Calhoun

Institutional Archive of the Naval Postgraduate School

Author(s)	Naval Postgraduate School (U.S.)
Title	Academic Year 1998
Publisher	Monterey, California. Naval Postgraduate School
Issue Date	1998
URL	http://hdl.handle.net/10945/30977

NAVAL POSTGRADUATE SCHOOL

ACADEMIC YEAR 1998

UNIQUE

INNOVATIVE

RELEVANT

EDUCATION

MONTEREY, CALIFORNIA

NAVAL POSTGRADUATE SCHOOL CATALOG

ACADEMIC YEAR 1998

OVERVIEW

The School

The Naval Postgraduate School is an academic institution whose emphasis is on study and research programs relevant to the Navy's interests, as well as to the interests of other arms of the Department of Defense. The programs are designed to accommodate the unique requirements of the military.

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, which has been home to NPS since 1947, houses state-of-the-art laboratories, numerous academic buildings, a library, government housing and impressive recreational facilities.

The Students

Nearly 1,500 students attend the Naval Postgraduate School. The student body consists of U.S. officers from all branches of the uniformed services, officers from approximately 30 other countries and a small number of civilian employees. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background.

The Faculty

The faculty, the majority of whom are civilians, are drawn from a broad diversity of educational institutions and represent a prestigious collection of scholars. Faculty/student interaction is high. Every class is taught directly by a faculty member— over 99% of whom have a Ph.D.

The Degrees

The Naval Postgraduate School offers classes leading to advanced degrees in a variety of fields.
MASTER OF ARTS DEGREE: National Security Affairs, Civil-Military Relations & International Security
MASTER OF SCIENCE DEGREE: Aeronautical Engineering, Applied Mathematics, Applied Physics, Applied Science, Astronautical Engineering, Computer Science, Defense Analysis, Electrical Engineering, Engineering Acoustics, Engineering Science, Human Resource Development, Information Technology Management, International Resource Planning and Management, Management, Materials Science and Engineering, Mechanical Engineering, Meteorology, Meteorology and Physical Oceanography, Modeling Virtual Environments and Simulation, Operations Research, Physical Oceanography, Physics, Software Engineering, Space Systems Operations, Systems Engineering, Systems Technology.
ENGINEER DEGREE: Aeronautical and Astronautical Engineer, Electrical Engineer, Mechanical Engineer.
DOCTOR OF PHILOSOPHY: Aeronautical and Astronautical Engineering, Applied Mathematics, Applied Physics, Computer Science, Electrical Engineering, Engineering Acoustics, Mechanical Engineering, Meteorology, Operations Research, Physical Oceanography, Physics.
DOCTOR OF ENGINEERING: Aeronautical and Astronautical Engineering, Engineering Acoustics, Mechanical Engineering.

For more information on admissions, or for a catalog, contact:

Director of Admissions
Code 01B3
Naval Postgraduate School
589 Dyer Road, Room 103C
Monterey, CA 93943-5100
Telephone: (408) 656-3093 / DSN 878-3093

The World Wide Web edition of the School's catalog is at: **http://www.nps.navy.mil**

TABLE OF CONTENTS

CNO GRADUATE EDUCATION STATEMENT

"Selection for graduate education at the Naval Postgraduate School (NPS) is one of the most visible symbols of the confidence the U.S. Navy has vested in an individual's professional ability and career potential.

The rigorous educational programs offered at NPS are among the most technically advanced and academically challenging in the country. They not only fulfill the Navy's need for specialists in many high-tech fields, they also provide students with a sound basis for achieving a broadened perspective on global issues and challenges that lie ahead.

Students will expand their breadth of knowledge in a particular discipline and will reinvigorate their ability to successfully analyze and solve the complex challenges we face. These important skills will help guide our Navy into the 21st century through fresh thinking and innovation.

Our Navy is the world's best. The richly rewarding educational experience of attending the Naval Postgraduate School will help its graduates maintain that status while producing our Navy's future leaders."

JAY L. JOHNSON
Admiral, U.S. Navy

INTRODUCTION

THE SCHOOL
To meet its educational requirements, the Navy has developed a unique academic institution at the Naval Postgraduate School (NPS) through the use of specially tailored academic programs, and a distinctive organization tying academic disciplines to naval and joint warfighting applications.

The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government and military officers and government civilian employees of other countries. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background. Students receive graduate degrees as a result of successful completion of study programs designed primarily to prepare them for future career assignments; however, degrees are awarded on the basis of the same academic standards that prevail at other accredited institutions.

NPS is an academic institution whose emphasis is on study and research programs that are relevant to the Navy's interests, as well as the interests of other arms of the Department of Defense (DoD). The programs are designed to accommodate the unique requirements of the military, including requirements for Defense Acquisition, and Program for Joint Education (PJE).

THE MISSION
The Naval Postgraduate School was established to serve the advanced educational needs of the Navy. The broad responsibility of the school is reflected in its stated mission:

> Increase the combat effectiveness of U.S. and Allied armed forces and enhance the security of the U.S.A. through advanced education and research programs focused on the technical, analytical, and managerial tools needed to confront defense related challenges of the future.

An expansion upon this mission which has been excerpted from SECNAV INSTRUCTION 1524.2A, April 4, 1989:

> The NPS exists for the sole purpose of increasing the combat effectiveness of the Navy and Marine Corps. It accomplishes this by providing post-baccalaureate degree and nondegree programs in a variety of sub-specialty areas not available through other educational institutions. The NPS also supports the DoN through the continuing programs of naval and maritime research and through the maintenance of an expert faculty capable of working in, or as advisors to, operational commands, laboratories, systems commands, and headquarters activities of the Navy and Marine Corps.

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, and to prepare officers to introduce and utilize future technologies.

ACCREDITATION
The Naval Postgraduate School is accredited by the Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges. Engineering curricula accredited by the Accrediting Board for Engineering and Technology (ABET) are Aeronautical, Electrical and Mechanical. The Systems Management Curricula are accredited by the National Association of Schools of Public Affairs and Administration. Certification for Phase I Program for Joint Education (PJE) has been approved by the Chairman, Joint Chiefs of Staff, for graduates of the Joint Education Electives Program (JEEP).

DEGREES CONFERRED
Although the curricula are tailored to address defense requirements, they are developed within the framework of classical academic degrees, meeting the highest academic standards. Each curriculum leads to a master's degree; however, additional study can lead to either an engineer's degree or the doctor's degree.

DEGREES

MASTER OF ARTS DEGREES
National Security Affairs
Civil-Military Relations & International Security

MASTER OF SCIENCE DEGREES
Aeronautical Engineering
Applied Mathematics
Applied Physics
Applied Science
Astronautical Engineering
Computer Science
Defense Analysis
Electrical Engineering
Engineering Acoustics
Engineering Science
Human Resource Development
Information Technology Management
International Resource Planning and Management
Management
Materials Science and Engineering
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
Modeling Virtual Environments and Simulation
Operations Research
Physical Oceanography
Physics
Software Engineering
Space Systems Operations
Systems Engineering
Systems Technology

ENGINEER DEGREES
(Typically requires one year of study beyond the Master's Degree)
Aeronautical and Astronautical Engineer
Electrical Engineer
Mechanical Engineer

DOCTOR'S DEGREES
Doctor of Philosophy:
Aeronautical and Astronautical Engineering
Applied Mathematics
Applied Physics
Computer Science
Electrical Engineering
Engineering Acoustics
Mechanical Engineering
Meteorology
Operations Research
Physical Oceanography
Physics

Doctor of Engineering:
Aeronautical and Astronautical Engineering
Engineering Acoustics
Mechanical Engineering

DUDLEY KNOX LIBRARY

The Dudley Knox Library is a university library and as such it is expected to meet standards established by the School's principal accrediting body, the Western Association of Schools and Colleges (WASC). It is unique within the community of academic libraries in that it is dedicated both to supporting research and graduate-level education and providing for the special requirements of the Naval Postgraduate School such as the Joint Professional Military Education (JPME) Program. In addition to its open-literature collections in the disciplines of science, engineering, national security affairs, and administrative sciences, the Library houses a collection of classified (Secret/ Confidential) research reports.

The Library administers a Secure Word Processing Facility which enables students and other members of the campus community to prepare theses and other reports of research which draw upon its collections of classified materials. Through its electronic resources areas, the Library provides direct patron access to an increasing number of CD-ROM databases and other electronic resources. Access to a growing number of Internet-based on-line databases is also made possible via the Library's Home Page [http://web.nps.navy.mil/~library/]. BOSUN (the Library's on-line catalog), is web-accessible and offers access to full text online resources, indexing and abstract services, and links to Internet sites organized by subject. Library staff members actively identify and provide links to many full-text electronic publications and journals. Through BOSUN, users can remotely renew their own materials, place holds or make book purchase suggestions.

Presently, the Library's holdings number approximately 400,000 bibliographic volumes in hard copy, 500,000 volumes in microform, and 1370 journal subscriptions. A staff of 34 librarians and library support personnel identify and process materials for the collection, and assist members of the campus community and the public to find information resources useful for their work.

The Library completed an expansion project in late 1993, nearly doubling the usable space which now totals approximately 100,000 sq. ft. The Library contains photocopy facilities, individual study carrels, and group study rooms and provides reference, on-line searching, circulation, and telephone paging services. The Christopher Buckley, Jr., Collection of books on naval maritime history includes both fiction and nonfiction. The Library is a selective depository for information distributed through the Federal Depository Program.

The Library is organized into service groups responsible for acquiring and processing research and instructional materials and providing customer support in the use of these materials. The Information Services group provides reference, user instruction, on-line searching, interlibrary loan, document delivery and circulation services for the Library's open-literature collections. The Library Systems Office provides hardware/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 on-line catalog, and maintains the accuracy of that database. The Restricted Resources and Services group provides circulation and reference services from the classified report literature from print, microform, and CD-ROM resources. The Library is in the process of developing a map collection in support of the curriculum.

The Library is a member of the Monterey Bay Area Cooperative (MOBAC) Library System which provides expedited interlibrary loan among its members. The Library also participates in the Online Computer Library Center (OCLC)'s interlibrary loan program, which facilitates borrowing of materials throughout the U.S.

CAMPUS COMPUTING

The many computer-based and professional support services provided by the Computer Center are available free to all faculty, staff and students of the School in connection with instructional, research or administrative activities. Round-the-clock operational support is provided on two major multi-access systems, an AMDAHL 5995-1100A running IBM's VM/XA and MVS/ESA operating systems, and a CRAY J90 Supercomputer running UNICOS.

The AMDAHL has 3 processors sharing 512 MB processor storage, 1 GB of expanded storage for paging space and 40 I/O channels. Auxiliary devices include IBM 3380 disks (models XE to XK), IBM 3480 Cartridge Tape Drives (18-track), IBM 3420-8 Tape Drives (9-track, 6250 bpi) and an IBM 3800-3 high-speed page printer. The most direct mode of user access is via 600 IBM 327X terminals, or PC-compatibles, distributed in public clusters and private offices throughout the academic buildings and hard-wired to the Center in Ingersoll Hall. In addition, full micro-to-mainframe dial-up capability is supported at speeds up to 28,800 bps.

The AMDAHL mainframe supports a wide range of applications under IBM's two operating systems: VM/XA (Virtual Machine/Extended Addressing), for interactive computing, and MVS/ESA (Multiple Virtual Systems) for batch-production and transaction processing for applications such as the Knox Library's On-line Catalog. The extensive programming facilities include FORTRAN, ADA, C, COBOL, PL/1, APL2, PASCAL and BASIC.

