stress factors such as noise, temperature, motion, work load, etc., on various aspects of human performance will be studied. Students will identify the control and display requirements or an EW system and design a workspace to accommodate an EW data reduction/analysis system. Prerequisite: OS3604.

**OS3404 Human-Machine Interaction (3-2)  
Fall/Winter/Spring**

An introduction to the man-machine interface problems in C3. Information, display, and human communication requirements for effective C3. Applied orientation involving message handling systems, query languages, computer-to-computer communications, command and control applications programs, file transfer between host computers, etc. Prerequisite: Enrollment in the Joint C4I curriculum.

**OS3601 Search, Detection, and Localization Models (4-0) Winter/Summer**

An introduction to the decision problems associated with Navy detection systems. The relation of detection models to search and localization models, measures of effectiveness of search/detection systems, and the optimum allocation of search effort are discussed. This course is designed for the USW curriculum. Prerequisite: None.

**OS3603 Simulation and Wargaming (3-1) Fall/Summer**

This course introduces students to systemic and interactive war-game simulation models. The students will understand and play two interactive war games and will run an existing systemic combat model to conduct output and sensitivity analyses on the results. Basic topics include measures of effectiveness, Monte Carlo processes for generating simulation events, decision and utility models, high resolution versus aggregated combat models, scenario development, and analysis objectives. Prerequisites: Basic Probability, Statistics, and Data Analysis at the level of OS2103 and OS3604 or equivalent, and a working knowledge of a computer programming language.

**OS3604 Decision and Data Analysis (4-0)  
Fall/Winter/Spring**

An introduction to statistics and data analysis for students in the operational curricula. Topics include point and interval estimation, hypotheses testing, analysis of variance, single and multiple regression, and categorical data analysis. Emphasis is placed on decision rules and in the analysis of data from operational environments. Prerequisite: OS2103 or equivalent.

**OS3680 Naval Tactical Analysis (3-0) Fall/Spring**

This course surveys and applies various tools of operational and decision analysis to naval tactical problems. Tools include game theory, cost-effectiveness, utility theory, simulation, and probability. Problems include search and patrol, mine warfare, target coverage, and reliability. Prerequisite: Probability and Statistics at the level of OS3180 or OS3104, or equivalent.

**OS3702 Manpower Requirements Determination (4-0) Winter**

The objective is to enable the student to use some of the tools of industrial engineering in the determination of the quantity and quality of manpower required in military systems. Techniques include motion and time study, work sampling, predetermined time standards, work design and layout, materials handling, procedures review, and process design. Applications for ship and squadron manning documents and SHORESTAMPS are included. Prerequisite: None.

**OS4001 Introduction to Probabilistic Modeling for HSI (4-0) Fall/Spring**

This course will introduce the student to desktop modeling of humans, particularly emphasizing models that are relevant to military systems. The course will demonstrate current software tools designed around models of human stature, movement, and behavior. We will focus on the utilization of existing modeling techniques, which are useful for system design or evaluation, e.g., JACK, MicroSAINT, and SAFTE/FAST. Prerequisite: None.

**OS4010 Engineering Risk Benefit Analysis (3-2) As Required**

(Same course as AA4202.) This course emphasizes three methodologies: Decision Analysis (DA), Reliability and Probabilistic Risk Assessment (RPRA), and Cost-Benefit Analysis (CBA). The course is designed to give students an understanding of how these diverse topics can be applied to the decision-making process of product design, which must take into consideration significant risk. The course will present and interpret a framework for balancing risks and benefits to applicable situations. Typically, these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts from CBA and RPRA are applied to real-world problems, resulting in decision models that provide insight and understanding, and consequently lead to improved decisions. Prerequisite: None.

**OS4011 Risk Benefit Analysis (3-2) Fall/Spring**

This course emphasizes decision analysis, probabilistic risk assessment, and cost-benefit analysis in systems analysis and systems acquisition contexts. The course is designed to give students an understanding of how these diverse topics can be applied to a decision-making process that must take into consideration significant technological and financial risk. The course will present and interpret a framework for balancing risks and benefits to applicable situations. Typically, these involve large financial and technological uncertainties. Concepts are applied to real-world problems resulting in decision models that provide insight, understanding, and improvement of acquisition decisions. Prerequisite: OS3080 or an equivalent graduate-level course in probability modeling.

**OS4083 Systems Analysis Cases III (3-4)****Summer/Winter**

This is the third course in a three-course sequence in systems analysis practice. This course focuses on hands-on experience conducting rapid quantitative systems analysis. Emphasis is on small-team (2-3 students) systems analysis projects and presentations. Typical projects are based on analysis proposals developed in the preceding course. Class time during the quarter is used for team progress briefings and critical class discussion. The projects culminate with a concise written report, including analytical results, and a presentation to decision makers. Prerequisite: OS3082.

**OS4580 Logistics Systems Analysis (4-0) Fall/Spring**

This course is about military logistics systems. It includes processes employed during system acquisition, chiefly reliability and maintainability analyses, which contribute, along with other aspects of a military logistics system, to determining the operational support costs and operational availability of military systems. In-service support includes the supply system for repair parts for organizational-level maintenance and the provision of military or contractor support of depot-level maintenance. Operational logistics includes logistics planning and predicting the sustainability of deployed forces. Prerequisites: OS3180 and SE4001.

**OS4680 Naval Systems Analysis (4-0) Winter/Summer**

This course covers the techniques for the analysis of proposed and existing systems. It includes analysis of alternatives and models in decision making, optimization in design and operations, queuing theory and analysis, Markov analysis, and selected additional topics to support project work. Students analyze case studies and complete a course project (in conjunction with the complementary architecture course, SI4001). Students also use spreadsheet software for modeling and analyzing design alternatives, and develop communication skills through oral presentations and written reports. Prerequisite: None.

**OS4701 Manpower and Personnel Models (4-0) Fall/Spring**

The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements, and validation. Application in the form of current military models is included. Prerequisites: GB3040 and GB4043, or OA3103, or consent of the instructor.

**Certificate in Systems Analysis - Curriculum 281****Academic Associate**

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## Brief Overview

The Systems Analysis Certificate program is a distributed learning, graduate-level, non-degree program designed to meet the needs of the Navy and other services in the Department of Defense (DoD) for non-degree technical education in systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. Students learn and apply modeling, optimization, simulation, and decision making under risk and uncertainty.

The Certificate Program consists of four, fully-accredited courses delivered entirely online over a one-year period. The course content and projects will challenge the student academically and address problems of interest to the Department of Defense. The courses are paced week-to-week by the instructors, but the students have great flexibility to do their course work at times of their choosing during each week.

## Requirements for Entry

A baccalaureate degree is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. An academic profile code (APC) of 335 is required.

## Entry Dates

At the beginning of the spring and fall quarters, with start dates in late March/early April and late September/early October, respectively.

## Program Length

Four Quarters.

## Graduate Certificate Requirements

Requirements for the graduate certificate in Systems Analysis are met by successful completion of all four courses.

## Required Courses

### Quarter 1

OS2080 (3-0) Fundamentals of Naval Analysis I

### Quarter 2

OS3380 (3-1) Combat Systems Simulation

### Quarter 3

OS3680 (3-0) Naval Tactical Analysis

### Quarter 4

OS4680 (4-0) Naval Systems Analysis

## Operations Analysis - Curriculum 360

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## Brief Overview

Operations Analysis (OA) is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning, and common sense to the improvement of real-world operations. Practitioners are called on to advise military and civilian decision makers on the allocation of scarce resources, the selection of new equipment and processes, and the optimal deployment of given resources to achieve required missions. The OA curriculum was founded by the Navy in 1951, in order to retain, develop, and promulgate the methods that were used so successfully in World War II.

Mathematics, probability, statistics, economics, human factors, and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting, and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria, and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments, and policy-making positions.

## Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above-average grades is considered minimal preparation. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 325 is required. Waivers may be obtained with a one-quarter refresher.

**Entry Date**

Operations Analysis is an eight-quarter course of study (including JPME) with entry dates in March and September. In general, students attend a one-quarter mathematics “refresher” prior to entering the JOL curriculum. This course sequence begins in January or July, for the March or September start dates, respectively. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

**Degree**

Requirements for the Master of Science degree are met en route to satisfying the Educational Skill Requirements of the curricular program as well as Service Intermediate-level PME and Phase I Joint PME credit.

**Master of Science in Applied Science**

Students with acceptable academic backgrounds may enter a program leading to a degree in Applied Science with a major in Operations Research. The program of each student seeking this degree must contain a minimum of 20 quarter-hours in operations research at the graduate level, including work at the 4000 level. Additionally, the program must contain a minimum of 12 graduate quarter-hours in an approved sequence of courses outside the Department of Operations Research. A total minimum of 12 quarter-hours at the 4000 level, plus an acceptable thesis, is required. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The Department Chairman's approval is required for all programs leading to this degree. Applications to include this degree in dual master's programs will not be approved.

**Master of Science in Operations Research**

The Master of Science in Operations Research degree requires:

- Completion of a minimum of 40 quarter-hours of graduate-level courses with:
  - At least 20 quarter-hours of 4000-level courses, of which at least 16 are OA.
  - An elective sequence approved by the Chairman, Department of Operations Research.
- Submission of an acceptable thesis on a subject previously approved by the Chairman, Department of Operations Research.

**Doctor of Philosophy in Operations Research**

The department offers the Doctor of Philosophy in Operations Research degree. The program begins with

advanced course work guided by the student's doctoral committee and leading to qualifying examinations in optimization, statistics, and stochastic processes as well as completion of a minor field of study outside of operations research. The primary emphasis then shifts to the student's research program, culminating in the Ph.D. dissertation.

An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, CA 93943-5100. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases, the student must fulfill the general school requirements for the doctoral degree. Residency for this program generally requires three years beyond completion of a master's degree.

**Subspecialty**

Completion of this curriculum qualifies an officer as an Operations Analysis Subspecialist with a subspecialty code of 3211P and JPME Phase I education certification. The curriculum sponsor is the Office of the Chief of Naval Operations, Assessment Division (OPNAV N81).

**Typical Subspecialty Jobs**

Defense Resources Management OPNAV Analyst  
 JCS Analyst Director, OPS Research: SACLANT  
 Assistant Staff OPS and PLANS: COMCARGRU  
 Staff OPS and PLANS: COMTHIRDFLT  
 BUPERS OSD Analyst  
 OPS Analyst: Naval War College Instructor: NPS  
 Cost Analyst Warfare Analyst

**Typical Course of Study (Naval Warfare Option)****Quarter 1**

MA1115	(4-0)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA2200	(3-1)	Computational Methods for Operations Research
OA3101	(4-1)	Probability

**Quarter 2**

OA3102	(4-2)	Statistics
OA3200	(4-1)	Computational Methods for Operations Research II
OA3304	(4-0)	Decision Theory
NW3230	(4-2)	Strategy and Policy

**Quarter 3**

OA3103	(4-1)	Data Analysis
OA3201	(4-0)	Linear Programming
OA3301	(4-0)	Stochastic Models

OA3401 (3-1) Human Factors in Systems Design I

#### Quarter 4

OA3302 (4-0) Simulation Modeling  
 OA3602 (4-0) Search Theory and Detection  
 OA4201 (4-0) Nonlinear Programming  
 OA4655 (4-0) Introduction to Joint Combat Modeling

#### Quarter 5 (First six weeks)

OA4202 (4-0) Network Flows and Graphs  
 OA4801 (3-2) Spreadsheet Modeling for Military Operations Research  
 (Last six weeks) Thesis Tour/Research

#### Quarter 6

OAXXXX Elective  
 OA4602 (4-0) Joint Campaign Analysis  
 NW3275 (4-0) Joint Maritime Operations - Part 1  
 OA0810 (0-8) Thesis Research

#### Quarter 7

OAXXXX Elective  
 OA4604 (4-0) Wargaming Applications  
 NW3276 (2-2) Joint Maritime Operations - Part 2  
 OA0810 (0-8) Thesis Research for Operations Analysis Students

#### Quarter 8

XX4XXX Elective  
 OA4702 (4-0) Cost Estimation  
 NW3285 (4-0) National Security Decision Making  
 OA0810 (0-8) Thesis Research for Operations Analysis Students

### Educational Skill Requirements (ESR) Operations Analysis - Curriculum 360 Subspecialty Code: 3211P

As revised during September 2004 OA Curriculum Review, approved by Curriculum Sponsor OPNAV (N81) on 12 October 2004, and recorded by Director of Naval Education and Training (N00T) on 3 November 2004.

1. **Basics:** The graduate will possess the mathematical skills required to support graduate study in operations research and have the ability to use stand-alone and network computers as a tool to aid in analysis.
2. **Modeling Uncertainty:** The graduate will be well-versed in applications of probability and statistics to the modeling, simulation, and analysis of military decision problems.
3. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major

uses of such models in DoD and the private sector.

4. **Stochastic Modeling:** The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and also be familiar with the major applications of such models.
5. **Simulation:** The graduate will be able to construct and utilize Monte Carlo simulations of combat and other processes that evolve in time, and will be able to deal with statistical issues associated with the need for replication.
6. **Warfare Analysis:** The graduate will be familiar with U.S./allied and potential enemy capabilities and doctrine, and tactical and logistical support concepts. The graduate will be able to model and analyze military operations using operations analysis techniques, and be able to develop new tactical concepts based on theory and exercise reconstruction and analysis.
7. **Human Factors:** The graduate will be familiar with the man-machine interface and also will be able to quantify the limitations imposed on systems designed for use by human operators.
8. **Systems Analysis:** The graduate will understand the basic principles of economics and systems analysis as well as their application to various defense problems.
9. **Joint Maritime Strategy:** The graduate will have a knowledge of development and execution of military strategy, the effects of technical developments on warfare, an understanding of the means of formulation of U.S. policy, the roles of military forces and joint planning, and current issues in defense organization.
10. **Practice:** The graduate will have gained experience working on all aspects of an analytical study, and will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

#### Curriculum Sponsor and ESR Approval Authority

Director, Assessment Division (N81); September 2004. Approved by N00T via letter Ser N00T/4U799282 of 3 Nov 2004.

#### Joint Operational Logistics - Curriculum 361

##### Program Officer

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### Brief Overview

This program provides education in mathematics, probability and statistics, physical science, economics, logistics, and computer science. These disciplines supply the theoretical background for planning and analysis of naval and joint logistics.

The course of study develops skills in computational capability, identifying relevant information, generating decision criteria, and selecting alternatives. This education enhances performance in all duties throughout a military career, including operational billets, technical management assignments, and policy-making positions.

### Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above-average grades is considered minimal preparation. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 325 is required. Waivers may be obtained with a one-quarter refresher.

### Entry Date

Joint Operational Logistics (JOL) is an eight-quarter course of study (including JPME) with entry dates in March and September. In general, students attend a one-quarter mathematics "refresher" prior to entering the JOL curriculum. This course sequence begins in January or July, for the March or September start dates, respectively. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

### Degree

Requirements for the Master of Science in Operations Research degree are met en route to satisfying the Educational Skill Requirements of the curricular program as well as Service Intermediate-level PME and Phase I Joint PME credit.

### Subspecialty

Completion of this curriculum qualifies an officer as an Operational Logistics Subspecialist with a subspecialty code of 3212P and JPME Phase I education certification. The curriculum sponsor is N-4, Office of the Deputy Chief of Naval Operations (Logistics).

### Typical Subspecialty Jobs

Joint Chiefs of Staff: Joint Logistics Planning,  
 Mobility Analyst  
 OPNAV: Operational Logistics Analyst, Logistics  
 Assessment  
 USACOM: Ordnance Planning Analyst  
 CINCLANT FLT: Logistics Plans Officer  
 CINCPAC FLT: Logistics Plans Officer  
 CINCEUR: Logistics Plans Officer  
 TRANSCOM: Operations and Plans Officer, Sealift  
 Analyst  
 Afloat Staffs: Logistics Planning Officer

### Typical Course of Study

#### Quarter 1

MA1115	(4-0)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA2200	(3-1)	Computational Methods for Operations Research I
OA3101	(4-1)	Probability

#### Quarter 2

OA3102	(4-1)	Statistics
OA3200	(4-1)	Computational Methods for Operations Research II
OA3304	(4-0)	Decision Theory
OA3501	(4-0)	Inventory I

#### Quarter 3

OA3103	(4-1)	Data Analysis
OA3201	(4-1)	Linear Programming
OA3301	(4-0)	Stochastic Models I
OA4501	(3-0)	Seminar in Supply Systems

#### Quarter 4

OA3302	(4-0)	OA System Simulation
OA3610	(4-0)	Introduction to Naval Logistics
OA4201	(4-0)	Nonlinear Programming
OA4655	(4-0)	Introduction to Joint Combat Modeling

#### Quarter 5 (First six weeks)

OA4202	(4-0)	Network Flows and Graphs
OA4611	(4-0)	Joint and Combined Logistics Experience Tour (off campus)

#### Quarter 6

OA4XXX		Elective
OA4XXX		Elective
NW3275	(4-0)	Joint Maritime Operations - Part 1

OA0810 (0-8) Thesis Research

#### Quarter 7

OA4604 (4-0) Wargaming Gaming Analysis

OA4801 (3-2) Spreadsheet Modeling for  
Military Operations Research

NW3276 (2-2) Joint Maritime Operations - Part 2

OA0810 (0-8) Thesis Research

#### Quarter 8

OA4602 (4-0) Joint Campaign Analysis

OA4612 (4-0) Logistics Models

NW3285 (4-0) National Security Decision Making

OA0810 (0-8) Thesis Research

### Educational Skill Requirements (ESR) Operational Logistics - Curriculum 361 Subspecialty Code 3212P

1. **Basics:** The graduate will possess the mathematical and computing skills to support quantitative analysis.
2. **Modeling Uncertainty:** The graduate will be well-versed in probability and statistics and their application to operations research (OR) problems.
3. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.
4. **Stochastic Modeling:** The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and be familiar with the major applications of such models.
5. **Joint Logistics:** The graduate will understand naval and joint logistics systems; joint planning systems; military and commercial transportation systems of all types; supply systems; maintenance, engineering, and health services; and the use of analysis in all aspects of planning for the logistics support of joint forces.
6. **Analysis of Military Operations:** The graduate will be familiar with U.S., allied, and potential enemy capabilities, and will be able to model and analyze joint military operations using OR techniques. The graduate will also be able to develop and evaluate new tactical and logistic concepts for a variety of operations ranging from humanitarian assistance/disaster relief to combat.
7. **Systems Analysis:** The graduate will understand the basic principles of economics and system analysis, as well as their application to various defense problems.

8. **Practice:** The graduate will have gained experience working on all aspects of an analytical study in the field of joint operational logistics. Specifically, the graduate will demonstrate the ability to conduct independent analytical studies, and proficiency in presenting the results both orally and in writing.
9. **Joint Professional Military Education (JPME):** Graduates will be prepared to transition from specialized technical duties to assignments that require a broad understanding of national policy and strategy, resource allocation and management, and joint and combined operations. This ESR is fulfilled by completing the NWC course sequence leading to Service Intermediate-level PME and Joint PME Phase I credit. Navy students take the NWC course sequence; the sequence is open to other students as desired.

### Curriculum Sponsor and ESR Approval Authority

As proposed to Director, Material Readiness and Logistics (N4) OPNAV Staff following 5 October 2005 OL Curriculum Review (Pending N17 approval).

### Human Systems Integration - Curriculum 362

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#### Brief Overview

Human Systems Integration (HSI) is an interdisciplinary program that emphasizes human considerations as a priority in systems design and acquisition, to reduce life cycle costs, and improve total system performance. HSI has been divided into several distinct domains that include human factors engineering, manpower, personnel, training, human survivability, health hazards, system safety, and habitability. HSI is based on the understanding that

people (operators, maintainers, and support personnel) are critical elements of the system and that a human-centered design perspective promotes system effectiveness, safety, and cost savings. This degree will provide students with the knowledge, skills, and abilities to be effective leaders in the assessment, design, testing, and management of a total human machine system throughout its life cycle.

**Requirements for Entry**

A baccalaureate degree with above-average grades is required. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 345 is required.

**Entry Date**

Human Systems Integration is an eight-quarter course of study (including Joint Professional Military Education (JPME)) with entry in the Winter Quarter. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

**Degree**

**Master of Science in Human Systems Integration**

The degree of Master of Science in Human Systems Integration requires:

- Completion of a minimum of 40 quarter-hours of graduate-level courses with:
  - At least 20 quarter-hours of 4000-level courses.
  - An elective sequence approved by the Chairman, Department of Operations Research.
- Submission of an acceptable thesis on a subject previously approved by the Chairman, Department of Operations Research.

**Typical Course of Study**

*(Navy, Marine Corps, Air Force)*

**Quarter 1**

SE4001	(4-1)	Systems Engineering and Architecture
OA3402	(3-0)	Research Methods for Performance Assessment
MA1010	(5-0)	Algebra and Trigonometry
MN3331	(5-1)	Systems Acquisition and Program Management

**Quarter 2**

OA3401	(3-1)	Introduction to Human Factors in Systems Design
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OS3111	(4-1)	Probability and Statistics for HSI and MOVES
GB3010	(3-0)	Organizational Behavior
MN3111	(4-0)	Personal Management Processes

**Quarter 3**

OA4401	(4-0)	Individual Performance: Sensation, Perception, and Cognition
OS3112	(4-2)	Statistics and Design of Experiments
GB4071	(4-0)	Economic Analysis and Defense Resource Allocation
NW3230	(4-2)	Strategy and Policy

**Quarter 4**

OA4406	(3-1)	Survivability, Habitability, Fundamental Safety, and Occupational Health
OS3113	(4-1)	Data Analysis for HSI and MOVES
OS3311	(4-0)	Probability Models for Military Applications
NW3285	(4-0)	National Security Decision Making

**Quarter 5**

OA4402	(3-1)	Team Performance and Decision Making
****	(4-0)	Human Factors in Virtual Environment
OA4701	(4-0)	Techniques in Manpower and Personnel Models
MN4125	(4-0)	Managing Planned Change in Complex Organizations

**Quarter 6**

OA4404	(4-0)	Skilled Operator Performance and Training Systems
OA4403	(3-1)	Anthropometry and Biomechanics Two electives related to HSI domain areas

**Quarter 7**

OA4603	(4-0)	Test Evaluation
GB3012	(3-0)	Communications for Managers
OA0810	(0-8)	Thesis Research for Operations Analysis Students
NW3275	(4-0)	Joint Maritime Operations - Part 1

**Quarter 8**

OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA0810	(0-8)	Thesis Research for Operations Analysis Students
MN4115	(4-0)	Training Foundations and Management
NW3276	(4-0)	Joint Maritime Operations - Part 2

**Typical Course of Study**

*(Army, International, Civilians)*



**Quarter 1**

SE4001	(4-1)	Systems Engineering and Architecture
OA3402	(3-0)	Research Methods for Performance Assessment
MA1010	(5-0)	Algebra and Trigonometry
MN3331	(5-1)	Systems Acquisition and Program Management

**Quarter 2**

OA3401	(3-1)	Human Factors in System Design
OS3111	(4-1)	Probability and Statistics for HSI and MOVES
GB3010	(3-0)	Organizational Behavior
MN3111	(4-0)	Personal Management Processes

**Quarter 3**

OA4401	(4-0)	Individual Performance: Sensation, Perception, and Cognition
OS3112	(4-2)	Statistics and Design of Experiments
GB4071	(4-0)	Economic Analysis and Defense Resource Allocation
OA4603	(4-0)	Test Evaluation

**Quarter 4**

OA4406	(3-1)	Survivability, Habitability, Fundamental Safety, and Occupational Health
OS3113	(4-1)	Data Analysis for HSI and MOVES
OS3311	(4-0)	Probability Models for Military Applications

**Provisional Educational Skill Requirements (ESR)****Human Systems Integration - Curriculum 362**

The goal of this curriculum is to educate military officers and civilian officials of the United States in Human Systems Integration. The delivery method is an in-resident course at the Naval Postgraduate School, Monterey, CA.

1. **Basics:** The graduate will recognize the human as the most valuable component in technology and weapon systems. The graduate will possess the skills necessary to function as a specialist in HSI. Graduates will possess a thorough background in all HSI components: Human Factors Engineering; Manpower, Personnel and Training; System Safety; Human Survivability; Habitability; and Health Hazards.
2. **Data Analysis:** Graduates will understand and be able to apply the statistical methods and tools necessary to perform analyses of data from HSI studies. They will have the requisite knowledge that enables successful application of these analytical methods and tools within the context

and constraints of military operations or system development.

3. **Research Design:** Graduates will be able to investigate a problem in HSI, formulate a research question, review pertinent literature, develop appropriate data collection protocols, analyze the data appropriately, and interpret the results. Graduates will be able to apply these research principles in both field and laboratory settings. Graduates will demonstrate the ability to present research findings in written and oral format to both technical and nontechnical audiences.
4. **Human Performance:** Graduates will understand the basis of human performance, including human information processing, perception, cognition, decision making, and motor control. Graduates will understand current theory and practice in assessing cognitive factors that affect human performance such as attention, memory, situation awareness, stress, fatigue, and motivation. Graduates will understand current scientific knowledge of factors affecting human performance and human error.
5. **Modeling:** Graduates will be able to apply HSI principles to human modeling capabilities and human-in-the-loop simulations. They will demonstrate the capability to apply human modeling techniques to analyses of military systems development and effectiveness.
6. **Organizational Behavior:** Graduates will understand the political, organizational, social, and economic issues associated with integrating human-machine systems into organizational cultures and environments.
7. **System Acquisition:** Graduates will understand and be able to apply the basic principles of defense acquisition.
8. **Manpower, Personnel and Training:** Graduates will understand the importance of properly assessing, screening, selecting, training, and integrating the human into military systems. This process includes understanding the empirical basis for recruitment, selection and classification, training, and retention of personnel. Graduates will understand current and emerging technologies that contribute to personnel success and performance, such as automation, training systems technologies, and job aids.
9. **Environment and Safety:** Graduates will acquire a thorough understanding of the environmental factors that influence human performance, effectiveness, and safety in the high stress and

hazardous environments commonly encountered in military operations. Graduates will acquire the knowledge and skills necessary to analyze environmental and safety issues for their impact on systems effectiveness and personnel safety.

10. **Professional Military Education:** Students will be encouraged to complete the JPME program. This sequence develops an understanding of war fighting within the context of operational art. Topics include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint multinational forces and integration at the operational level of war. JPME includes coursework in war gaming designed to develop an appreciation of the art of war.

### **Curriculum Sponsor and ESR Approval Authority**

Approved as Provisional ESRs; N00TB and N12 letter "PESR APPROVAL LETTER REV B 15 DEC 04.doc" received by Operations Research Department Program Officer via email on 15 January 2005.

## **Master of Systems Analysis - (Distributed Learning) - Curriculum 363**

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### **Brief Overview**

The Master of Systems Analysis (MSA) program is a distributed learning, graduate degree program, designed to meet the needs of the Navy and other services in the Department of Defense (DoD) for technical graduate education in systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. Students acquire foundation skills and hands-on experience in all aspects of analytical studies, which includes the skills to formulate problems, use the analytical process to design study requirements, highlight critical

assumptions, recognize strengths and weaknesses of applied analytical methodologies, and evaluate study recommendations.

This program is especially tailored to students whose career pattern will not allow them to get away for a full-time, graduate education program. The entire degree program can be completed at the student's current duty station. This program consists of a blend of approximately 50% Web-based, online instruction, and 50% video-tele-education (VTE). The Web-based instruction is paced week-to-week by the instructors, but the students have great flexibility to do their course work at times of their choosing during each week. The VTE classes meet at a scheduled time, once per week, during the workday, with the agreement of the student's current command.

### **Requirements for Entry**

A baccalaureate degree is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. An academic profile code (APC) of 335 is required.

### **Entry Dates**

The MSA an eight-quarter course of study with start dates in late March/early April and late September/early October. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

### **Degree**

#### **Master of Systems Analysis**

The MSA is a professional degree awarded for completing a curriculum focused on the practice of the profession rather than the more general arts or sciences behind the profession. It is analogous to the professional focus of an MBA (Master of Business Administration) compared to the more academic focus of an MS (Master of Science) in Management Science.

### **Program Description**

The MSA program is a 24-month, part-time program. Students take two courses per quarter, for eight quarters. The curriculum consists of four blocks. Two of the blocks comprise stand-alone, Web-based sequences. One is a four-course sequence leading to a Certificate in Systems Analysis, the other is a four-course option track approved by the student's service sponsor in a particular defense systems area in which systems analysis may be applied. The other two blocks round out the master's program with additional systems analysis core courses and a sequence of systems analysis case studies and projects that are an approved equivalent of a master's thesis. All students

who successfully complete the distance-learning course of study will receive:

- A Certificate in Systems Analysis awarded after completion of the first four quarters.
- A Master of Systems Analysis degree awarded upon completion of the two-year program.

A second certificate may be earned in an approved systems analysis context option track. The standard option track for Navy Unrestricted Line Officer students is a four-course sequence in Defense Resources Management. The student's service sponsor may approve another option based on course availability and needs of the sponsor and student. Some currently available certificate options include:

- Information Systems Technology (IST)
- Space Systems (SS)
- Anti-Submarine Warfare (ASW)
- Information Systems and Operations (ISO)

### Subspecialty

Completion of this curriculum is designed to qualify an officer as an Systems Analysis Subspecialist with a subspecialty code of 3200P, when established. The curriculum sponsor is N81, Office of the Chief of Naval Operations, and Assessment Division (OPNAV N81).

### Typical Subspecialty Jobs

OPNAV staff  
JCS staff  
Fleet staff  
Type Commander staff  
Battle Group staff  
OSD staff

### Typical Course of Study (Navy URL Option)

#### Quarter 1, Spring/Fall

OS2080 (3-0) Fundamentals for Naval Analysis I (SA Cert)  
MO1180 (3-2) Topics in Mathematics for Systems Analysis

#### Quarter 2, Summer/Winter

OS3380 (3-1) Combat Systems Simulation (SA Cert)  
OS3080 (3-0) Fundamentals for Naval Analysis II

#### Quarter 3, Fall/Spring

OS3680 (3-0) Naval Tactical Analysis (SA Cert)  
OA4702 (4-0) Cost Estimation

#### Quarter 4, Winter/Summer

OS4680 (4-0) Naval Systems Analysis (SA Cert)  
OS3211 (4-0) Systems Optimization  
SA Certificate Award Ceremony

#### Quarter 5, Spring/Fall

OS4011 (3-2) Risk Benefit Analysis  
MN4053 (4-0) Defense Budget and Financial Management Policy (DRM track)

#### Quarter 6, Summer/Winter

OS3081 (3-0) Systems Analysis Cases I (MSA Thesis Equivalent)  
MN3510 (3-0) Defense Financial Management Practice (DRM track)

#### Quarter 7, Fall/Spring

OS3082 (3-0) Systems Analysis Cases II (MSA Thesis Equivalent)  
MN3221 (3-0) Systems Acquisition and Program Management I (DRM track)

#### Quarter 8, Winter/Summer

OS4083 (3-2) Systems Analysis Cases III (MSA Thesis Equivalent)  
MN3222 (3-0) Systems Acquisition and Program Management II (DRM track)

Graduation week at NPS

### Educational Skill Requirements (ESR)

#### Master of Systems Analysis (MSA) - Curriculum 363

#### Subspecialty Code: 3200P

1. **Systems Analysis:** The graduate of this curriculum will understand and be able to apply the basic principles of systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. The following specific Educational Skill Requirements support this high-level objective.
2. **Basics:** The graduate will possess the mathematical skills required to support graduate study in systems analysis.
3. **Uncertainty Fundamentals:** The graduate will be well versed in uncertainty fundamentals for systems analysis, including applications of probability, statistics, data analysis, and modeling uncertainty.
4. **Simulation:** The graduate will be able to construct and utilize Monte Carlo simulations of combat and other processes that evolve in time, and will be able to deal with statistical issues associated with the need for replication.
5. **Tactical Analysis:** The graduate will be able to apply operations analysis methods to tactical and operational problems, including tactical decision analysis, search and detection, and weapons effectiveness.

6. **Cost Analysis:** The graduate will understand the methods and practice of cost analysis including various cost models, with particular emphasis in the relationship of effectiveness models and measures to cost, and applications in cost-benefit analysis.
7. **Risk-Benefit Analysis:** The graduate will be able to apply the principles of probabilistic risk assessment in the context of systems analysis decision problems. This includes a framework for balancing risks and benefits, and analysis under conditions of large financial and technological uncertainties.
8. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems with particular emphasis on applications in optimum allocation of scarce resources and multi-year capital budgeting.
9. **Practice:** The graduate will have gained experience in all aspects of analytical studies, including review, critique, and oversight of the work of others, as well as participation in the conduct of an analytical study. Review, critique, and oversight include the ability to highlight critical assumptions, recognize strengths and weaknesses of applied analytical methodologies, and evaluate study recommendations. Practice in the design and conduct of an analytical study includes the skills to formulate problems, use the analytical process to define study requirements, and apply appropriate analytical methodologies. Practice also includes demonstrating proficiency in presenting results both orally and in writing.
10. **Systems Analysis Context:** The graduate will have completed an approved option sequence in Defense Resource Management, or another approved option sequence in a particular defense systems area in which systems analysis may be applied.

#### **Curriculum Sponsor and ESR Approval Authority**

Director, Assessment Division (N81); as drafted during October 2005 MSA Curriculum Review, pending approval by Curriculum Sponsor: OPNAV, Office of the Chief of Naval Operations, Assessment Division (OPNAV N81).

## SCHOOL OF INTERNATIONAL GRADUATE STUDIES (SIGS)

### Website

www.nps.navy.mil/SIGS

### Dean

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### The School of International Graduate Studies includes:

Center for Homeland Defense and Security	NS
Department of National Security Affairs	NS
Defense Resource Management Institute	DR
Center for Civil-Military Relations	CM
Center for Contemporary Conflict	NS
Center for Stabilization and Reconstruction Studies	CM
International Graduate Programs Office	IGPO

### Overview

The School of International Graduate Studies (SIGS) provides graduate-level education studies and research to U.S. and international students. Established in 2001, it is the newest and most dynamic school within the Naval Postgraduate School (NPS).

### Mission

Our mission is to educate the next generation of U.S. and international leaders and prepare them for assignments in defense and foreign policy, international relations and security cooperation.

We prepare our students to lead and manage today's and tomorrow's new security environments. We fulfill that purpose by empowering student minds with an understanding of the dynamics of international politics, providing them with forward looking graduate courses that focus on today's hot topics, such as homeland defense and security. Furthermore, we

assist our students' understanding of civilian and military interagency alliances and bilateral and multilateral cooperation with our allies and friends. Our graduates are more than just well-educated students, they are tomorrow's leaders.

### Unique Programs

SIGS offers innovative master's degree curriculum, in-residence or mobile education seminars, workshops and conferences that promote U.S. defense/foreign policy objectives. Our unique programs include:

- Homeland Defense and Security Master's Degree program
- Counter-terrorism workshops and seminars
- Graduate education programs aboard U.S. naval ships and vessels at sea or in port.
- Graduate education for National Guard division staffs deploying to Bosnia-Herzegovina, Kosovo, and Afghanistan, and many others.

### Programs Offered

#### Graduate Master's Degree Programs (12-24 months):

All Master's Degree courses are held in residence at NPS.

#### Short-term Seminars:

Intensive one-to four-week courses focusing on today's defense topics, such as Combating Terrorism, Counter-drug, Defense Resources Management, and others.

#### Mobile Education Teams:

Courses are conducted overseas or in-residence at NPS. These are one-to four-weeks seminars tailored to meet the needs/requirements of the host country. Past participants include: presidents, ministers of defense, chiefs of staff of Armed Forces, and other high-level civilian and military officials.

### Participants

#### U.S. Participants:

Military officers  
Civilians from all federal offices

#### International Participants:

Senior executives  
Military officers  
Mid-career program managers

Non-governmental personnel  
Policy makers and legislators

## The SIGS Experience

SIGS provides an exciting environment for students. Many of our professors undertake research projects sponsored by various U.S. government agencies with students participation. What's more, our professors are engaged in mobile education teams worldwide, providing assistance to foreign countries and working with the host nation's senior officials. As a result, our instructors bring their first-hand experiences, unique insights, and understanding of a country or region to the classroom. This enhances the students' understanding of the political/military dynamics of the country or region they are studying.

## Department of National Security Affairs (NSA)

### Website

[www.ccc.nps.navy.mil/nsa](http://www.ccc.nps.navy.mil/nsa)

### Chairman

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**Donald Abenheim**, Associate Professor and Academic Associate for Civil-Military Relations (1985)\*; Ph.D., Stanford University, 1985.

**Anne Marie Baylouny**, Assistant Professor (2003); Ph.D., University of California at Berkeley, 2003.

**Glen Browder**, Distinguished Visiting Professor (1997); Ph.D., Emory University, 1971.

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**Anne L. Clunan**, Assistant Professor (2002); Ph.D., University of California at Berkeley, 2001.

**Ahmad Ghoreishi**, Lecturer (1994); Ph.D., University of Colorado, 1965.

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**Karen Guttieri**, Assistant Professor (2001); Ph.D., University of British Columbia, 1999

**Scott E. Jasper**, CAPT, USN, Lecturer (2002); M.A., Naval War College, 1997; MBA, San Jose State University, 1988

**Abbas Kadhim**, Assistant Professor (2005); Ph.D., UC Berkeley

**Jeffrey W. Knopf**, Lecturer (2000); Ph.D., Stanford University, 1991.

**Peter Lavoy**, Assistant Professor (1993); Ph.D., University of California at Berkeley, 1995.

**Letitia Lawson**, Visiting Assistant Professor (1996); Ph.D., University of California at Davis, 1995.

**Ted Lewis**, Professor (1993); Ph.D., Washington State University, 1971.

**Robert Edward Looney**, Professor (1979); Ph.D., University of California at Davis, 1969.

**Michael Malley**, Assistant Professor (2004); Ph.D., University of Wisconsin-Madison.

**H. Lyman Miller**, Associate Professor (1999); Ph.D., George Washington University, 1974.

**Daniel Moran**, Associate Professor (1994); Ph.D., Stanford University, 1982.

**Vali Nasr**, Professor and Associate Chair of Research, Ph.D., MIT.

**Edward Allan Olsen**, Professor (1980); Ph.D., American University, 1974.

**Robert L. Ord III**, LTG, USA (Ret.), SIGS Dean (2002); M.S., Georgia Institute of Technology

**Jessica Piombo**, Assistant Professor and Academic Associate, Regional Studies (2003); Ph.D., MIT, 2002.

**Douglas Porch**, Professor (1996); Ph.D., Cambridge, 1972.

**Maria Rasmussen**, Associate Professor and Academic Associate, Security Studies (1993); Ph.D., Yale University, 1990.

**Raymond Roll**, CDR, USN, Program Officer for the Department of National Security Affairs. Ph.D. candidate, University of San Diego.

**Paul N. Stockton**, Associate Professor and Director, Center for Homeland Defense and Security (1990); Ph.D., Harvard University, 1986.

**Brian Swanland**, Senior Lecturer and Academic Associate for In-Residence Homeland

Defense/Security Programs, (2005); Ph.D, University of Texas at Austin, 1995.

**Harold A. Trinkunas**, Associate Professor and Associate Chair of Instruction (1999); Ph.D., Stanford University, 1999.

**Mikhail Tsypkin**, Associate Professor (1987); Ph.D., Harvard University, 1985.

**Christopher Twomey**, Assistant Professor (2004); Ph.D., MIT.

**Tuong Vu**, Assistant Professor (2004), Ph.D., University of California, Berkeley.

**James J. Wirtz**, Professor and Department Chairman (1990); Ph.D., Columbia University, 1989.

**David Scott Yost**, Professor (1979); Ph.D., University of Southern California, 1976.

### Brief Overview

The Department of National Security Affairs (NSA) specializes in international relations, regional studies, military history, and security policy. NSA combines an outstanding faculty of historians, political scientists and, economists, with students from all services, from various defense agencies, and international officers and civilians from more than 60 countries, to prepare tomorrow's military and civilian leaders to deal with an evolving security environment.

### Our Approach

NSA's mission is to use education to create more proficient and professional officers. Because NSA professors undertake research projects sponsored by various U.S. government agencies, or travel abroad on Mobile Education Teams to assist countries dealing with security challenges, they bring first-hand experience, unique insights, and understanding of a country or region to the classroom. This, combined with the knowledge that many students have gained in their deployments or bring from their host countries, creates a dynamic learning environment that combines academic perspectives with "real world" experience. This enhances the students' understanding of the political/military dynamics of the country or region, and allows him or her to better appreciate the complexity and implications of the security issues they will confront in future assignments. Most NSA students write a thesis, which allows them to study a particular issue in depth.

### Degree

NSA offers fully accredited programs leading to the Master of Arts degree (M.A.). Programs vary in length from 12 to 18 months and are offered in

residence at NPS. A flexible schedule based on a quarter system, combined with year-round teaching, allows students to enter the program in January, April, July, or October.

U.S. and international students can choose Regional Studies or Security Studies.

### Regional Studies

NSA is one of the leading centers for regional studies education in the world. The curriculum meets the high standards set by the U.S. Army, and now the U.S. Navy, for Foreign Area Officer education. Students can specialize in the following four areas:

1. Middle East, South Asia, and Sub-Saharan Africa
2. Far East, Southeast Asia, and the Pacific
3. Europe and Eurasia
4. Western Hemisphere

### Security Studies

The Security Studies curriculum is divided into several tracks for both U.S. and international students:

- Civil-Military Relations
- Stabilization and Reconstruction
- Defense Decision Making and Planning
- Counterterrorism Policy and Strategy
- Homeland Security (U.S. students)

At least 44 units of approved graduate study in National Security Affairs, including five departmental core courses (NS 2011, 3000 or 3001, 3023, 3024 or 3025, and 3040 or 3041), and at least 16 units of course work at the 4000 level;

The completion of an approved sequence of required and elective courses pertinent to one of the departmental curricula tracks;

Successful completion of a master's thesis or a written comprehensive examination;

Language proficiency, as required for some Regional Studies students, which may, in some cases, substitute for a thesis.

All students in Regional Studies and Security Studies are expected to acquire a basic familiarity with four academic fields: history, international relations, comparative politics, and economics. The courses required to satisfy this requirement are listed below, and vary somewhat by curriculum (the specific requirements are listed separately within each curriculum).

### NSA Disciplinary Core Courses

NS3000	War in the Modern World
NS3023	Introduction to Comparative Politics
OR	

NS3001	War and Its Impact on Post-conflict Reconstruction
NS3024	Introduction to International Relations
NS3040	The Politics of Global Economic Relations
OR	
NS3041	Comparative Economic Systems
OR	
NS3001	War and Its Impact on Post-conflict Reconstruction
NS2011	Policy Analysis and Research Methods

These disciplinary core courses should be taken as early as possible in a student's program of study.

The two-hour course in research methods, NS2011, Policy Analysis and Research Methods, is required as an overload (a fifth course) during the first or second quarter of enrollment.

### Curricular Core Courses

Every curriculum includes courses that are required either individually or as one of a small number of specified alternatives. In the Regional Studies curricula, the curricular core courses provide a basic introduction to the subspecialty region. In the Security Studies curricula, the core courses provide a basic introduction to the major themes and issues in that topic of study.

### Curricular Electives

Curricular electives are courses directly and substantially pertinent to the subspecialty curriculum. Curricular electives differ from curricular core courses to the extent that individual courses are not required. They differ from "general" electives to the extent that student choices are confined to a list of designated courses. The array of courses offered as curricular electives varies from year to year, and will change as new courses are developed. In nearly all cases, the appropriateness of a course as a curricular elective for a given region will be apparent from its title (i.e., the title of the course mentions the region or country on which it focuses.) Questions about the appropriateness of new or unlisted courses as curricular electives should be addressed to the Academic Associate.

### General Electives

A student's choice of general electives is not constrained by formal requirements—though it is assumed that the courses chosen will be consistent with the student's overall educational goals, and with the goals of subspecialty education as described in the sponsor's ESRs. General electives may be chosen to support thesis research, to pursue secondary areas of academic interest, or to prepare for the comprehensive examination. They may be chosen from all courses in National Security Affairs or, with permission of the Academic Associate, from other departments or groups at NPS.

### SECNAV Requirement

The Secretary of the Navy has ordered that all DoN personnel enrolled at NPS take at least four hours of graduate-level course work addressing:

*...the historical, current, and evolving elements of maritime strategy. Instruction in developments in naval warfare will include an analysis and comparison of present and emerging tactical and strategic naval doctrine as well as an analysis of emerging technical developments and their potential effect upon the prosecution of tactical and strategic naval warfare by the United States, our allies, and our potential adversaries.*

Navy and Marine officers may satisfy this requirement by enrolling in NW 3230, Strategy and Policy: The American Experience. Marine officers who either have attended or will attend the Command and Staff College may validate the requirement. Others may take the course at any time. Navy officers should take it during their first quarter, to ensure that they are able to complete the rest of the JPME sequence, which includes this course.

### Naval Intelligence Requirement

All Naval Intelligence officers are required to take two courses in addition to their curricular requirements and electives. These courses are NS3159, Principles of Joint Operational Intelligence, and NS4159, Intelligence Capstone Seminar. One of these courses may be used as a substitute for one regional curricular elective.

### JPME Requirement

A course sequence conveying Joint Professional Military Education Phase I certification is required of all U.S. Navy officers in Regional Security Studies. Regional Studies curricula allocate five course blocks of time, in addition to the SECNAV course, to complete the sequence. JPME courses are an independent requirement, and may not be used to validate other required courses, nor do they count as general electives. *Questions about Joint Professional Military Education should be addressed to:*

Professor Fred P. Drake  
 Chairman, Joint Professional Military Education  
 Naval Postgraduate School  
 1 University Circle, Halligan Hall, Room 239  
 Monterey, CA 93943

(831) 656-3003, DSN 756-3003

fpdrake@nps.edu

### Thesis Research

Students who enroll in programs of study lasting 18 months are required to write a thesis. Students who



enroll in 689A, 689B and the 18-month 689C tracks are required to write a thesis. To do so, they are afforded the opportunity to enroll in NS0810, Thesis Research, a maximum of three times. Thesis students must also take NS4080, Research Colloquium, normally during their third or fourth quarter in residence.\* Students who satisfy curricular course requirements through validation of courses or by other means (e.g., taking an overload in a previous quarter), may enroll in NS0810 more frequently with the permission of the Academic Associate. Those who prefer to take additional courses while completing their theses may enroll less frequently.

Students in 12-month programs may elect to write a thesis in lieu of taking the Comprehensive Examination. Such a choice entails using some or all general electives to enroll in NS0810, Thesis Research. In these cases, NS4080, Research Colloquium, substitutes for NS0811, Comprehensive Examination.

Students in 15-month programs shall write a thesis or take a departmental comprehensive examination as is established in the requirements for their individual curricular track.

All students writing theses should familiarize themselves with departmental policies regarding thesis proposals, and the timetable for the submission of the final manuscript.

*\* Note that NS4080 is a 2-hour Pass/Fail course. It does not count toward the requirement that students take four 4000-level courses.*

### **Comprehensive Examination**

Students in the 681-4 curricula whose language training requirements allow them only 12 months of graduate study may substitute such training for a master's thesis, for the purpose of satisfying NPS degree requirements. Students who elect to make this substitution must also complete a written Comprehensive Examination in their sub-specialty field. Students in the 15-month 689C track who are completing their JPME may elect a thesis substitute in the form of a written Comprehensive Examination in their sub-specialty field. Students taking comprehensive examinations are afforded time to prepare via enrollment in NS0811, Comprehensive Examination. Note, however, that this course is not required. Students may use the time to take an additional elective if they wish. See the NSA Comprehensive Examination policies for further information.

## **National Security Affairs Course Descriptions**

### *FL Courses*

#### **FL0001-9 Language As Required**

This course is a generic identifier for a foreign language course taken at the Defense Language Institute (DLI). Prerequisites: None.

### *NS Courses*

#### **NS0001 National Security Affairs Seminar (0-1) As Required**

(No credit) Distinguished lecturer series. Lectures discuss matters and issues related to joint intelligence. Attendance is required by students every quarter. Prerequisites: None. Classification: TS/SCI.

#### **NS0810 Thesis Research (0-8) As Required**

Students conducting thesis research will enroll in this course. Prerequisites: None.

#### **NS0811 Preparation for Comprehensive Examination (No Credit) (0-0) Fall/Winter/Spring/Summer**

Students preparing for comprehensive examinations will enroll in this course. Prerequisites: None.

#### **NS2001 Comparative Politics (4-0) Fall/Winter/Spring/Summer**

This course tries to explain why and how governments differ in what they do, and what their people prefer, by comparing the ways some nation-states in Europe, Asia, Africa, the Middle East and Latin America confronted modernity and industrialization, mediated conflicts among interest, religious and/or ethnic groups, constructed their national identities and developed political institutions. Prerequisites: None. Classification: for undergraduate.

#### **NS2011 Research Methods (2-0) Fall/Winter/Spring/Summer**

This course provides an overview of the methods/techniques used in social scientific inquiry. Students review various policy research designs, including hypothesis testing and comparative case studies. They also are introduced to measurement issues (such as sampling and scaling techniques) and to data analysis (such as analysis of elites, event data analysis, etc.). Prerequisites: None.

#### **NS2012 History Colloquium (2-0) As Required**

Overview of historical methods. Prerequisites: None.

#### **NS2024 Introduction to International Relations (4-0) Fall/Winter/Spring/Summer**

Overview of the basic concepts of international relations. Prerequisites: None.

#### **NS2401 Language Maintenance: Russian (2-0) Fall/Winter/Spring/Summer**

This course is designed to maintain the language proficiency of intermediate and advanced Russian speakers during their studies at the Naval Postgraduate School. It is primarily aimed at students who have completed language training at DLI. Recent DLPT 2/2 or higher in Russian is a required for participation. Prerequisites: None.

**NS2501 Language Maintenance: Spanish (2-0)**

**Fall/Winter/Spring/Summer**

This course is designed to maintain the language proficiency of intermediate and advanced Spanish speakers during their studies at the Naval Postgraduate School. It is primarily aimed at students who have completed language training at DLI. Recent DLPT 2/2 or higher in Spanish is a required for participation. Prerequisites: None.

**NS2601 Language Maintenance: Japanese (2-0)**

**Fall/Winter/Spring/Summer**

This course is designed to maintain the language proficiency of intermediate and advanced Japanese speakers during their studies at the Naval Postgraduate School. It is primarily aimed at students who have completed language training at DLI. Recent DLPT 2/2 or higher in Japanese is a required for participation. Prerequisites: None.

**NS2602 Language Maintenance: Mandarin Chinese (2-0) Fall/Winter/Spring/Summer**

This course is designed to provide a structured environment for students to practice spoken Chinese Mandarin. Prerequisites: None.

**NS2701 Language Maintenance: French (2-0)**

**Fall/Winter/Spring/Summer**

This course is designed to maintain the language proficiency of intermediate and advanced French speakers during their studies at the Naval Postgraduate School. It is primarily aimed at students who have completed language training at DLI. Recent DLPT 2/2 or higher in French is a required for participation. Prerequisites: None.

**NS2801 Arabic Language Maintenance: Arabic (2-0)**

**Fall/Winter/Spring/Summer**

This course is designed to maintain the language proficiency of intermediate and advanced Arabic speakers during their studies at the Naval Postgraduate School. Major topic areas include: Reading: Level 2+ and higher Authentic Materials; Listening: Videotapes of news summaries and interviews translation to and from Arabic; Speaking; Current events. Prerequisites: None.

**NS3000 War in the Modern World (4-0)**

**Fall/Winter/Spring/Summer**

This course provides an introduction to war as a political and social phenomenon, and as a force in the international system. Major themes include: the development of leading ideas about war; the mutual interactions of politics, society, and warfare; the impact of military doctrine on war fighting; allocation of resources and coordination of effort among land, sea, and air forces; national strategic cultures, and their implications for strategic practice. Prerequisites: None.

**NS3001 War and Its Impact on Post-Conflict Reconstruction (4-0) Winter**

The problem of post-conflict reconstruction is hardly a new one. In the past, victors in wars frequently had to manage and rebuild societies shattered by conflict. This course will examine historical examples of post-conflict reconstruction. War creates a competitive environment exploited by groups who seek political power. This competition begins while the war is under way. Competitors seek to place themselves in a position to take advantage of the new post-war environment by choosing allies and enemies, perhaps also arming themselves. On the new post-war playing field, old

antagonisms assume new guises. Groups who might have been insignificant or repressed before the conflict can often exploit the new post-war environment to seek power. The military may also be strengthened by war, posing challenges to civilian governments or occupying powers. Social disorder, economic dislocation, and the de-legitimization of old political groups or ideas may invite chaos and even civil war. Prerequisites: None.

**NS3011 Policy Analysis and Research Methods (4-2)**

**As Required**

Survey of the methods and techniques used in social scientific inquiry. Topics include policy research design, measurement, sampling, and generation of data using survey research, scaling techniques, interviewing, content analysis, analysis of elites, event data analysis, and bibliographic research techniques. The course emphasizes hypothesis testing, using both statistical methods and the method of structured, focused comparison of case studies. Special focus is placed on applying the principles and methods of social science to the general problem of indications and warning. Laboratory experience includes extensive use of the equipment and software in the NSA computer lab. Prerequisites: None.

**NS3020 The Operational Level of War (4-0)**

**Winter/Summer**

This course provides a theoretical and historical introduction to the operational level of war, with emphasis on the conduct of joint and combined operations by American and other armed forces in the modern era. Topics include: the application of military theory and 'principles of war' at the operational level; campaign planning; the operational art; decision-making at the operational level; the theoretical and practical relationship between operations, strategy, and tactics; the role of war aim. Prerequisite: None.

**NS3021 Military Transformation (4-0) Summer/Winter**

This course examines Joint and Service innovative concepts and experimentation programs for transforming the military to meet the operational challenges of the future security environment. The course will analyze emerging operational concepts, organizational configurations, technological capabilities, and doctrinal and training adjustments for shifting the character and conduct of warfare from both an historical and desired future capabilities perspective. The course will introduce revolutionary methods to improve command and control, fires, maneuver and logistics through concept development, field experiments, technology demonstrations, and war-games. The course will conclude with a glimpse of transformation-related initiatives to improve multinational and interagency coordination in operational planning and execution. Prerequisites: None.

**NS3023 Introduction to Comparative Politics (4-0)**

**Fall/Winter/Spring/Summer**

This course is designed to introduce students to the major intellectual approaches to the study of comparative politics. Readings will be drawn from major theorists and leading schools of thought. Students will confront the central questions on the nature of economic, political, and cultural development. Prerequisites: None.

**NS3024 Introduction to International Relations (4-0)**

**Fall/Winter/Spring/Summer**

This course provides an overview of the prominent theories of international relations. It surveys explanations based on

decision-making, organizational behavior, domestic politics, international regimes and international systems, especially in terms of the insights they offer into the conduct of international relations in the post-Cold War world. Prerequisites: None.

**NS3025 Introduction to Civil-Military Relations (4-0)**  
**Winter**

This course introduces students to the basic concepts and issues in civil-military relations. It offers a historical and comparative analysis of different patterns of military participation in politics, defense policy making and national development. The course also introduces alternative models for structuring civil-military relations, and examines the problems associated with the models adopted by the United States and other nations. Prerequisites: None.

**NS3026 Introduction to Post-Conflict Security Building (4-0) As Required**

This course introduces students to the fuller program, intended to prepare them to work together in operations that build security in post-conflict environments. As such, it provides both conceptual tools for thinking about post-conflict security building and empirical referents to ground later study. Military strategists have written much about going to war, but have given less consideration to the movement from war to peace. How can one think strategically about the post-conflict environment? This course introduces students to characteristics of post-conflict environments and the diverse actors seeking to shape it. The course draws upon real-world cases to identify patterns of conflict and their consequences for post-conflict transition. In particular, the course will focus on interventions by external actors, civilian and military, in peace implementation. What are the typical components of post-conflict security building programs? This course covers practical issues in, and normative dimensions of, post-conflict security building. Prerequisites: None.

**NS3030 American National Security Policy (4-0)**  
**Spring/Fall**

This course provides an institutional and functional analysis of the national and international factors that shape U.S. defense policy. Attention is focused on two major areas: (1) the decision-making process, including the legislative-executive budgetary process, as well as the influence of bureaucratic politics and interest group participation upon defense decisions; and (2) the problems of strategic choice, including security assistance, threat analysis, net assessment, deterrence theory, and limited war. Prerequisites: None.

**NS3037 The Role of Congress in U.S. National Security Policy (4-0) Spring**

Survey of the roles, processes and orientations of the U.S. Congress in making national security policy. The course examines the powers and responsibilities granted to Congress by the Constitution, how the role of Congress has changed over time, and the way the role may evolve in the future. Specific topics include the budget process, War Powers, security assistance, and the problems of executive-legislative coordination in foreign and military policy making. Prerequisites: None.

**NS3040 The Politics of Global Economic Relations (4-0) Fall/Winter/Spring/Summer**

Examination of the world economy. Focuses on implications for the United States over changes in the world trading and financial systems. Topics covered include trade patterns, economic integration, trade blocs, new international economic order, and international economic organizations. Prerequisites: None.

**NS3041 Comparative Economic Systems (4-0)**  
**Summer/Winter**

Examination of the economic systems and development problems in developing countries, including post-communist states. The course focuses on the political and ideological bases of economic organizations, and the nature of basic economic problems in these regions. Special attention is given to the socio-economic strategies and tactics used in the management of the economy, and institutions and techniques of decision making. Attention is also given to problems of economic stabilization in the developing world. Prerequisites: NS3040.

**NS3042 Economics of Insurgencies for Security Building (4-0) Spring**

The course examines the economic issues related to civil wars and insurgencies, and reconstruction and development after conflict. Prerequisites: None.

**NS3077 Practicum in Regional Security Studies (4-0)**  
**TBD**

This course combines scholarly research with unique field experience. Under the direct supervision of the faculty, the student conducts research on selected topics in civil-military relations and regional security issues. The student subsequently participates with faculty in a Center for Civil Military Relations (CCMR) seminar, offered in Monterey or abroad, dealing with these topics in the region studied in the course. The student will write a paper of approximately 30 pages on the status of these civil-military topics in that country or region. The Practicum is open to all students enrolled in the curricula in Regional or International Security Studies (681-684 and 689), with preference for students who are foreign area officers (FAOs) or participants in National Guard state partnership programs. Prerequisites: Extensive course background in the region and competence in the relevant language.

**NS3078 Post-Conflict Bosnia: The Role of The United States in Promoting Peace and Stability (4-0)**  
**Spring/Fall**

This is a course based on a combination of distance learning and in resident seminar. The seminar is held twice a year, in the spring and fall, for a total of forty hours of lectures during a period of one week. It is preceded by twenty hours of delivery of course material by distance learning, primarily via the Web. The in resident course is followed by a Web-based continuing education program based on the analysis of relevant current events. The student, in order to receive course credit, will submit a research paper of approximately thirty pages that will be evaluated by a NSA faculty member. While the course is primarily designed for military officers prior to deployment to Bosnia, other students can petition for enrollment. Prerequisites: None.

**NS3079 Directed Studies in National Security Affairs (4-0) As Required**

(Credit 1-0 to 4-0) Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations. Prerequisites: None.

**NS3118 Strategies for Building Consensus (4-0) As Required**

Post-conflict environments bring together representatives from different nations and organizations. In order to accomplish the goals of interest, these varying representatives must develop awareness, appreciation, and ability to collaborate with each other. There is no formal organization that provides structures or standards to guide the collaboration of these individuals; they must rely on informal mechanisms for collaborative post-conflict efforts. Because the goals and interests of the participating parties frequently are not in alignment, consensus building capabilities contribute importantly to success. Consensus is a decision process that makes use of all available resources and perspectives for the resolution of problems. Consensus is difficult to reach and requires a complex set of skills related to interpersonal and group dynamics, such as conflict management, trust building, perspective taking, and negotiation. Prerequisites: None.

**NS3155 Intelligence and Democracy (4-0) Spring**

This course examines the methods civilian authorities in emerging democracies can use to establish strong, effective controls over their intelligence agencies. The course begins by examining the intelligence process in the United States and the United Kingdom, and the potential problems that intelligence activities can pose to democratic governance. Next, students will analyze the mechanisms used by the U.S., the U.K., France and other long-established democracies to maintain control over their intelligence organizations. These instruments of control include use of the power of the purse, structural and organizational arrangements, legislative oversight, and legal mechanisms. Employing the case study approach, students will examine the recent efforts by democracies in Latin America, Central Europe, Africa, and Asia to establish their own democratic controls over intelligence, and the challenges that such nations will face in the future. Prerequisites: None.