The CRAY mini-supercomputer has 4 processors sharing 1 GB main storage and 50 GB disk storage. It is used for numerically-intensive, research computing in science and engineering. The AMDAHL and the CRAY systems share a StorageTek Corp.'s Automated Cartridge System (with capacity for 12,000 tape cartridges at 400 MB each) for system-managed mass storage, backup and archiving of data. The CRAY is directly connected by FDDI link to the

Center's Scientific Visualization Laboratory in Ingersoll Hall, Room 148. This lab contains a variety of high-performance graphics work-stations including a Silicon Graphics' 380 VGX system with 8 processors for sophisticated graphics rendering, computer animation and generation of professional-quality video tapes. This is a state-of-the-art facility for visualization of the results of complex computer simulations and models run on the School's computers and workstations.

All of these, and other, server facilities are accessible on the campus backbone network which presently supports 10 Mbps Ethernet over fiber-optic cable. In early 1994 the bandwidth was improved to at least 100 Mbps. The Center also maintains several laboratories and open clusters of workstations distributed in the academic buildings. These include six Learning Resource Centers - classrooms equipped with PCs, Macs and Unix workstations. The open clusters contain SUN SPARC10 workstations with full network access and IBM 327X terminals directly connected to the AMDAHL mainframe. Some 270 workstations area available in these facilities for use by students, faculty and staff.

Wide-area network support includes the INTERNET and MILNET. The Center's professional staff conducts short courses, and provides consulting help in systems and applications programming, and on computer problem-solving tools and techniques. They also engage in a research and development program directed primarily toward continuously improving the campus computing environment and the exploitation of new and emerging technologies in support of academic computing.

Supplementing the Center's facilities are the many departmental classrooms and laboratories equipped with microcomputers and/or workstations which support their subspecialized educational or research needs. Most of these systems are on local-area networks which are connected to the campus backbone.

NAVAL POSTGRADUATE SCHOOL FOUNDATION

The Foundation is a non-profit corporation whose purpose is to provide support from private sources to the Naval Postgraduate School. Towards this end, the Foundation solicits, receives and administers tax-exempt charitable contributions. These gifts are expended in behalf of programs and activities that are deemed important by the School Superintendent but are outside government funding limits.

Since its founding in December 1970, ongoing Foundation support has enabled it to have progressively increasing impact on School operations. Currently, it administers more than a dozen major projects serving to promote excellence in teaching and research, and enhancing the academic and support facilities of the School. Individuals wishing to participate in the work of the Foundation may obtain further information by writing to the Naval Postgraduate School Foundation, P.O. Box 8626, Monterey, CA, 93943.

ALUMNI RELATIONS OFFICE

The Alumni Relations Office was established in July, 1997 at the recommendation of the Superintendent to communicate with the 20,000 alumni of the Naval Postgraduate School. The purpose of the Alumni Relations Office is to inform the university community, specifically alumni, of important news, events, academic achievements and accomplishments of the students, alumni and faculty. The Naval Postgraduate School would like to foster a stronger relationship with alumni throughout the armed forces.

The Alumni Relations Office produces a quarterly newsletter, Alumni@NPS. The newsletter is circulated to the university community, alumni and friends. Please call, fax or e-mail to provide updated addresses after graduation so that the office can keep alumni updated about the university. The Alumni Relations Office is located on the first floor of Herrmann Hall.

<div align="center">

Director, Alumni Relations
1 University Circle
Code 004
Monterey, CA 93943-5029
Telephone (408) 656-2981/DSN 878-2981/FAX (408) 656-3172
e-mail: alumni@nps.navy.mil
Homepage: http://web.nps.navy.mil/~alumni/

</div>

SCHOOL STRUCTURE AND ORGANIZATION

The Naval Postgraduate School was established and is funded by the Congress of the United States. It is administered as an activity within the Department of the Navy. The institution's governance and administration follow norms for civilian higher education, adapted appropriately for the Navy's specialized needs.

GRADUATE EDUCATION REVIEW BOARD

A Graduate Education Review Board, chaired by the Chief of Naval Operations and including the Vice Chief of Naval Operations, the Deputy Chief of Naval Operations (Manpower, Personnel and Training, N-1), the Superintendent, Naval Postgraduate School and a representative from the Naval Systems Commands (on a rotating basis) meets annually to provide policy guidance and direction for the Navy's graduate education programs. The Board reviews the adequacy and stability of resources and student input. Prior to this meeting, a separate Graduate Education Review Group, chaired by the Vice Chief of Naval Operations, meets to review graduate education issues and identify matters of potential interest to the Graduate Education Review Board. The Graduate Education Review Group membership includes the principal warfare sponsors, principal subspecialty primary consultants and the Superintendent, Naval Postgraduate School.

BOARD OF ADVISORS

The Board of Advisors is composed of distinguished professionals, consisting of 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 Superintendent on strategic matters of the Navy's Graduate Education Programs and advise the Secretary of the Navy of their needs. 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 are appointed for terms of two years by the Secretary of the Navy upon the recommendation of the Superintendent. Each appointment is renewable once for a second period of two years.

The Board meets annually at the Naval Postgraduate School and submits a report of its recommendations to the Secretary of the Navy via the Superintendent. Board members also serve on departmental academic review committees during the year and assist in other matters as requested by the Superintendent or the Secretary of the Navy.

ADMINISTRATION
The Superintendent of the Postgraduate School is a flag officer of the line of the Navy. The Superintendent's principal assistant is the Provost/Academic Dean, who is the ranking member of the civilian faculty.

<div align="center">

SUPERINTENDENT
Marsha J. Evans
Rear Admiral, U.S. Navy

PROVOST & ACADEMIC DEAN
Richard S. Elster, Ph.D.
Professor of Systems Management

</div>

The Superintendent has command responsibility for accomplishment of the School's mission. The Provost/Academic Dean is the chief educational officer and is responsible to the Superintendent for all academic matters. He is appointed by the Secretary of the Navy upon the recommendation of a council of NPS senior personnel, chaired by the Superintendent.

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

ADMINISTRATIVE STAFF
Principal assistants to the Superintendent and Provost are two captains of the line, one supply corps captain, four civilian deans, three civilian associate provosts and the Director of the Library. The military positions are Dean of Students/Director of Programs, Commander, Naval Support Activity and Director of Resource Management. The academic dean positions are Dean of Management and Security Studies, Dean of Engineering and Computational Sciences, Dean of Operational and Applied Science, and Dean of Research. The academic associate provost positions are Associate Provost for Instruction, Associate Provost for Innovation, and Associate Provost for Computer and Information Services. These positions are currently held by:

<div align="center">

DIRECTOR OF RESOURCE MANAGEMENT
J. J. Gallagher
Captain, U.S. Navy

DEAN OF STUDENTS/DIRECTOR OF PROGRAMS
James J. Miller
Captain, U.S. Navy

COMMANDER, NAVAL SUPPORT ACTIVITY
Mary J. Meyer
Captain, U.S. Navy

</div>

DEAN OF MANAGEMENT AND SECURITY STUDIES
James S. Blandin
Professor of Management

DEAN OF ENGINEERING AND COMPUTATIONAL SCIENCES
Rudolph Panholzer
Professor of Electrical and Computer Engineering

DEAN OF OPERATIONAL AND APPLIED SCIENCE
Peter Purdue
Professor of Operations Research

DEAN OF RESEARCH
David W. Netzer
Distinguished Professor of Aeronautics and Astronautics

ASSOCIATE PROVOST FOR INSTRUCTION
Maurice D. Weir
Professor of Mathematics

ASSOCIATE PROVOST FOR INNOVATION
David R. Whipple
Professor of Systems Management

ASSOCIATE PROVOST FOR COMPUTER INFORMATION SERVICES
James C. Emery
Professor of Systems Management

DIRECTOR, DUDLEY KNOX LIBRARY
Maxine H. Reneker
Professor of Library Science

ACADEMIC DEPARTMENTS, GROUPS AND COMMITTEES

Members of the faculty are organized into eleven Academic Departments, four interdisciplinary Academic Groups and two Academic Committees. Each is supervised by a chairman who reports to their respective Division Dean. Over 80% of the teaching staff are civilians of varying professional rank and the remainder are military officers.

ACADEMIC DEPARTMENTS	ACADEMIC GROUPS	ACADEMIC COMMITTEES
Aeronautics and Astronautics	Command, Control and	Engineering Acoustics
Computer Science	Communications	Special Operations
Electrical and Computer Engineering	Information Warfare	Curriculum Committee
Mathematics	Space Systems	
Mechanical Engineering	Undersea Warfare	
Meteorology		
National Security Affairs		
Oceanography		
Operations Research		
Physics		
Systems Management		

CURRICULAR OFFICES

The Curricular Offices are organizational entities that are separate from, but interactive with, the Academic Departments, Groups and Committees in the educational operations of the school. The former are staffed by naval officers and civilian faculty members whose primary functions are threefold: (1) academic counseling and military supervision of officer students, (2) curriculum development and management to ensure attainment of professional and academic objectives, and (3) liaison with curricular sponsor representatives.

Students are grouped in accordance with their curricular programs and are assigned to one of ten Curricular Offices for program supervision and for academic and professional counseling.

Students in each curricular group pursue similar or closely related curricula. Each Curricular Office is staffed by one or more military officers of suitable experience and rank and one or more Academic Associates. The latter are faculty members selected for this part-time assignment. They are responsible to the Deans for the integrity and academic soundness of the academic features of curriculum options. Curricular Officers ensure their curricula meet Navy needs and ensure the proper administrative operation of their respective offices. They report to the Dean of Students/Director of Programs.

The table beginning on page 14 summarizes the curricula offered through the Naval Postgraduate School. Specific academic requirements for enrollment are contained in each curriculum segment.

Students entering any of the technical curricula normally are ordered to a six-week mathematics refresher course. It begins in the seventh week of each quarter. This course is not designed to teach math, but rather to reacquaint students with calculus. During this refresher, students also take introductory courses in other topics related to their assigned curriculum. Refer to the Six Week Technical Refresher section for additional information.

Some officers are ordered to Engineering Science (Curriculum 460) if they require more preparation for entering one of the technical curricula. This program is either one or two quarters long and includes calculus and other preparatory courses. Refer to the Engineering Science section for additional information.

INTERNATIONAL PROGRAMS OFFICE

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

Since 1954, over 3100 International officers from 65 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 Programs Office sponsors the courses:

IT1500 Information 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. Graded on Pass/Fail only.

IT1600 Communication Skills for International Officers (4-2)
Designed to increase the student's ability and comprehension in communicating effectively in written and spoken English through guided practice and individual exercises. Introduction to the core concepts of communication and to the difference between effective writing. Primary emphasis is on improving the student's functional writing skills, especially those that will help the student write reports, term papers, and a thesis. Graded on Pass/Fail only.

NAVAL POSTGRADUATE SCHOOL PROGRAM FOR JOINT EDUCATION (PJE)

The NPS Program for Joint Education (PJE) prepares military officers for the increasingly complex future security challenges by offering programs which blend excellent graduate-level education in diverse fields with both intermediate level professional military education (PME) and program for Joint Education (PJE). Viewed as a cost-effective "one-stop shopping" opportunity, the CNO approved intermediate-level PME equivalence for naval officers in selected NPS curricula in December 1994. NPS Navy graduates subsequently can obtain senior level PME by attending a Service War College or the National Defense University. The NPS Joint Education Electives Program (JEEP), a four-course series completed in conjunction with PME-equivalent curricula, is certified by the Chairman, Joint Chiefs of Staff, as meeting Phase I Program for Joint Education (PJE) requirements. All Services are authorized to grant Phase I PJE credit to graduates of this program. PJE graduates become eligible to earn Phase II PJE at the Armed Forces Staff College en route to joint duty assignments and designation as Joint Specialty Officers (JSOs).

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Aerospace Engineering				
Aeronautical Engineering	610	24	April/October	31
Aeronautical Engineering with Avionics	611	24	April/October	31
NPS/TPS	612	15 + TPS	January/July	31
Combat Systems Sciences & Technology				
Combat Systems Science/Tech	533	27	April/October	33
Underwater Acoustics	535	21	October	33
Electronics & Computer Programs				
Computer Science	368	24	April/October	32
Modeling, Virtual Environments & Simulation	399	24	April/October	32
Electronics Systems Eng	590	21-27	Any Quarter	32
Joint Command, Control, Communications Computers & Intelligence (C4I)				
Joint Command, Control, Communications, Computers & Intelligence (C4I) Systems	365	21	October	39
Scientific & Technical Intel	823	20	February	39
Meteorology and Oceanography				
Meteorology	372	21	April/October	35
METOC	373	27	April/October	35
Operational Oceanography	374	24	April/October	35
Oceanography	440	24-36	April/October	35
National Security and Intelligence				
Middle East, Africa, South Asia	681	18	January/July	38
Far East, Southeast Asia Pacific	682	18	January/July	38
Western Hemisphere	683	18	January/July	38
Russia, Europe, Central Asia	684	18	January/July	38
Strategic Planning	688	24	January/July	38
Civil-Military Relations & Int'l Sec	689	12	January	38
Intelligence (Regional Studies)	824	24	January/July	38
Intelligence (OPINTEL)	825	18	July	38
Naval/Mechanical Engineering				
Naval/Mechanical Engineering	570	24-27	April/October	34
Operations Analysis				
Operations Analysis	360	24	April/October	30
Operational Logistics	361	24	October	30
Advanced Science (Applied Mathematics)	380	24	January/July	30
Special Operations				
Special Operations	699	18	July	38
Systems Management				
Information Technology Management	370	24	April/October	36
Transportation Logistics Management	813	21	July	36
Transportation Management	814	21	July	36
Acquisition & Contract Management	815	18	January, July	36
Systems Acquisition Management	816	21	January, July	36
Defense Systems Analysis	817	18	January, July	36
Defense Systems Management International	818	18	January, July	36

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Systems Inventory Management	819	18	July	36
Resource Planning and Management for International Defense	820	18	January	36
Material Logistics Support Management	827	18	January, July	36
Financial Management	837	18	January, July	36
Manpower Systems Analysis	847	21	January, July	36
Leadership Education and Development	856	12	June	36

Undersea, Space Systems and Information Warfare

Space Systems Operations International	364	24	October	37
Space Systems Operations	366	24	October	37
Undersea Warfare	525	24	April/October	37
Undersea Warfare International	526	24	April/October	37
Space Systems Engineering	591	27	April/October	37
Information Warfare	595	24	October	37
Electronic Warfare Systems International	596	24	October	37

Each service identifies military billets that require specific graduate level education for successful performance. More than 6,000 subspecialty coded billets are presently identified in the Navy. Quotas for officer inputs to graduate education programs are generated annually to meet current and projected billet requirements. Sponsors such as the Naval Sea Systems Command and Naval Air Systems Command identify the skill requirements for subspecialty coded billets, and the Naval Postgraduate School administers curricular programs to meet the promulgated skill requirements. Curriculum titles, minimum threshold APC levels, subspecialty codes and degree titles are listed below by ascending curriculum number.

Curriculum Number	Curriculum Title	Admission APC	Subspecialty Code	Degree
360	Operations Analysis	324	XX42P	MS Operations Research
361	Operational Logistics	324	XX43P	MS Operations Research
364	Space Systems Operations International	324	None	MS Space Systems Operations
365	Joint Cmd, Cntrl, Comm, Comp/Intel (C4I) Sys	325	XX45P	MS Systems Tech (C3)
366	Space Systems Operations	324	XX76P	MS Space Systems Operations
368	Computer Science	325	XX91P	MS Computer Science
370	Information Technology Management	325	XX89P	MS Information Technology Management
372	Meteorology	323	XX48P	MS Meteorology
373	METOC	323	XX47P	MS Meteorology & Physical Oceanography
374	Operational Oceanography	323	XX49P	MS Physical Oceanography
380	Applied Mathematics	324	XX41P	MS Applied Mathematics
399	Modeling, Virtual Environ & Simulation	325	XX99P	MS Modeling, Virtual Environments & Simulation
440	Oceanography	323	XX49D	PhD Physical Oceanography
525	Undersea Warfare	323	XX44P	MS Applied Mathematics, Applied Science, Computer Science, Operations Research, Physical Oceanography, Electrical Engineering or Engineering Acoustics
526	Undersea Warfare - International	323	None	
533	Combat Systems Sciences & Technology	323	XX66P	MS Applied Physics, Physics, Engineering Acoustics, Computer Science, Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, Material Science & Engineering.
535	Underwater Acoustics Systems	323	None	MS Engineering Acoustics
570	Naval/Mechanical Engineering	323	XX54P	MS Mechanical Engineering
590	Electronic Systems Engineering	323	XX55P	MS Electrical Engineering
591	Space Systems Engineering	323	XX77P	MS Electrical Engineering, Physics, Astronautical Engineering, Computer Science, Mechanical Engineering
595	Information Warfare	324	XX46P	MS Systems Engineering
596	Electronic Warfare Systems International	324	None	MS Systems Engineering
610	Aeronautical Engineering	323	XX71P	MS Aeronautical Engineering
611	Aeronautical Engineering-Avionics	323	XX72P	MS Aeronautical Engineering
612	NPS/TPS Cooperative Program	323	XX71P	MS Aeronautical Engineering
681	Middle East, Africa, South Asia	365	XX21P	MA National Security Affairs
682	Far East, Southeast Asia, Pacific	365	XX22P	MA National Security Affairs
683	Western Hemisphere	365	XX23P	MA National Security Affairs
684	Russia, Europe, Central Asia	365	XX24P	MA National Security Affairs
688	Strategic Planning	335	XX28P	MA National Security Affairs
689	Civil-Military Relations & International Security	335	XX28P	MA Civil-Military Relations & International Security
699	Special Operations	365	XX29P	MS Defense Analysis
813	Transportation Logistics Management	345	1304P	MS Management
814	Transportation Management	345	XX35P	MS Management
815	Acquisitions & Contract Management	345	1306P	MS Management
816	Systems Acquisition Management	345	None	MS Management
817	Defense Systems Analysis	345	None	MS Management
818	Defense Systems Management International	345	None	MS Management
819	Systems Inventory Management	345	1302P	MS Management
820	Resource Planning /Mgmt for International Defense	345	None	MS International Resource Planning and Management
823	Intelligence (Sci & Tech)	223	XX17P	MS Systems Tech (Scientific & Tech Intel)
824	Intelligence (Regional Studies)	365	XX18P	MA National Security Affairs
825	Intelligence (OPINTEL)	235	XX19P	MA National Security Affairs
827	Material Logistics Support Management	345	XX32P	MS Management
837	Financial Management	345	XX31P	MS Management
847	Manpower Systems Analysis	345	XX33P	MS Management
856	Leadership Education and Development	365	XX38P	MS Human Resource Development

FACULTY ORGANIZATIONS
The faculty plays a role in school-wide policy making and planning through various established Councils. The Faculty Council functions as a primary faculty input advisory vehicle to the Provost and Superintendent. The Academic Council, a representative body of each academic department and group, has cognizance over all academic standards and degree-granting considerations. The composition of each Council and its specific functions are described in the NPS Organization and Regulations Manual.

STUDENT COUNCIL
The Officer Student Advisory Council (OSAC) is an organized communication mechanism between the NPS students and the NPS administration. It functions in an advisory capacity in matters involving curricula, facilities, procedures and policies deemed worthy of attention. The OSAC is comprised of thirty-five student representatives and membership is distributed among the curricula by student population, with each curriculum having at least one representative.

The OSAC is headed by a Chairman, Vice Chairman and Secretary elected by members of the Student Council. Officers serve for a six-month period.

Besides a Steering Committee and an Election Committee, Student Council committees are formed to correspond with those NPS committees or councils which have an impact or effect on the student body and which can give or receive benefit from such representation. OSAC representation is included in the following NPS standing Councils and Committees:

Academic Council
Faculty Council
Library Council
Exchange/Bookstore Committee

ADMISSIONS

U.S. Navy officers interested in attending one of the curricula offered at the Naval Postgraduate School are referred to OPNAVINST 1520.23 and to the latest OPNAVNOTE 1520. These documents provide guidance, information and policy for the Navy's fully funded graduate education program.

SELECTION PROCEDURES

NAVAL OFFICERS
Selection for the Navy 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 NAVPGSCOL), individuals are eligible for assignment. Officers who are professionally qualified, but lack academic qualifications, should contact the Director of Admissions for information on ways to improve their academic background.

OTHER U.S. MILITARY OFFICERS
Officers on duty with other branches of service are eligible to attend the Postgraduate School. Requests for admission or transcripts from individual officers should not be sent directly to 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.

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 Attache Office of the U.S. Embassy, the MLO, MAAG or ODC, as appropriate. Correspondence must be processed through official channels; requests from individual prospective students should not be sent directly to the School. In addition to English language comprehension, as demonstrated by current results of the Test of English as a Foreign Language (TOEFL) and the Test of Written English (TWE), candidates must satisfy the curriculum academic standards, as described in this catalog.

Requests for admissions should be directed to the Director of International Programs, Code 035, Naval Postgraduate School, 699 Dyer Road, Room M5, Monterey, CA 93943-5108. Questions about available programs or admission procedures may be telephoned to (408) 656-2186 or e-mail: 035@nps.navy.mil.

CIVILIAN EMPLOYEES OF U.S. GOVERNMENT
A civilian employee of 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 01B3, Naval Postgraduate School, 589 Dyer Rd., RM 103C, Monterey, CA 93943-5100. Questions about available programs or admission procedures may be telephoned to (408) 656-3093 or DSN 878-3093 or e-mail: grad-ed@nps.navy.mil.

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. The School Structure and Organization and the Curricular Offices sections describe the available curricula.

Degree Programs: For civilian students, programs may be designed which lead to the award of a graduate degree while meeting the educational goals of each individual. In order 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. 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.

Admission: 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 will require submission of official transcripts covering all college work completed to date.

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:

Director of Admissions
Code 01B3, Naval Postgraduate School,
589 Dyer Rd., RM 103C
Monterey, CA 93943-5100
Telephone (408) 656-3093 / DSN 878-3093

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

Director of International Programs
Code 035, Naval Postgraduate School,
699 Dyer Rd., RM M5
Monterey, CA 93943-5108
Telephone (408) 656-2186 / DSN 878-2186 / FAX (408) 656-3064

ACADEMIC PROFILE CODES

The Academic Profile Code (APC) is a three-digit code which summarizes pertinent portions of an officer's prior college performance. The Naval Postgraduate School routinely generates APCs for officers of most Navy communities, usually within three years of commissioning. The three independent digits reflect an individual's cumulative grade-point average (QPR), 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 -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.

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 one hundred semester hours or one hundred fifty 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.

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-of-one-variable with a C+ or B average and a major in physics or pertinent engineering area with upper-division courses with a C+ or B average.

Threshold
Each curriculum at the Naval Postgraduate School has a specified threshold APC for admission. A list of these is given in the NPS Curricula Summary section. Officers with deficient APCs may qualify for entry into these curricula by completing suitable courses at any accredited civilian college. Transcripts (not grade reports) of work done at civilian schools must be forwarded to the Director of Admissions, Code 01B3, Naval Postgraduate School, 589 Dyer Rd., RM 103C, Monterey, CA 93943-5100, to effect an APC change. The grades in all courses completed will be used to revise an officer's QPR.

GENERAL INFORMATION

COURSE CODES
Courses are designated by an alpha-numeric symbol consisting of two letters and four numbers. The first two letters designate the academic department which offers the course and are defined as follows:

Aeronautics and Astronautics	AA
Command, Control and Communications	CC
Computer Science	CS
Electrical and Computer Engineering	EC
Interdisciplinary Courses	EO
Information Warfare	IW
International Programs	IT
Mathematics	MA
Mechanical Engineering	ME
Total Ship System Engineering	TS
Materials Science	MS
Meteorology	MR
National Security Affairs	NS
Oceanography	
Oceanographic Sciences	OC
Operations Research	
Operations Analysis	OA
Service Courses	OS
Physics	PH
Science and Engineering	SE
Space Systems	SS
Special Operations	SO
Systems Management	
Administrative Sciences	AS
Information Systems	IS
Management	MN
Services Courses	SM
Undersea Warfare	UW

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 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 http://www.nps.navy.mil. There may have been changes made since these courses were published, so please refer to the NPS home page or the specific department for the most up to date information.