**NS3157 Intelligence and National Security (4-0) Fall**

This course is an introduction to the history, structure, roles, and functions of the U.S. Intelligence Community. It is intended for non-intelligence specialists. Students will be introduced to the intelligence cycle and the roles of various intelligence organizations in the collection, analysis, production, and dissemination of intelligence to national foreign policy and homeland defense policy decision makers. The course also considers contemporary issues facing the Intelligence Community, such as combating terrorism, homeland defense, oversight and ethical questions, and structural reform. Prerequisites: None.

**NS3159 Principles of Joint Operational Intelligence (4-0) Summer**

This course examines the intelligence process, organizational structure and related C4I architecture within the context of intelligence support to the planning and conduct of joint and combined operations at the operational level of war. This course addresses the conduct of intelligence to include the

development of requirements, collection management, threat analysis, assessments, and dissemination of intelligence to the decision maker. The course includes an overview of intelligence data systems and associated connectivity. Students are required to prepare and present intelligence briefings and staff intelligence studies, incorporating the knowledge gained in the course. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

**NS3160 Human Intelligence (4-0) As Required**

This course familiarizes students with the concepts, principles, and methodology of Human Intelligence collection. Additionally, students will comprehend the capabilities and limitations of various collectors and programs, learn the organizational architecture and understand the collection management process of Human Intelligence. This course is a requirement for all students in the Regional Intelligence Track of the Joint Intelligence Curriculum. Classification: Student must be a U.S. citizen holding a TOP SECRET clearance with eligibility for access to Sensitive Compartmented Information.

**NS3230 Strategic Planning and the Military (4-1) Summer/Winter**

Introduction to strategic planning approaches and methods inherent to national security policy formulation and, specifically, military defense planning. Includes long-range strategic planning, scenario building and forecasting of macro-trends affecting defense policies and capabilities, and the military dimensions of those factors. Theory and process meet through case study/analysis of U.S. defense planning practices and the evolution of the Joint Strategic Planning System (JSPS), including the changing roles of the Joint Staff, Unified CINC and Component, Joint Task Force, and Service staffs following passage of the Goldwater-Nichols Act and post-Cold War international security developments. This course covers various learning objectives specified by the CJCS to meet Phase One Program for Joint Education (PJE) criteria. Prerequisites: NS3000, NS3159 (may be taken concurrently). Classification: U.S. citizen holding a SECRET clearance.

**NS3225 Civil-Military Relations and Defense Budgeting (4-0) As Required**

This course provides a detailed analysis of the budget process used by the United States and other democracies to allocate defense resources. Students will become familiar with the planning, programming and budgeting system (PPBS) and other budgeting models and techniques. Students will also examine the sources of civil-military conflict in defense budgeting, and analyze different structures to resolve those conflicts. Prerequisite: Permission of instructor.

**NS3260 Drug Control Strategy and Policy (4-0) Spring**

This course provides an overview of the challenges posed by the production, trafficking, and consumption of illegal drugs, both in the U.S. and abroad, and evaluates government drug control efforts. It addresses the presidential, congressional, and bureaucratic politics that shape the formulation of domestic and international drug control policies. The challenges of implementing drug control policies will be analyzed, in particular the need for interagency coordination and international cooperation to address this complex threat. Both supply-side and demand-side policies will be discussed in detail and their effectiveness assessed. Prerequisites: None.

**NS3280 Nuclear Strategy and National Security (4-0)****Winter**

This course surveys the history of U.S. nuclear weapons policies and explores deterrence and arms control theories. The course also evaluates the challenges posed by the proliferation of weapons of mass destruction and advanced delivery systems. Prerequisites: none.

**NS3300 Islam (4-0) Fall**

Islam is one of the great monotheistic faiths of the modern world. This survey course examines the history and tenets of Islam and the breadth of Muslim cultures and civilizations. Prerequisites: None.

**NS3301 African History and Cultures (4-0) Summer**

This course provides a broad overview of African history, with an emphasis on understanding the historical foundations of important contemporary issues. In addition, it examines the process of cultural change in Africa over the course of the twentieth century, through an in-depth study of the fiction of Chinua Achebe. Prerequisites: None.

**NS3310 Survey of Middle East History to 1914 (4-0)****Winter**

A broad survey of Middle East history prior to World War I. While some earlier history may be covered, the emphasis in this course is primarily on the late Ottoman and Persian empires, and on the rise of colonialism in the Middle East. Prerequisites: None.

**NS3311 Government and Politics in Sub-Saharan Africa (4-0) Winter**

This course is designed for graduate students with little or no background in the study of African government and politics. It introduces students to the main structures and processes of contemporary African politics, and to important theoretical debates in the field of African studies. The emphasis is less on formal institutions of government and more on the informal practices that comprise the primary arena of African government and politics. Prerequisites: None.

**NS3320 U.S. Foreign Policy in the Middle East (4-0)****Fall**

The course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on how different U.S. administrations in the post-World War II era defined American interests in the Middle East, and on the major policies enacted to pursue those interests. Prerequisites: None.

**NS3330 The Middle East in World Affairs (4-0)****Summer/Winter**

Focuses on the Middle East region's role in world events in the post-World War I era, including the impact of great power rivalries in the region, transnational movements, and environ-strategic considerations. Prerequisites: None.

**NS3340 Middle East in the International Economy (4-0)****Summer**

This course explores timely international and regional economic development issues. We will examine both international and regional economic interactions and possibilities, including regional trade agreements, negative and positive international agreements (sanctions, foreign aid, the WTO, etc.) and shared international resources such as water. We will tackle the problem of late development, the effects of

oil, labor migration, and tax regimes on the economies and business-government relations, privatization moves, and current prospects for employment and poverty-alleviation. Prerequisites: None.

**NS3351 Anthropology of Africa (4-0) Winter**

Examines various facets of African anthropology. Prerequisites: None.

**NS3360 Politics and Security in North Africa (4-0)****Summer/Winter**

A survey course on the politics and security of North Africa in the post-World War I era. The geographic focus is on the countries of Egypt, Libya, Tunisia, Algeria and Morocco. Prerequisites: None.

**NS3361 Politics and Security in Levant (4-0) Summer**

A survey course on the politics and security of the Levant in the post-World War I era. The geographic focus is on the countries of Syria, Jordan, Lebanon, Israel and Palestine. Prerequisites: None.

**NS3362 Politics and Security in the Northern Tier (4-0)****Spring**

A survey course on the politics and security of the Northern Tier in the post-World War I era. The geographic focus is on the countries of Turkey, Iran and Afghanistan. Prerequisites: None.

**NS3363 Politics and Security in the Persian Gulf (4-0)****Winter**

A survey course on the politics and security of the Persian Gulf in the post-World War I era. The geographic focus is on the countries of Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, Oman and the UAE. Prerequisites: None.

**NS3367 Politics and Security of The Arabian Peninsula (4-0) Spring**

Examines the twentieth century history of the Persian Gulf, the evolution of U.S. regional strategy and policy, and summarizes threats to regional security in the new century. The course will also provide students with general background behind security issues in the Middle East and the Persian Gulf, and cover some of the more recent policy debates surrounding the war with Iraq. Prerequisites: None.

**NS3400 History of Russia and Eurasia (4-0) Spring/Fall**

An examination of the history of Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy. Prerequisites: None.

**NS3401 Contemporary Politics of Russia (4-0) Winter**

This course introduces students to the contemporary politics of Russia focusing on the post-Soviet. Prerequisites: None.

**NS3410 Russia, Eastern Europe and Central Asia in World Affairs (4-0) Spring/Fall**

This course is concerned with the international conduct and security policies of Russia, the other countries of Eastern Europe, and Central Asia. It examines their major geopolitical, historical, demographic, and economic influences. Prerequisites: None.

**NS3412 Government and Security in the Central Asian Republics (4-0) Fall**

With China and Russia taking an ever-increasing greater interest in central Asia, U.S. policy makers face the challenge of maintaining an influential presence in the region. Over a decade since the breakup of the Soviet Union, the five Central Asian Republics have emerged as a critical security issue as WMD, terrorists and hard-line regimes have come to dominate the landscape. In a land where Islam is more cultural than religious, communism more trusted than capitalism, and ethnic divisions a Soviet invention, how can stable democracies emerge? This course will represent a comprehensive assessment of the newly formed states of central Asia that were formerly parts of the Soviet Union. Through examination of the complex historical, ethnic, religious, and linguistic factors that unite and divide the Central Asian Region, we will better understand the challenges of political modernization, economic reform, and integration into the international community. The course topics will include: the history of the region; the relationship between Islam and Central Asia; environmental issues; economic development and emerging energy markets in the region; the contemporary political scene; and the role of the region in world affairs. Special emphasis will be placed on the contemporary crises in the region. Prerequisites: None.

**NS3450 Military Strategy in Russia, Eastern Europe and Central Asia (4-0) Spring**

The course examines the international factors that condition military strategy and doctrine in Russia, Eastern Europe, and Central Asia. It focuses on contemporary strategic concepts and strategy: conventional war fighting capabilities, strategy for nuclear war, roles played by the fleets in military strategy, threat and net assessment, and arms control. Emphasis is on the strategic and operational levels of warfare. Prerequisites: None.

**NS3460 Government and Security in Eastern Europe (4-0) Winter**

This course examines the countries of east central Europe that fell in the Soviet sphere of influence after World War II. It is concerned in particular with the complex relationship of Marxism and nationalism, the nature of communist revolution from abroad, revolutions against communist states including Hungary in 1956 and Poland in 1980, and the present situation of the Central European states in the transition from communism to democracy. Prerequisites: None.

**NS3501 History and Cultures of Latin America (4-0) Winter**

This introductory course examines the heritage of Latin America from pre-Columbian Indian traditions and Iberian colonial patterns, through the independence movements of the early 19th century, and the global economic relationships that re-oriented the region toward Northwestern Europe and the United States. Prerequisites: None.

**NS3510 Government and Politics in Latin America (4-0) Summer**

This introductory course is designed to familiarize students with the politics of contemporary Latin America. The course will cover such topics as the various types of political systems found in Latin America, the political economy of development and the issue of regime transition. Prerequisites: None.

**NS3520 Latin America International Relations and Security (4-0) Winter**

This course surveys the international relations of Latin American nations. It analyzes the relations of Latin America with the United States and other nations, both within and outside of the region. Attention is given to political, security, economic, and cultural issues. Prerequisites: None.

**NS3600 History and Cultures of East Asia (4-0) Spring/Fall**

This course addresses the historical development of the peoples of East, South, and Southeast Asia. It emphasizes their economic, political, and military development through the late nineteenth century. Prerequisites: None.

**NS3601 History And Cultures of Southeast Asia (4-0) As Required**

This course addresses the historical development of the peoples of mainland and island Southeast Asia from their origins to the end of the nineteenth century. It focuses on the political, military, social and economic development of these societies and on their belief systems, including Hinduism, Buddhism, and Islam. Prerequisites: None.

**NS3602 Asian Relations: 18th Century to WWII (4-0) As Required**

Examines U.S. Asian relations during the 18th Century through WWII. Prerequisites: None.

**NS3620 Asian Modernization (4-0) Winter**

An analysis of major national and international developments within Asia, and between Asia and the non-Asian world from the mid-nineteenth century to the late mid-twentieth century. Includes an examination of U.S. relations with Asia. Prerequisites: None.

**NS3621 International Relations of South East Asia (4-0) Spring**

This course focuses on the contemporary international relations of South East Asia, to include Thailand, Malaysia, Singapore, Indonesia, and Oceania. Prerequisites: None.

**NS3635 Asian Civil-Military Relations (4-0) As Required**

This course addresses the political, economic, and societal roles of the armed forces in the nations of East Asia, Southeast Asia, South Asia, and Central Asia from the mid-twentieth century to the contemporary era. It focuses on civil-military relationship successes and failures, as well as prospects for the future. Prerequisites: None.

**NS3640 Asian Human Rights (4-0) As Required**

This course examines trends in Asia that support or undermine the establishment of more democratic political forms and the protection of human rights. Topics include the relationship between political development and economic development, transformation of political cultures, evolving state-society relations, and the impact of regional institutions and international norms on domestic practices. Prerequisites: None.

**NS3645 Political Economy of Asia (4-0) Winter**

This course explores the reasons for the different timing and paths of economic development in Japan, China, Taiwan and South Korea. It examines the reasons for the lateness of

development of East Asia relative to the West, and especially the lateness of development of China compared to Japan. Emphasis will be on the evolution of institutions in the course of state building, and the international geopolitical context of Asian development.

**NS3661 Government and Security in China (4-0) Winter**

An examination of the rise of the Chinese Communist Party and the establishment of the Communist state; its domestic achievements and problems; the special problem of Taiwan; changing foreign policies and the current role of the People's Republic of China in world affairs. Includes an examination of U.S. relations with China. Prerequisites: None.

**NS3662 Government and Security in Japan (4-0) Fall**

An examination of Japan in the contemporary world, focusing on Japan's political dynamics, economic evolution, social transformation, the National Self Defense Forces and alternatives for ensuring national security. Includes examination of U.S. relations with Japan. Prerequisites: None.

**NS3663 Government and Security in Korea (4-0) Winter**

An examination of the division of the Korean nation into two states; the aftermath of the Korean war; domestic political, economic and social problems of North Korea and South Korea; the prospects for reunification; the military balance and the changing strategic environment; and the relations of Pyongyang and Seoul with their key allies. Includes an examination of U.S. relations with Korea. Prerequisites: None.

**NS3664 Government & Security in Southeast Asia (4-0) Winter**

This course examines the development of Southeast Asian politics from decolonization to the present day. Prerequisites: None.

**NS3667 Chinese Foreign Policy (4-0) Fall**

This course provides a systematic examination of contemporary Chinese foreign policy. It reviews the evolution of Beijing's international goals and policies since 1949, but focuses of Beijing's contemporary foreign policy goals, its policy-making process, and the foreign relations instruments at its disposal including military force. Prerequisites: NS3661 or consent of instructor.

**NS3668 Politics and Security in South Asia (4-0) Winter**

This course traces the history and evolution of South Asian politics leading up to the partition of the Subcontinent. It familiarizes students with the key debates and future trajectories in contemporary South Asia. This course creates a sound base for advance seminars on NS4668, which should be a logical follow-up and other regional security seminars. Prerequisites: None.

**NS3700 History of Modern Europe (4-0) Winter**

Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present. Prerequisites: None.

**NS3710 Government and Security in Western Europe (4-0) Winter**

Survey and analysis of government and security issues in contemporary Western Europe. The course emphasizes the political systems and security policies of Britain, France, Italy, and Germany. Prerequisites: None.

**NS3720 European Security Institutions (4-0)**

**Spring/Fall**

Survey and analysis of the main international institutions dealing with European security, including the North Atlantic Treaty Organization (NATO), the Conference on Security and Cooperation in Europe (CSCE), the Western European Union (WEU), and the European Community (EC). The survey will include selected challenges facing each organization, particularly NATO, and their relation to specific European countries and to U.S. foreign and defense policy. Prerequisites: None.

**NS3730 The Balkans: History & Politics (4-0) Spring**

A survey of the historical background of and contemporary developments in the Balkans region, with a special focus on the collapse of the former Yugoslavia, the various conflicts that followed, including that in Kosovo, the role of other regional actors in these events, and the prospects for future stability and progress in the region. Prerequisites: None.

**NS3801 International Terrorism (4-0) As Required**

This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. Prerequisites: NS3023 or consent of instructor.

**NS3900 International Law and Organizations (4-0)**

**Spring/Fall**

An introduction to the principles of international law including origins, sources, sovereignty, states, territory, jurisdiction, persons, treaties, settlement of disputes and the Law of the Sea. The course also traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various forms of multinational and transnational organizations. Prerequisites: None.

**NS4020 Seminar on the Chinese People's Liberation Army (4-0) Winter**

This course examines the evolution of the Chinese People's Liberation Army. Prerequisites: None.

**NS4021 Special Topics on Europe: Europe and the U.S. (4-0) Summer**

A historical-political advanced seminar on the evolution of U.S. policy towards Europe from the end of the 19th century until the present; the character of anti-European ideas in U.S. political and strategic culture; the role of leading personalities in the formulation of U.S. policy towards Europe in the critical periods of the twentieth century; the character of anti-U.S. sentiment in continental Europe; U.S. alliance cohesion and cultural diplomacy in continental Europe. The seminar analyzes readings in common and requires a larger independent research project. Prerequisites: None.

**NS4022 Special Topics on CMR: Soldiers & Politics in the Euro-Atlantic (4-0) Winter**

A comparison in an advanced seminar format via historical case studies of the evolution of the soldier and the state in the Anglo-Saxon countries and their continental European counterparts. The evolution of civil-military relations from dynastic, absolutist Europe to the era of total war in the twentieth century, with special attention to the German, British and U.S. cases of the evolution of state, national and military institutions, alliance cohesion, and wars of ideology. Further attention is also paid to the proliferation of warfare, ideology, and mass politics and the professional soldier in modern history. An analysis of common readings as well as an independent research paper round out the seminar. Prerequisites: None.

**NS4023 Special Topics on European Nations: State, Nation, and Nationalism. 1500-1945. (4-0) Winter**

An advanced seminar on the evolution of the state, nation, and nation-state in western, central and eastern Europe from the seventeenth century until the middle of the twentieth. Special emphasis falls on the rise of national ideas in the eighteenth century, case studies of nation building and the propagation of nationalism in the nineteenth and twentieth centuries, as well as the transformation of nationalism into a force of total war and genocide in the twentieth century. An analysis of the common readings as well as an independent research project is required. Prerequisites: None.

**NS4024 Special Topics on Asia: Political Economy of China (4-0) Summer**

This course explores how state, society and politics impinge on the Chinese economy in its transition from planned to market economy; and examines what political and economic adjustments China has to make as the country becomes increasingly integrated with the world economy. Prerequisites: None.

**NS4025 Special Topics on Asia: Comparative Market Reform (4-0) Winter**

We use a paired comparative method in order to assess some of the leading theories on market transformation, and examine the geopolitical context, the strategies, process of institutional adjustment, and the coalition of interests formed to support or resist change as Japan, North and South Korea, China and Russia undertake market reform. Prerequisites: None.

**NS4026 Capstone Seminar: Reconstruction of Civil Society (4-0) Fall/Summer**

This course pulls together empirical, experiential and theoretical student learning in the post-conflict security building track. It explores multiple approaches to reconstruction and the conditions under which they tend to work in post-conflict transitions. Fundamental questions are addressed. From the perspective of international financial institutions, how can societies experiencing humanitarian emergencies make transition from relief to development? From the perspective of external actors, civilian and military, what patterns of interventions emerge in peace implementation? Considering perspectives of the host nation and external implementers of peace agreements, what are the costs and benefits of outside intervention? How can program responsibility shift effectively from military officials to civilians? What institutions and processes are vital to

reconstruction of civil society, and how might military demobilization, reconstitution programs and police reform programs fit with those institutions and processes? How can indigenous stakeholders "own" the reconstruction in the face of outside intervention? Students participating in this course will share their insights from case analyses and build a data set for future students and researchers. Prerequisites: None.

**NS4027 Special Topics in Asia: Democratization in East and Southeast Asia (4-0) Winter**

As in most other regions, the past few decades have been a period of unexpected democratic dynamics for East and Southeast Asia. When the "Third wave of Democratization" began in 1974, only one country (Japan) could be categorized as a "liberal democracy." Thirty years of "Third Wave" latter, at least five more political regimes have achieved some level of democratization since the mid 1980s; however, democratization in Asia is still a fragile process. Only a small number of regimes in Asia are clearly en route to becoming successful, well-functioning democracies, or at least have made some democratic progress and still enjoy a positive dynamic of democratization. Others have not achieved a relatively well-functioning democracy. Although de jure political rights, civil liberties, and the institutions of constitutionalism and the rule of law are found in many countries, a whole battery of de facto restrictions, usually informal ones, curb the effective working of the formal rules and significantly distort their value. In a small number of countries (e.g., Burma, Cambodia) initial political openings have failed and authoritarianism seems to re-solidify. Finally there is a number of "hybrid regimes," combining autocratic with democratic elements of governance (for example, Singapore). Prerequisites: None.

**NS4030 Special Topics in National Security Policy (4-0) Fall**

This course will focus on special topics in national security policy. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisites: Consent of instructor.

**NS4031 Special Topics in International Security Affairs (4-0) Spring**

This course will focus on current topics in international security affairs. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisites: Consent of instructor.

**NS4032 Special Topics in International Relations (4-0) As Required**

This course will focus on current topics in the broader international system. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisites: Consent of instructor.

**NS4033 Special Topics in U.S. Foreign Policy (4-0) As Required**

This seminar focuses on contemporary topics in U.S. foreign policy. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the



seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded paper research paper is required. Prerequisites: Consent of instructor.

**NS4034 Special Topics in American Government (4-0)  
As Required**

This course will focus on special topics in American government. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisites: Consent of instructor.

**NS4035 Special Topics in Joint Intelligence (4-0)  
Summer**

This seminar will focus on contemporary topics involving joint intelligence and related areas. The list of issues to be analyzed for the seminar is announced one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. Prerequisites: Consent of instructor. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

**NS4036 Comparative Strategic Cultures (4-0) Fall**

Overview of strategic cultures around the world and the manner in which they affect defense/military strategies.

**NS4037 NATO (4-0) Summer**

Course title and description are correct for NS4280. Action: Change NS4037 to read as follows: This advanced seminar is a colloquium on the past and present policy and strategy of NATO via an examination of its leading crises from 1949 until 2003 in an effort to understand the nature of alliances in the Euro-Atlantic world, their strategies and issues of cohesion amid crisis. The class examines such themes as: a.) the evolution of ideas in the formulation of alliance statecraft and strategy; b.) the dimension of burden sharing in alliance statecraft and bi-lateral relations; c.) the problems of defense and military transformation in the past, especially connected with alliance politics and political biography; d.) the past instances of severe discord in national strategy and alliance statecraft with enduring importance for the essence of NATO; the modalities of NATO enlargement in the era 1989-1999 and beyond; the post-1990 shift from forward defense in central Europe to the rise of peace enforcement operations in S.E. Europe. Finally, attention is also given to the issues of the present connected with the role of NATO in ongoing security operations on a wide front. This class is taught in a colloquium format; further, it requires an additional book report and the preparation of large synthetic essay on the sum of the readings. Prerequisites: None.

**NS4040 Conflict in Africa (4-0) Winter**

This course examines multiple aspects of ethnic conflict in Africa. In the first half, we consider theoretical approaches to ethnicity, ethnic conflict, cross border contagion, and regional conflict. The second half of the course is dedicated to case studies, to be prepared and presented by the students. Prerequisites: None

**NS4079 Advanced Directed Studies in National Security Affairs (V-0) Fall/Winter/Spring/Summer**

(Variable credit, from 1-0 to 4-0.) Format and content vary. Normally involves extensive individual research under direction of the instructor and submission of a substantial

paper of graduate seminar quality and scope. Prerequisites: Consent of instructor.

**NS4080 Research Colloquium (2-0)  
Fall/Winter/Spring/Summer**

A research colloquium in which NSA/Intelligence/Special Operations students present the main findings from their master's thesis research for critical analysis and discussion. Grading: Pass/Fail. Prerequisites: None.

**NS4152 Joint Warfare: Intelligence Analysis (4-0)  
Spring**

Advanced seminar on intelligence support to military commanders and national-level officials. Using case studies, the course examines concepts of individual and organizational decision making, factors in threat analysis, and issues in intelligence activities. Prerequisites: NS3159 or consent of instructor. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

**NS4156 Intelligence for Homeland Security (4-0)  
Spring**

The September 11 terrorist attacks on the World Trade Center and Pentagon have focused the nation's attention on homeland security. This course examines threats, vulnerabilities, objectives, strategy, instruments of national power, resources, and risk associated with ensuring homeland defense. NS3156 is designed to inform students on key questions and issues facing the Intelligence Community and its role in Homeland Security. Students will have the opportunity to fully address policy, organizational and substantive issues regarding Homeland Security intelligence support. Course reference material will provide an overview of diverse intelligence disciplines and how the Intelligence Community operates. Course emphasis will be on issues affecting policy, oversight and intelligence support to Homeland Security and national decision making. Prerequisites: None.

**NS4157 Operational Intelligence for Homeland Defense (4-0) Winter**

This course will provide students with a fundamental knowledge of U.S. operational intelligence capabilities to detect and deter terrorist threats to the United States. Topics will include the structure and function of U.S. intelligence organizations, systems, architecture, and capabilities. Issues in intelligence oversight, intelligence sharing, and intelligence community administration will be discussed in relation to multi-agency counter-terrorism efforts. Prerequisites: None.

**NS4159 Seminar on Joint Intelligence Support to Crisis Operations (4-0) Winter**

Advanced seminar on intelligence support to military commanders and national-level policy makers. Using case studies, the course examines concepts of individual and organizational factors affecting the analytic process. Students will identify near-to mid-term regional events with force employment implications, develop associated intelligence support requirements, and create collection plans in support of indications and warnings, crisis shaping and identified operational mission areas. Prerequisites: NS3159, or consent of instructor. Open to intelligence specialists. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

**NS4160 Foreign Intelligence Services (4-0) As Required**

This course examines selected foreign intelligence services. It emphasizes their organization, missions, and functions. This course is intended for students in the Joint Intelligence Curriculum and others upon consent of instructor. Prerequisites: NS3160 or consent of instructor. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

**NS4200 Seminar on the National Interest (4-0) As Required**

An advanced study of the underlying assumptions and objectives of American security and foreign policy. The core of the course is an in-depth analysis of approaches to understanding the American national interest in the international context. Students are required to write a major seminar paper on American national interest in a specific country or region. Prerequisites: NS3030.

**NS4225 Civil-Military Relations and Transitions to Democracy (4-0) Fall**

A seminar which reviews selected cases of transitions from authoritarian rule in the post-1945 period. The course compares the various roles played by the military and other actors in these transitions, examines the participation of the military in the consolidation of democracy and the problem of democratic consolidation. Students will also examine different theories and concepts of democratic transition and consolidation. Prerequisites: NS3025 or consent of instructor.

**NS4230 Seminar on Joint Strategic Planning (4-0) Fall**

Advanced study in the concept and methods of strategic planning and analysis, particularly with respect to Department of the Navy and other services, the Joint Chiefs of Staff, the Office of the Secretary of Defense, the Department of State, the National Security Council, White House, and the Congress. This course covers various learning objectives specified by the CJCS to meet Phase One Professional Joint Education (PJE) criteria. Prerequisites: NS3000 or NS3030 or consent of instructor. Classification: U.S. citizen holding a SECRET clearance.

**NS4231 Seminar on Terrorism Financing and State Response (4-0) Fall/ Winter/Spring/Summer**

This course examines exactly how far we have come in understanding how terrorists raise, store, and transfer funds. It also evaluates challenges facing the U.S. government and international community in responding to this problem. In each module, we use a mix of official reports, academic papers, and other works to explore the subject and identify problems with the received wisdom about terrorist financing. Prerequisites: None.

**NS4235 Seminar on Peace Support Operations (4-0) Spring/Winter**

This seminar examines the problems of military alliances in the post-Cold War era, and the civil-military relation issues raised by defense cooperation, including operations other than war. Prerequisites: NS4225 or consent of instructor.

**NS4236 Stability Operations (4-0) As Required**

The theme of this course is the nexus of policy, doctrine and operations in stability operations. In the first part of the course, we will discuss the policy in which doctrine and operations are embedded, and the considerations for

translating policy into doctrine and operations. In the second part of the course, we directly address the challenges of war termination, occupation, counterinsurgency and coalition stability operations. This course focuses primarily on the American approach to stability operations. These military operations have been variously described as 'small wars,' 'low intensity conflict,' and in current joint doctrine JP 3-07 (1995), 'military operations other than war' (MOOTW). Prerequisites: NS4225 or consent of instructor.

**NS4239 Special Topics: Border Security and Civil-Military Relations (4-0) Fall/Winter/Spring/Summer**

The purpose of the Special Topics course is to provide students with an extra focus on 2 or 3 major issues that have current visibility in debates about homeland security. Currently, those topics focus on dilemmas in the evolving relationships between civil and military authority and between government and community. Prerequisites: NS4156, NS3180, and SO3210.

**NS4240 Seminar on Regional Security Planning Problems (4-0) Spring**

This seminar, which is the national security policy capstone course in the Resource Planning for Management and International Defense (RePMID) curriculum, provides advanced study of regional and inter-regional security problems which are likely to confront emerging democracies in the immediate and mid-range future. Potential roles of individual countries and coalitions are explored to develop new and innovative strategies for dealing with both common and unique security problems in diverse regions. Through the course readings, students critically analyze the implications of the most likely future security environment challenges and opportunities for each region. Prerequisites: Completion of previous RePMID courses, or consent of instructor.

**NS4251 Seminar on Net Assessment (4-0) Spring**

The seminar examines the methodology of comparative threat analysis (net assessment), including: security policies, forces, the RMA, and capabilities of the world's military superpowers. The course introduces the student to original source material. Prerequisites: NS3024. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI.

**NS4253 Seminar on Military Operations Other Than War (4-0) Winter**

This course is intended to develop an understanding of the interrelationship of technology and strategic planning. Issues include technological risk, affordability, institutional impediments to innovation, and a strategy for long range technology investments. Prerequisites: consent of instructor.

**NS4255 Naval History and Maritime Strategy (4-0) Fall**

This course examines the role of naval power and maritime strategy during the period when global warfare conducted on and from the high seas was a central element of the international system; that is, from the seventeenth through the twentieth centuries. Topics include: naval armaments, arms races, and arms control; economic warfare; "gunboat diplomacy"; neutral rights and the law of the sea; naval power projection. Prerequisite: prior completion of NS3000, or consent of instructor.

**NS4261 Survey of Strategic Studies (4-0) Spring/Fall**

Survey of the classical and contemporary literature on strategic thinking: national objectives and strategic alternatives; deterrence, counterforce, arms control, counter insurgency; components and rules of the international strategic system; and arms competitions, nuclear proliferation, and terrorism. Prerequisites: NS3030 or consent of instructor.