SIX WEEK TECHNICAL 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 curricular 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 Technical Refresher begins during week seven of the quarter.

A typical Six Week Technical Refresher consists of:

Computer Science	Information Warfare	Operations Analysis	Information Technology Mgt
MAR125	MAR118	MAR117	MAR117
CSR100	MAR142	MAR125	CSR100
CSR101	PHR110	MAR142	CSR101
		OAR200	IS0001
		OA0001	

Prospective students are encouraged to contact the curricular officer regarding the specifics of their particular Six Week Technical Refresher course sequence.

ENGINEERING SCIENCE (CURRICULUM 460)

This is not a specific curriculum, but rather a sequence of courses developed by the curricular officer and the academic associate to better prepare incoming students for entering a technical curriculum.

The Engineering Science curriculum is designed for prospective students who:

(1) have an APC which 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 curricular 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 Engineering Science program.

For some students, the Engineering Science sequence of courses may also include courses from the Six Week Technical Refresher. For this type of course sequence, the student usually begins the quarter with two courses, then gains one or more additional courses during week seven. CSR100 and CSR101 are examples of courses which would not begin until week seven of the quarter.

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

A typical Engineering Science course sequence consists of the following:

Aero Engineering	Space Systems Engineering	Combat Sys Sci & Tech	METOC
MA1118	MA1118	MA1117	MA1117
ME2502	MA1043	MA1042	MR/OC2020
ME2601	PH1121	PH1121	MA1042
AA2042	EC1010	EC1010	MR/OC3140 or OC3230

Prospective students are encouraged to contact the curricular officer regarding the specifics of their particular Engineering Science 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	Ungraded
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. Withdrawals may be made after that 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 elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Curricular 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 approved 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.

ACADEMIC COUNSELING
The NAVPGSCOL provides academic counseling services as indicated below 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 NAVPGSCOL, are advised to contact the appropriate NAVPGSCOL curricular office listed in the Curricular Offices and Programs section of this catalog. Officers not yet selected for graduate education and seeking general information about the curricula offered at the school, or for general information on the fully-funded graduate education selection process, are advised to contact the Director of Admissions (Code 01B3), NAVPGSCOL, or telephone (408) 656-3093, DSN 878-3093.

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 term. No student will receive credit for a course unless registration in that course has been approved by one of the following: the student's Curricular Officer or Academic Associate, the Chairman of his/her doctoral committee, or the Associate Provost for Instruction.

Overload
A student may not enroll for more than 18 total credit hours or more than four 3000 and/or 4000 courses (excluding laboratories or explicit curriculum requirements) per quarter unless he or she has either a total QPR of at least 3.50 or permission of the Department or Group Chairman and the Associate Provost for Instruction.

Repetition of Courses
A student may repeat a course for the purpose of improving a grade provided such course repetition is taken at the Postgraduate School. Approval must be granted by both the Curricular 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.

Medical Absence

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 reasons. The transcript will show, "Excused for the term for medical 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 Curricular Officer and approved by the Associate Provost for Instruction.

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 also utilize knowledge gained through self-study, experience of service-related education to seek validation, or credit for curricular courses by taking a departmental examination.

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.

Questions on transfer credit should be directed by letter to the appropriate curricular Academic Associate, as listed in this 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 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 hours must be earned on campus.

- A thesis or its equivalent is required.

Admission to a program leading to the Master's degree requires:

- General undergraduate work as defined in Chapter 4 of the Academic Council Policy Manual.

- Appropriate undergraduate preparation for the curriculum to be pursued. A student entering the Postgraduate School with inadequate undergraduate preparation will be required to complete the undergraduate prerequisites in addition to the degree requirements.

- A demonstrated academic potential for completing the curriculum.

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 the remaining courses or 2.75 in all courses of the curriculum.

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 Council Policy Manual.

EDUCATIONAL SKILL REQUIREMENTS

Each subspecialty curriculum at NPS is based on Educational Skill Requirements (ESRs) developed by the Primary Consultant in their capacity as the central point of contact for the assigned subspecialty skill field. The ESRs represent the criteria essential for performance in the subspecialty. Using the ESRs, and as a cooperative effort between the Primary Consultant and the school, NPS develops the curriculum that will meet the criteria of the ESRs. This phase involves course development, tying subject matter to military applications, and other items to insure the knowledge, skills and competencies established by the Primary Consultant are addressed in the curriculum. The ESRs for all of the curricula offered at NPS are included at the end of each curricular office section.

It is important to point out that curricular content is a continual discussion item between each NPS Curricular Officer and faculty Academic Associate team and the Primary Consultant's office. This includes the Primary Consultant providing or making available material to be used in class, forwarding lists of suggested thesis topics, and providing opportunities and financial support for student experience tours. It is the School's experience that only with such an extended process (a partnership) can we insure the needs of the subspecialty community are met.

ALUMNI TRANSCRIPT REQUESTS

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

1. Facsimile request: (408) 656-2891. Include your full name, Social Security Number, year last attended and current mailing address.

2. Mail request:

   Naval Postgraduate School
   Registration and Scheduling
   Code 01B1
   589 Dyer Rd., Room 102
   Monterey, CA 93943-5113

   Include your full name, Social Security Number, year last attended and current mailing address.

3. Telephone request: (408) 656-2591

4. E-mail request: mscheffel@nps.navy.mil. Include your full name, Social Security Number, last year attended and current mailing address.

There is a transcript fee of $3.00 for the first copy and .50 cents for each additional copy (per request).

CURRICULA CONDUCTED AT OTHER UNIVERSITIES

The Navy's fully-funded graduate education program supports 71 subspecialties. This involves 78 curricula, 42 at NPS and 36 at over 65 civilian institutions. Programs available at NPS are not offered at civilian institutions. Approximately 20% of the fiscal year officer graduate education assignments are slated for these universities. Where more than one school is listed for a particular curriculum, subspecialty education placement officers plan quota distribution.

If you decide to pursue your master's degree on your off-duty time, and want to ensure you receive a code for your subspecialty, call the Civilian Institutions Office (CIVINS) at NPS to get your curriculum approved. The CIVINS Office will compare your degree program against the subspecialty granting curriculum and make suggestions on which courses will lead to a subspecialty code. Call the CIVINS office at DSN 878-2319/3605 or commercial (408) 656-2319.

In order to qualify for the Civilian Institutions program, officers must be Postgraduate School selected and must meet

Curriculum	Number	Length	Institution	Primary Consultant
Chemistry	382	2 yrs.	Various	NAVSEASYSCOM
Criminal Law	884	1 yr.	Various	NJAG
Education and Training Management	867	12-18 mos.	Various	CNET
Environmental Law	880	1 yr.	Various	NJAG
Facilities Engineering	470-473	1 yr.	Various	NAVFACENGCOM
Health Care Law	885	1 yr.	Various	NJAG
International Law	887	1 yr.	Various	NJAG
Joint Intelligence	990	9-12 mos.	JMIC	NAVINTCOM
Labor Law	886	1 yr.	Various	NJAG
Adv Military Justice	881	9-12 mos.	JAG School	NJAG
Logistics Management	770	15 mos.	AFIT	NAVAIRSYSCOM
National Security (International Relations & Diplomacy)	680	12 mos.	Various	CNO N511
National Security (International Relations & Diplomacy)	690	12 mos.	Various	CNO N511
Naval Construction and Engineering	510	2-3 yrs.	M.I.T.	NAVSEASYSCOM
Nuclear Engineering (ED)	520	2 yrs.	M.I.T.	NAVSEASYSCOM
Ocean Engineering	472	15-18 mos.	Various	NAVFACENGCOM
Ocean Law	883	1 yr.	Various	NJAG
Operational Oceanography	375	27 mos.	M.I.T.	CNO OP-096
Petroleum Management	811	18-21 mos.	Univ of Kansas	NAVSUPSYSCOM
Petroleum Engineering	630	12-24 mos.	Various	NAVFACENGCOM
Public Affairs	920	1 yr.	Various	CHINFO
Religion	971-975, 977	9 mos.	Various	CHCHAP
Retailing	830	18-21 mos.	Various	NAVSUPSYSCOM
Subsistence Technology	860	18-21 mos.	Michigan State	NAVSUPSYSCOM
Supply Acquisition/ Distribution Mgmt	810	18-21 mos.	Various	NAVSUPSYSCOM
Tax Law	882	1 yr.	Various	NJAG

Inquiries concerning curricula conducted at other universities should be directed to:

Director of Civilian Institutions Programs
Code 031A
Naval Postgraduate School
589 Dyer Rd, Root Hall Room 228
Monterey, CA 93943-5143

Education Skill Requirements (ESRs) for the above curricula may be obtained from the Director of Civilian Institutions Programs. Detailed information including applicable designators and the list of approved civilian institutions for the above curricula may be found in OPNAVNOTE 1520.

CURRICULAR OFFICES
AND PROGRAMS

AEROSPACE ENGINEERING PROGRAMS

Curricula Officer:
William J. Welch
CDR, USN
Code 31, Halligan Hall
Room 133
(408) 656-2491
DSN 878-2491

AERONAUTICAL ENGINEERING AND AERONAUTICAL ENGINEERING (AVIONICS) CURRICULA 610 and 611

The Aerospace Engineering programs are designed to meet the specific needs of the Navy technical managers with a broad-based graduate education in Aeronautical Engineering. While an undergraduate degree in engineering is preferred, special preparatory programs can accommodate officers with other backgrounds.

These programs give the student a broad aeronautical engineering education in the five principal areas of aeronautics: aerodynamics, flight mechanics, propulsion, flight structures and systems integration. Additionally, officers receive graduate level instruction in aircraft/missile design and aero-computer science. Students in the 611 curriculum receive primary emphasis on avionics systems. The programs are divided into preparatory, graduate core and advanced graduate phases. The preparatory phase is tailored to each officer's background and is programmed for minimum time consistent with capability. After the preparatory phase, both the 610 and 611 students undertake a graduate core pertinent to their respective curriculum. During the advanced graduate phase, all students receive in-depth graduate coverage through advanced electives in areas of their choice including flight dynamics, gas dynamics, propulsion, structures and aircraft or missile design. Students in curriculum 611 receive advanced studies in guidance and control, radar systems and electronic warfare, aeronautical data systems and avionics design.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, with an above-average QPR, preferably in engineering or the physical sciences, is required. In addition, mathematics through differential and integral calculus, with above-average grades and completion of a calculus-based physics sequence with above-average grades is also required. An APC of 323 is the requirement for direct entry, but the Engineering Science Program (Curriculum 460) is available for candidates who do not meet all the admission requirements for direct entry. The required APC for entry via Curriculum 460 is 334.

ENTRY DATES

Aeronautical Engineering is a seven or eight-quarter course of study with entry dates in April and October. This is preceded by a six week refresher of fundamentals of math and engineering. Those requiring the Engineering Science Curriculum will have their time of arrival adjusted to accommodate it. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curricula 610 and 611
Academic Associate:
Max F. Plazter, Distinguished Professor
Code AA/Pl, Halligan Hall
Room 205A
(408) 656-2058, DSN 878-2058

DEGREE

Requirements for the degree Master of Science in Aeronautical Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular programs.