**NS4280 Nuclear, Biological and Chemical: Proliferation and Non-Proliferation (4-0) Summer**

This advanced research seminar examines the origins of nuclear, biological, and chemical (NBC) weapons proliferation, and its impact on U.S. and international security. The course investigates the causes and consequences of proliferation; studies central debates and key case-studies on the subject; and evaluates policy responses designed to impede, discourage, and cope with the spread of NBC weapons. This course is unclassified. The seminar presumes familiarity with U.S. national security approaches to proliferation, and prefers, though not require-prior participation in NS3280. The seminar refers to and draws upon topics that are covered in NS3280: nuclear strategy, deterrence theory, and strategic arms control. Prerequisites: NS3280.

**NS4282 The Politics of Nuclear Nonproliferation (4-0) Winter**

Examines the main political issues surrounding nuclear nonproliferation.

**NS4285 Counterproliferation (4-0) Spring/Fall**

This course will prepare students to counter nuclear, biological, and chemical (NBC) weapons threats in future operational or staff assignments by improving their understanding of the causes and consequences of NBC weapons proliferation and use and the strategies and capabilities available to counter these threats. Prerequisites: None. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI.

**NS4300 Seminar in Middle Eastern Politics (4-0) Winter**

A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. Since the topic of the seminar will vary, the registrar will be provided with the full title each quarter the course is taught. Sample subject areas include the Arab-Israeli conflict, the politics of oil, and the revolution in the Middle East. This course may be repeated as long as the subject material and title of the class is different. Prerequisites: Two 3000-level Middle East courses or consent of instructor.

**NS4301 African Political Economy (4-0) Winter**

This course examines economic development issues in Sub-Saharan Africa from a very broad perspective. We will consider how political and social as well as economic structures impact economic growth and development, assess policy and performance in the postcolonial period, and discuss the challenges for the twenty-first century. Prerequisites: None.

**NS4305 Military, Polity and Society in the Middle East (4-0) Summer**

Seminar in Middle East military affairs, politics and society. Prerequisites: None.

**NS4310 Seminar on Middle Eastern Security Issues (4-0) Summer**

A research seminar on security issues in the contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. Since the topic of the seminar will vary, the registrar will be provided with the full title each quarter the course is taught. Sample subject areas include the domestic security implications of Middle East peace, environmental security in the Middle East, and terrorism in the Middle East. This course may be repeated as long as the subject material and title of the class is different. Prerequisites: Two 3000-level Middle East courses or consent of instructor.

**NS4311 Contemporary Issues in African Politics (4-0) Fall**

This course will survey the major issues confronting African states today: the HIV/Aids epidemic, endemic civil wars, dimensions of ethnicity and ethnic conflict, issues of democratization and authoritarian rule, the nature of states and the phenomenon of state collapse, and patterns of trade and economic development. The focus will cover the entire sub-Saharan region, while utilizing country case studies to elaborate each of the main issue areas. Designed as an upper-level seminar, the course will focus on discussion and debate of weekly reading assignments. Prior coursework in African Politics is desired, but not required.

**NS4313 Government and Security in West Africa (4-0) Spring**

This course introduces students to government and politics in West Africa, with an emphasis on political, economic, and social change since the end of the Cold War. Why are some countries in the sub-region making peaceful progress toward democratic consolidation while others are dissolving into violent conflict? How does the coexistence of zones of conflict and peace affect regional security? Prerequisites: None.

**NS4315 Security and Politics in Iran (4-0) Summer/Winter**

Iran has been one of the most important countries in the Middle East region. It is located strategically, connecting the Caucasus and Central Asia to the Persian Gulf on the one side, and South Asia to the Arab Middle East on the other. Iran is home to one of the principal languages and cultures of the region. It is also one of the most populous countries in the Middle East with one of the largest economies. Iran has been a politically and strategically significant country for most of the past century. It was a frontline state during the Cold War. It was the scene of a major revolution that changed the face of the Muslim world and the relations between the United States and regional powers. Since 1979, Iran has been an avowedly Islamic state that has been engaged in a protracted war with the West. However, Iran has also witnessed profound political, social, and cultural changes that can be consequential for the future of the region. This course provides an overview of Iranian politics. It also uses social science theory to examine what factors have determined the evolution of Iranian politics, and how those developments in turn change our views on political change in the Muslim world and beyond. Prerequisites: None.

**NS4320 Islamic Fundamentalism (4-0) Summer**

A research seminar on the ideology and practice of Islamic fundamentalists in the Middle East. Students read primary

source translations of major fundamentalist ideologues, such as Ayatollah Khomeini and Sayyid Qutb, in addition to focusing on the strategies and histories of specific fundamentalist groups. Students will conduct and present original research on this topic. Prerequisites: NS3000 or consent of instructor.

**NS4321 U.S. Interests and Policies in Africa (4-0) Fall**

This course examines U.S. foreign policy in Sub-Saharan Africa since 1960, with emphasis on the post-Cold War period. Prerequisites: None.

**NS4322 Seminar on U.S. Security Strategy in the Middle East and Persian Gulf (4-0) Spring**

Examines current United States security strategy in the Middle East and Persian Gulf region. Prerequisites: None.

**NS4325 War in the Middle East (4-0) Spring**

This course studies the international history of the Middle East and North Africa since the fall of the Ottoman Empire, with a particular focus on the origin, conduct, and consequences of the region's major wars. Prerequisites: None.

**NS4327 Southern African Politics (4-0) Fall**

The countries of the Southern African region are closely linked by economics, social demographics, and history. This course will examine the dynamics of Southern Africa combining detailed studies of individual countries with themes that cross the region, such as migration, trade, regional security, economic development, and post-conflict reconstruction. Some of the topics we will cover include attempts by Southern African countries to strengthen regional integration; the role of South Africa as local hegemony; how recent events in Zimbabwe have impacted on regional dynamics; democratization and demobilization in South Africa, Namibia and Mozambique, and the peace process in Angola. Designed as an upper-level seminar, the course will focus on discussion and debate of weekly reading assignments. Prior coursework in African Politics is desired, but not required. Prerequisites: None.

**NS4328 Government and Security in the Horn of Africa (4-0) Summer**

Addresses government and security issues in the Horn of Africa. Its main focus is on how conflicts in the region -- persistent civil war in Sudan, state collapse in Somalia, contentious ethnic politics and secessionist movements in Ethiopia and Djibouti, state formation processes in (internationally recognized) Eritrea and (internationally unrecognized) Somaliland -- interact to produce a particularly challenging regional security environment. We conclude with a consideration of what this regional security environment means for the War on Terrorism, as well as how the War on Terrorism is impacting the regional security environment. Prerequisites: None.

**NS4332 Ethnicity and Ethnic Conflict in the Developing World (4-0) Spring**

The goal of this course is to examine issues of ethnicity and ethnic identity as they relate to conflict and democracy in the non-Western world. This course will be offered as an elective that will fit in with the regional studies curricula for students in the Africa, Latin America, Middle East, and Asian curricula in the NS department. The course will provide students with the theoretical tools and approaches to the study of ethnicity and ethnic conflict in multiple-country contexts. The course is divided into three main subject areas: (1) the

nature of ethnicity, (2) the nature of and explanations for ethnic conflict, and (3) solutions to ethnic conflict. Weekly course readings present a mix of theoretical approaches and case studies, and will cover all the major areas of the world: Africa, the Middle East, Latin America, Asia, and Eastern Europe. Prerequisites: None.

**NS4361 Government and Politics in Egypt, Turkey and Israel (4-0) Winter**

Examines the government and politics of Egypt, Turkey and Israel. Prerequisite: None.

**NS4410 Seminar on Security Issues in Russia, Eastern Europe and Central Asia (4-0) Fall**

This advanced seminar addresses the security problems of the successor states to the former Soviet Union, focusing on the military, the security environment, political culture, Russian and non-Russian nationalism, and the relationship between domestic and foreign policies. Prerequisites: NS3400 or NS3410, or NS3450, or consent of instructor.

**NS4415 Seminar on Security Issues in Central Asia (4-0) Winter**

For the purpose of this course, Central Asia refers to Kazakhstan Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The seminar will consist of three parts. In the first part, the students will gain a general background in history of Central Asia. In the second part, the students will survey the current situation in Central Asia. The seminar sessions in the third part of the course will be dedicated to presentations of students' research. Prerequisites: None.

**NS4425 Russian Foreign Policy (4-0) Spring**

This advanced seminar introduces theoretical approaches to the study of foreign policy and focuses on the content of post-Soviet Russia's foreign policy. Students will learn what Russia's foreign policy consists of and who or what makes it. The course aims to give students a greater ability to analyze the critical determinants of foreign policy and an in-depth understanding of the various aspects of contemporary Russia's foreign policy interests. Prerequisites: None.

**NS4501 Politics, Film and Fiction in Latin America (4-0) Spring**

This course explores how Latin American film and fiction has portrayed politics. Specific novels, short stories and films (all with a political context) will be compared with social scientific readings analyzing the same topics. All movies will be in Spanish with English subtitles. All readings will be available in Spanish and English versions. Prerequisites: NS3501.

**NS4502 Russian Film and Fiction (4-0) Summer**

Examination of Russian culture through that country's film and fiction. Prerequisites: None.

**NS4510 Seminar on Latin America Government and Politics (4-0) Fall**

An advanced seminar on Latin American politics in government. The topics analyzed include those of most current relevance including political transitions, the changing role of different political movements and institutions, and the prospects for economic growth and political stability. Prerequisites: NS3510 or NS3520, or consent of instructor.

**NS4540 The Political Economy of Latin America (4-0) Spring**

This course examines the complex relationship between politics and economics in Latin America. The course is structured around two overarching sets of questions. First, how can political science help us understand the economic development strategies that Latin American countries have pursued at different points in time? How have political actors and forces shaped the paths of economic development and what national patterns have emerged in the conflict over economic policy making? Second, reversing the direction of causation, when these economic development strategies succeed or fail, what is the impact on politics across Latin America? How has the pursuit of different economic ideologies, ranging from Marxism to neo-liberalism, altered politics in the region? Prerequisites: None.

**NS4560 Seminar on Latin American Security Issues (4-0) Summer**

A research seminar on security issues in contemporary Latin America. Students focus on challenges to regional security, regime stability, and public safety. Students conduct and present original research on selected issues concerning Latin American security. Prerequisites: NS3510 or NS3520, NS3024 or consent of instructor.

**NS4610 Asian Seminar: United States-Asian Relations (4-0) Fall**

Overview of the current state of U.S.-Asia relations. Prerequisites: None.

**NS4620 Seminar on the Chinese People's Liberation Army (4-0) As Required**

This course is a reading seminar on the evolution of the PRC's military and its domestic and foreign policy roles. It reviews the evolution of Maoist and post-Mao security strategies, military decision making, professionalism versus politicization of the army, the calculus of deterrence and the use of force in PRC foreign policy, and party-army and civil military relations. Prerequisites: None.

**NS4621 Political and Ethnic Violence in Southeast Asia (4-0) As Required**

The course will examine the sources, evolution and outcomes of political violence in Southeast Asia in the post-World War II period. We will explore the reasons for violence, its manifestations, and the various instruments that might be used hasten its end. Readings will include classic works on violence and war in the region, along with important contemporary analyses of ongoing conflicts. Throughout the course, we will investigate the evolution of war and other forms of large-scale violence, especially within states and as perpetrated by states against citizens. We will focus on Cambodia, Indonesia, Burma, Thailand and the Philippines. Prerequisites: None.

**NS4630 Seminar on Northeast Asian Security (4-0) Summer**

Advanced study of and research on regional and global security interests of the states of Northeast Asia. The focus is on Japan, North Korea, and South Korea in contemporary affairs and their policy options for the future. Prerequisites: NS3662 and NS3663 or consent of instructor.

**NS4640 Seminar on Wars in Asia (4-0) As Required**

This course studies the history of war and international relations in South Asia and the Asia-Pacific region in the nineteenth and twentieth centuries. It emphasizes the relationship between military action and political developments within the region, and also seeks to explore the impact of regional developments on the larger world system. Students will write an independent research paper in this class. Prerequisites: Consent of instructor.

**NS4641 Political and Ethnic Violence in South East Asia (4-0) Summer**

This course will examine the sources of political and ethnic violence in the South East Asia region. Prerequisites: NS3620.

**NS4645 Asian Security: Theory and Practice (4-0) Summer**

East Asia contains four "great powers," three-plus nuclear powers, two countries still divided since WWII, and several of the most dynamic economies on the globe. This course considers the prospects for war and peace in this complex constellation of powers in the current era. Will the U.S. and China become rivals? What are the prospects for stability on the Korean Peninsula and in the Taiwan Strait? Will Japan become a "normal" nation? What role do nuclear and other WMD play in shaping regional affairs? Why are security institutions so few in East Asian Security affairs? Is international cooperation fundamentally different in East Asia? What is the nature of civil-military relations across the countries of the region? Each of these questions will be addressed. The course will begin with a brief discussion of international security theory before turning toward specific regional security topics. Throughout the semester we will make use, however, of theoretically informed arguments regarding East Asian security issues. Prerequisites: None.

**NS4660 Seminar on Asia in World Affairs (4-0) Spring**

Advanced study of Asia's contemporary economic, security, diplomatic, and cultural roles in world affairs, with special emphasis upon the policy interaction of China, Japan, India and other key states with the United States, Russia, Europe and the developing world. Prerequisites: A NS3000-level course on Asia, or consent of instructor.

**NS4661 Contemporary Afghan Politics (4-0) Spring**

This course will explore recent developments in Afghan politics during the 1990s through 2005, including a detailed analysis of the 2004 Presidential and 2005 Parliamentary elections. Prerequisites: None.

**NS4662 Seminar on the Politics of South East Asia (4-0) Spring**

Advanced seminar on the contemporary politics of South East Asia. Prerequisites: None.

**NS4663 Politics and Security in South West Asia (4-0) Winter**

This seminar is focused on the political and security dynamics of three countries: Afghanistan, Iran and Pakistan. No other region in recent history has undergone greater or more rapid transformation than these three contiguous countries, tied through history, geography, politics and the nature of people. Internal schisms—ethnic and religious—have posed challenges to the state power in the past five decades. And as each state grapples with several internal challenges, each poses security challenges to the others. This complex interplay—of

intrigues, proxies, and the involvement of outside regional and global powers—has made the region a hotbed for instability, a focal point and conduit for global terrorism, drug production and trafficking, and weapons proliferation and, consequently, a challenge for international security. Prerequisites: None.

**NS4664 Religious Activism in South Asian Politics (4-0) Summer**

The Events of September 11 have underscored the importance of religious activism in South Asian politics. These movements have impacted regional politics and international security and are likely to continue to do so in the years to come. This course aims to provide students with an in depth understanding of the role of religion in South Asian politics by familiarizing them with the historical context for religion's involvement in South Asian politics, introducing the important actors, key ideas, and major events. The course will deal with both Islamic and Hindu religious movements in the Afghanistan-Pakistan-India arc. This will provide a comprehensive approach to the topic and will provide students with a comparative framework to analyze relevant issues. The course will use important works in the disciplines to provide a historical framework for the study of religion and politics in South Asia. Prerequisites: None.

**NS4667 Political Development in South Asia (4-0) Spring**

This course covers a selected range of topics for understanding current South Asian political developments and towards answering the larger question of why South Asia is the way it is: What are the internal and external structures and institutions in South Asian countries that shape their political activities and stance? In this course we study contemporary issues in the context of regional, national, and local political developments in India, Pakistan, Bangladesh, Nepal, and Sri Lanka. This will assist in thinking relationally and comparatively across nations of the region, as well as provide an understanding of different movements and events that shape this region. Prerequisites: None.

**NS4668 Security in South Asia (4-0) Summer**

The seminar places particular emphasis on the conditions affecting the occurrence, conduct, and aftermath of war in the region. Topics covered in the seminar include the independence of India and Pakistan in 1947 and the creation of political, ethnic, religious, and territorial disputes between the two countries; ethnic and religious sources of instability in the region; civil-military relations; South Asia during the Cold War; South Asia and the global war against terrorism; the foreign relations of India and Pakistan with the United States, Russia, China, and neighboring countries; the origins and military conduct of the three India-Pakistan wars; and the acquisition of nuclear weapons by India and Pakistan and their impact on regional security and international stability. Depending on student interest, the course also will cover security dynamics of smaller South Asian states (Afghanistan, Bangladesh, Nepal, Sri Lanka, and Bhutan). Prerequisites: None.

**NS4669 Conflict and Cooperation in World Politics (4-0) Spring**

NS4669 is a required core course for students in the Defense Decision Making and Policy Curriculum (689C), which is part of the Security Studies Curriculum (689) in the National Security Affairs Department; the course can also be taken as

an elective by other students. The course introduces students to representative literature on key topics in the fields of strategic studies and security studies. The course is taught as a research seminar. It is organized around four main topic areas: the parameters of strategic studies and security studies, and alternative definitions of security; alternative approaches to maintaining order at a regional or global level, with the main focus on the prospects for stability when there is a hegemonic power; the concept of strategic culture; and the effectiveness of alternative strategies for influencing states in bilateral relations so as to reduce security threats and the chances of military conflict. Prerequisites: None.

**NS4690 Seminar on International Security Issues of Asia (4-0) Winter**

Advanced study of Asian security issues with special emphasis on the balance of forces, regional and external alliances, prospects for conflict, and Asian concepts of security and strategy. Prerequisites: A NS3000-level course on Asia, or consent of instructor.

**NS4710 Seminar on European Politics (4-0) Spring**

A research seminar on politics in contemporary Europe. Students conduct and present original research on selected issues concerning European politics, with an emphasis on defense and security problems. Prerequisites: NS3710 or consent of instructor.

**NS4720 Seminar on European Security Issues (4-0) Spring**

A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. Prerequisites: NS3720 or consent of instructor.

**NS4722 Special Topics in European Security Issues (4-0) Winter**

Upper level seminar that debates advanced issues in European Security. Specifics topic vary by instructor. Prerequisites: None.

**NS4801 International Terrorism (4-0) Spring/Winter**

This course attempts to provide a broad sweep of the field of terrorism. We explore general issues—the structure of terrorist groups, the motivation of those who join, the patterns of authority and decision making within groups, the impact of different types of operations on governments and the public. In the second portion of the course, we discuss in greater depth the campaigns of a few selected terrorist organizations. We will also look at what some scholars call the “new” terrorism. Prerequisites: None.

**NS4802 The Intelligence Dimension of Counterterrorism (4-0) Spring**

The Intelligence Dimension of Counterterrorism. This course examines the intelligence process, organizational structure and related policy issues at the operational level of counterterrorism operations. The course addresses the conduct of intelligence collection, threat analysis, assessment, and dissemination. Particular attention is devoted to the inter-agency process, international (combined) intelligence sharing, data fusion, data mining, intelligence oversight and legal issues.

**NS4880 Seminar on Legal and Military Responses to Political Violence (4-0) Fall**

The course will first review the variety of legal and military policy options open to any state that confronts political violence, with particular attention to short versus long-term consequences of different policy options. It then analyzes a few individual cases (the British in Ulster, violence in Spain) in depth, in order to assess how different policy options combine or cancel each other. Prerequisites: Consent of instructor.

**NS4900 Seminar on International Negotiations (4-0) Summer**

Advanced study in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security. Prerequisites: NS3900 or consent of instructor.

**NS4903 Ethics: Good in Theory (4-0) Spring/Fall**

Ethics is not simply distinguishing right from wrong—more often it is a choice of which is more right - or less wrong. Most of the time we think we know what is right—other times we read the news and wonder how good officers find themselves making ethically poor decisions. And as we move from junior officer to senior are, the issues different? How does a good XO make tough choices? As we move from operational focus to the policy arena, do the standards change? When it is up to us to decide, how do we take apart the difficult issues to make a better choice—a choice that will not come back to bite us, whether it is our conscience or outside authorities doing the biting? We will explore classic theories, common sense, and fresh ideas to widen our options as we climb the professional responsibility ladder. Prerequisites: None.

**NS4904 Right Across Cultures: Comparative Ethics in the World's Religions and Philosophies (4-0) Summer/Winter**

This course will examine where the concept of something being right began and how it has evolved over the ages, paying particular attention to the religions and philosophies of various cultures and how they have influenced that society's sense of what is right. We will explore the distinctives of the world's major religions, and the cultures we are most likely to deal with in the military, as well as the significance of fundamentalism in all religions. We will look at tools for planning, negotiation and meaningful dialogue in many settings. Prerequisites: None.

**NS4920 Special Topics in Civ-Mil Relations (4-0) Summer**

Selected special issues in Civ-Mil relations. Prerequisites: None.

**NS4930 Media and War (4-0) Spring**

This seminar will analyze the interaction between the media, both in the United States and abroad, and society during wartime. Prerequisites: None.

**Regional Security Studies - Middle East, Africa, and South Asia - Curriculum 681****Program Officer**

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**Brief Overview**

The Department of National Security Affairs offers a comprehensive master's degree program in Regional Security Studies, tailored to the intellectual needs and institutional requirements of the U.S. armed forces and related federal agencies and departments. We provide fully accredited curricula concentrating on Europe and Eurasia, Asia, Africa, Latin America, and the Middle East, in an academic environment that includes students from all the U.S. armed services, other government departments, and many foreign countries.

The sections that follow indicate the course requirements of the Regional Studies Middle East, Africa, and South Asia track, including NSA core requirements, track-specific core requirements, and track elective courses of which several must be completed. Requirements vary depending upon whether a student concentrates on the Middle East, Africa, or South Asia.

**Requirements for Entry**

Students may enter our curricula in any academic quarter. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S.

Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

**Entry Date**

A flexible schedule, based on quarter system combined with year-round teaching, allows students to enter the program in January, April, July, or October.

**Degree**

Master of Arts in National Security Affairs

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

- Defense Attaché
- Foreign Area Officer
- Intelligence Officer
- Plans Officer, Staff Planner
- Various joint command positions
- Service Headquarters - Political / Military officers
- Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements**

**NSA Core Requirements**

- NS3000 War in the Modern World
- NS3023 Introduction to Comparative Politics
- NS3024 Introduction to International Relations
- NS3040 Politics of Global Economic Relations; or NS3041, Comparative Economic Systems
- NS2011 Policy Analysis and Research Methods

**Curricular Core Requirements**

*Middle East specialists*

- NS3300 Islam
- NS3310 History of Modernizing Middle East, 1800-1958
- NS3320 U.S. Foreign Policy in the Middle East
- NS3330 Contemporary Politics in the Middle East
- NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

*Africa specialists*

- NS3301 History and Cultures of Sub-Saharan Africa
- NS3311 Government and Politics in Sub-Saharan Africa
- NS4301 Seminar on African Political Economy
- NS4321 U.S. Policy Toward Africa
- NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

*South Asia specialists*

- NS3668 Politics and Security in South Asia
- NS4664 Religious Activism in South Asia or
- NS4230 Islamic Fundamentalism
- NS4667 Seminar on Political Development in South Asia
- NS4668 Seminar on Security in South Asia

- NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

**Curricular Electives**

*Middle East specialists*

Four of the following, of which at least two must be at the 4000-level.

- NS3340 International and Regional Economy of the Middle East
- NS3360 Politics and Security in North Africa
- NS3361 Politics and Security in the Levant
- NS3362 Politics and Security in the Northern Tier
- NS3365 Politics and Security in the Persian Gulf
- NS4021-29 Special Topics (region-specific titles)
- NS4300 Social Mobilization and Conflict in the Middle East
- NS4305 Military, Polity, and Society in the Middle East
- NS4310 Seminar in Middle East Security
- NS4315 U.S. Policy and the Islamic Republic of Iran
- NS4320 Islamic Fundamentalism
- NS4325 War in the Middle East
- NS4328 Government and Security in the Horn of Africa
- NS4332 Ethnicity and Ethnic Conflict in the Developing World
- NS4361 Politics and Government in Egypt and Turkey
- NS4369 Seminar on Politics and Security in Israel
- SO4830 Low-Intensity Conflict: Middle East

*Africa specialists*

Students must complete four of the following courses, two of which must be at the 4000 level.

- NS3351 Anthropology of Africa
- NS3361 Politics and Security in North Africa
- NS4311 Contemporary Issues in African Politics
- NS4327 Southern African Politics
- NS4328 Government and Security in the Horn of Africa
- NS4332 Ethnicity and Ethnic Conflict in the Developing World
- NS4313 Government and Security in West Africa
- SO4820 Low Intensity Conflict: Africa

*South Asia specialists*

Students must complete four of the following courses, of which at least two must be at the 4000 level:

- NS3300 Islam
- NS3363 Politics and Security in the Northern Tier
- NS3635 Asian Civil-Military Relations
- NS3640 Asian Human Rights
- NS3667 Chinese Foreign Policy
- NS4021-29 Special Topics (region-specific)
- NS4020 Seminar on the Chinese PLA
- NS4320 Islamic Fundamentalism
- NS4332 Ethnicity and Ethnic Conflict in the Developing World
- NS4640 Seminar on Wars in Asia
- NS4660 Seminar on Asia in World Affairs
- NS4663 Politics and Security in Afghanistan, Pakistan and Iran
- NS4667 Seminar on Political Development in South Asia
- NS4669 Seminar on U.S. Policy Toward South Asia
- NS4690 Seminar on International Security Issues of Asia



**General Electives**

General electives may be selected from among all courses in the Department of National Security Affairs or, with permission of the Academic Associate, from such courses in other departments and groups. The number of general electives available to a student varies with service affiliation, length of stay, and other factors.

**Typical Course of Study**

18 Month Program [non-sequential; **Middle East Specialization**]

**Quarter 1**

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3310	(4-0)	History of the Modernizing Middle East, 1800-1958
--	(4-0)	NS General Elective or JPME (USN)
NS2011*	(2-0)	Policy Analysis & Research Methods

**Quarter 2**

NS3024	(4-0)	Introduction to International Relations
NS3320	(4-0)	U.S. Foreign Policy in the Middle East
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

**Quarter 3**

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3330	(4-0)	Contemporary Politics in the Middle East
--	(4-0)	NS General Elective or JPME (USN)
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective

**Quarter 4**

NS3300	(4-0)	Islam
NS4255	(4-0)	Naval History and Maritime Strategy (req. USN) or Elective
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective

**Quarter 5**

NS0810	(0-4)	Thesis Research
	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective
	(4-0)	NS General or Curricular Elective

**Quarter 6**

NS0810	(0-4)	Thesis Research
NS0810	(0-4)	Thesis Research
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

12 Month Program [non-sequential; **Middle East Specialization**]

**Quarter 1**

NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or General Elective
NS3000	(4-2)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3310	(4-0)	Historical Survey of the Middle East
NS2011*	(2-0)	Research Methods

**Quarter 2**

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3024	(4-0)	Introduction to International Relations
NS3320	(4-0)	U.S. Foreign Policy in the Middle East
--	(4-0)	NS General or Curricular Elective

**Quarter 3**

NS3330	(4-0)	Contemporary Politics in the Middle East
NS3300	(4-0)	Islam
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

**Quarter 4**

NS0811	(0-0)	Comprehensive Examination
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

Plus language to fulfill sponsor requirements as necessary.  
*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

18 Month Program [non-sequential; **South Asia Specialization**]

**Quarter 1 \***

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3668	(4-0)	Politics and Security in South Asia
--	(4-0)	NS General Elective or JPME (USN)
NS2011	(2-0)	Policy Analysis & Research Methods

**Quarter 2**

NS4668	(4-0)	Seminar on Security in South Asia
NS3024	(4-0)	Introduction to International Relations
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

**Quarter 3**

NS4667	(4-0)	Seminar on Political Development in South Asia
NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
--	(4-0)	NS General Elective or JPME (USN)

NW3230 (4-2) Strategy and Policy SECNAV (USN/USMC only) or Elective -- (4-0) NS General or Curricular Elective

**Quarter 4**

NS4664 (4-0) Religious Activism in South Asia or NS4320 Islamic Fundamentalism  
 NS4255 (4-0) Naval History and Maritime Strategy (req. USN) or Elective  
 -- (4-0) NS General Elective or JPME (USN)  
 -- (4-0) NS General or Curricular Elective

**Quarter 5**

NS0810 (0-4) Thesis Research  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

**Quarter 6**

NS0810 (0-4) Thesis Research  
 NS0810 (0-4) Thesis Research  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

12 Month Program [non-sequential; **South Asia Specialization**]

**Quarter 1 \***

NS3000 (4-0) War in the Modern World  
 NS3023 (4-0) Introduction to Comparative Politics  
 NS3368 (4-0) Politics and Security in South Asia  
 -- (4-0) NS General or Curricular Elective  
 NS2011\* (2-0) Policy Analysis & Research Methods

**Quarter 2**

NS4668 (4-0) Seminar on Security in South Asia  
 NS3024 (4-0) Introduction to International Relations  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective  
 NS4080\* (2-0) Research Colloquium

**Quarter 3**

NS4667 (4-0) Seminar on Political Development in South Asia  
 NS3040 (4-0) Global Economic Relations or NS3041 Comparative Economic Systems  
 NW3230 (4-2) Strategy and Policy SECNAV (USN/USMC only) or Elective  
 -- (4-0) NS General or Curricular Elective

**Quarter 4**

NS0811 (0-0) Comprehensive Examination  
 NS4664 (4-0) Religious Activism in South Asia or NS4330 Islamic Fundamentalism  
 -- (4-0) NS General or Curricular Elective

-- (4-0) NS General or Curricular Elective  
 \* Overload

Plus language to fulfill sponsor requirements as necessary.  
*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

18 Month Program [non-sequential; **Africa Specialization**]

**Quarter 1**

NS3000 (4-2) War in the Modern World  
 NS3023 (4-0) Introduction to Comparative Politics  
 NW3230 (4-2) Strategy and Policy SECNAV (USN/USMC only) or Elective  
 -- NS General or Curricular Elective

NS2011\* (2-0) Research Methods

**Quarter 2**

NS3040 (4-0) Global Economic Relations or NS3041 Comparative Economic Systems  
 NS3024 (4-0) Introduction to International Relations  
 NS4301 (4-0) Seminar on African Political Economy  
 NS3311 (4-0) Government and Politics in Sub-Saharan Africa

**Quarter 3**

NS4321 (4-0) Seminar in U.S. policy Towards Africa  
 NS4255 (4-0) Naval History and Maritime Strategy (req. USN) or Elective  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

**Quarter 4**

NS0811 (0-0) Comprehensive Examination  
 NS3301 (4-0) History and Cultures of Sub-Saharan Africa  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

**Quarter 5**

NS0810 (0-4) Thesis Research  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

**Quarter 6**

NS0810 (0-4) Thesis Research  
 NS0810 (0-4) Thesis Research  
 -- (4-0) NS General or Curricular Elective  
 -- (4-0) NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

## Typical Course of Study

12 Month Program [non-sequential; **Africa Specialization**]

### Quarter 1

NS3000	(4-2)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective NS General or Curricular Elective
--		
NS2011*	(2-0)	Research Methods

### Quarter 2

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3024	(4-0)	Introduction to International Relations
NS4301	(4-0)	Seminar on African Political Economy
NS3311	(4-0)	Government and Politics in Sub-Saharan Africa

### Quarter 3

NS4321	(4-0)	Seminar in U.S. policy Towards Africa
--		NS General or Curricular Elective
--		NS General or Curricular Elective
--		NS General or Curricular Elective

### Quarter 4

NS0811	(0-0)	Comprehensive Examination
NS3301	(4-0)	History and Cultures of Sub-Saharan Africa
--		NS General or Curricular Elective
--		NS General or Curricular Elective

\* Overload

Plus language to fulfill sponsor requirements as necessary.  
Overall program must include 16 hours of work at the 4000-level.

## Educational Skill Requirements (ESR)

### 1. Basic Graduate Level Skills:

Core and elective courses on:

- Research:** Be proficient at assembling information from the full range of data sources applicable to analyzing, understanding, and explaining international political, economic, and military events. (NS2011, NS4080 and NS4000 level courses)
- Analysis:** Be able to logically combine data and theory to analyze and explain international political, economic, and military events and to formulate innovative solutions to strategic problems. (NS2011, NS4080 and NS4000 level courses)
- Communications:** Be able to clearly summarize large quantities of information and

persuasively present recommended policy positions and courses of action using a broad range of verbal and written communications formats, including short and concise statements of the strongest or most pertinent facts and recommendations (e.g., short oral arguments or written summaries such as position/talking point papers) and comprehensive, fully documented presentations of all pertinent facts, hypotheses, and conclusions (e.g., academic theses). (NS4080 and NS4000 level courses)

### 2. General Political Science, International Relations and Security Studies:

Core and elective courses on:

- International and Comparative Politics:** Understand the conditions, events, and ideas that shape the interactions of nation-states and other actors in the international system. Know the history and major theories explaining international relations (including realism, cognitive, and cultural paradigms) and be able to use this knowledge to analyze and explain international and domestic issues. (NS3023 and NS3024)
- The International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure. (NS3040 or NS3041)
- Diplomatic History:** Know origins and development of diplomatic relations between the countries of the world, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords. (NS3000)
- International Law and Organizations:** Know the rudiments of international law, including the law of the sea and the laws of armed conflict. Understand the history of international organizations and their role in international politics and the theory and practice of international mediation and negotiations, formal and informal security arrangements, treaty regimes, international law, and their impact on U.S. military planning and rules of engagement, including the role and impact of non-governmental organizations on peacekeeping and

- humanitarian operations. (NS3024 and/or NS3900)
- e. **U.S. Public Management and Organization:** Know the theory and practice of management in the U.S. public sector, including strategies and tactics of executive branch management, organizational change and adaptation, and problems of leadership in civilian branches and agencies, including Congress. (NWC courses or NS3037 or NS3030)
  - f. **Military History and Defense Organization:** Know rudiments of U.S. and world military history, including the origins and evolution of current U.S. security policy and strategy. (NS3000)
  - g. **U.S. Security Policy and Strategy:** Understand the formulation and execution of U.S. national security policy and strategy, including interactions among the executive departments and agencies and between the executive and legislative branches of government in policy, strategy, and budget decisions. (NWC courses, NS3030 or NS3037)
3. **Professional Joint Military Education**
    - a. **National Military Capabilities and Command Structure:** Understand the capabilities and limitations of U.S. military forces; the organizational framework within which joint forces are employed; the purpose, roles, functions, and relationships of the President, National Security Council, Chairman of the Joint Chiefs of Staff, Joint Chiefs of Staff, combatant commanders, Joint Force Commanders (JFCs), and combat support organizations; joint force command relationships and directive authority for logistics support joint war-fighting capabilities; and how the U.S. military is organized to plan, execute, sustain, and train for joint, interagency, and multinational operations. (NWC)
    - b. **Joint Doctrine:** Understand current joint doctrine, the factors influencing joint doctrine, the relationship between Service and joint doctrine, and be able to formulate and defend solutions to operational problems using current joint doctrine. (NWC)
    - c. **Joint and Multinational Forces at the Operational Level of War:** Understand the relationships among national objectives, military objectives, and conflict termination; the relationships among the strategic, operational, and tactical levels of war; how theory and principles of war apply at the operational level; the considerations for employing joint and multinational forces at the operational level; and be able to plan for the operational level employment of joint forces. (NWC)
    - d. **Joint Planning and Execution Processes.** Understand the fundamentals of campaign planning; the relationship between national objectives and available means through the framework of joint planning processes; the effect of time, coordination, policy changes, and political developments on the planning process; how defense planning systems affect joint operational planning; and how national, joint, and Service intelligence organizations support JFCs. (NWC)
  4. **SECNAV Requirements for all Navy Students at Naval Postgraduate School:**  
NWC course on:
    - a. **Naval Power and Policy:** Understand the historical, current and evolving elements of maritime strategy; including an analysis and comparison of present and emerging tactical and strategic naval doctrine as well as an analysis of emerging technical developments and their potential effect upon the prosecution of tactical and strategic naval warfare by the United States, our allies and our potential adversaries. (NW3230)
  5. **Strategic Planning:**  
To include a focus on one of the following five areas:
    - a. **Coalitions and Combined Military Operations:** Know the facts and theories behind the principal alliances and international organizations shaping the current security environment, including their role in U.S. national strategy. Understand problems of coalition warfare and combined operations across the full range of military missions, from peace operations to major war. (NS3026, NS4026, or NS4235)
    - b. **Proliferation and Counter-proliferation of Weapons of Mass Destruction (WMD):** Understand the implications of WMD proliferation for the security of the United States and other countries; why states and other actors seek nuclear, chemical, and/or biological weapons and associated delivery systems, and the strategic effects in different regions of WMD proliferation; and the successes and limitations of traditional

- nonproliferation efforts, and limitations and potential for success of new military measures designed to counter WMD proliferation. (NS4280, NS4282, or NS4285)
- c. **Nuclear Strategy:** Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations. (NS3280)
  - d. **Military Innovation and Transformation:** Understand the basic dynamics of military innovation as social, political, strategic, and operational problems; including the role of technological, conceptual and organizational innovation in producing revolutionary changes in the conduct and character of warfare, necessary for sustaining United States competitive advantage in the 21st century security environment. (NS3021)
  - e. **Maritime Strategy:** Understand the role of sea power and maritime strategy in the international system, and the use of naval forces in the conduct of war; including naval armaments, arms races, and arms control, gunboat diplomacy, law of the sea, littoral and amphibious operations, naval aviation and strategic naval forces. (NS 4255)
6. **Regional Security Studies:** Core and elective courses available on customized list for each major region:
    - a. **Regional Politics, History and Culture:** Understand major political systems, historical background, political culture, religion, and prevalent political ideologies and their impact on regional security, as well as the influence of ethnic, cultural, and religious values on security situations (NS3600, NS3601, NS3602, NS3620, NS4722)
    - b. **Emerging Security Challenges:** Understand the major global and regional security issues, including political and military relationships between states, especially the potential for military conflict, insurgencies and terrorism, social and economic problems, and other issues affecting the security of nations and regions. Know the regional sources of political and social instability and violence, including ethnic conflict, and their influence on regional security planning and U.S. national security policy (NS3600 series or NS4600 courses).
    - c. **Regional Conflict:** Understand the characteristic patterns of violent conflict in the region, the likely sources and character of regional wars in the present and future, and the historical and prospective impact of such wars on the international system as a whole (NS3600 series, NS4600, or NS4640).
    - d. **Military Forces and Strategic Posture:** Understand the main factors determining the strategic postures of countries in the region, including strategic culture and goals, threat perceptions, and military force structures (NS3600 series, NS4600 series, or NS4640, or NS4690).
    - e. **U.S. Regional Security Policy:** Understand the U.S. foreign policy objectives and political, economic, and military strategy, including U.S. engagement policy, for the region; the formulation of U.S. policy for the region, including the role of Congress and the interagency process; and U.S. security assistance programs relevant to the region. (NS3600 series, NS4600 series, NS4660, NS4669)

## Regional Security Studies - Far East, Southeast Asia, and the Pacific - Curriculum 682

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### Brief Overview

The sections that follow indicate the course requirements of the Regional Studies Far East, Southeast Asia, and the Pacific track, including NSA core requirements, track-specific core requirements, and track elective courses of which four must be completed.

### Requirements for Entry

Students may enter our curricula in any academic quarter. Students must have obtained their bachelor's

degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

**Entry Date**

A flexible schedule, based on quarter system combined with year-round teaching allows students to enter the program in January, April, July, or October.

**Degree**

Master of Arts in National Security Affairs

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

- Defense Attaché
- Foreign Area Officer
- Intelligence Officer
- Plans Officer, Staff Planner
- Various joint command positions
- Service Headquarters - Political / Military officers
- Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements**

**NSA Core Requirements**

- NS3000 War in the Modern World
- NS3020 Introduction to Comparative Politics
- NS3024 Introduction to International Relations
- NS3040 The Politics of Global Economic Relations; or NS3041, Comparative Economic Systems
- NS2011 Policy Analysis and Research Methods

**Curricular Core Requirements**

*Note: Where there is a choice in core classes, students specializing in Far East or Southeast Asia should take the class that matches their region of study.*

- NS3600 Modern History of East Asia OR NS3601 - History and Cultures of Southeast Asia
- NS3620 Survey of Asian Politics

- NS3621 International Relations of South East Asia OR NS4630 - Seminar on Northeast Asian Security
- NS3645 Political Economy of Asia
- NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

**Curricular Electives**

Four of the following [excluding courses chosen to satisfy the curricular core requirement], of which at least two must be at the 4000-level.

- NS3300 Islam
- NS3600 Modern History of East Asia (if not used for core requirement)
- NS3601 History and Cultures of Southeast Asia (if not used for core requirement)
- NS3602 U.S.-Asian Relations: 18<sup>th</sup> Century - WWII
- NS3621 International Relations of South East Asia (if not used for core requirement)
- NS3661 Government and Security in China
- NS3662 Government and Security in Japan
- NS3663 Government and Security in Korea
- NS3664 Government and Security in Southeast Asia
- NS3635 Asian Civil-Military Relations
- NS3667 Chinese Foreign Policy
- NS3668 Politics and Security in South Asia
- NS4021-29 Special Topics (region-specific). The following is not a comprehensive list.
- NS4020 Seminar on the Chinese PLA
- NS4025 Comparative Market Reform
- NS4028 Political Development in South East Asia
- NS4315 Central Asia
- NS4332 Ethnicity and Ethnic Conflict in the Developing World
- NS4415 Seminar in Security Issues in Central Asia
- NS4610 Asian Seminar: United States-Asian Relations
- NS4630 Seminar on Northeast Asian Security (if not used for core requirement)
- NS4640 Seminar on Wars in Asia
- NS4641 Political and Ethnic Violence in Southeast Asia
- NS4660 Seminar on Asia in World Affairs
- NS4661 Seminar on Democratization in Southeast Asia
- NS4662 Seminar on the Politics of Southeast Asia
- NS4667 Seminar on Political Development in South Asia
- NS4668 Seminar on Security in South Asia
- NS4690 Seminar on International Security Issues of Asia
- NS4730 Imperialism
- SO4860 Low-Intensity Conflict: The Far East

**General Electives**

General electives may be selected from among all courses in the Department of National Security Affairs or, with permission of the Academic Associate, from such courses in other departments and groups. The number of general electives available to a student varies with service affiliation, length of stay, and other factors.

**Typical Course of Study**

18 Month Program [non-sequential; **Far East Asia Specialization**]

**Quarter 1**

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3620	(4-0)	Survey of Asian Politics
--	(4-0)	NS General Elective or JPME (USN)
NS2011*	(2-0)	Policy Analysis & Research Methods

**Quarter 2**

NS3024	(4-0)	Introduction to International Relations
NS3600	(4-0)	Modern History of East Asia
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General Elective or JPME (USN)

**Quarter 3**

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

**Quarter 4**

NS4630	(4-0)	Seminar on Northeast Asian Security
NS4255	(4-0)	Naval History and Maritime Strategy (req. USN) or Elective
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective

**Quarter 5**

NS3645		Political Economy of Asia
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective
NS0810	(0-4)	Thesis Research

**Quarter 6**

NS0810	(0-4)	Thesis Research
NS0810	(0-4)	Thesis Research
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

12 Month Program [non-sequential; **Far East Asia Specialization**]

**Quarter 1**

NS3000	(4-2)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3620	(4-0)	Survey of Asian Politics
--	(4-0)	NS General or Curricular Elective
NS2011*	(2-0)	Policy Analysis & Research Methods

**Quarter 2**

NS3024	(4-0)	Introduction to International Relations
NS3600	(4-0)	Modern History of East Asia
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General or Curricular Elective

**Quarter 3**

NS3645	(4-0)	Political Economy of Asia
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

**Quarter 4**

NS4630	(4-0)	Seminar on Northeast Asian Security
NS0811	(0-0)	Comp Examination
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

Plus language training to fulfill sponsor requirements as necessary.

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

18 Month Program [non-sequential; **Southeast Asia Specialization**]

**Quarter 1**

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3620	(4-0)	Survey of Asian Politics
--	(4-0)	NS General Elective or JPME (USN)
NS2011*	(2-0)	Policy Analysis & Research Methods

**Quarter 2**

NS3024	(4-0)	Introduction to International Relations
NS3601	(4-0)	History and Cultures of Southeast Asia
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General Elective or JPME (USN)

**Quarter 3**

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS4255	(4-0)	Naval History and Maritime Strategy (req. USN) or Elective
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

**Quarter 4**

NS3621	(4-0)	International Relations of Southeast Asia
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

**Quarter 5**

NS0810	(0-4)	Thesis Research
NS3645		Political Economy of Asia

- (4-0) NS General or Curricular Elective
- (4-0) NS General or Curricular Elective

**Quarter 6**

- NS0810 (0-4) Thesis Research
- NS0810 (0-4) Thesis Research
- (4-0) NS General or Curricular Elective
- (4-0) NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

12 Month Program [non-sequential; **Southeast Asia Specialization**]

**Quarter 1**

- NS3000 (4-0) War in the Modern World
- NS3023 (4-0) Introduction to Comparative Politics
- NS3620 (4-0) Survey of Asian Politics
- (4-0) NS General or Curricular Elective
- NS2011\* (2-0) Policy Analysis & Research Methods

**Quarter 2**

- NS3024 (4-0) Introduction to International Relations
- NS3601 (4-0) History and Cultures of Southeast Asia
- NW3230 (4-2) Strategy and Policy SECNAV (USN/USMC only) or Elective
- (4-0) NS General or Curricular Elective

**Quarter 3**

- NS3645 (4-0) Political Economy of Asia
- (4-0) NS General or Curricular Elective
- (4-0) NS General or Curricular Elective
- (4-0) NS General or Curricular Elective

**Quarter 4**

- NS0811 (0-0) Comp Examination
- NS3621 (4-0) International Relations of Southeast Asia
- (4-0) NS General or Curricular Elective
- (4-0) NS General or Curricular Elective

\* Overload

Plus language training to fulfill sponsor requirements as necessary.

*Overall program must include 16 hours of work at the 400-level. All NSA curricula share the same Educational Skill Requirements. These are listed once in Regional Security Studies; Curriculum (681) - Middle East, South Asia, and Africa.*

**National Security Studies Western Hemisphere - Curriculum 683**

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**Brief Overview**

The sections that follow indicate the course requirements of the Regional Studies Western Hemisphere track, including NSA core requirements, track-specific core requirements, and track elective courses of which three must be completed.

**Requirements for Entry**

Students may enter our curricula in any academic quarter. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

**Entry Date**

A flexible schedule, based on quarter system combined with year-round teaching, allows students to enter the program in January, April, July, or October.

**Degree**

Master of Arts in National Security Affairs

**Subspecialty**

**Navy P-Codes:** 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

- Defense Attaché
- Foreign Area Officer
- Intelligence Officer
- Plans Officer, Staff Planner
- Various joint command positions
- Service Headquarters - Political / Military officers



Major staff jobs in Combatant Commands and Fleet Commands

### Course Requirements

#### NSA Core Requirements

NS3000	War in the Modern World
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
NS3040	The Politics of Global Economic Relations; or NS 3041, Comparative Economic Systems
NS2011	Policy Analysis and Research Methods

#### Curricular Core Requirements

NS3501	History and Cultures of Latin America
NS3510	Government and Politics in Latin America
NS3520	Latin American International Relations
NS4255	Naval History and Maritime Strategy (required for USN, otherwise elective)
NS4510	Latin American Democratization and Reform
NS4560	Latin American Security Issues

#### Curricular Electives

Students must complete three of the following:

NS3155	Intelligence and Democracy
NS3900	International Law and Organizations
NS4030-39	Special Topics (region-specific)
NS4225	Civil-Military Relations in Transitions to Democracy
NS4235	Seminar on Operations Other than War
NS4501	Film, Fiction and Politics of Latin America (Spanish and English language sections)
NS4540	Political Economy of Development in Latin America
NS4801	International Terrorism
NS4880	Legal and Military Responses to Political Violence
SO4850	Low-Intensity Conflict: Latin America

#### General Electives

General electives may be selected from among all courses in the Department of National Security Affairs or, with permission of the Academic Associate, from such courses in other departments and groups. The number of general electives available to a student varies with service affiliation, length of stay, and other factors.

#### Typical Course of Study

18 Month Program [non-sequential; **Western Hemisphere Specialization**]

##### Quarter 1

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3501	(4-0)	History and Cultures of Latin America
--	(4-0)	NS General Elective or JPME (USN)
NS2011*	(2-0)	Policy Analysis & Research Methods

##### Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3520	(4-0)	Latin American International Relations
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General Elective or JPME (USN)

##### Quarter 3

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3510	(4-0)	Government and Politics in Latin America
--	(4-0)	NS General Elective or JPME (USN)
--	(4-0)	NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

##### Quarter 4

NS4510	(4-0)	Seminar in Latin America Government and Politics
NS4560	(4-0)	Seminar in Latin American Security Issues
--		NS General Elective or JPME (USN)
--		NS General or Curricular Elective
--		NS General or Curricular Elective
NS4080*	(2-0)	Research Colloquium

##### Quarter 5

NS0810	(0-4)	Thesis Research
NS4255	(4-0)	Naval History and Maritime Strategy (req. USN) or Elective
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

##### Quarter 6

NS0810	(0-4)	Thesis Research
NS0810	(0-4)	Thesis Research
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

#### Typical Course of Study

12 Month Program [non-sequential; Western Hemisphere specialization]

##### Quarter 1

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3501	(4-0)	History and Cultures of Latin America
NS3520	(4-0)	Latin American International Relations
NS2011*	(2-0)	Policy Analysis & Research Methods

##### Quarter 2

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3024	(4-0)	Introduction to International Relations
NS4560	(4-0)	Seminar in Latin American Security Issues
--	(4-0)	NS General or Curricular Elective

**Quarter 3**

NS3510	(4-0)	Government and Politics in Latin America
NS4510	(4-0)	Seminar in Latin America Government and Politics
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General or Curricular Elective

**Quarter 4**

NS0811	(0-0)	Comprehensive Exam
NS4560	(4-0)	Seminar in Latin American Security Issues
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\*Overload

Plus language training to fulfill sponsor requirements as necessary.

*Overall program must include 16 hours of work at the 4000 level.*

All NSA curricula share the same Educational Skill Requirements. These are listed once in Regional Security Studies; Curriculum (681) - Middle East, South Asia, and Africa.

**National Security Studies - Russia, Europe, and Central Asia - Curriculum 684**

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**Brief Overview**

The sections that follow indicate the course requirements of the Regional Studies Russia, Europe, and Central Asia track, including NSA core requirements, track-specific core requirements, and track elective courses of which three must be completed. Requirements vary depending upon whether a student concentrates on Western Europe, or Eastern Europe and the states of the former Soviet Union.

**Requirements for Entry**

Students may enter our curricula in any academic quarter. Students must have obtained their bachelor's degree from an accredited academic institution. While

the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

**Entry Date**

A flexible schedule, based on quarter system combined with year-round teaching, allows students to enter the program in January, April, July, or October.

**Degree**

Master of Arts in National Security Affairs

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

Defense Attaché  
Foreign Area Officer  
Intelligence Officer  
Plans Officer, Staff Planner  
Various joint command positions  
Service Headquarters - Political / Military officers  
Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements**

**NSA Core Requirements**

NS3000	War in the Modern World
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
NS3040	The Politics of Global Economic Relations; or NS3041, Comparative Economic Systems
NS2011	Policy Analysis and Research Methods

**Curricular Core Requirements**

*Europe specialists*

NS3700	History of Modern Europe
NS3710	Government and Security in Europe
NS3720	European Security Institutions
NS4710	Seminar in European Politics
NS4720	Seminar in European Security Issues

NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

*Russia/Eurasia specialists*

NS3400 History and Politics in Russia and Eurasia

NS3401 Contemporary Government and Politics in Russia and Eurasia

NS3720 European Security Institutions

NS4410 Seminar in Security Issues in Russia and Eurasia

NS4425 Russian Foreign Policy

NS4255 Naval History and Maritime Strategy (required for USN, otherwise elective)

### Curricular Electives

Students must complete three courses from the following list, excluding those taken to satisfy the curricular core. For East European specialists, one elective must be at the 4000-level

*Europe specialists*

Three Required. For East European specialists, one elective must be at the 4000-level

NS3155 Intelligence and Democracy

NS3400 History and Politics in Russia and Eurasia

NS3401 Contemporary Government and Politics in Russia and Eurasia

NS3450 War in Russia and Eurasia

NS3460 Government and Security in Eastern Europe

NS3730 The Balkans: Politics, History and Security

NS3900 International Law and Organizations

NS4020-29 Special Topics (region-specific)

NS4021 Europe and the United States

NS4022 Soldiers and Politics in the Euro-Atlantic Region

NS4023 Nationalism in Europe, East and West

NS4036 Comparative Strategic Cultures

NS4037 NATO

NS4160 Foreign Intelligence Services

NS4410 Seminar in Security Issues in Russia, Eastern Europe, and Central Asia

SO4840 Low-Intensity Conflict: Europe and the Trans-Caucasus

*Russia/Eurasia specialists*

Students must complete three courses from the following list.

NS3412 Government and Security in the Central Asian Republics

NS3450 War in Russia and Eurasia

NS3460 Government and Security in Eastern Europe

NS3700 History of Modern Europe

NS3710 Government and Security in Europe

NS3730 The Balkans: History, Politics and Security

NS3900 International Law and Organizations

NS4020-29 Region-Specific Special Topics Courses

NS4021 Europe and the United States

NS4022 Soldier and Politics in the Euro-Atlantic Region

NS4023 Nationalism in Europe, East and West

NS4037 NATO

NS4160 Foreign Intelligence Services

NS4332 Ethnicity and Ethnic Conflict in the Developing World

NS4415 Seminar in Security Issues in Central Asia

NS4502 Russian Film and Fiction

NS4720 Seminar in European Security Issues

NS4036 Comparative Strategic Cultures

SO4840 Low-Intensity Conflict: Europe and the Trans-Caucasus

### General Electives

General electives may be selected from among all courses in the Department of National Security Affairs or, with permission of the Academic Associate, from such courses in other departments and groups. The number of general electives available to a student varies with service affiliation, length of stay, and other factors.

### Curricular Sub-Divisions

The NSA department splits students into the Europe and Eurasia sub-curricula based on the designations used in the Army FAO program, as follows:

**Europe:** United Kingdom, Ireland, France, Norway, Netherlands, Belgium, Sweden, Denmark, Luxembourg, Germany, Austria, Switzerland, Italy, Spain, Portugal, Hungary, Bulgaria, Czech Republic, Slovak Republic, Poland, Albania, Croatia, Bosnia-Herzegovina, Serbia Montenegro, Macedonia, Finland, Romania, Greece, Liechtenstein, Malta, Monaco, Andorra, San Marino, Slovenia and Iceland.

**Eurasia:** Russia, Belarus, Ukraine, Moldova, Armenia, Georgia, Kazakhstan, Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan, Azerbaijan, Estonia, Latvia and Lithuania.

### Typical Course of Study

18 Month Program [non-sequential; **Europe Specialization**]

#### Quarter 1

NS3700 (4-0) History of Modern Europe

NS3023 (4-0) Introduction to Comparative Politics

NS4710 (4-0) Seminar in European Politics

-- NS General Elective or JPME (USN)

NS2011\* (2-0) Policy Analysis & Research Methods

#### Quarter 2

NS3024 (4-0) Introduction to International Relations

NS3040 (4-0) Global Economic Relations or NS3041 Comparative Economic Systems

NW3230 (4-2) Strategy and Policy SECNAV  
(USN/USMC only) or Elective  
-- (4-0) NS General Elective or JPME (USN)

**Quarter 3**

NS3000 (4-0) War in the Modern World  
NS3710 (4-0) Government and Security in Europe  
-- (4-0) NS General Elective or JPME (USN)  
-- (4-0) NS General or Curricular Elective  
NS4080\* (2-0) Research Colloquium

**Quarter 4**

NS3720 (4-0) European Security Institutions  
NS4255 (4-0) Naval History and Maritime Strategy (req.  
USN) or Elective  
-- (4-0) NS General Elective or JPME (USN)  
-- (4-0) NS General or Curricular Elective

**Quarter 5**

NS0810 (0-4) Thesis Research  
NS4720 Seminar in European Security Institutions  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

**Quarter 6**

NS0810 (0-4) Thesis Research  
NS0810 (0-4) Thesis Research  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

\*Overload.

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

12 Month Program [non-sequential; **Europe Specialization**]

**Quarter 1**

NS3000 (4-0) War in the Modern World  
NS3023 (4-0) Introduction to Comparative Politics  
NS3700 (4-0) History of Modern Europe  
NS4710 (4-0) Seminar in European Politics  
NS2011\* (2-0) Policy Analysis & Research Methods

**Quarter 2**

NS3040 (4-0) Global Economic Relations or NS3041  
Comparative Economic Systems  
NS3024 (4-0) Introduction to International Relations  
NS3720 (4-0) European Security Institutions  
-- (4-0) NS General or Curricular Elective

**Quarter 3**

NS3710 (4-0) Government and Security in Europe  
NW3230 (4-2) Strategy and Policy SECNAV  
(USN/USMC only) or Elective  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

**Quarter 4**

NS0811 (0-0) Comp Examination

NS4720 (4-0) Seminar in European Security Institutions  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

\* Overload

Plus language training to fulfill sponsor requirements as necessary.

*Overall program must include 16 hours of work at the 4000-level.*

**Typical Course of Study**

18 Month Program [non-sequential; **Russia/Eurasia Specialization**]

**Quarter 1**

NS3000 (4-0) War in the Modern World  
NS3023 (4-0) Introduction to Comparative Politics  
NS3400 (4-0) Government and Politics in Russia and Eurasia  
-- (4-0) NS General Elective or JPME (USN)  
NS2011\* (2-0) Policy Analysis & Research Methods

**Quarter 2**

NS3024 (4-0) Introduction to International Relations  
NS3720 (4-0) European Security Institutions  
NW3230 (4-2) Strategy and Policy SECNAV  
(USN/USMC only) or Elective  
-- (4-0) NS General Elective or JPME (USN)

**Quarter 3**

NS3040 (4-0) Global Economic Relations or NS3041  
Comparative Economic Systems  
NS3401 (4-0) Contemporary Government and Politics in Russia and Eurasia  
-- (4-0) NS General Elective or JPME (USN)  
-- (4-0) NS General or Curricular Elective  
NS4080\* (2-0) Research Colloquium

**Quarter 4**

NS4410 (4-0) Seminar in Security Issues in Russia and Eurasia  
NS4255 (4-0) Naval History and Maritime Strategy (req.  
USN) or Elective  
-- (4-0) NS General Elective or JPME (USN)  
-- (4-0) NS General or Curricular Elective

**Quarter 5**

NS0810 (2-0) Thesis Research  
NS4425 (4-0) Russian Foreign Policy  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

**Quarter 6**

NS0810 (0-8) Thesis Research  
NS0810 (0-8) Thesis Research  
-- (4-0) NS General or Curricular Elective  
-- (4-0) NS General or Curricular Elective

\* Overload

*Overall program must include 16 hours of work at the 4000-level.*

## Typical Course of Study

12 Month Program [non-sequential; **Russia/Eurasia Specialization**]

### Quarter 1

NS3000	(4-2)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3400	(4-0)	Government and Politics in Russia and Eurasia
--		NS General or Curricular Elective
NS2011*	(2-0)	Policy Analysis & Research Methods

### Quarter 2

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3024	(4-0)	Introduction to International Relations
NS4425	(4-0)	Russian Foreign Policy
--	(4-0)	NS General or Curricular Elective

### Quarter 3

NS3401	(4-0)	Contemporary Government and Politics in Russia and Eurasia
NS3720	(4-0)	European Security Institutions
NW3230	(4-2)	Strategy and Policy SECNAV (USN/USMC only) or Elective
--	(4-0)	NS General or Curricular Elective

### Quarter 4

NS0811	(0-0)	Comp Examination
NS4410	(4-0)	Seminar in Security Issues in Russia and Eurasia
--	(4-0)	NS General or Curricular Elective
--	(4-0)	NS General or Curricular Elective

\* Overload

Plus language training to fulfill sponsor requirements as necessary.

*Overall program must include 16 hours of work at the 4000-level.*

## Curriculum Options

U.S. and international students can choose Regional Studies or Security Studies.

### Regional Studies:

Students can specialize in the following four areas:

- Middle East, Africa, and South Asia
- Far East, Southeast Asia, and the Pacific
- Europe, Russia, and Central Asia
- Western Hemisphere

### Security Studies:

The Security Studies curriculum is divided into several tracks for both U.S. and international students:

- Civil-Military Relations

- Stabilization and Reconstruction
- Defense Decision-Making and Planning
- Homeland Security (U.S. students)

All NSA curricula share the same Educational Skill Requirements. These are listed once in Regional Security Studies; Curriculum (681) - Middle East, South Asia, and Africa.