AERONAUTICAL ENGINEERING SUBSPECIALTY (610)

Completion of this curriculum qualifies an officer as an Aeronautical Engineering Subspecialist with a subspecialty code of XX71P. The Curriculum Sponsor and Primary Consultant is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:
Deputy Program Manager: Naval Air Systems Command
Project Officer: Naval Aviation Depot, San Diego, CA
Aircraft Class Desk Officer: COMNAVAIRLANT, Norfolk, VA
Program Integrator: Defense Plant Representative Office, St. Louis, MO

TYPICAL COURSE OF STUDY

Refresher Quarter

MAR118	(3-3)	Refresher: Multivariable Calculus
MAR142	(2-0)	Refresher: Matrix Algebra
AAR242	(5-0)	Thermodynamics/Fluid Mechanics Refresher
AAR261	(5-0)	Solid Mechanics Refresher

Quarter 1

OS3104	(4-0)	Statistics for Science and Engineering
MA2121	(4-0)	Differential Equations
ME2440	(3-0)	The Digital Computer as an Engineering Tool
AA2021	(4-1)	Introduction to Flight Structures

Quarter 2

MA3046	(4-1)	Matrix Analysis
AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics
AA3101	(3-2)	Flight Vehicle Structural Analysis

Quarter 3

AA3451	(3-2)	Aircraft and Missile Propulsion
AA2036	(3-2)	Performance and Static Stability
AA2339	(3-2)	Aerospace System Dynamics
AA3202	(3-2)	Aircraft Structural Failure, Fracture and Fatigue

Quarter 4

MA3243	(4-1)	Numerical Methods for Partial Differential Equations
AA3501	(3-2)	Aerodynamic Analysis
AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
AA2801	(3-2)	Aero-Laboratories

Quarter 5

AA3272	(3-2)	Introduction to Systems Engineering
AA0810	(0-8)	Thesis Research
AA3341	(3-2)	Control of Aerospace Vehicles
AA3802	(3-2)	Aeronautical Measurement Techniques

Quarter 6

AA4XXX		Elective
AA0810	(0-8)	Thesis Research
AA4201	(4-0)	Reliability Engineering and System Safety Management
AA4273	(3-2)	Aircraft Design

Quarter 7

AA4XXX		Elective
AA0810	(0-8)	Thesis Research
AA0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy

AERONAUTICAL ENGINEERING (AVIONICS) SUBSPECIALTY (611)
Completion of this curriculum qualifies an officer as an Aeronautical Engineer with an Avionics Subspecialty and a subspecialty code of XX72P. The Curriculum Sponsor is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:
Avionics Class Desk Officer: COMNAVAIRLANT, Norfolk, VA
Avionics Systems Project Officer: Naval Air Systems Command
Deputy Program Manager: Naval Air Systems Command
Project Officer: Naval Air Warfare Center (Aircraft Division), Patuxent, MD

TYPICAL COURSE OF STUDY

Refresher Quarter

AAR242	(5-0)	Thermodynamics/Fluid Mechanics Refresher
MAR118	(3-3)	Refresher: Multivariable Calculus
MAR142	(2-0)	Refresher: Matrix Algebra

Quarter 1
AA2440	(3-2)	Introduction to Digital Computation
EO2402	(4-1)	Introduction to Linear Systems
MA2049	(3-0)	Vector Analysis with Applications
MA2121	(4-1)	Differential Equations

Quarter 2
AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics
EO2652	(4-1)	Fields, Waves and Electromagnetic Engineering
EO3402	(4-1)	Signal Processing Systems

Quarter 3
AA2036	(3-2)	Performance and Static Stability
AA2339	(3-2)	Aerospace System Dynamics
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
MA3046	(4-1)	Matrix Analysis

Quarter 4
AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
AA3501	(3-2)	Aerodynamic Analysis
EO3512	(3-1)	Communications and Countermeasures
AA3251	(4-1)	Aircraft Combat Survivability

Quarter 5
AA3276	(3-2)	Introduction to Avionics
AA3341	(3-2)	Control of Aerospace Vehicles
AA3260	(3-2)	Introduction to Avionics Software Engineering
OS3104	(4-0)	Statistics for Science and Engineering

Quarter 6
AA4276	(3-2)	Avionics System Design
AA4342	(3-2)	Advanced Control for Aerospace Systems
AA0810	(0-8)	Thesis Research
EO3678	(4-2)	Principles of Radar Systems

Quarter 7
AA0810	(0-8)	Thesis Research
AA4641	(3-2)	Digital Avionics Systems
EC4680	(3-3)	Radar Electronic Warfare Techniques and Systems
AA4XXX	(4-0)	Elective

Quarter 8
NS3252	(4-0)	Joint and Maritime Strategy
AA0810	(0-8)	Thesis Research
AA0810	(0-8)	Thesis Research
AA4XXX	(4-0)	Elective

NPS/TPS COOPERATIVE PROGRAM (612)
A program which combines portions of the 610 or 611 curriculum at the NPS with the completed U.S. Naval Test Pilot School syllabus is currently available to selected officers with strong undergraduate engineering backgrounds. After completion of five quarters of study at NPS, selectees proceed to Patuxent River for the full Test Pilot School Curriculum. This NPS/TPS Cooperative Program results in a test pilot designation, XX73G, the Aeronautical Engineering subspecialty code XX71P or XX72P, and award of the master's degree in Aeronautical Engineering at the completion of test pilot school.

Curriculum 612
Academic Associate:
Max F. Platzer, Distinguished Professor
Code AA/Pl, Halligan Hall
Room 205A
(408) 656-2058, DSN 878-2058

TYPICAL COURSE OF STUDY

Refresher Quarter
MAR118	(3-3)	Refresher: Multivariable Calculus
MAR142	(2-0)	Refresher: Matrix Algebra
AAR242	(5-0)	Thermodynamics/Fluid Mechanics Refresher
AAR261	(5-0)	Solid Mechanics Refresher

Quarter 1
MA3046	(4-1)	Matrix Algebra
MA2121	(4-0)	Differential Equations
AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics

Quarter 2
AA2339	(3-2)	Aerospace Systems Dynamics
AA2021	(4-1)	Introduction to Flight Structures
AA3451	(3-2)	Aircraft and Missile Propulsion
AA2036	(3-2)	Performance and Static Stability

Quarter 3
MA3243	(4-1)	Numerical Methods for Partial Differential Equations
AA3101	(3-2)	Flight Vehicle Structural Analysis
AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
AA3501	(3-2)	Aerodynamic Analysis

Quarter 4
AA3272	(3-2)	Introduction to Systems Engineering
AA3341	(3-2)	Control of Aerospace Vehicles
AA3202	(3-2)	Aircraft Structural Failure, Fracture and Fatigue
AA3802	(3-2)	Aeronautical Measurement Techniques

Quarter 5
AA3251	(4-1)	Aircraft Combat Survivability
AA4273	(3-2)	Aircraft Design
OS3104	(4-0)	Statistics for Science and Engineering
NS3252	(4-0)	Joint and Maritime Strategy

EDUCATIONAL SKILL REQUIREMENTS
AERONAUTICAL ENGINEERING
CURRICULUM (610)
Subspecialty Code XX71P

Officers completing the educational skill requirements for this curriculum are qualified to receive an XX71P subspecialty code. They consist of a core of prescribed aeronautical engineering skills in ten disciplines, which all graduates must acquire; plus a set of five specialization options of advanced topics in aircraft structures, aerodynamics, propulsion, flight mechanics or systems design, which the student may pursue as electives.

CORE REQUIREMENTS

1. **AIRCRAFT STRUCTURES AND MATERIALS:** Be able to apply U.S. military standards and practices to analyze structural components of tactical and transport aircraft, using engineering analytic methods on idealized models and automated finite element methods on realistic models to determine stresses, strains, deformations and appropriate limiting conditions of yielding, fracture, buckling and fatigue. These analytical skills should be built upon a fundamental understanding of aircraft materials and familiarity with nondestructive means of experimental evaluation, which includes detection of hidden damage and repair of military flight vehicles that might be done up to the depot level.

2. **FLIGHT MECHANICS:** Be able to calculate all performance parameters for both propeller driven and jet powered military aircraft, and to determine their longitudinal and lateral-directional, static and dynamic stability characteristics. Be able to analyze and design aircraft and missile guidance and control systems, including feedback stabilization schemes and stochastic processes, using classical and modern control techniques.

3. **AIRCRAFT AND MISSILE PROPULSION:** Understand the principles and operating characteristics of aircraft and missile propulsion engines and be able to analyze the performance of gas turbines through a knowledge of the behavior and design characteristics of the individual components. Be able to perform on-design and off-design cycle analysis and to understand the principles used to position the gas generator operating line on the compressor map. Be able to calculate performance parameters used in engine selection and know the state-of-the-art reasons for limitations on gas turbine engine performance, as well as the potential for future gains in the field. Be able to analyze the performance of rockets and ramjets through a knowledge of the behavior of individual components, and be able to make steady-state, internal ballistic calculations for solid rocket motors.

4. **AERODYNAMICS:** Be able to use classical analytic, experimental and modern computational techniques of subsonic and supersonic aerodynamics, including laminar and turbulent boundary-layer viscous effects, without heat addition, to calculate internal flow properties through inlets, nozzles and engines and external air flow pressure distributions over wings, canards, tails, and other lifting surfaces to determine the resulting lift, drag and pitching moment.

5. **INFORMATION PROCESSING:** Be able to use current computer methods to solve aeronautical engineering problems and possess a knowledge of the application of dedicated avionic and systems computers on board Naval aircraft.

6. **ENGINEERING MATHEMATICS:** Demonstrate analytic ability to apply differential and integral calculus, ordinary and partial differential equations, complex variables, vector calculus, matrix algebra, probability and statistics and numerical analysis in the development of engineering theory and its application to Naval engineering problems.

7. **ELECTRICAL ENGINEERING:** Understand basic electrical circuits, systems and electronic devices as a foundation for interfacing mechanical and electronic systems in aircraft.

8. **SYSTEMS DESIGN:** Be able to integrate all of the disciplines of aeronautics into a design of an aircraft or missile in response to a realistic set of military requirements, specifications, constraints and cost limitations. The design must include considerations for safety, reliability, maintainability and survivability.

9. **JOINT AND MARITIME STRATEGIC PLANNING:** Possess a knowledge of joint and maritime strategic planning to include development and execution of military strategy and the effects of technical developments of warfare; formulation of U. S. policy, roles of military forces, joint planning and current issues in defense reorganization.

10. RESEARCH, DEVELOPMENT, TEST AND EVALUATION: Apply principles of project scoping, planning, design and execution to investigate a current research, development, test or evaluation problem of interest to the Department of Defense that culminates in the publication of a thesis of academic quality.

SPECIALIZATION OPTIONS

Listed below are educational skills in five specialization options that may be pursued as advanced topic electives in aeronautical engineering after the core has been completed in that area.

AIRCRAFT STRUCTURES: Obtain experience in the use of finite element codes as they are applied to aircraft and missile structures; be able to analyze composite structural components, including laminates and sandwich construction and understand fabrication and repair techniques; be able to analyze aircraft structural components under dynamic loads.

FLIGHT MECHANICS: Obtain experience in flight test and evaluation by means of an in-flight laboratory and/or flight simulators; be able to analyze aircraft components for the transient load and unsteady aerodynamics of gusts, buffeting and flutter; apply principles of linear optimal control, Kalman filtering and H_2 and H_∞ techniques to tactical fighters.

AIRCRAFT AND MISSILE PROPULSION: Understand the conversion of energy in aerodynamic design and computational analysis of flow through compressors and turbines; be able to use computer codes to select and size a ramjet or gas turbine engine for a given mission and carry out the preliminary design of its components.

AERODYNAMICS: Be able to analyze steady and unsteady, inviscid and viscous, compressible (including transonic and hypersonic) flows over aircraft, missiles, helicopters and spacecraft and flows through jet engines using modern computational fluid dynamics.