## Security Studies Civil-Military Relations - Curriculum 689A

### Program Officer

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### Brief Overview

The Civil-Military Relations curriculum, 689A, is an inter-disciplinary program, tailored for officers and civilian employees of other countries and the U.S. National Guard. The program is designed to meet three related needs. First, the program gives students the skills they need to resolve the security problems confronting their own democracies. Second, the program offers an in-depth understanding of civil-military relations. Finally, the program prepares students to resolve the civil-military issues raised by participation in U.N. peacekeeping operations, membership in the Partnership for Peace and other alliances, and security cooperation between other nations and the United States.

### Requirements for Entry

A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

Officers and civilian employees in defense and other agencies of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all

undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records.

**Entry Date**

The International Security and Civil-Military Relations Curriculum 689A is a five-quarter (15 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Program Officer.

**Degree**

Master of Arts in Security Studies (Civil-Military Relations).

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

Defense Attaché  
 Foreign Area Officer  
 Intelligence Officer  
 Plans Officer, Staff Planner  
 Various joint command positions  
 Service Headquarters - Political / Military officers  
 Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements and Electives**

**NSA Core Requirements**

- NS3000 War in the Modern World
- NS3023 Introduction to Comparative Politics
- NS3024 Introduction to International Relations
- NS3040 Politics of Global Economic Relations or NS3041-Comparative Economic Systems
- NS2011 Policy Analysis and Research Methods

*For International Students*

- IT1500 Information Program Seminar for International Officers
- IT1600 Communication Skills for International Officers
- IT1700 Academic Writing for International Officers

**Curricular Core Requirements**

- NS3025 Introduction to Civil-Military Relations Theory
- NS3155 Intelligence and Democracy
- NS4225 Civil-Military Relations and Transitions to Democracy
- NS4235 PSO and MOOTWA
- NS4880 Seminar on Legal and Military Responses to Political Violence

**Curricular Electives**

689A students are also required to take three regional electives focused on one region of the world and three

general electives during their course of studies. One of these electives must be taken at the 4000 level.

**Typical Course of Study**

**Quarter 1**

- NS3025 (4-0) Introduction to Civil-Military Relations
- NS3023 (4-0) Introduction to Comparative Politics
- NS3000 (4-0) War in the Modern World
- IT1600 (3-0) Communications Skills for International Officers OR Elective
- NS2011\* (2-0) Policy Analysis and Research Methods

**Quarter 2**

- NS3225 (4-0) Civil-Military Relations and Defense Budgeting
- NS4225 (4-0) Civil-Military Relations and Transitions to Democracy
- NS3024 (4-0) Introduction to International Relations
- NS0810 (0-8) Thesis Research OR Elective
- IT1500 (4-0) Information Program Seminar for International Officers

**Quarter 3**

- NS4880 (4-0) Seminar in Legal and Military Responses to Political Violence Elective
- 
- NS0810 (0-8) Thesis Research OR Elective
- NS0810 (0-8) Thesis Research OR Elective

**Quarter 4**

- NS4235 (4-0) Seminar on Diplomacy and Strategy of Coalition Warfare and Ops Other than War
- NS4080 (2-0) Research Colloquium
- NS0810 (0-8) Thesis Research OR Elective

**Quarter 5**

- NS3155 (4-0) Intelligence and Democracy
- NS4030-34 (4-0) Seminar on Special Topics in National Security Affairs (Topics vary) Elective
- 
- NS0810 (0-8) Thesis Research OR Elective

**Educational Skill Requirements (ESR)**

None.

**Security Studies Stabilization & Reconstruction - Curriculum 689B**

**Program Officer**

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**Brief Overview**

Stabilization and Reconstruction is a relatively new track within the Security Studies tracks. It is based on a very simple premise. Sustainable economic and political development can go forward only when effective, democratically-controlled institutions can provide security for a nation's people. In nations where U.S. and international forces are providing this security, those forces need to work with civilian development agencies and NGOs to help build indigenous security institutions. Otherwise, military forces risk creating a climate of dependency, in which continued local reliance on those forces slows their exit and impedes progress towards broader political and economic development.

The purpose of the program is the creation of a security environment within which economic and political development can flourish. By building indigenous capacities to provide security, military forces can "work themselves out of a job" and facilitate their own exit. Moreover, by conducting operations in close cooperation with civilian development agencies and NGOs, forces can facilitate the hand-off to these partners and contribute directly to their development work. In short: the Security Building program is designed to help the United States and its allies win and maintain the peace long after their military forces have returned home.

The program will accomplish its purpose by providing the specialized expertise, problem-solving skills, and management tools required by civilians and military officers (U.S. and international) operating in the post-conflict environment.

**Requirements for Entry**

A baccalaureate degree with above-average grades and fluency in written and verbal English is required for all students. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students

Officers and civilian employees in defense and other agencies of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will

primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records.

**Entry Date**

The Stabilization and Reconstruction Curriculum 689B is a five-quarter (15 months) course of study with an entry date of July. If further information is needed, contact the Academic Associate for the curriculum or the Program Officer.

**Degree**

Master of Arts in Security Studies (Stabilization and Reconstruction)

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

Defense Attaché  
Foreign Area Officer  
Intelligence Officer  
Plans Officer, Staff Planner  
Various joint command positions  
Service Headquarters - Political / Military officers  
Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements and Electives****NSA Core Requirements**

NS3001 War and Its Impact on Post-conflict Reconstruction  
NS3023 Introduction to Comparative Politics  
NS3024 Introduction to International Relations  
NS3042 Economic Development in Stabilization and Reconstruction  
NS2011 Policy Analysis and Research Methods

*For International Students:*

IT1500 Information Program Seminar for International Officers  
IT1600 Communication Skills for International Officers  
IT1700 Academic Writing for International Officers

**Curricular Core Requirements**

NS3025 Introduction to Civil-Military Relations Theory  
NS3026 Introduction to Stabilization and Reconstruction  
MN3118 Strategies for Building Consensus  
MN4123 Organizing & Planning in Complex Networks  
NS4026 Capstone Seminar in Stabilization and Reconstruction  
NS4235 PSO and MOOTWA  
NS4236 Stability Operations

*The following are suggested electives for 689B students:*

NS3330 Politics of Middle East

NS3510	Gov & Pol Latin America
NS4904	Ethics Across Cultures
NS4225	Civil-Military Relations in Transitions to Democracy
SO3802	Guerrilla Warfare
NS4880	Legal/Military Responses to Political Violence
NS4332	Ethnic Conflict
NS3900	International Law and Organizations
NS4801	International Terrorism
SO3750	Anthropology of Conflict

### Typical Course of Study

#### Quarter 1

NS3026	(4-0)	Introduction to Post-Conflict Security Building
NS3024	(4-0)	Introduction to International Relations
NS3900	(4-0)	International Law and Organizations
IT1500	(4-0)	Information Program Seminar for International Officers
IT1600	(4-0)	Communication for International Officers

#### Quarter 2

NS3023	(4-0)	Introduction to Comparative Politics
NS3001	(4-0)	War and its Impact on Post-Conflict Reconstruction
NS3155	(4-0)	Intelligence and Democracy
NS2011*	(2-0)	Policy Analysis and Research Methods
IT1700	(4-0)	Written Communication for International Officers

#### Quarter 3

NS4235	(4-0)	Seminar on Diplomacy and Strategy of Coalition Warfare and Ops Other than War
MN3118	(4-0)	Strategies for Building Consensus
NS3042	(4-0)	Economic Development for Security Building
NS0810	(0-4)	Thesis Research
NS4080*	(2-0)	Research Colloquium

#### Quarter 4

NS3025	(4-0)	Introduction to Civil-Military Relations
MN4123	(4-0)	Organizing and Planning in Complex Networks
--		Regional Elective
NS0810	(0-4)	Thesis Research

#### Quarter 5

NS4026	(4-0)	Capstone Seminar: Reconstruction of Civil Society
NS4880	(4-0)	Seminar in Legal and Military Responses to Political Violence
--		Regional Elective
NS0810	(0-4)	Thesis Research

### Educational Skill Requirements (ESR)

None.

## Security Studies Defense Decision-Making & Planning Curriculum - 689C

### Program Officer

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### Brief Overview

This five- or six-quarter curriculum prepares future strategists by providing an understanding of the domestic and international variables involved in the formulation of defense and security policy. It combines the interrelated areas of general strategic studies, international organization, and negotiation to address the dynamic challenges of the future security environment.

This inter-disciplinary curriculum emphasizes the strategic interests and objectives of the United States Armed Forces, their allies, and potential adversaries; the roles, structures, and effectiveness of international organizations and international law as they affect national security policy; the effects of military transformation and threat proliferation; and the process of U.S., allied, and adversary strategic decision-making.

The program will accomplish its purpose by providing the specialized expertise, problem-solving skills, and management tools required by U.S military officers to address current and emergent strategic problems. The NSA department is a unique environment in which to pursue this course of studies since its student body is inherently joint and combined, providing students with both a stimulating intellectual environment and an opportunity to establish networks and life-long working relationships with fellow officers from other services and countries.

While fulfilling academic requirements, students in the five-quarter program have an option of either completing a thesis or taking three additional 4000 level courses. Students in this curriculum will have the opportunity to complete Joint Professional Military Education Phase 1 through a five-course sequence offered by the Naval War College detachment at the Naval Postgraduate School.



### Requirements for Entry

Students may enter the curriculum in any academic quarter. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

### Entry Date

The Security Studies (Defense Decision Making and Planning) Curriculum 689C is offered January, April, July, or October. If further information is needed, contact the Academic Associate for the curriculum or the Program Officer.

### Degree

Master of Arts in Security Studies (Defense Decision Making and Planning)

### Subspecialty

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

### Typical Subspecialty Jobs

Defense Attaché  
Foreign Area Officer  
Intelligence Officer  
Plans Officer, Staff Planner  
Various joint command positions  
Service Headquarters - Political / Military officers  
Major staff jobs in Combatant Commands and Fleet Commands

### Course Requirements and Electives

#### NSA Core Requirements

NS3000	War in the Modern World
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
NS3040	Politics of Global Economic Relations; or NS 3041-Comparative Economic Systems
NS2011	Policy Analysis and Research Methods

### Curriculum Core Requirements

NS3021	Military Transformation
NS3280	Introduction to Nuclear Strategy and Planning
NS3900	International Law and Organizations
NS4669	Seminar on Conflict and Cooperation
NS4285	Seminar on Counter-Proliferation

### Curriculum Electives

Students electing the non-thesis option should select five elective courses, three of which must be taken at 4000 level. Students electing to write a thesis should select two at the 4000 level of instruction.

NS3001	War and its impact on Post-Conflict Reconstruction
NS3025	Introduction to Civil-Military Relations
NS3026	Introduction to Post-Conflict Security Building
NS3030	American National Security Policy
NS3037	Role of Congress in U.S. National Security Policy
NS3155	Intelligence and Democracy
NS3159	Principles of Joint Operational Intelligence
NS3260	Drug Control Strategy and Policy
NS4159	Seminar on Joint Operational Intelligence
NS4240	Seminar on Regional Security Planning Problems
NS4253	Seminar on Technology and Strategic Planning
NS4255	Seminar on Naval History and Maritime Strategy
NS4280	Seminar on Nuclear Proliferation
NS4801	International Terrorism
MN4123	Planning and Organizing in Complex Networks

### Typical Course of Study

15 Month Program (U.S. Military Officers)

#### Quarter 1

NS3040	(4-0)	Global Economic Relations or NS3041 Comparative Economic Systems
NS3023	(4-0)	Comparative Politics
NS3280	(4-0)	Nuclear Strategy and Planning
NW3230	(4-2)	Strategy and Policy

#### Quarter 2

NS4285	(4-0)	Counter-proliferation
NS3024	(4-0)	International Relations
NS3021	(4-0)	Military Transformation
NW3285	(2-1)	National Security Decision Making 2
NS2011*	(2-0)	Research Methods

#### Quarter 3

NS3000	(4-0)	War and the Modern World
NS4669	(4-0)	Conflict and Cooperation
--		Curricular Elective

NW3285	(2-1)	National Security Decision Making 1
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#### Quarter 4

NS3900	(4-0)	International Law
--		Curricular Elective
--		Curricular Elective (Thesis Substitute, 4000 level)
NW3275	(2-0)	Joint Maritime Operations I

**Quarter 5**

-- Curricular Elective (Thesis Substitute, 4000 level)  
 -- Curricular Elective (Thesis Substitute, 4000 level)  
 NS0811 Comprehensive Exam Preparation  
 NW3275 (2-0) Joint Maritime Operations II  
 \* Overload  
 Overall Program must include 16 hours of work at the 4000-level.

**Typical Course of Study**

18 Month Program (International Military Officers)

**Quarter 1**

NS3000 (4-0) War in the Modern World  
 NS3023 (4-0) Comparative Politics  
 NS3280 (4-0) Nuclear Strategy and Planning  
 -- JPME (USN only) or General Elective  
 NS2011\* (2-0) Research Methods

**Quarter 2**

NS3040 (4-0) Global Economic Relations or NS3041  
 Comparative Economic Systems  
 NS3024 (4-0) International Relations  
 NS3900 (4-0) International Law  
 -- JPME (USN only) or General Elective

**Quarter 3**

-- General Elective  
 NS4280 (4-0) WMD Planning  
 -- Curricular Elective  
 -- JPME (USN only) or General Elective  
 NS4080\* Research Colloquium

**Quarter 4**

-- General Elective  
 NS4285 (4-0) Counterproliferation  
 -- Curricular Elective  
 -- JPME (USN only) or General Elective

**Quarter 5**

NS0810 (0-8) Thesis Research  
 -- Curricular Elective  
 -- Curricular Elective  
 -- JPME (USN only) or General Elective

**Quarter 6**

NS0810 (0-8) Thesis Research  
 NS0810 (0-8) Thesis Research  
 -- General or Curricular Elective  
 -- JPME (USN only) or General Elective

\* Overload

*Overall Program must include 16 hours of work at the 4000-level.*

**Educational Skill Requirements (ESR)**

None.

**Security Studies Counter Terrorism Policy & Strategy - 689D**

**Program Officer**

Raymond B. Roll, CDR, USN  
 Code 38, Glasgow Hall, Room 380  
 (831) 656-2067, DSN 756-2067  
 rbroll@nps.edu

**Academic Associate**

Maria Jose Rasmussen, Ph.D.  
 Code 38, Glasgow Hall, Room 397  
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 mrasmussen@nps.edu

**Brief Overview**

This five-quarter curriculum provides an understanding of the nature and dynamics of terrorist organizations, and the domestic and international variables involved in the formulation of counterterrorist policy. The curriculum allows the students to combine a regional focus with comparative courses that discuss terrorist organizations and operations, the financing of terror, legal and policing developments in counterterrorism, intelligence, and the military role in homeland defense.

The NSA department is a unique environment in which to pursue this course of studies since its student body is inherently joint and combined, providing students with both a stimulating intellectual environment and an opportunity to establish networks and life-long working relationships with fellow officers from other services and countries.

**Requirements for Entry**

A baccalaureate degree with above-average grades. Officers and civilian employees in defense and other agencies of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis.

**Entry Date**

The Security Studies (Counterterrorism Policy and Strategy) track 689D is offered in January.

**Degree**

Master of Arts in Security Studies (Counterterrorism Policy and Strategy)

**Subspecialty**

Navy P Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

Defense Attaché  
Foreign Area Officer  
Intelligence Officer  
Plans Officer, Staff Planner  
Various joint command positions  
Service Headquarters- Political/ Military Officers  
Major staff jobs in Combatant Commands and Fleet Commands

**Typical Course of Study**

*15 Month Program*

**Quarter 1**

NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3025	(4-0)	Introduction to Civil-Military Relations
NS2011	(2-0)	Policy Analysis and Research Methods
IT1600	(2-0)	Communication Skills

**Quarter 2**

NS3040	(4-0)	Global Economic Relations
NS3024	(4-0)	Introduction to International Relations
NS3801	(4-0)	Introduction to Terrorism
IT1500	(4-0)	Information Program

**Quarter 3**

NS4802	(4-0)	The Intelligence Dimension of Counterterrorism
----		Curricular Elective
----		Curricular Elective
----		General Elective
NS4080*	(2-0)	Research Colloquium

**Quarter 4**

NS4880	(4-0)	Legal and Military Responses to Political Violence
NS0810	(0-8)	Thesis Research
----		Curricular Elective
----		Curricular Elective
IT1700*	(2-0)	Academic Writing Skills

**Quarter 5**

NS0810	(0-8)	Thesis Research
NS0810	(0-8)	Thesis Research
----		General Elective
----		General Elective

**Course Requirements and Electives****NSA Core Requirements**

NS3000	War in the Modern World
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
NS3040	The Politics of Global Economic Relations
NS3041	Comparative Economic Systems
NS2011	Policy Analysis and Research Methods
NS4080	Research Colloquium

**For International Students**

IT1500	Information Program Seminar for International Officers
IT1600	Communication Skills for International Officers
IT1700	Academic Writing for International Officers

**Curriculum Core Requirements**

NS3025	Introduction to Civil-Military Relations; or
NS3028	Comparative Government for Homeland Security
NS3801	Introduction to Terrorism
NS4802	The Intelligence Dimension of Counterterrorism
NS4880	Legal and Military Responses to Political Violence

**Curriculum Electives**

689D students must select four curriculum electives from the following list:

NS3300	Islam
NS3900	International Law
NS4231	Seminar on Terrorism Financing and State Response
NS4300	Social Mobilization and Conflict in the Middle East
NS4320	Islamic Fundamentalism
NS4332	Ethnicity and Ethnic Conflict in the Developing World
NS4801	International Terrorism
NS4930	Media and War

Students must also take three general electives during their course of studies. One of these electives must be taken at the 4000 level.

**Thesis**

A thesis is required for completion. NS2011 and NS4080 address this need. Students writing a thesis are also allowed up to three NS0810 thesis blocks.

\* Overload

Overall Program must include 16 hours at the 4000-level

**Educational Skill Requirements (ESR)**

None

## Homeland Defense and Security - Curriculum 690

### Program Officer

Raymond B. Roll, CDR, USN  
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rbroll@nps.edu

### Academic Associate

Brian Swanland, Ph.D., Lt Col, USAF  
Code 38, Glasgow Hall, Room 308  
(831) 656-3952, DSN 756-3952  
beswanla@nps.edu

### Brief Overview

Homeland Defense/Security is a track within the Security Studies curriculum (690). This five-quarter curriculum is designed to provide homeland defense decision makers with a theoretical and practical understanding of the domestic security environment, asymmetric and unconventional threats, and organizational strategies to deal with such threats. An Intelligence sub-specialty within the curriculum is intended to provide an understanding of intelligence issues that were identified as primary challenges in homeland defense and security.

This inter-disciplinary curriculum explores the Department of Defense's primary role in deterring and preventing attacks on the territory of the United States and its secondary role in consequence management. In addition to maritime and aerospace domain awareness and defense, DoD's role in ensuring that threats to the United States are deterred before they are implemented on U.S. territory is emphasized. The strategic interests and objectives of the United States; the roles, missions, structures, and effectiveness of U.S. Homeland Security organizations and intelligence organizations, as well as potential threats to U.S. domestic security are examined. U.S. students in this curriculum also have the opportunity to complete phase I JPME.

### Requirements for Entry

Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records. Questions about admissions procedures should be addressed to the

Naval Postgraduate School Director of Admissions, or to the National Security Affairs Program Officer.

### Entry Date

The Security Studies Homeland Defense/Security Curriculum 690 is currently offered only in the Fall quarter. If further information is needed, contact the Academic Associate for the curriculum or the Program Officer.

### Degree

Master of Arts in Security Studies (Homeland Defense and Security)

### Subspecialty

Navy P-Codes: 2600

### Typical Subspecialty Jobs

Intelligence Officer  
Plans Officer, Staff Planner  
Various Joint Command Positions  
Service Headquarters-Homeland Defense/ Critical Infrastructure Protection  
Major Staff Jobs in Combatant Commands and Fleet Commands

### Course Requirements and Electives

#### NSA Disciplinary Core Courses:

NS3030	American National Security Policy
NS3024	Introduction to International Relations
NS3028	Comparative Government for Homeland Defense/Security
DA3211	The Unconventional Threat in Homeland Defense
NS2011	Policy Analysis and Research Methods

#### Curriculum Core Courses:

NS3180	Introduction to Homeland Defense
NS3030	American National Security Policy
NS3024	Introduction to International Relations
NS4157	Intelligence for Homeland Defense
NS4XX	Air and Maritime Defense*
NS3028	Comparative Government for Homeland Defense
CS3660	Critical Infrastructure Vulnerability Analysis & Protection
NS4231	Seminar on Terrorism Financing and State Response
NS4880	Legal and Military Responses to Political Violence

#### Sub-Specialty Core Courses: Intelligence

NS3159	Principles of Joint Operational Intelligence
NS4152	Joint Warfare: Intelligence Analysis
NS4159	Seminar in Joint Intelligence Support to Crisis Operations
NS4035	Special Topics in Joint Intelligence

#### Curriculum Elective Courses

NS3001	War and its impact on Post-Conflict Reconstruction
NS3021	Military Transformation

NS3026	Intro to Post-Conflict Security Building
NS3030	American National Security Policy
NS3037	Role of Congress in U.S. National Security Policy
NS3155	Intelligence and Democracy
NS3260	Drug Control Strategy and Policy
NS4036	Comparative Strategic Cultures
NS4159	Seminar on Joint Operational Intelligence
NS4235	Seminar on MOOTW
NS4240	Seminar on Regional Security Planning Problems
NS4253	Seminar in Technology and Strategic Planning
NS4280	Seminar on Nuclear Proliferation
NS4285	Seminar on Counter-proliferation
MN4123	Planning and Organizing in Complex Networks
NS4801	Seminar on International Terrorism

### Typical Course of Study

#### Quarter 1

NS3180	(4-0)	Introduction to Homeland Defense
NS3030	(4-0)	American National Security Policy
NS3024	(4-0)	Introduction to International Relations
-----	(4-0)	Elective or JPME

#### Quarter 2

NS4157	(4-0)	Intelligence for Homeland Defense
NS3028	(4-0)	Comparative Government for Homeland Defense
DA3211	(4-0)	The Unconventional Threat in Homeland Defense
-----	(4-0)	Elective or JPME

#### Quarter 3

CS3660	(4-0)	Critical Infrastructure Vulnerability Analysis & Protection
NS4XX	(4-0)	Air and Maritime Defense
NS4231	(4-0)	Seminar on Terrorism Financing and State Response
-----	(4-0)	Elective or JPME

#### Quarter 4

NS3159	(4-0)	Principles of Joint Operational Intelligence
NS4159	(4-0)	Seminar in Joint Intelligence Support to Crisis Operations
NS0810	(4-0)	Thesis Research
-----	(4-0)	JPME or Elective

#### Quarter 5

NS4880	(4-0)	Legal and Military responses to Political Violence
NS0810	(4-0)	Thesis Research
NS4035	(4-0)	Special Topics in Joint Intelligence
-----	(4-0)	JPME or Elective

### Educational Skill Requirements (ESR)

#### Homeland Security and Defense - Curriculum 690

#### Subspecialty Code 2600P

1. **Analytical Skills:** Graduates will be able to logically combine data and theory to analyze and explain political, economic, and military events in the

context of the new Department of Homeland Security. Students will demonstrate writing, briefing, and computer skills in preparing and presenting their findings. Each course requires individual students to present a significant project to the entire class.

2. **National Security Issues:** Graduates will be aware of the economic, political, social, and military characteristics of homeland security, homeland defense, and national security issues. These issues include: intelligence gathering and information sharing, posse comitatus, and the interaction of law enforcement with military command
3. **Critical Infrastructure Vulnerability:** Graduates will gain an understanding of how the eight major critical infrastructure sectors within the United States work, what are their vulnerabilities, and how to "harden" the critical nodes in each sector. Particular emphasis will be on the Internet and "networks of all kinds" that contain critical nodes.
4. **Threat Analysis:** Graduates will learn about domestic threats and asymmetric conflict and how they pertain to homeland security, NORCOM, and state, local, and federal responses. What is the nature of the threat, and who are the terrorists?
5. **Civil-Military Relations:** Graduates will understand the field of civil-military relations as it applies to homeland security and security building within the confines of the U.S. Constitution and civil-military history. Students will be able to identify key players in homeland security at the various levels of government, and understand the dynamics of political institutions in homeland security: office of homeland security, Northern Command, FBI, CIA, etc.
6. **Law Enforcement and the Judicial System:** Graduates will understand the interface between domestic law enforcement, state and local police, emergency response teams, military support of civilians, and investigations by various agencies such as the U.S. Postal Service, etc. Graduates will know the roles and responsibilities of various law enforcement agencies. Finally, graduates will understand how the judicial system interfaces with the military, at the state and local levels.
7. **Intelligence in Homeland Security:** Graduates will understand the role of intelligence in defense of the homeland, and how it is different from military intelligence. Graduates will recognize what can be learned from military intelligence and applied to homeland security. Graduates will understand the complexities of information

sharing, gathering, and analysis in the context of homeland security.

8. **Comparative Politics:** Graduates of the program will use the knowledge gained in the Civil-Military Relations, Comparative Governments, and Introduction to Homeland Security courses to make policy for local, state, and federal level programs
9. **Information Technology for Homeland Security:** Computers, the Internet, software for law enforcement, data collection, information sharing, and analysis are key technologies for successful homeland security building. Graduates will become familiar with the tools and techniques of information technology in various sectors, ranging from critical infrastructure protection to intelligence gathering and analysis.

### **Curriculum Sponsor and ESR Approval Authority**

Deputy Chief of Naval Operations (Plans, Policy and Operations) (N3/N5)

### **Point of Contact Information**

#### **Academic Programs**

*For additional information about academic programs in Homeland Defense/Security, please contact:*

Brian Swanland, Ph.D., Lt Col, USAF  
Academic Associate for Homeland Defense/Security  
Glasgow Hall, Room 308  
Department of National Security Affairs  
Naval Postgraduate School  
Monterey, CA 93943

(831) 656-3952 , DSN 756-3952  
beswanla@nps.edu

*For additional information about academic programs in Regional Studies, please contact:*

Professor Michael. S. Malley  
Academic Associate for Regional Studies  
Glasgow Hall, Room 392  
Department of National Security Affairs  
Naval Postgraduate School  
Monterey, CA 93943

(831) 656-2409, DSN 756-2409  
msmalley@nps.edu

*For additional information about academic programs in Security Studies, please contact:*

Professor Maria Jose Rasmussen, Ph.D.  
Academic Associate for Security Studies

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Department of National Security Affairs  
Naval Postgraduate School  
Monterey, CA 93943

(831) 656-3673, DSN 756-3673  
mrasmussen@nps.edu

#### **Service-Related Matters**

*Questions about service-related matters, course enrollment procedures, and so forth, should be addressed to:*

Dora Martinez  
Educational Technician  
Glasgow Hall, Room 309  
National Security and Intelligence Programs  
Naval Postgraduate School  
Monterey, CA 93943

(831) 656-2845, DSN 756-2845  
dmartinez@nps.edu

#### **Joint Professional Education**

*Questions about Joint Professional Military Education should be addressed to:*

Professor Fred P. Drake  
Chairman, Joint Professional Military Education  
Naval Postgraduate School  
1 University Circle, Halligan Hall, Room 239  
Monterey, CA 93943

(831) 656-3003, DSN 756-3003  
fpdrake@nps.edu

#### **Admissions**

*Questions about admission to the Naval Postgraduate School should be addressed to:*

Susan Dooley  
Director of Admissions  
Naval Postgraduate School  
1 University Circle, Herrmann Hall, Room 022  
Monterey, CA 93943

(831) 656-3093, DSN 756-3093  
grad-ed@nps.edu

#### **International Students**

*International students may also wish to contact the International Graduate Programs Office:*

Gary Roser, Col, USMC (Ret.)  
Assistant Dean of the School of International Graduate Studies  
1 University Circle, Herrmann Hall, Room 047D  
Monterey, CA 93943

(831) 656-2186, DSN 756-2186, FAX (831) 656-3064  
 Website: [www.nps.edu/Adminsrv/IGPO/index.html](http://www.nps.edu/Adminsrv/IGPO/index.html)

## Center for Homeland Defense and Security (CHDS)

### Website

[www.chds.us](http://www.chds.us)

### Director

Paul Stockton, Ph.D.  
 Code 01

(831) 656-2356, DSN 756-2356, FAX (831) 656-2619  
[CHDSMAAP@nps.edu](mailto:CHDSMAAP@nps.edu)

**Christopher Bellavita**, Director, Academic Programs (2003); Ph.D., University of California at Berkeley, 1980

**Robert Bach**, Adjunct Professor (2005); Ph.D., Duke, 1978

**Richard Bergin**, Visiting Assistant Professor (2002); M.S., Marshall School of Business, 1998.

**Larry Beutler**, Visiting Professor (2003); Ph.D., University of Nebraska, 1970

**David Brannan**, Adjunct Professor (2003); M.A., University of St. Andrews, 1999

**Jim Breckenridge**, Visiting Professor (2003); Ph.D., University of Houston, 1982

**Rudy Darken**, Associate Professor (1996); DS.c., George Washington University, 1995.

**Ellen Gordon**, Associate Director for Executive Education Program (2005); M.A., Naval Postgraduate School, 2004

**Seth Jones**, Adjunct Professor (2005); Ph.D., University of Chicago, 2004

**Anthony Kendall**, Lecturer ( ); M.S., Naval Postgraduate School, 1980

**Charles J. LaCivita**, Professor and Director, DRMI ( ); Ph.D., University of California at Santa Barbara, 1981

**Ted Lewis**, Professor (1993); Ph.D., Washington State University, 1971.

**Thomas Mackin**, Adjunct Professor (2005); Ph.D., Pennsylvania State University, 1991

**Nadav Morag**, Adjunct Professor (2005); Ph.D., Tel Aviv University, 2000

**Robert Simeral**, Senior Intelligence Officer ( ); M.A., NPS, 1979

**Paul Stockton**, Associate Professor and Director, Center for Homeland Defense and Security (1990); Ph.D., Harvard University, 1986.