SYSTEMS DESIGN: Expand design experience over that obtained in the core by executing designs to meet a given set of military mission requirements under realistic constraints in one or more of the following areas: fixed wing aircraft, rotary wing aircraft, tactical missiles and/or aircraft gas turbine engines and explore optimizations of these designs.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
June 1996

EDUCATIONAL SKILL REQUIREMENTS
AERONAUTICAL ENGINEERING (AVIONICS)
CURRICULUM (611)
Subspecialty Code XX72P

Officers completing the educational skill requirements for this curriculum are qualified to receive an XX72P subspecialty code. They consist of a core of prescribed aeronautical engineering skills in nine disciplines, which all graduates must acquire; plus a set of four specialization options of advanced topics in flight mechanics, information processing, electrical engineering and systems design, which the student may pursue as electives.

CORE REQUIREMENTS

1. **STRUCTURES**: Possess a knowledge of basic structural concepts of stress, strain, and deflections and their interrelationships and be able to analyze beams in simple bending, shafts transmitting torque, thin-walled vessels subjected to internal pressure and buckling of long columns.

2. **FLIGHT MECHANICS:** Be able to calculate all performance parameters for both propeller driven and jet powered military aircraft, and to determine their longitudinal and lateral-directional, static and dynamic stability characteristics. Be able to analyze aircraft and missile guidance and control systems, using deterministic and stochastic theory, and design such systems using classical and modern feedback control techniques, including H_∞ and H_2.

3. **AERODYNAMICS:** Be able to use classical analytic, experimental and modern computational techniques of subsonic and supersonic aerodynamics, including laminar and turbulent boundary-layer viscous effects, with or without heat addition, to calculate internal flow properties through inlets, nozzles and engines and external air flow pressure distributions over wings, canards, tails, and other lifting surfaces to determine the resulting lift, drag and pitching moment.

4. **INFORMATION PROCESSING:** Understand the general functional and system architecture of typical military avionics systems, including an understanding of microprocessor interfaces and a knowledge of software design, and be able to use the tools of deterministic and stochastic systems theory to analyze and design basic guidance, navigation and control systems, determining overall stability and performance.

5. **ENGINEERING MATHEMATICS:** Demonstrate analytic ability to apply differential and integral calculus, ordinary and partial differential equations, complex variables, vector calculus, matrix algebra, probability and statistics and numerical analysis in the development of engineering theory and its application to military engineering problems.

6. **ELECTRICAL ENGINEERING:** Understand basic electrical circuits, systems, and electronic devices, microwave communications, signal processing, antenna theory, electro-optics of pulse and continuous beamforming, and infra-red and laser technology as foundational tools for application to design and analysis of military aircraft avionics systems.

7. **SYSTEMS DESIGN:** Be able to integrate the disciplines of aeronautics and electronics into a design of an aircraft avionics system in response to a realistic set of military requirements, specifications and constraints. The design must include considerations for safety, reliability, maintainability and survivability.

8. **JOINT AND MARITIME STRATEGIC PLANNING:** Possess a knowledge of joint and maritime strategic planning to include development and execution of military strategy and the effects of technical developments of warfare; formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

9. **RESEARCH, DEVELOPMENT, TEST AND EVALUATION:** Apply principles of project scoping, planning, design and execution to investigate a current research, development, test or evaluation problem of interest to the Department of Defense that culminates in the publication of a thesis of academic quality.

SPECIALIZATION OPTIONS

Listed below are educational skills in four specialization options that may be pursued as advanced topic electives in aeronautical engineering after the core has been completed in the area.

FLIGHT MECHANICS: Obtain experience in flight test and evaluation by means of an in-flight laboratory and/or flight simulators; be able to analyze aircraft components for the transient load and unsteady aerodynamics of gusts, buffeting and flutter.

INFORMATION PROCESSING: Be able to use modern computer methods in aeronautical engineering analysis; understand data bus architectures, including fiber optic concepts.

ELECTRICAL ENGINEERING: Be able to incorporate digital signal processing techniques to mission relevant applications such as radar systems, electronic warfare, antisubmarine warfare and electro-optic sensors.

SYSTEM DESIGN: Expand design experience over that obtained in the core by executing designs to meet a given set of military mission requirements under realistic constraints in one or more of the following areas: fixed wing aircraft, rotary wing aircraft, tactical missiles and/or aircraft gas turbine engines.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
June 1996

COMBAT SYSTEMS PROGRAMS

Curricular Officer:
M.R. Polnaszek
CDR, USN
Code 33, Spanagel Hall
Room 200
(408) 656-2116/7 DSN 878-2116/7

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY
CURRICULUM 533
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. Included in the core are courses on electromagnetic radiation, signal processing, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, mine warfare, engineering materials, combat simulation, quantum detection devices, detection and engagement elements, combat systems integration, and computers for advanced combat systems. Additionally, the officer will take a sequence of five or more courses in one of the following concentration areas: electromagnetic sensors systems, nuclear and conventional weapons and effects, underwater acoustic systems, or an engineering area related to combat systems. The officer will also conduct thesis research on a specific technical problem. The curriculum includes survey courses in areas not covered by the officer's concentration.

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. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) Curriculum. An APC of 323 is required.

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Combat Systems Sciences and Technology Subspecialist with a subspecialty code of XX66P. The curriculum sponsors are Naval Sea Systems Command and the Space and Naval Warfare Command.

Typical Jobs in this Subspecialty:
NTDS-CIC: FLTCOMBDSSA, San Diego, CA
Warfare Systems Officer: SPAWAR OPSUPFLD 6
Weapons Instructor: Naval Academy, Annapolis, MD
Staff Readiness (Weapons): COMCRUDESGRU 1, 2, 3, 5, 8, 12
Testing Officer: COMOPTEVFOR
Weapons Instructor: SWOSCOLCOM
Weapons Department Head: Naval Academy, Annapolis, MD
Research Associate: Lawrence Livermore Laboratory
Physics Instructor: Naval Academy, Annapolis, MD
Research Associate: Los Alamos National Laboratory
Electro-Optics Project Officer: Naval Ocean Systems Center, San Diego CA
Testing Officer: COMOPTEVFOR
Research Officer: Naval Research Laboratory
Project Management: Naval Sea Systems Command
Test Manager: Defense Nuclear Agency (DNA)
Research and Development Coordinator: Defense Nuclear Agency (DNA)
Physicist: Defense Nuclear Agency (DNA) Tactical Nuclear Weapons/Plans: CINCLANT
Test Officer/Programs Officer: DNA, Kirkland AFB
Navy Research Officer: Los Alamos National Laboratory
Navy Research Officer: Lawrence Livermore Laboratory
Nuclear Effects Officer/Nucleonics Officer: SPAWARSYSCOM
Nuclear Physicist: DNA, Los Alamos
Instructor: Nuclear Weapons Training Group - Atlantic
Instructor: Naval Postgraduate School, Monterey, CA
Training Officer: PDW-124 (Undersea Surveillance)
Staff: Commander 7th Fleet
Staff: COMNAVSURFLANT
Test and Evaluation Officer: OPTEVFOR
Strategic Systems Project Officer: Director of SSPO
Staff Antisubmarine Warfare: NAVSEASYSCOM
Research and Development Project Officer: Office of Secretary of Defense

ENTRY DATES
Combat Systems Sciences and Technology is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum. Other entry dates are possible by special arrangement with the curricular officer.

Curriculum 533
Academic Associate:
James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200A
(408) 656-3884/2116, DSN 878-3884/2116

DEGREE
Requirements for the degree Master of Science in Applied Physics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. On a case-by-case basis, some students, depending on background, may earn a Master of Science in Physics, Computer Science, Engineering Acoustics, Systems Engineering or one of the engineering disciplines.

TYPICAL COURSE OF STUDY

Quarter 1
MA1118	(5-2)	Multi-Variable Calculus
MA2121	(4-0)	Differential Equations
NS3252	(4-0)	Joint and Maritime Strategy
SE2012	(3-3)	Applied Physics Laboratory I: Fundamentals
SE2020	(1-0)	Combat Systems Requirements and Design

Quarter 2
PH2911	(3-2)	Introduction to Computational Physics
PH2151	(4-1)	Particle Mechanics
PH3991	(4-0)	Theoretical Physics
SE2013	(3-3)	Applied Physics Laboratory II: Analog Techniques

Quarter 3
PH3152	(4-0)	Mechanics of Physical Systems
PH2351	(4-1)	Electromagnetism
PH2652	(4-1)	Quantum Physics
SE2014	(3-3)	Applied Physics Laboratory III

Quarter 4
PH3352	(4-0)	Electromagnetic Waves and Radiation
PH3653	(4-1)	Foundations of Quantum Devices
PH3292	(3-2)	Applied Optics
SE3015	(2-3)	Applied Physics Laboratory IV: Systems Control

Quarter 5
MS2201	(3-2)	Introduction to Materials Science and Engineering
PH3172	(4-1)	Fluid Dynamics of Weapons
PH4050	(4-0)	Physics of Electromagnetic Detection I
PH4911	(3-2)	Simulation of Physical & Weapon Systems

Quarter 6
----------		Concentration Course
MS3202	(3-2)	Properties, Performance & Failure of Engineering Materials
PH3171	(4-0)	Explosives and Explosions
PH3400	(4-2)	Survey of Underwater Acoustics

Quarter 7
----------		Concentration Course
PH3800	(4-0)	Intro to the Effects of Conventional & Unconventional Weapons
XX0810	(0-8)	Thesis Research
SE4021	(4-0)	Combat Systems Project Integration

Quarter 8
----------		Concentration Course
----------		Concentration Course
XX0810	(0-8)	Thesis
EO3816	(3-0)	Computer Architecture for Military Applications

Quarter 9

----------		Concentration Course
----------		Concentration Course
XX0810	(0-8)	Thesis Research
XX0810	(0-8)	Thesis Research

Concentration Area and Representative Courses

Electromagnetic Sensor Systems:
Thermodynamics & Statistical Physics; Advanced Electromagnetic Propagation; Sensors and Devices; Advanced Concepts in Target Surveillance, Acquisition, & Engagement; Sensors, Signal & Systems; Thermal Imaging & Surveillance Systems; Directed Energy Weapon Systems; Free Electron Lasers; Plasma Physics; Space Environment.

Weapons and Effects:
Nuclear Physics; Directed Energy Weapon Systems; Weapons Survivability & Lethality; Physics of High Velocity Impact; Physics of Nuclear Weapons; Weapons Proliferation, Control and Disposal.

Underwater Acoustic Systems:
Fundamental Acoustics; Underwater Acoustics; Transducer Theory and Design; Noise, Shock & Vibration Control; Sound Propagation in the Ocean; Sonar Signal Processing.

UNDERWATER ACOUSTICS SYSTEMS
CURRICULUM 535
Underwater Acoustics Systems is an interdisciplinary program designed for students not requiring Naval Subspecialty Codes upon completion. It consists of courses in physics and electrical engineering. Based on fundamental science and engineering, the emphasis is on underwater 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.

REQUIREMENTS FOR ENTRY
For direct input, a baccalaureate degree with mathematics through ordinary differential equations and integral calculus and a calculus-based basic physics sequence are required. Prior courses in the physical sciences and engineering are highly desirable. Officers not having the qualifications for direct input may enter the program indirectly through the Engineering Science Curriculum discussed elsewhere in this catalog. An APC of 323 is required.

ENTRY DATES
Underwater Acoustic Systems is a seven quarter course of study with entry date in October. Other entry dates are possible for either well-prepared officers or officers with more than seven quarters available. For specific information, contact the Academic Associate.

Curriculum 535
Academic Associate:
James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200A
(408) 656-3884, DSN 878-3884

DEGREE
All the requirements for the degree, Master of Science in Engineering Acoustics are met as a milestone en route to satisfying the curricular program.