**Stan Supinski**, Adjunct Professor (2005); Ph.D., Florida State University, 1996

**Kathleen Toomey**, Adjunct Professor (2005); M.D., Harvard University, 1978

**David Tucker**, Associate Professor (1998); Ph.D., Claremont Graduate School, 1981.

**James Wirtz**, Professor and Department Chairman (1990); Ph.D., Columbia University, 1989.

**Lauren Wollman**, Managing Director, Academic Programs (2004); Ph.D., University of Southern California, 2000

**Phillip Zimbardo**, Visiting Professor; Ph.D., Yale, 1959

### Overview

CHDS is the nation's homeland security educator. Established in 2002, CHDS is focused on producing graduate-level education programs that are designed to meet the immediate and long-term leadership needs of organizations responsible for homeland defense and security. The graduates of the program will return to key positions in federal, state, and local government organizations and the military with the education, skills and ability to expand national homeland security capacity.

### Our Approach

CHDS is a unique organization that is the result of a partnership between the Department of Homeland Security, Office of Grants and Training, and the Department of the Navy. CHDS conducts a wide range of graduate education programs to assist current and future homeland security leaders develop the strategies, policies, and organizational elements to defeat terrorism in the U.S. Through graduate and executive-level coursework, seminars and research, government leaders gain the analytical skills and substantive expertise to prevent, deter, and respond to terrorist attacks and to bridge gaps in interagency and civil-military cooperation. Participants are actively engaged in full-time missions and duties in local, state and federal homeland security agencies. The programs under CHDS are custom built to accommodate the challenges of these officials. All programs are aimed at developing leaders with a

prevention-focused approach to homeland defense and security.

**Programs Offered**

**Master of Arts Degree**

**Participants:** U.S. students only.

This 18-month program is offered at no cost to eligible senior and fast-track local, state, and federal officials and NORTHCOM-sponsored officers with significant homeland security responsibilities.

**Program:**

Designed to accommodate busy officials, the Master of Arts degree program requires participants to be in residence (at the Naval Postgraduate School in Monterey, California) two weeks each quarter (for a total of 12 weeks). Participants complete the remainder of their coursework via network-based distance learning methods. The curriculum and research are focused on current policy, strategy and organizational design challenges. Participants complete research papers and a thesis on policy development issues confronting their city, state, or sponsoring organization.

The program graduated its first class in June 2004 (class started in January 2002) and graduates approximately 30 officials every six months. A military variant of the program, including classified courses, is available through the Department of National Security Affairs.

**Center for Homeland Security and Defense Courses**

**CS3660 Critical Infrastructure: Vulnerability Analysis and Protection (4-0) Spring**

Critical Infrastructure is one of the cornerstones of homeland security. At the completion of the course, students will be able to apply the model-based vulnerability technique to any critical infrastructure within their multi-jurisdictional region, and derive optimal strategies and draft policies for prevention of future terrorist attacks. Prerequisites: NS3180.

**IS4010 Technology for Homeland Security (4-0) Spring, Fall, Winter**

Government agencies in today's information age are more dependent than ever on technology and information sharing. This course provides individuals involved in homeland security a broad overview of homeland security technology. This course focuses on technology as a tool to support homeland security personnel regardless of functional specialty. The ultimate objectives are to show students how homeland security professionals can exploit technology and to use it in the most efficient, innovative and productive manner. Prerequisites: None

**NS2013 Policy Analysis and Research Methodology (2-0) Spring, Fall, Winter &**

**NS4081 (2-0) Spring, Summer, Fall, Winter**

The purpose of these courses is to help learners reinforce their mastery of modes of inquiry and critical thinking needed not only for the intellectual work of the master's program, but also in their professional lives. the goal of the sequence is to support the degree objectives of the CHDS master's program by preparing students to conduct graduate-level, policy-relevant research and deliver the results of this research in an academically rigorous thesis. Prerequisites: None.

**NS3028 Comparative Government for Homeland Security (4-0) Spring, Summer, Fall, Winter**

The objectives of the NS 3028 course are: (1) to assess important counterterrorism strategies employed by liberal democracies around the world; (2) to distill and extrapolate policy implications from these examples; and (3) to apply these lessons to the organizational and functional challenges faced by homeland security leaders and first responders in the United States. Prerequisites: None.

**NS3180 Introduction To Homeland Security (4-0) Winter**

This course provides an overview of the essential ideas that constitute the emerging discipline of homeland security. It has two central objectives: to expand the way participants think, analyze and communicate about homeland security; and to assess knowledge in critical homeland security knowledge domains. Prerequisites: None.

**NS4081 (See NS2013 above.)**

**NS4133 The Psychology of Fear Management and Terrorism (4-0) Winter**

This course serves as an introduction for homeland security professionals to terrorism as a psychological phenomenon. Government agencies involved in homeland security need to understand the psychological consequences of mass-casualty terrorist attacks and other disasters. This course provides a broad overview of psychological effects of terrorism. Prerequisites: NS3180.

**NS4156 Intelligence for Homeland Security: Organizational and Policy Challenges (4-0) Spring**

This course examines key questions and issues facing the U.S. intelligence community and its role in homeland security and homeland defense. Students will have the opportunity to fully address policy, organizational and substantive issues regarding homeland intelligence support. Prerequisites: None.

**NS4232 Knowledge into Practice: A Homeland Security Capstone Course (3-0) As Required**

This course is intended to provide participants the opportunity to expand their ability to enact he knowledge and technical learning acquired in the courses leading up to the capstone. This course will provide students with the motivation and skills to perform their professional roles in new ways, ways that will initiate and sustain change even at the level of the broader institutional context of governance in which they must function. Prerequisites: NS4156, CS3660, SO3210.

**NS4239 Special Topics in American Government for Homeland Security (4-0) Spring, Summer, Fall, Winter**

The purpose of the Special Topics course is to provide students with an extra focus on 2 or 3 major issues that have



current visibility in debates about homeland security. Currently, those topics focus on dilemmas in the evolving relationships between civil and military authority and between government and community. Prerequisites: NS4156, NS3180, SO3210.

**NS4755 Strategic Planning and Budgeting for Homeland Security (4-0) Summer, Winter**

Homeland security requires programs in such disparate areas as counter-terrorism, information security, border security, counter-drug activities, etc. This course will provide students with an analytical framework useful for translating long-term plans into programs and budgets. Prerequisites: NS3180.

**NS4881 The Law and Homeland Security: A Multi-Disciplinary Approach (4-0) Summer**

Homeland security efforts in the United States constitute a project framed by the rule of law. Constitutional concerns, civil rights issues and the roles of the various disciplines engaged in the effort are driven and impacted by the various local, state, and federal systems of law. This course allows students to explore the homeland security project in relation to the laws that support and constrain it. Prerequisites: None.

**SO3210 Asymmetric Conflict and Homeland Security (4-0) Spring**

The purpose of this course is to provide an introduction to the operational and organizational dynamics of terrorism. It considers those who act as individuals, in small groups or in large organizations. By the end of the course, students should be able to design effective measures for countering and responding to terrorism based on an understanding of its organizational and operational dynamics. Prerequisites: None.

**Center for Homeland Defense and Security - Curriculum 251**

**Program Manager**

Heather Issvora  
Code 38, Herrmann Hall, Room 021A

(831) 656-2003 or (831) 402-4672, DSN 756-2003  
hissvora@nps.edu

**Academic Associate**

Ted Lewis, Ph.D.  
Code 06, Watkins Hall, Room 370

(831) 656-2930, DSN 756-2930, FAX (831) 656-2575  
tlewis@nps.edu

**Requirements for Entry**

Applicants eligible for sponsorship must be full-time state, local or federal DHS officials. All others, including military and NORTHCOM, are eligible to apply but must obtain financial sponsorship from their command. A baccalaureate degree or its equivalent is required. A minimum grade point average of 3.0 or its equivalent is required. A complete application is available online at [www.chds.us](http://www.chds.us)

**Entry Date**

This is an 18-month program with entry dates in spring and fall.

The program requires 12 weeks of in-residence attendance, with the balance of coursework conducted online.

**Degree**

Master of Arts in Security Studies (Homeland Security and Defense)

**Typical Subspecialty Jobs (Executive Level)**

Homeland Security  
Emergency Management  
Public Health  
Public Safety (Law, Fire Enforcement)

**Subspecialty Code**

Navy P-Code: 2600

**Typical Course of Study**

**Quarter 1**

NS3180 Introduction to Homeland Security  
SO3120 Asymmetric Conflict and Homeland Security  
NS2013 Policy Analysis & Research Methodology

**Quarter 2**

IS4010 Technology for Homeland Security  
NS4156 Intelligence for Homeland Security: Organizational and Policy Challenges  
NS4081 Policy Analysis and Research Methodology

**Quarter 3**

CS3660 Critical Infrastructure: Vulnerability Analysis & Protection  
NS4239 Special topics in American Government for Homeland Security

**Quarter 4**

NS4881 The Law and Homeland Security: A Multi-Disciplinary Approach  
NS3028 Comparative Government for Homeland Security

**Quarter 5**

NS4755 Planning and Budgeting for Homeland Security  
NS4133 Psychology of Fear Management and Terrorism

**Quarter 6**

NS4232 Capstone

**Educational Skill Requirements (ESR)**

**Center for Homeland Security and Defense - Curriculum 251 - Subspecialty Code: 2600P**

1. **Analytical Skills:** Graduates will be able to logically combine data and theory to analyze and explain political, economic, and military events in the context of the new Department of Homeland

Security. Students will demonstrate writing, briefing, and computer skills in preparing and presenting their findings. Each course requires individual students to present a significant project to the entire class.

2. **National Security Issues:** Graduates will be aware of the economic, political, social, and military characteristics of homeland security, homeland defense, and national security issues. These issues include: intelligence gathering and information sharing, posse comitatus, and the interaction of law enforcement with military command
3. **Critical Infrastructure Vulnerability:** Graduates will gain an understanding of how the eight major critical infrastructure sectors within the United States work, what are their vulnerabilities, and how to "harden" the critical nodes in each sector. Particular emphasis will be on the Internet and "networks of all kinds" that contain critical nodes.
4. **Threat Analysis:** Graduates will learn about domestic threats and asymmetric conflict and how they pertain to homeland security, NORCOMM, and state, local, and federal responses. What is the nature of the threat, and who are the terrorists?
5. **Civil-Military Relations:** Graduates will understand the field of civil-military relations as it applies to homeland security and security building within the confines of the U.S. Constitution and civil-military history. Students will be able to identify key players in homeland security at the various levels of government, and understand the dynamics of political institutions in homeland security: office of homeland security, Northern Command, FBI, CIA, etc.
6. **Law Enforcement and the Judicial System:** Graduates will understand the interface between domestic law enforcement, state and local police, emergency response teams, military support of civilians, and investigations by various agencies such as the U.S. Postal Service, etc. Graduates will know the roles and responsibilities of various law enforcement agencies. Finally, graduates will understand how the judicial system interfaces with the military, at the state and local levels.
7. **Intelligence in Homeland Security:** Graduates will understand the role of intelligence in defense of the homeland, and how it is different from military intelligence. Graduates will recognize what can be learned from military intelligence and applied to homeland security. Graduates will understand the complexities of information

sharing, gathering, and analysis in the context of homeland security.

8. **Comparative Politics:** Graduates of the program will use the knowledge gained in the Civil-Military Relations, Comparative Governments, and Introduction to Homeland Security courses to make policy for local, state, and federal level programs
9. **Information Technology for Homeland Security:** Computers, the Internet, software for law enforcement, data collection, information sharing, and analysis are key technologies for successful homeland security building. Graduates will become familiar with the tools and techniques of information technology in various sectors ranging from critical infrastructure protection to intelligence gathering and analysis.

### Curriculum Sponsor and ESR Approval Authority

Deputy Chief of Naval Operations (Plans, Policy and Operations) (N3/N5)

### Homeland Security Mobile Education Team (MET)

**Participants:** U.S. students only.

**Program:** MET are intensive, half-day seminars, designed for state governors and their homeland security team. It is also available for major urban area leaders, and focuses exclusively on enhancing the capacity of top government officials to address new homeland security challenges. Topics are discussed in an interactive roundtable format and may include: Local/State/Federal Responsibilities and Coordination, Intelligence Collection, Assessment, and Dissemination and Information Sharing and Critical Infrastructure Protection.

### Homeland Security Executive Education

#### Executive Education

**Participants:** U.S. students only.

**Program:** The Executive Education Seminar is a multi-day program designed to help senior local, state, and federal officials build U.S. capacity to defeat terrorism. Each program offers presentations on selected topics such as: intelligence, critical infrastructure, or public health issues. Participants consider complex issues and case studies and work through problems and scenarios that will enable them to strengthen working relationships across regions, agencies, and local-state-federal jurisdictional lines. This program is designed to bridge the education gap

between the 18 month Master's Degree Program and the half-day MET Seminar.

## Homeland Security Certificate Program

**Participants:** U.S. students only.

**Program:** Program provides “first preventers” in homeland security the knowledge and skills necessary to execute the national homeland security mission. Conducted exclusively online with cutting-edge distance learning technologies, the program is tailored to the needs of each discipline involved in homeland security, especially at the state and local levels. The Certificate Program is being conducted by the Center for Rural Development with support from NPS' Center for Homeland Defense and Security.

## Defense Resources Management Institute (DRMI)

### Website

[www.nps.navy.mil/drmi](http://www.nps.navy.mil/drmi)

### Executive Director

Charles J. LaCivita, Ph.D.  
Code DRMI, Halligan Hall, Room M5

(831) 656-2104 / 2306, DSN 756-2104 / 2306,  
FAX (831) 656-2139  
[clacivita@nps.edu](mailto:clacivita@nps.edu)

### Overview

Established in 1965, DRMI pioneered the education program that teaches the principles and concepts of defense resources management. The DRMI course is taught in residence (at Naval Postgraduate School) and overseas (by the requesting country). DRMI's teaching methods have served as a model in numerous foreign countries.

*Note: Over 29,000 officials, of whom over 15,000 represented 166 foreign nations, have participated in programs conducted by DRMI.*

### Our Approach

The focus of all programs conducted by DRMI is on the development of knowledge and improvement of understanding of the concepts, techniques and application of modern defense management, with specific emphasis on analytical decision making. The mission, objectives and responsibilities of DRMI are set forth in Department of Defense Directive 5010.35.

### Programs Offered

**Defense Resources Management Course** - (Four weeks in length; presented five times a year)

**International Defense Management Course** - (11-weeks in length; presented twice a year)

**Senior International Defense Management Course** - (Four weeks in length; presented once each year; normally in the month of June)

**Mobile Education Courses** - Normally two weeks in length, for U.S. military services and defense agencies, and for foreign governments upon specific request and approval.

**Courses for Other Agencies** - Programs are from two to four weeks duration, resident or on-site, for non-defense federal governments upon specific request and approval.

### DRMI Curricula

Integrate economic reasoning, management science, and quantitative analysis in a systems approach to decision making.

### Course Descriptions

#### Defense Resources Management Course (DRMI):

**Participants:** U.S. and international military officers and civilians.

(U.S.): Military officers from all services (grades 0-4 and above); DoD civilians GS-11 and above.

(International): Equivalent military and civilians as above. English language capability required.

The objective of this four-week course is to provide an appreciation of the concepts, principles, and methods of defense management as they concern planning, programming, budgeting, and related activities. Emphasis is placed on the analytical aspects of management, stemming from the disciplines of management systems, economics, and quantitative analysis.

Course methodology includes lectures, small group discussions reinforced by case studies and problem sets, as well as selected daily reading assignments.

#### International Defense Management Course (IDMC):

**Participants:** International students only. Military grades of 0-4 (Major/Lieutenant Commander) through 0-6 (Colonel/Captain) and defense-related civilians of equivalent rank.

The course is presented in English.

The course provides a series of lectures in three major areas: the defense management environment, quantitative and economic analysis, and management systems in the context of strategy, implementation, and operations. The lectures are supplemented by

small group discussions and workshops that concentrate on the lecture topics and associated readings, problems, and cases.

During the course, DRMI conducts a field trip to selected military and government agencies in the Washington D.C. area. This trip provides an opportunity for the participants to receive special briefings on management techniques and problems, and to observe actual practices at the operating level.

**Senior International Defense Management Course (SIDMC):**

**Participants:** Senior international students only. Enrollment is restricted to military flag and general officers (grades 0-7 and above) and defense-related civilians of equivalent rank, except for countries where the 0-6 grade is comparable to flag/general rank, in which case officials may be enrolled on a waiver basis.

Participation in this course is normally 50-54 senior officials from as many as 45 countries.

The course is presented in English.

The lecture, small discussion group, case study, and problem format and content described above for the International Defense Management Course also apply, but are compressed in time. Two or three senior U.S. guest speakers are invited to address the class and a short field trip is conducted.

**DRMI: Fiscal Year 2006**

IDMC 05-2	International Defense Management Course *26 Sep - 9 Dec 2005, 11 weeks
DRMC 06-19	Defense Resources Management Course Jan - 3 Feb 2006, 4 weeks
IDMC 06-1	International Defense Management Course 6 Feb - 19 Apr 2006, 11 weeks
DRMC 06-2	Defense Resources Management Course 24 Apr - 18 May 2006, 4 weeks
DRMC 06-3	Defense Resources Management Course 22 May - 16 Jun 2006, 4 weeks
SIDMC 2006	35th Annual Senior International Defense Management Course 26 Jun - 21 Jul 2006, 4 weeks
DRMC 06-4	Defense Resources Management Course 25 Jul - 18 Aug 2006, 4 weeks

DRMC 06-521 Defense Resources Management Course  
Aug - 15 Sep 2006, 4 weeks

IDMC 06-2 International Defense Management Course\*  
25 Sep - 8 Dec 2006, 11 weeks

*These courses convene in one fiscal year and continue into the next fiscal year.*

**Center for Civil- Military Relations (CCMR)**

**Website**

www.ccmr.org

**Director**

Richard J. Hoffman

Code CCMR, Glasgow Hall, Room 341B

(831) 656-3171, DSN 756-3171, FAX (831) 656-3351

ccmr@nps.organizationy.mil

**Overview**

Established at NPS in 1994, the Center for Civil-Military Relations (CCMR) provides graduate level education to foreign civilian and military participants through resident and nonresident courses. Its programs assist foreign nations in resolving civil-military issues resulting from defense transformation, stability and support operations, combating terrorism, and other security challenges.

**Our Approach**

CCMR has a long record of meeting the unique civil-military requests and requirements of the security cooperation community and partner countries. The CCMR employs seminars, workshops and courses, encouraging active and applied learning to:

- Provide high quality, graduate-level educational experience, custom-designed and built to meet the specific objectives and conditions of a recipient country.
- Teach multiple, international best-practice approaches to achieving the educational objectives of each program.
- Use world-class civil-military faculty teams with international expertise that bring both academic and practical backgrounds to each program.

**Our Programs**

**Civil-Military Relations**

The Civil-Military Relations (CMR) program is tailored to the needs of the recipient country and

addresses general or in-depth aspects of civil-military relations, including challenges of democratic consolidation, formulating national defense strategy, civilian control of the military, military professionalism, media-military relations, building linkages between the military and the legislature, intelligence and democracy, and defense transformation.

### **Peace Operations**

The Global Peace Operations Initiative (GPOI) program builds peace support operations (PSO) capability and capacity through education and training worldwide.

The Leader Development and Education for Sustained Peace (LDESP) program prepares U.S. military leaders and units deploying to Stability Operations, to accomplish the mission in cooperation with multinational partners, other U.S. Agencies and civil authorities. LDESP provides an educational foundation enabling leadership and units to establish a frame of reference for understanding the complex, ambiguous, and rapidly changing stability operations environment.

### **International Defense Acquisition**

The International Defense Acquisition Resource Management (IDARM) program offers a wide range of defense acquisition resource management courses that address acquisition, contracting, and program management.

### **Combating Terrorism**

In support of the "Regional Defense Counter-Terrorism Fellowship" program (RDCTF), CCMR developed a series of custom-built courses for bilateral, regional, and global audiences. The program provides a comprehensive approach to examining how governments can respond effectively to terrorism.

### **Stabilization and Reconstruction**

The Center for Stabilization and Reconstruction Studies (CSRS) is a teaching and research institute created in September 2004. The center's purpose is to educate the full-spectrum of stabilization and reconstruction (S&R) actors, including U.S. and foreign military officers, civilian government officials, and representatives from non-governmental organizations, and international organizations.

### **Long Term Education Projects**

CCMR's unique capacity-building programs provide recipient countries with Department of Defense expertise in the area of defense management. These programs respond to, and facilitate the spread of, democratic defense management norms throughout

the world in order to improve legitimacy, effectiveness and efficiency of defense and security institutions.

### **Program Administration**

All courses will be administered in accordance with the applicable laws, policies, and regulations of the U.S. funding provided for course execution. International participation is arranged through the Office of the Secretary of Defense and individual service security cooperation agencies. Overall quota control and programming is exercised by the Naval Education and Training Assistance Field Activity (NETSAFA).

Programs are designed for mid- to senior-grade military officers, civilian officials, legislators, and personnel from non-governmental organizations, both in residence and overseas. All programs provide participants with insights and analytical tools for enhancing civil-military cooperation at all levels.

### **Course Titles Mobile Education Teams (MET) Programs**

P273001	MET Regional Civil-Military Relations
P273011	MET Civil-Military Responses to Terrorism (Regional)
P309064	MET Preparing for Peacekeeping Deployments: Negotiating Effective Support Agreements with International Organizations
P309065	MET Preparing for Peacekeeping Deployments: Reviewing Inter-Ministerial Peace Keeping Roles & Missions
P309066	MET Preparing for Peacekeeping Deployments: Reviewing MOD and Defense HQ's PK
P309067	MET Preparing for Peacekeeping Deployments: Adopting Task Lists and Standing Operating Procedures
P309069	MET Civil-Military Responses to Terrorism
P309070	MET Civil-Military Relations
P309073	Civil-Military Relations Pre-Survey
P309077	Enhanced International Peace Keeping Capabilities (EIPC) Peace Support Operations Phase I Pre-Survey
P309078	MET EIPC Peace Support Operations
P309079	MET Enhancing Border Security through National Means and International Cooperation
P309098	MET Civil-Military Relations Continued Education
P309140	MET Implementing Strategic Planning: Developing Effective Personnel Management Policy
P309141	MET Defense Strategic Planning: Transformation Strategies for Defense Reform
P309142	MET Implementing Strategic Planning: Developing Strategic Guidance
P309143	MET Implementing Strategic Planning: The Operational Dimension
P309144	MET Implementing Strategic Planning: The Development of National Tasks Lists
P309145	MET Translating National Level Policy into Defense Guidance: Approaches & Implementation

- P309146 MET Implementing Strategic Planning: Developing National Logistics Concepts
- P309147 MET Security Building in Post-Conflict Environment
- P309148 MET The Media and the Military
- P309149 MET Intelligence and Democracy
- P309150 MET Building Linkages between the Legislature and the Military
- P309151 MET Domestic Support Operations (Military Support to Civilian Authorities)
- P309152 MET Civilian Control of the Armed Forces in a Democracy: Methods, Techniques and Applications
- P309153 MET Civil-Military Cooperation (CIMIC): Support of Multinational and Interagency Relief and Reconstruction Operations
- P309154 MET Civil Affairs (CA)/Civil-Military Cooperation (CIMIC) Support of Information Operations (IO)
- P309154 MET Establishing Democratic Civil-Military Relations and the Rule of Law

### **In Residence Programs**

- P170001 Executive Program in Defense Decision Making
- P171400 Civil-Military Relations CONUS Planning
- P171401 Planning Peace Operations (PPO)
- P171402 Defense Restructuring
- P171401 Intelligence and Democracy
- P171405 Multinational Logistics
- P171406 International Defense Transformation
- P173400 EIPC Instructor Course
- P179018 Civil-Military Response to Terrorism (Global)
- P181006 Distinguished Visitor Orientation Tour (DVOT)

## **Center for Contemporary Conflict (CCC)**

### **Website**

[www.ccc.nps.navy.mil](http://www.ccc.nps.navy.mil)

### **Director**

Peter Lavoy, Ph.D.

Code NS, Glasgow Hall, Room 396

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[ccmr@nps.navy.mil](mailto:ccmr@nps.navy.mil)

### **Overview**

As the research arm of the Naval Postgraduate School's Department of National Security Affairs, the Center for Contemporary Conflict conducts research on current and emerging security concerns of the United States and its allies. Projects range from tightly focused queries that engage one or two center members, to broad collaborative efforts that bring in outside experts from the United States, its allies, and other cooperating nations.

### **Activities**

### **Publications**

CCC members regularly publish research on current and emerging security issues. Recent books, book chapters, monographs, and journal articles are listed in the CCC webpage listed in the above. The website also features a monthly assessment of key regions and security issues.

### **Conferences, Forums, and Lectures**

The CCC hosts and participates in conferences and forums that advance understanding of contemporary security challenges facing the United States and its allies. Often, the CCC organizes conferences in support of ongoing research projects

### **Student Research**

Naval Postgraduate School students completing master's theses in National Security Affairs conduct in-depth research into key regions or security issues, such as Middle East, Europe, East Asia, and many others

## **Center for Stabilization and Reconstruction Studies (CSRS)**

### **Website**

[www.nps.edu/CSRS](http://www.nps.edu/CSRS)

### **Director**

Matthew Vaccaro

Code CCMR, Glasgow Hall, Room 347

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[mvaccaro@nps.edu](mailto:mvaccaro@nps.edu)

### **Overview**

Established in September 2004, the Center for Stabilization and Reconstruction Studies (CSRS) is dedicated to building more effective responses to failed or failing states. The Center provides short and long-term graduate education, creates knowledge through research, and conducts educational outreach in the broad functional area of stability and reconstruction (S&R).

### **Our Approach**

The challenges of stabilization and reconstruction of states are a central feature of contemporary international relations – and are likely to remain so for some time. These activities are inherently difficult, conducted by multiple actors, and are extremely dynamic. The best learning in stabilization and reconstruction occurs when the curriculum is multi-disciplinary and interactive among a diverse student

mix. The programs of CSRS incorporate students from the complete range of actors that are involved in these activities, including:

- U.S. and foreign military officers;
- U.S. and foreign government civilians; and
- Civilians from international organizations and non-governmental organizations.

## **Our Programs**

### **Master's Degree in Stabilization and Reconstruction**

The Master's Degree in Stabilization and Reconstruction is offered through the Department of National Security Affairs in the School of International Graduate Studies. It is a comprehensive, applied degree for U.S. and international students designed to create experts in S&R. Graduates are well prepared for:

- Operational-level staff and leadership roles;
- Education or trainer duties;
- Service or national policy positions; and,
- Positions in international organizations.

The MA is designed to be completed in five consecutive quarters and is made up of a diverse student mix.

### **Educational Games**

CSRS conducts educational games focused on a wide range of activities associated with stabilization and reconstruction operations. Games enhance the ability of participants to manage real world S&R activities by creating a learning environment in which participants gain experience and understanding of complex issues through role-playing. Games are particularly useful in promoting critical aspects of S&R, such as unity of effort. Additionally, games aid scholars in researching and publishing on S&R activities.

### **Short Courses**

CSRS also conducts short courses focused on the wide range of stabilization and reconstruction activities. Short courses are specially tailored for sponsor needs and can be conducted in Monterey or elsewhere.

### **Research Projects**

NPS is a world-class nexus for learning and knowledge, which greatly facilitates applied research on S&R activities. Additionally, each master's degree student researches a specific S&R issue as part of their thesis.

### **Outreach**

CSRS conducts various outreach activities, including workshops/seminars/symposia/lecture series, designed

to increase knowledge and awareness between the diverse groups involved in S&R activities.

### **Courses**

Please consult our website ([www.nps.edu/CSRS](http://www.nps.edu/CSRS)) for the most current listing of CSRS courses and events.

### **Program Administration**

CSRS seeks partners and sponsors for specific activities and events. Please let us know if you have an educational requirement related to S&R, or are interested in partnering in some fashion.

Participation by U.S. and foreign military officers, U.S. and foreign governmental civilians, and representatives of NGOs/IOs in CSRS short courses, educational games, and outreach activities is encouraged and usually easily accommodated. Please contact the CSRS staff for more information. Matriculation into the master's degree program conducted through the National Security Affairs Department is managed through the regular university procedures controlled by the Registrar.

### **Requirements for Entry for Master's Degree Program**

A baccalaureate degree with above-average grades and fluency in written and verbal English is required for all students. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

Officers and civilian employees in defense and other agencies of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Students must have obtained their bachelor's degree from an accredited academic institution. While the NSA department will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. GRE scores are not required, but are suggested for those with poor academic records.

### **Entry Date**

The Stabilization and Reconstruction Curriculum 689B is a five-quarter (15 months) course of study with an entry date of July. If further information is needed, contact the Academic Associate for the curriculum or the Program Officer.