TYPICAL COURSE OF STUDY (NON U.S. NAVY AND INTERNATIONALS)

Quarter 1

MA1118	(5-2)	Multi-Variable Calculus
MA2121	(4-0)	Differential Equations
SE2012	(3-3)	Applied Physics Laboratory I: Fundamentals

Quarter 2

PH2151	(4-1)	Particle Mechanics
PH3991	(4-0)	Theoretical Physics
PH2911	(3-2)	Introduction to Computational Physics
SE2013	(3-3)	Applied Physics Laboratory II: Analog Techniques

Quarter 3

PH3119	(4-2)	Oscillation and Waves
PH2351	(4-1)	Electromagnetism
SE2014	(3-3)	Applied Physics Laboratory III

EC2400	(3-1)	Discrete Systems

Quarter 4

PH3451	(4-2)	Fundamental Acoustics
PH3352	(4-0)	Electromagnetic Waves and Radiation
SE3015	(2-3)	Applied Physics Laboratory IV: Systems Control
EC2410	(3-1)	Analysis of Signals and Systems

Quarter 5

PH3452	(4-2)	Underwater Acoustics
PH4410	(1-6)	Advanced Acoustics Laboratory
EC3400	(3-1)	Digital Signal Processing
XX0810	(0-8)	Thesis Research

Quarter 6

PH4454	(4-2)	Sonar Transducer Theory and Design
EC4450	(4-1)	Sonar Systems Engineering
EC/OCXXX		Elective
XX0810	(0-8)	Thesis Research

Quarter 7

PH4455	(4-0)	Sound Propagation in the Ocean
EC/OCXXX		Elective
XX0810	(0-8)	Thesis Research
XX0810	(0-8)	Thesis Research

TOTAL SHIP SYSTEM ENGINEERING

This is a broad-based education program focusing on the warship as a total engineering system. This program is open to select students in the Combat Systems Sciences and Technology, Electronics Systems Engineering and Naval/Mechanical Engineering curricula. Further information can be found in the Naval/Mechanical Engineering Programs section of this catalog.

EDUCATIONAL SKILL REQUIREMENTS
COMBAT SYSTEMS SCIENCES AND TECHNOLOGY
CURRICULUM (533)
Subspecialty Code XX66P

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. **SCIENTIFIC AND ENGINEERING PRINCIPLES** necessary to understand the elements of combat systems:

   a. Acoustic and electromagnetic propagation; physics of solid-state, electro-optic, and quantum devices; principles of radar and sonar systems; and signal analysis and decision theory.
   b. Communication systems, fiber optics, open architectures and their implications on integration of computing resources in advanced combat systems, and automatic control systems.
   c. Fluid dynamics of subsonic and supersonic weapons, warheads and their effects (nuclear and conventional), counter measures and deception techniques.
   d. Combat systems simulation and testing including sufficient probability and statistics theory to appreciate the limits of simulation.

3. **COMBAT SYSTEMS ENGINEERING:** An understanding of the principles of design, development, improvement, and logistics engineering; and the importance of technical and economic trade-offs in combat systems.

4. **MATERIALS SCIENCE:** A familiarity of 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.

5. **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.

6. **GRADUATE CONCENTRATION:** A concentration of several graduate-level courses in a technical field within the general area of combat systems. The knowledge required for an approved concentration is:

A. ELECTROMAGNETIC SYSTEMS

1) Propagation and scattering of optical and microwave radiation in the turbulent atmosphere as they influence target detection.
2) Advanced sensor and detection techniques for military applications.
3) Advanced concepts of target surveillance, acquisition, and engagement.

B. WEAPONS & EFFECTS

1) Nuclear and statistical physics.
2) Nuclear weapons and their effects.
3) Effects of radiation & EMP on electronic systems.
4) Principles of directed energy weapons systems and their effects.
5) Survivability & lethality considerations for conventional, nuclear, biological and chemical weapons.

C. UNDERWATER ACOUSTIC SYSTEMS

1) Wave propagation in the ocean; scattering, fluctuations and boundary interactions as they effect detection, localization, and prosecution of underwater targets; underwater transducer design and array theory.
2) Active and passive acoustic signal processing for detection of submarines, mines, and other underwater weapons; adaptive techniques.

3) Acoustic influences of oceanographic phenomena which effect target detection including boundary characteristics, ambient noise, sound speed profiles, fronts, and eddies.

D. ENGINEERING DISCIPLINE:
A series of at least five graduate-level courses in an area related to combat systems in the disciplines of either Engineering, Computer Science, or Physics. This series must be approved by the Curricular Officer.

7. A survey course in each of the above concentration areas not covered in the officer's individual program.

8. **THESIS:** The graduate will demonstrate the ability to conduct independent analysis 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.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Sea Systems Command
July 1996

ELECTRONICS AND COMPUTER PROGRAMS

Curricular Officer:
Mike Dulke
CDR, USN
Code 32, Spanagel Hall
Room 404
(408) 656-2056/2174
DSN 878-2056/2174
FAX 656-3681
e-mail: mdulke@nps.navy.mil

COMPUTER SCIENCE
CURRICULUM 368
Home page on the WWW "http://www.cs.nps.navy.mil/"

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 to provide the officer with practical experience in applying modern computer equipment and research techniques to solve military problems.

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, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination), 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.

COMPUTER SCIENCE SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Computer Science Subspecialist with a subspecialty code of XX91P.

Typical Jobs in this Subspecialty:
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, COMOPTEVFOR
ADP System Security, NSA/CSS, FT Meade

ENTRY DATES
Computer Science is an eight-quarter course of study with entry dates in April and October. 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 Curricular Officer for this curriculum.

Curriculum 368
Academic Associate:
Yutaka Kanayama, Professor
Code CS/Ka, Spanagel Hall, Room 512
(408) 656-2095, DSN 878-2095
Fax: (408) 656-2814, DSN 878-2814
e-mail:kanayama@cs.nps.navy.mil

DEGREE
Requirements for the degree Master of Science in Computer Science are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS2970	(4-2)	Structured Programming with Ada
CS3010	(4-0)	Computer Systems Principles
MA3025	(5-1)	Logic and Discrete Mathematics
MA3030	(4-1)	Introduction to Combinatorics and its Applications

Quarter 2

CS3970	(4-2)	Advanced Object-Oriented Programming using ADA
CS3200	(3-2)	Computer Architecture
CS3300	(3-2)	Data Structures
CS3601	(4-0)	Theory of Formal Languages and Automata

Quarter 3

CS3310	(4-0)	Artificial Intelligence
CS3701	(4-0)	C++ as a Second Language
CS3650	(4-0)	Design and Analysis of Algorithms
CS3600	(3-2)	Introduction to Computer Security
CS4900	(0-2)	Research Seminar in Computer Science

Quarter 4

CS3450	(3-2)	Operating Systems
CS3460	(3-1)	Software Methodology
CS3320	(3-1)	Database Systems
-----------	(4-0)	Track Requirement*
CS4900	(0-2)	Research Seminar in Computer Science

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
-----------	(4-0)	Elective
-----------	(4-0)	Track Requirement*
-----------	(4-0)	Track Requirement*

Quarter 6

CS4203	(3-2)	Interactive Computation Systems
-----------	(4-0)	Track Requirement*
-----------	(4-0)	Track Requirement*
CS0810	(0-8)	Thesis Research

Quarter 7

NS3252	(4-0)	Joint and Maritime Strategy
-----------	(4-0)	Track Requirement*
-----------	(4-0)	Track Requirement*
CS0810	(0-8)	Thesis Research

Quarter 8

-----------	(4-0)	Track Requirement*
-----------	(4-0)	Track Requirement*
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

*NOTE: Track Requirement courses will be determined by the selection of one of the following specialization track options: Artificial Intelligence and Robotics, Computer Graphics and Visual Simulation, Database and Data Engineering, Software Engineering, Computer Systems and Architectures, or Computer Systems and Security.

TRACK OPTIONS

The objectives of the Artificial Intelligence and Robotics Track are to present current state of knowledge regarding advanced symbolic computation, to develop skills in the use of AI languages and expert system shells and to present fundamental scientific/engineering knowledge in robotics for military applications.

The Computer Graphics and Visual Simulation Track is designed to provide an understanding of the methodologies and techniques required in real-time, three-dimensional, interactive, visual simulations for military applications.

The objective of the Database and Data Engineering Track is to provide an understanding of data retrieval and processing using the best available database system management and operating system techniques and concepts.

The purposes of the Software Engineering Track are to provide knowledge of all aspects of software development and to develop skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques, with particular emphasis on the use of Ada and C++.

The Computer Systems and Architectures Track is designed to provide knowledge of computer architecture and system software for real-time and multi-computer systems with emphasis on military applications to embedded computers and secure systems.

The Computer Systems and Security Track 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 development, evolution or implementation of secure computer systems.

MASTER OF SCIENCE IN SOFTWARE ENGINEERING (MSSE)

The Master of Science in Software Engineering 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 by the completion of a total of 12 graduate-level Software Engineering courses, which are taught at NPS and televised to the distance site, and an acceptable thesis in addition to the required course work.

REQUIREMENTS FOR ENTRY

An accredited Bachelor's degree in computer science, computer engineering, or equivalent, with above-average grades in mathematics, resulting in an APC of at least 325, and at least two years of experience in software development or management is required for entry.

ENTRY DATES

The MSSE is a nine-quarter curriculum with entry dates in October. If further information is needed, contact the Distance Learning Program Coordinator or Curriculum Office for this program.

Distance Program Coordinator
Man-Tak Shing, Associate Professor
Code CS/Sh, Spanagel Hall, Room 544B
(408) 656-2634, DSN 878-2634
Fax: (408) 656-2814, DSN 878-2814
e-mail: mantak@cs.nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1
CS3460	(3-1)	Software Methodology
IS3171	(4-0)	Economic Evaluation of Information Systems II

Quarter 2
CS4500	(3-1)	Software Engineering
CS4510	(3-0)	Computer-Aided Prototyping

Quarter 3
CS3502	(4-0)	Computer Communications and Networks
IS4300	(3-2)	Software Engineering and Management

Quarter 4
CS4520	(3-0)	Advanced Software Engineering
CS4540	(3-0)	Software Testing

Quarter 5
CS4560	(3-0)	Software Evolution
CS4580	(3-0)	Designed of Embedded Systems (*)

Quarter 6
CS4570	(3-0)	Software Reuse
CS4550	(4-0)	Computer Networks II (*)

Quarter 7
CS3600	(3-2)	Introduction to Computer Security (*)
IS4185	(4-1)	Decision Support Systems (*)

Quarter 8
CS0810   (0-8)   Thesis Research

Quarter 9
CS0810   (0-8)   Thesis Research

(*) Choose two courses from CS3600, CS4550, CS4580, IS4185

MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES)
CURRICULUM 399
Homepage on the WWW "http://www-npsnet.cs.nps.navy.mil/moves"
The MOVES Curriculum was developed in response for an interdisciplinary graduate education program beyond that available through the Computer Science Curriculum's Computer Graphics and Visual Simulation track.

The MOVES Curriculum of the Naval Postgraduate School provides the M.S. and Ph.D. student both fundamental and specialized courses in applied computer 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 program whose core covers the fundamentals of computer science, visual simulation and human-computer interaction. Specific topics include object-oriented programming, artificial intelligence, software methodology, computer communications and networks, computer graphics, virtual worlds and simulation systems, physically based modeling, probability, statistics, stochastic modeling, data analysis, and human performance evaluation.

Specialization by the M.S. student is accomplished by choosing a track and completing a sequence of courses providing depth in the selected area. There are two tracks that support the curriculum's research efforts, the Visual Simulation Track and the Human-Computer Interaction Track.

Once the MOVES Curriculum core courses have been taken and while the specialization courses are underway, the final step in the M.S. degree program is the completion of a written thesis. This thesis is usually conducted on a research problem specified by a thesis advisor attached to a MOVES-associated laboratory. Current laboratories working with the MOVES Curriculum are the NPSNET Research Group, a leading developer of networked, large-scale virtual environments, and the Information Infrastructure Research Group (IIRG), whose focus is on advanced network issues such as asynchronous transfer mode (ATM), multicast backbone (MBONE) and internetworking regional research institutions.