### **Degree**

Master of Arts in Security Studies (Stabilization and Reconstruction)

**Subspecialty**

Navy P-Codes: 2101P, 2102P, 2103P, 2104P

**Typical Subspecialty Jobs**

Defense Attaché  
 Foreign Area Officer  
 Intelligence Officer  
 Plans Officer, Staff Planner  
 Various joint command positions  
 Service Headquarters - Political / Military officers  
 Major staff jobs in Combatant Commands and Fleet Commands

**Course Requirements and Electives****Core Requirements**

NS3001 War and Its Impact on Post-conflict Reconstruction  
 NS3023 Introduction to Comparative Politics  
 NS3024 Introduction to International Relations  
 NS3042 Economic Development in Stabilization and Reconstruction  
 NS2011 Policy Analysis and Research Methods

*For International Students:*

IT1500 Information Program Seminar for International Officers  
 IT1600 Communication Skills for International Officers  
 IT1700 Academic Writing for International Officers

**Curricular Core Requirements**

NS3025 Introduction to Civil-Military Relations Theory  
 NS3026 Introduction to Stabilization and Reconstruction  
 MN3118 Strategies for Building Consensus  
 MN4123 Organizing & Planning in Complex Networks  
 NS4026 Capstone Seminar in Stabilization and Reconstruction  
 NS4235 PSO and MOOTWA *or*  
 NS4236 Stability Operations

**Curricular Electives**

The following are suggested electives for 689B students:

NS3330 Politics of Middle East  
 NS3510 Government & Political in Latin America  
 NS4904 Ethics Across Cultures  
 NS4225 Civil-Military Relations in Transitions to Democracy  
 SO3802 Guerrilla Warfare  
 NS4880 Legal/Military Responses to Political Violence  
 NS4332 Ethnic Conflict  
 NS3900 International Law and Organizations  
 NS4801 International Terrorism  
 SO3750 Anthropology of Conflict

**Typical Course of Study****Quarter 1**

NS3026 (4-0) Introduction to Post-Conflict Security Building

NS3024 (4-0) Introduction to International Relations  
 NS3900 (4-0) International Law and Organizations  
 IT1500 (4-0) Information Program Seminar for International Officers  
 IT1600 (4-0) Communication for International Officers

**Quarter 2**

NS3023 (4-0) Introduction to Comparative Politics  
 NS3001 (4-0) War and its Impact on Post-Conflict Reconstruction  
 NS3155 (4-0) Intelligence and Democracy  
 NS2011\* (2-0) Policy Analysis and Research Methods  
 IT1700 (4-0) Written Communication for International Officers

**Quarter 3**

NS4235 (4-0) Seminar on Diplomacy and Strategy of Coalition Warfare and Ops Other than War  
 MN3118 (4-0) Strategies for Building Consensus  
 NS3042 (4-0) Economic Development for Security Building  
 NS0810 (0-4) Thesis Research  
 NS4080\* (2-0) Research Colloquium

**Quarter 4**

NS3025 (4-0) Introduction to Civil-Military Relations  
 MN4123 (4-0) Organizing and Planning in Complex Networks  
 -- Regional Elective  
 NS0810 (0-4) Thesis Research

**Quarter 5**

NS4026 (4-0) Capstone Seminar: Reconstruction of Civil Society  
 NS4880 (4-0) Seminar in Legal and Military Responses to Political Violence  
 -- Regional Elective  
 NS0810 (0-4) Thesis Research



## SYSTEMS ENGINEERING ANALYSIS CURRICULUM COMMITTEE (SEACC)

### Chair

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### Overview

The Systems Engineering Analysis Curriculum Committee provides oversight of this unique interdisciplinary and inter-departmental curriculum, in order to enhance its effectiveness to meet the needs of the unrestricted line officers community in contributing to naval and joint operations. This SEA curriculum is of special interest to the CNO and NPS.

The SEACC reports to the Provost, who is consulted in matters of policy and procedure and, each year, approves the budget allocated to support SEA teaching, program administration, and faculty supervision of the capstone project. The SEACC Chair manages and distribute this budget to the Academic Departments and the Meyer Institute of Systems Engineering (MISE), according to the workload assigned to each respective department/institute.

The responsibilities of the SEACC are:

1. To maintain the military relevance and academic excellence of the SEA program,
2. To foster close relationships with the appropriate officers in OPNAV and the Fleet, and with a curriculum sponsor, emphasizing the curriculum goal of improving the technical-tactical-operational prowess of the unrestricted line,
3. To draw on the best qualified and most knowledgeable faculty to serve as instructors and curriculum/course advisors,
4. Working through the Academic Associate, to ensure the interdisciplinary nature of the program is maintained, and that the best possible use is made of existing courses and faculty,
5. Working through the Director MISE, to ensure the availability of suitable student capstone projects, the professionalism of faculty advisors, and the quality of written project reports,
6. To foster the selection and matriculation of well-qualified students who have intellectual and professional promise of being future leaders of the Navy, and
7. To advise the SEACC Chair in the management and distribution of the annual budget allocated for teaching SEA courses, administration of SEA students, and supervising the SEA Capstone project.

## Degrees Awarded

The SEACC awards the Master of Science in Systems Engineering Analysis (MS SEA) degree. The SEA curriculum is designed for unrestricted line officers who aspire to command and seek a graduate degree tailored to enhance their value as combat officers. The hallmark of the curriculum is a strong scientific and technical content that offers a balanced blend and breadth in systems thinking and analysis of current and future military operations.

Candidates normally are expected to have studied mathematics and science in their undergraduate work. Undergraduate engineering study is advantageous, but not required.

The Master of Science degree in Systems Engineering Analysis requires a minimum of 48 quarters-hours of graduate-level course work. The candidate must take all courses in an approved study program, which must also satisfy the following requirements: A minimum of 32 quarter-hours of credits in 3000- and 4000-level courses, including a minimum of 12 quarter-hours at the 4000 level.

A student seeking the Master of Science in Systems Engineering Analysis must also demonstrate knowledge in systems design and integration, systems analysis and application, combat technology, and familiarity with professional military education in strategy and policy. This may be accomplished by completing all courses in an approved study program.

Participation in a capstone project with a minimum of 16 credit-hours is required for the degree. An acceptable thesis for a minimum of 16 credits, may be substituted in lieu of a team project. The Academic Associate and the Program Officer must endorse such a request, which will be subject to final approval by the Systems Engineering Analysis Curriculum Committee.

## Systems Engineering Analysis Program – Curriculum 308

### Program Officer

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This inter-disciplinary curriculum provides a foundation in systems thinking, technology, and operations analysis for warfighters. Graduates will be able to understand how to develop and fight new systems of combat systems, and have a more thorough understanding of current combat systems.

Students normally complete group projects in lieu of theses. These “capstone” projects are chosen to allow students to gain a thorough understanding of a critical warfare area and to provide the Navy and other services insights about future systems options to meet emerging needs.

The program is designed as a highly integrated graduate education. Lectures, team projects, and individual research are provided, as well as seminars from visiting experts. The length of this program is six quarters.

### Requirements for Entry

For entry, the officer must have at least a C+ undergraduate grade point average, with at least one calculus course with a C or better and at least one calculus-based physics course with a C or better (APC 335). If an officer is an outstanding performer, but lacks the necessary academic preparation, the Naval Postgraduate School offers refresher and transition courses before the program starts.

### Systems Engineering Analysis Subspecialty

Completion of this curriculum qualifies a naval officer as a Systems Engineering Sub-specialist, subspecialty code 6500P.

### Entry Dates

The Systems Engineering Analysis curriculum is a six-quarter curriculum with entry dates in January and July. If it is necessary, due to APC requirements, the twelve-week refresher will begin study prior to this entry date. If further information is needed, contact the Program Officer or Academic Associate for this curriculum.

### Degrees

#### Master of Science in Systems Engineering Analysis

This degree is proposed for all students completing the 308 curriculum. The System Engineering Analysis Curriculum Committee is the approving authority for the degree.

**Master of Science in Systems Engineering**

To be considered for this degree, a student must enter the curriculum with an ABET accreditable engineering BS degree and complete all the requirements of curriculum #308. The chair of the Department of Systems Engineering is the approving authority for the degree.

**Master of Science in Systems Analysis**

Selected students may elect to earn a degree in Systems Analysis from the Department of Operations Research. This involves a thesis in lieu of project and an extended analysis sequence. The chair of the Department of Operations Research is the approving authority for the degree.

**Typical Course of Study**

The first quarter of the SEA curriculum reflects a review of mathematics and physics, from a systems perspective. Subsequent quarters present a balance of courses in systems engineering, operations analysis, technology, joint professional military education, and project work. The students gain additional knowledge and insight through seminars and field trips.

**Quarter 1 (Accelerated)**

SE1001	(4-2)	Math I for SEA
SE1002	(3-1)	Math II for SEA
SE2010	(4-2)	Fundamentals of Mechanical Systems
SE2011	(4-2)	Fundamentals of Electro-Optical Systems

**Quarter 2**

SE3100	(3-2)	Fundamentals of Systems Engineering
SE3112	(3-0)	Combat Technology I (Sensors)
OS3180	(4-1)	Probability and Statistics for Systems Engineers
NW3230	(4-2)	Strategy and Policy

**Quarter 3**

SI3400	(3-4)	Fundamentals of Engineering Project Management
SE3121/CC3000	(3-0)	Combat Technology III (C4I)
SI4000	(1-0)	Project Seminar
OS3680	(3-0)	Naval Tactical Analysis
OA4602	(4-0)	Joint Campaign Analysis
NW3275	(4-0)	Joint Maritime Operations I (U. S. Navy URL only)

**Quarter 4**

SE3302	(3-2)	Systems Suitability
SE3113	(3-0)	Combat Technology II (Weapons)
SI4000	(1-0)	Project Seminar
OS4680	(4-0)	Naval Systems Analysis

OS3380	(3-1)	Combat Systems Simulation
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**Quarter 5**

SE3303*	(3-2)	Systems Assessment
SE4115/TS	(3-2)	Combat Technology Integration
4000		
SI0810	(0-8)	Integrating Project
SI0810	(0-8)	Integrating Project
SI4000	(1-0)	Project Seminar

**Quarter 6**

SI0810	(0-8)	Integrating Project
SI0810	(0-8)	Integrating Project
NW3276	(2-2)	Joint Maritime Operations II (U. S. Navy URL only)
NW3285	(3-0)	National Security Decision Making
SE4000	(1-0)	Project Seminar

*\*OA4702 Cost Analysis or OA4603 Test and Evaluation may be substituted, depending on the background of the officer.*

**Educational skill Requirements  
Systems Engineering Analysis Curriculum****Broad Objective**

This curriculum teaches U.S. Navy Unrestricted Line Officers how the Navy builds and operates large combat systems of systems. The primary objective is to prepare officers to serve afloat by giving them the technological and analytical understanding to fight the fleet today and in the future. The emphasis is on integration of complex warfare systems with compatible tactics. In addition, graduates with experience afloat will be prepared to serve ashore as program managers and in technical/analytical billets on headquarters staffs.

- Fundamental Skills.** Introduction to the mathematics, physics, and computer skills needed to understand the technical aspects of weapon, information, and decision systems.
- Information Systems Technology.** Develop knowledge of information systems and the underlying technologies to include computer systems, computer networks and communications systems, software engineering, and databases. Demonstrate awareness of the capabilities, limitations, designs, and vulnerabilities of information systems. Understand defensive and offensive Information Operations. Understand C4I systems.
- Sensors and Weapons.** Gain an operator's understanding of the scientific, mathematical, and engineering principles behind existing and future military sensors and weapons, to include sensor technologies and performance in all domains, and weapon effects and underlying design principles,

to include weapons of mass destruction.

Understand the principles and tools that have been used to successfully integrate weapons, sensors, and their control systems.

4. **Operations Analysis.** Understand decision making under uncertainty and risk, and its impact on military planning, operations, and tactics. Emphasis is on the art of improving naval operations and tactics. Requires familiarity with modeling and simulation of alternative choices, including cost benefit analysis. Understand introductory level operations research techniques, including optimization, experimental design, test, and evaluation, to include planning and analyzing fleet experiments. Emphasis is on assisting military executives to make better decisions using quantitative methods.
5. **Systems Engineering.** Understand and apply the systems engineering process, to include system design, development, deployment, technical and economic trade-offs, and human factors. Demonstrate, by practical project work, the ability to perform the systems engineering process as a member of a large team over a sustained period of six months or longer.
6. **Strategy and Policy.** Acquire an understanding of strategic and campaign planning by studying past military campaigns and application of lessons learned through critical qualitative and quantitative analysis. This objective is fulfilled by completing the first of the Naval War College course series of Intermediate-level Professional Military Education, and earning Phase I Joint PME credit.
7. **Independent Study.** Demonstrate the ability for independent creative thinking and analyze problems that link technical/tactical solutions to combat or operational problems. Demonstrate presentation skills with individual written reports and oral briefings.

## NAVAL WAR COLLEGE PARTNERSHIP & JPME

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**Thomas P. Moore**, Associate Professor (2001); COL USAR; Ph.D., Virginia Tech (1986); M.S., Stanford University (1975); B.A., Northeastern University (1974)

**Donald J. Stoker**, Professor (1999); Ph.D., Florida State University (1997); M.A., B.A., Valdosta State University

### Professional Military Education (PME) and Joint Professional Military Education (JPME)

The U.S. Naval War College curricula offered at NPS meets all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for JPME (as established by the Chairman, Joint Chiefs of Staff) for Intermediate Level Professional Military Education. The importance of offering a program that blends graduate-level study with Joint Professional Military Education was recognized by NPS in the early 1990s. Originally called the Joint Education Electives Program (JEEP) when it began in 1993, the program's name was changed to the Program for Joint Education (PJE) to make its name consistent with current military education terminology. In academic year 1999-2000, NPS partnered with the U.S. Naval War College (NWC), Newport, RI to provide NPS students with a tailored program leading to a Naval War College diploma and JPME phase I certification. It should be recognized that the courses described below are Naval War College courses, which are taught by Naval War College faculty. As such, course content, teaching methodology and program management are the sole responsibility of the Naval War College. The entire sequence of courses including Strategy and Policy, National Security Decision Making and Joint Maritime Operations (parts 1&2), has been reviewed and approved through the Process

for Accreditation of Joint Education (PAJE) process conducted by the Joint Chiefs of Staff at the Naval War College's College of Distance Education.

The three-course NWC program provides coverage of all mandatory "learning areas" outlined in CJCS's Officer Professional Military Education Policy (OPMEP), CJCSINST 1800.01 (series). The NWC program, both at NPS and on the College's main campus in Newport, RI, provides instruction in three course areas: *Strategy and Policy* (S&P), *National Security Decision Making* (NSDM), and *Joint Maritime Operations* (JMO). Effective in September 1999, the S&P curriculum replaced the NPS course *Joint Maritime Strategy* NS-3252, which had been required for all department of the Navy (DoN) students since 1989. Completion of the NWC S&P course is now the mandatory course requirement fulfilling the Secretary of the Navy's maritime strategy requirement which must be met by all DoN students.

*Note: Only those students who complete the entire sequence (S&P, NSDM and JMO) will earn JPME phase I certification.*

Transcripts of those students who complete all NWC courses (S&P, NSDM and JMO) through any methodology – Fleet Seminar, correspondence, NWC Monterey courses – will be annotated to verify their JPME phase I certification.

All versions of NWC courses are academically rigorous and will require significant effort on the part of each student. The goal is to enable each student to earn both their NPS degree and the NWC diploma (with JPME phase I). It should be recognized, however, that students who cannot complete all of the NWC requirements while in Monterey can enroll in the remaining NWC courses, by Fleet Seminar or other DL course offerings, at their next duty station.

## Naval War College Course Descriptions

### **NW3230 Strategy & Policy: The American Experience (4-2).**

The S&P course is designed to prepare the military officer for the mid-level to advanced stages of a professional career in which he or she may be intimately involved in the interplay between military power and the political process – that is, between strategy and policy. The course uses historical examples to demonstrate the military officer's urgent need for a joint and combined warfare perspective on the military profession. That perspective significantly enhances the ability of strategic thinkers and war-fighters to wield the military instrument in support of national goals. In the early stages of an officer's career he or she is trained in tactics. The S&P curriculum, in contrast, is designed to teach officers to think strategically. The course illustrates the relationship between a nation's political interests and goals and the ways military force may be used to achieve them. It focuses on a series of studies that begins with interests, continues through conflict and ends with the final post-war settlement. Academic disciplines of history, political science, military studies, and

international relations are woven into a coherent analysis of how wars begin, how they are fought and how they end.

The Strategy & Policy course hones the officer's ability to analyze past operations and apply historical lessons to future joint and combined operations. Three facets of the course develop strategic thought. First and foremost, the course focuses extensively on the strategic analyses that are the cornerstone of strategic thought, particularly the works of Clausewitz, Sun Tzu, Mahan and Corbett. Second, the masters' work is used to analyze strategic decisions made during several historical conflicts. Collectively these case studies sharpen the student's understanding of the essence of strategy. Clear, objective and imaginative thinking is the framework for the final part of the course where students consider recent wars as well as conflicts that may occur in the future.

### **NW3275 Joint Maritime Operations (Part 1) (4-0).**

The Joint Maritime Operations curriculum develops the ability to translate contemporary national and regional military strategies into naval, joint and multinational operations, with particular emphasis on the operational art and employment of the Sea Services. Thus, it enables officers to make sound operational decisions in both command and staff positions. JMO is an executive development course that emphasizes planning and decision making factors at the joint task force level for operations in the maritime environment. Planning and executing military/maritime operations requires military officers to make increasing use of many disciplines. This differs from the past where application of a single discrete discipline was more often the norm. Officers must have a firm grasp of military strategy, an understanding of joint and combined operations, and a thorough background in the essential elements of the military planning and decision making process to deploy, employ and sustain U.S. military forces efficiently and successfully. Consequently, the JMO course employs a multi-disciplinary approach, providing the student the opportunity to synthesize various ideas that include maritime strategy, joint and service doctrine, military decision-making, operational planning, naval warfare, military warfare, threat assessment, and war gaming techniques. JMO *applies* these ideas to military problems requiring decisions in dynamic situations. The integrating themes of the courses are joint maritime operations, the operational level of war, and military-decision making. Emphasis is placed on the ability to identify the military conditions required to achieve strategic goals, the required sequence of actions, resources and associated costs or risks in that process. NW-3275 is the first of a sequence of two classes required to complete the JMO curriculum; it must be followed by NW-3276 to earn credit for the course.

### **NW3276 Joint Maritime Operations (Part 2) (4-0).**

This class is the second in a sequence of two classes required to complete the JMO curriculum. Prerequisite: NW-3275. (See NW-3275 for info.)

### **NW3285 National Security Decision Making (4-0).**

The National Security Decision Making curriculum educates military officers in the effective selection and leadership of armed forces within national resource constraints, providing instruction in: the strategic planning and selection of future military forces: systematic approaches to programmatic resource choices under conditions of high uncertainty; and the nature of economic, political, organizational and behavioral

factors affecting selection and command of military forces. The NSDM curriculum is an executive development course wherein major emphasis is placed on the preparation of officers for intermediate-level command and staff assignments. Selection of concepts and materials is predicated on the belief that an effective career executive does not apply discrete disciplines, but rather is required to synthesize many disciplines relevant to different situations. Moreover, the appropriate point of view is an integrative one that seeks a balanced use of reasoning based on both an academic and professional foundation. For this reason, the NSDM curriculum employs a multidisciplinary approach, synthesizing selective concepts from economics, political science, strategy, operations research, leadership, psychology, management control, and other related fields. All instruction seeks to use the broad experience of the student body and focuses on making and implementing critical decisions within the national security environment.

### **Marine Corps Professional Military Education at NPS**

Marine Corps officers selected to attend NPS through the Marine Corps' Special Education Program (SEP) can participate in Marine Corps PME seminar programs for captains and majors. The Marine Corps' College of Continuing Education (CCE) designs, develops, and delivers both of the Marine Corps' officer distance education programs (DEP): the Expeditionary Warfare School (EWSDEP) and the Command & Staff College (CSCDEP). Interested officers can contact the CCE regional coordinator for NPS through the CCE website:

<https://www.marinenet.usmc.mil/cce>.

USMC PME information is found at [www.mcu.usmc.mil/pme/Officer/officerpme.htm](http://www.mcu.usmc.mil/pme/Officer/officerpme.htm)

**NPS JPME Requirement.** All naval officers (Navy and Marine Corps) must take NW-3230 "Strategy and Policy: The American Experience" while attending the Naval Postgraduate School. This requirement was established by SECNAVINST 1524.2A in 1989.

Credit for NW-3230 validates the first unit of Marine Corps Command and Staff, 8801 "The Theory and Nature of War." As NW-3230 is an NPS JPME requirement, validating NW-3230 requires the full completion of the entire Command and Staff 8800 series.

**Naval War College C&S option.** Marine Corps officers attending NPS may enroll in the Naval War College Command and Staff program in lieu of the Marine Corps Command and Staff DEP. This requires completion of Marine Corps CCE course 8845 "The MAGTF" and consists of lessons 8804 and 8805 from the Marine Corps Command and Staff series. The Naval War College courses needed to complete the Navy C&S requirement while at NPS are: NW3230 (Strategy and Policy-one quarter), NW3275 and

NW3276 (Joint Maritime Operations-two consecutive quarters), and NW3285 (National Security Decision Making-one quarter).

### **Air Force Intermediate Development Education (IDE) at NPS**

Air Force officers selected for IDE programs at the NPS are managed by the Air Force Institute of Technology, Civilian Institution Programs (AFIT/CI) office at Wright-Patterson AFB OH. Selected officers complete a master's degree program at NPS in a field of study appropriate to their careers. They will also complete the appropriate PME courses in conjunction with their degree (if they have not already completed Air Command and Staff College by either seminar or correspondence).

[https://www.afit.edu/cip/ide\\_nps.cfm](https://www.afit.edu/cip/ide_nps.cfm)

## NONRESIDENT EDUCATION OPPORTUNITIES (DISTRIBUTED LEARNING)

### Office of Continuous Learning

NPS employs Distributed Learning (DL) technologies as an innovative tool for broadening the professional and intellectual horizons of students, preparing them to assume leadership roles in tomorrow's defense environment.

OCL Website: [www.nps.edu/dl/nps](http://www.nps.edu/dl/nps)

NPS offers high quality and flexible delivery of degree and non-degree programs that are uniquely relevant to defense needs. These programs directly link to competencies which allow for the building of an appropriate foundation of naval leaders. Robust return on investment is in the form of knowledge, skills and abilities critical to naval combat effectiveness.

NPS' DL strategy provides the following comprehensive options to:

Increase flexibility and opportunity for graduate education

Take the education to the student through distributed learning and satellite locations in Fleet Concentration Areas

Use innovative learning technology to deliver education

Pursue "two-for-one" – graduate degree and JPME phase I credit in a single program

Enhance ability to fill subspecialty-coded billets

Support continuous educational development of Navy Officers

The following Certificate Programs can be obtained entirely online:

- Anti-Submarine Warfare (ASW)
- Fundamentals in Information Systems Technology (eFIST)
- Information Systems and Operations (ISO)
- Information Systems Technology (IST)
- Systems Analysis (SA)
- Space Systems (SS)

The following Certificate Program is obtained via a combination of Video Tele-Education and online classes:

- Systems Engineering (SE)

The following Degree Program can be obtained entirely online:

- Masters of Computing Technology (MCT)

The following Degree Program is obtained via a combination of Video Tele-Education and online classes:

- Master of Systems Analysis (MSA) Degree Program
- Master of Science in Systems Engineering (MSSE) Degree Program
- Systems Engineering Management- Product Development Leadership Education for the 21st Century (SEM-PD21)

As a part of its overall DL strategy, NPS, through the Office of Continuous Learning (OCL), has established outreach offices in Fleet Concentration Areas in support of these DL methods, broadening its outreach and ability to disseminate graduate educational opportunities. The primary functions of the Outreach offices include:

- Conducting demographic educational Market Analysis
- Shaping Educational Programs to meet local student needs
- Marketing NPS on-campus and DL programs
- Liaison with local DoD commands
- Building relationships with other DoD agencies to include the intelligence, acquisition and JPME communities
- Counseling officers on educational and promotion opportunities
- Supporting visiting NPS faculty
- Identifying local Distributed Learning Support facilities
- Working with NPS departments to experiment with new technology methods to improve DL delivery
- Creating joint programs with local universities

### Opportunities for Enlisted Personnel

On January 6, 2006, the President signed the National Defense Authorization Act for Fiscal Year 2006 into law. Included in Section 526 of this Act is a revision to the current policy regarding education of enlisted service members at NPS. The Act specifically states that eligibility is expanded to allow "...an eligible enlisted member of the Navy or Marine Corps to receive instruction from the Postgraduate School in certificate programs and courses required for the performance of the member's duties."; however, the Act is restricted such that "The Secretary [of the Navy] may not award a baccalaureate, masters, or



doctorate degree to an enlisted member based upon instruction received at the Postgraduate School....”

### **Air Force Institute of Technology— Distance Learning**

The Air Force Institute of Technology (AFIT), located at Wright-Patterson AFB, Ohio, is the Air Force's graduate school of engineering and management as well as its institution for technical professional continuing education. AFIT is developing distance learning programs for government students who cannot enroll in one of AFIT's resident programs. Detailed information about AFIT's nonresident programs can be found at <http://www.afit.edu/en/dl/>

The Naval Postgraduate School maintains a Strategic Alliance with the Air Force Institute of Technology. A memorandum of agreement between the Secretary of the Navy and the Secretary of the Air Force forms this alliance to ensure the two institutions continuously work together to meet the educational needs of the Armed Forces of the United States. NPS and AFIT will continue to reflect the heritage and character of their respective services, meeting Joint and service-unique needs, minimizing unnecessary redundancy, maintaining quality and realizing efficiencies and economies of scale.

NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transfer from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

## ACADEMIC CALENDARS

### Academic Calendar AY 2006

#### Spring Quarter

Reporting Date ( <b>International</b> )	Sunday	12 Mar
Reporting Date	Monday	20 Mar
Instruction Begins	Monday	27 Mar
Reporting Date for Refresher	Monday	1 May
Refresher Begins	Monday	8 May
Memorial Day (Holiday)	Monday	29 May
Pre-graduation Awards Ceremony	Tuesday	6 Jun
Final Examinations Begin	Monday	12 Jun
Graduation	Friday	16 Jun
Summer Break		19 Jun - 1 Jul

#### Summer Quarter

Reporting Date ( <b>International</b> )	Sunday	18 Jun
Reporting Date	Monday	26 Jun
Independence Day (Holiday)	Tuesday	4 Jul
Instruction Begins	Wednesday	5 Jul
Reporting Date for Refresher	Monday	7 Aug
Refresher Begins	Monday	14 Aug
Labor Day (Holiday)	Monday	4 Sep
Pre-graduation Awards Ceremony	Tuesday,	12 Sep
Final Examinations Begin	Monday	18 Sep
Graduation	Friday	22 Sep
4/21/04		

### Academic Calendar AY 2007

#### Fall Quarter

Reporting Date ( <b>International</b> )	Sunday	10 Sept 2006
Reporting Date	Monday	18 Sept
Instruction Begins	Monday	25 Sept
Columbus Day (Holiday)	Monday	9 Oct
Reporting Date for Refresher	Monday	30 Oct
Refresher Begins	Monday	6 Nov
Veteran's Day (Holiday)	Friday	10 Nov
Thanksgiving Day (Holiday)	Thursday	23 Nov
Pre-graduation Awards Ceremony	Tuesday	5 Dec
Final Examinations Begin	Monday	11 Dec
Graduation	Friday	15 Dec
Christmas Break		18 Dec - 1 Jan 2007

#### Winter Quarter

Reporting Date ( <b>International</b> )	Wednesday	7 Dec 2006
New Years Observed (Holiday)	Monday	1 Jan 2007
Reporting Date	Tuesday	2 Jan
Instruction Begins	Thursday	Jan
Martin Luther King's Birthday (Holiday)	Monday	5 Jan
Reporting Date for Refresher	Monday	5 Feb
Refresher Begins	Monday	2 Feb
President's Day (Holiday)	Monday	9 Feb
Pre-graduation Awards Ceremony	Tuesday	3 Mar
Final Examinations Begin	Monday	9 Mar
Graduation	Friday	3 Mar

**Spring Quarter**

Reporting Date ( <b>International</b> )	Sunday	11 Mar
Reporting Date	Monday	19 Mar
Instruction Begins.	Monday	26 Mar
Reporting Date for Refresher	Monday	30 April
Refresher Begins	Monday	7 May
Memorial Day (Holiday)	Monday	28 May
Pre-graduation Awards Ceremony	Tuesday	5 Jun
Final Examinations Begin	Monday	11 Jun
Graduation	Friday	15 Jun
Summer Break		18 Jun - 1 Jul

**Summer Quarter**

Reporting Date ( <b>International</b> )	Sunday	24 Jun
Independence Day (Holiday)	Wednesday	4 Jul
Reporting Date	Thursday	5 Jul
Instruction Begins	Monday	9 Jul
Reporting Date for Refresher	Monday	13 Aug
Refresher Begins	Monday	20 Aug
Labor Day (Holiday)	Monday	3 Sep
Pre-graduation Awards Ceremony	Tuesday	18 Sep
Final Examinations Begin	Monday	24 Sep
Graduation	Friday	28 Sep
9/26/05		

**Academic Calendar AY 2008****Fall Quarter**

Reporting Date ( <b>International</b> )	Sunday	16 Sept 2007
Reporting Date	Monday	24 Sept
Instruction Begins	Monday	1 Oct
Columbus Day (Holiday)	Monday	8 Oct
Reporting Date for Refresher	Monday	5 Nov
Veteran's Day (Holiday).	Monday	12 Nov
Refresher Begins	Tuesday	13 Nov
Thanksgiving Day (Holiday)	Thursday	22 Nov
Pre-graduation Awards Ceremony	Tuesday	11 Dec
Final Examinations Begin	Monday	17 Dec
Graduation	Friday	21 Dec
Christmas Break		21 Dec - 4 Jan 2008

**Winter Quarter**

Reporting Date ( <b>International</b> )	Thursday	27 Dec 2007
New Years Observed (Holiday)	Tuesday	1 Jan 2008
Reporting Date	Wednesday	2 Jan
Instruction Begins	Monday	7 Jan
Martin Luther King's Birthday (Holiday)	Monday	21 Jan
Reporting Date for Refresher.	Monday	11 Feb
President's Day (Holiday)	Monday	18 Feb
Refresher Begins	Tuesday	19 Feb
Pre-graduation Awards Ceremony.	Tuesday	18 Mar
Final Examinations Begin	Monday	24 Mar
Graduation	Friday	28 Mar

**Spring Quarter**

Reporting Date ( <b>International</b> )	Sunday	16 Mar
Reporting Date	Monday	24 Mar
Instruction Begins.	Monday	31 Mar

ACADEMIC CALENDARS

Reporting Date for Refresher	.Monday	5 May
Refresher Begins	Monday	12 May
Memorial Day (Holiday)	Monday	26 May
Pre-graduation Awards Ceremony	Tuesday	10 Jun
Final Examinations Begin	Monday	16 Jun
Graduation	Friday	20 Jun
Summer Break		20 Jun - 4 Jul

**Summer Quarter**

Reporting Date ( <b>International</b> )	Sunday	22 Jun
Reporting Date	Monday	30 Jun
Independence Day (Holiday)	Friday	4 Jul
Instruction Begins	Monday	7 Jul
Reporting Date for Refresher	Monday	11 Aug
Refresher Begins	Monday	18 Aug
Labor Day (Holiday)	Monday	1 Sep
Pre-graduation Awards Ceremony	Tuesday	16 Sep
Final Examinations Begin	Monday	22 Sep
Graduation	Friday	26 Sep
9/26/05		

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