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 GRE (Graduate Record Examination), 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.

MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Modeling, Virtual Environments and Simulation Subspecialist with a subspecialty code of XX99P.

ENTRY DATES
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 Curricular Officer for this curriculum.

Curriculum 399
Academic Associate:
Michael Zyda, Professor
Code CS/Zk, Spanagel Hall, Room 516
(408)656-2305, DSN 878-2305
Fax: (408)656-2814, DSN 878-2814
e-mail: zyda@siggraph.org

DEGREE
Requirements for the degree 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.

TYPICAL COURSE OF STUDY
VISUAL SIMULATION TRACK

Refresher
CSR100	(2-1)	Refresher for Beginning Programming
MAR142	(2-0)	Refresher: Matrix Algebra
MAR125	(3-0)	Introduction to Finite Mathematics (MA3025 for Engineering Science)
MAR117	(3-3)	Refresher: Single Variable Calculus (MA1117 for Engineering Science)

Quarter 1
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
CS3010	(4-0)	Computer Systems Principles
OA3101	(4-1)	Probability
MA1118	(5-2)	Multi-variable Calculus

Quarter 2
CS3700	(3-2)	Advanced Programming in C++
CS3200	(3-2)	Computer Architecture
OA3102	(4-1)	Probability and Statistics
CS3472	(3-2)	Introduction to Physically Based Modeling

Quarter 3
CS3310	(4-0)	Artificial Intelligence
OA3401	(4-0)	Human Performance Measurement I
OA3103	(4-1)	Statistics
OA3301	(4-0)	Stochastic Models I
CS4901	(0-2)	Research Seminar in MOVES

Quarter 4
CS3450	(3-2)	Operating Systems
CS4202	(3-2)	Computer Graphics
OA3104	(3-1)	Data Analysis
OA3302	(4-0)	OA System Simulation

Quarter 5
CS3502	(4-0)	Computer Communications and Networks
CS4314	(3-2)	Symbolic Computing
CS4473	(3-2)	Virtual Worlds and Simulation Systems
CS4112	(3-2)	Distributed Operating Systems

Quarter 6
CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD
CS4470	(3-2)	Image Synthesis
CS4474	(3-2)	Virtual Environment Network and Software Architectures
CS4472	(3-2)	Physically-Based Modeling

Quarter 7
OA4401	(4-0)	Human Performance Evaluation
CS4471	(3-2)	Computer Animation
CS3202	(3-2)	Introduction to Multimedia Production
CS0810	(0-8)	Thesis Research

Quarter 8
NS3252	(4-0)	Joint and Maritime Strategy (international students take IT1500 instead)
OA4655	(4-0)	Airland Combat Models II
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
HUMAN-COMPUTER INTERACTION TRACK

Refresher
CSR100	(2-1)	Refresher for Beginning Programming
MAR142	(2-0)	Refresher: Matrix Algebra
MAR125	(3-0)	Introduction to Finite Mathematics (MA3025 for Engineering Science)
MAR117	(3-3)	Refresher: Single Variable Calculus (MA1117 for Engineering Science)

Quarter 1

CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
CS3010	(4-0)	Computer Systems Principles
OA3101	(4-1)	Probability
MA1118	(5-2)	Multi-variable Calculus

Quarter 2

CS3700	(3-2)	Advanced Programming in C++
CS3200	(3-2)	Computer Architecture
OA3102	(4-1)	Probability and Statistics
CS3472	(3-2)	Introduction to Physically Based Modeling

Quarter 3

CS3310	(4-0)	Artificial Intelligence
OA3401	(4-0)	Human Performance Measurement I
OA3103	(4-1)	Statistics
OA3301	(4-0)	Stochastic Models I
CS4901	(0-2)	Research Seminar in MOVES

Quarter 4

CS3450	(3-2)	Operating Systems
CS4202	(3-2)	Computer Graphics
OA3104	(3-1)	Data Analysis
OA3302	(4-0)	OA System Simulation

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
CS4314	(3-2)	Symbolic Computing
CS4473	(3-2)	Virtual Worlds and Simulation Systems
CS4112	(3-2)	Distributed Operating Systems

Quarter 6

CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD
OA4655	(4-0)	Airland Combat Models II (for those in the Human-Computer Interaction Track)
OA3402	(3-0)	Human Performance Measurement II
CC4103	(2-4)	C4I Systems Evaluation

Quarter 7

OA4401	(4-0)	Human Performance Evaluation
OA4333	(4-0)	Simulation Methodology
OA4404	(4-0)	Operations Research in Man-Machine Systems
CS0810	(0-8)	Thesis Research

Quarter 8

NS3252	(4-0)	Joint and Maritime Strategy (international students take IT1500 instead)
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

TRACK OPTIONS

The Visual Simulation track is designed to provide the officer student an understanding of the technological possibilities of virtual environments for modeling and simulation, and an understanding of how to develop new virtual environments technology.

The objective of the Human-Computer Interaction track is to provide the officer student the ability to evaluate visually-based modeling and simulation systems, and an understanding of the issues behind building training systems with virtual environments.

ELECTRONIC SYSTEMS ENGINEERING
CURRICULUM 590
Home page on the WWW "http://vislab-www.nps.navy.mil/~ece/"
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 through 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 (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

ELECTRONICS SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code XX55. The curriculum sponsor is Space and Naval Warfare Systems Command.

Typical Jobs in this Subspecialty:

Instructor: Naval Academy, Annapolis, MD
Executive Officer: SPAWARHDQTRS
Operations Test and Evaluation: COMOPTEVFOR
Electronics Research Manager: NSA/CSS, Ft Meade
C3 Staff Officer: DISA HQ, Washington, DC
Electronics Material Officer: USS BLUE RIDGE LCC 19, USS MT WHITNEY LCC 20
Project Officer: Warfare Systems Architecture and Engineering, SPAWARHDQTRS

ENTRY DATES

Electronic Systems Engineering is 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 Curricular Officer.

Curriculum 590
Academic Associate:
David Jenn, Associate Professor
Code EC/Jn, S-414
(408) 656-2254, DSN 878-2254
e-mail: jenn@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Electrical Engineering are met en route to satisfying the Educational Skill Requirements.

TYPICAL COURSE OF STUDY
COMPUTER SYSTEMS OPTION

Quarter 1

EC2100	(4-2)	Circuit Analysis
EC2820	(3-2)	Digital Logic Circuits
MA1118	(5-2)	Multi-Variable Calculus
NS3252	(4-0)	Joint and Maritime Strategy

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
EC3910	(2-0)	Research Seminar in ECE

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
EC3910	(2-0)	Research Seminar in ECE

Quarter 5

ECXXXX		BSEE Elective II
EC2220	(2-4)	Applied Electronics
EC3820	(3-1)	Computer Systems
ECXXXX		BSEE Elective III

Quarter 6

EC3550	(3-1)	Fiber Optic Systems
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, and satellite communications.

The Computer Systems area of concentration 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 area of concentration is designed to provide and 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. Course in specific areas of military application currently include military robotics, missile guidance and control, and integrated target tracking.

The Joint Services Electronic Warfare option is designed to provide advanced education in the evolving technology and systems integration which support modern electronic warfare. Courses in specific areas of relevance include sensor and data fusion, radar and IR/EO systems, radar and communications ECM/ECCM, RCS prediction and reduction, military applications of space.

The Power Systems option is designed to provide 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 knowledge of algorithms and design of systems for analysis and processing of signals and images encountered in communications, control, surveillance, radar, sonar, and underwater acoustics.

The Signals Intelligence option provides a broad education in the fields of electrical engineering that relate to the signals intelligence area, such as Communications, Electronic Warfare, Signal Processing, and Computer Systems. This option is open only to U.S. citizens with the appropriate security clearance.

TOTAL SHIP SYSTEMS ENGINEERING
This is a broad-based education program focusing on the warship as a total engineering system. This program is open to select students in the Electronics Systems Engineering, Naval/Mechanical Engineering and Combat Systems Sciences and Technology curricula. Further information can be found in the Naval/Mechanical Engineering Programs section of this catalog.

EDUCATIONAL SKILL REQUIREMENTS
COMPUTER SCIENCE
CURRICULUM (368)
Subspecialty Code XX91P

All officers with advanced degree education in Computer Science must possess skills and competencies in software engineering and design methodologies, computer system design and computer architecture. The skills and competencies are detailed below.

1. JOINT AND MARITIME STRATEGIC PLANNING

Joint and maritime strategic planning to include development and execution of military strategy 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.

2. SOFTWARE ENGINEERING

The officer must have a thorough knowledge of software engineering to include:

a) An understanding of the software development process, including specification of requirements, design, implementation, testing, maintenance, and process metrics;

b) The ability to plan and implement a major programming project and develop the appropriate documentation, and;

c) The ability to incorporate and enforce modern software engineering techniques in system design, and use modern tools to assure quality and short delivery times.

3. SOFTWARE TECHNOLOGY

The officer must have a thorough knowledge of software technology to include:

a) The design of programming languages covering syntax and semantics, properties of object-oriented languages, programming techniques for parallel and distributed applications, and evaluation of languages;

b) The structure of storage media, the methods useful in representing structured data in storage, techniques of operating upon data structures, databases, distributed databases, object-oriented databases, and interoperability of database systems;

c) Computer systems organization from the operating systems level down to the computer architecture level, memory management, file system design and management, system accountability, security, object-oriented operating environments, computer-human interfaces, and networking;

d) Design and implementation of database systems including network models, relational models, object-oriented models, and language extensions required to support such systems;

e) Computer graphics covering human-computer interaction, virtual worlds, distributed interactive simulation, intelligent displays, and computer-mediated autonomous systems; use of video, audio, and other sensory 1/0 to coordinate human-machine activities via remote access;

f) Artificial intelligence techniques including heuristic search, artificial intelligence languages, knowledge representation, expert systems, and means-end analysis, and;

g) Formal methods for the design and analysis of software systems; rapid prototyping, reusable designs, object-oriented design; and use of tools.

4. COMPUTER SYSTEMS DESIGN

The officer must have a thorough knowledge of computer system design to include:

a) Empirical and analytical methods for determining the efficiency and performance of computer systems; analysis of algorithms, and modeling of processes;

b) An understanding of the design issues of hardware/ software compatibility, operating systems compatibility, information systems requirements, and interoperability especially via networks;

c) Computer science theory relevant to the capabilities and limitations of hardware and software systems and;

d) Computer security of hardware systems, software systems, and networks.

5. COMPUTER ARCHITECTURE

The officer must have a thorough knowledge of computer architecture to include:

a) Basic components of computer systems and their patterns of configuration and communication including large scale mainframes, microcomputers, supercomputers, parallel processors, networks of workstations;

b) The organization, logic design, and components of digital computing systems relating to multiprocessing, parallel processing, distributed processing, networking, communication, multimedia, and peripheral devices and;

c) The application of high performance computing clusters to various disciplines of engineering, ocean sciences, management, etc.

6. 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 Navy organization. This includes:

a) Completing a significant project applying academic skills outside of the classroom, and;

b) Exercising skills in problem formulation, criteria specification, analysis, and evaluation and presentation of results.

c) Clearly communicating the project in writing and verbally.

Curriculum Sponsor and ESR Approval Authority
Deputy Director, Space, Information Warfare, Command and Control (N62)
December 1996

EDUCATIONAL SKILL REQUIREMENTS
MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES)
CURRICULUM (399)
Subspecialty Code XX99P

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 (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.

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 modeling and simulation in distributed simulation networks joining a variety of modeling and simulation tools, developed and operated by other Service agencies.

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 environments and simulation systems.

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 upon 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.

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; an understanding of the design issues of hardware/software compatibility, operating systems compatibility, information systems requirements, and interoperability, especially via networks.

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; the organization, logic design, and components of digital computing systems relating to multi-processing, parallel processing, distributed processing, networking, communication, multimedia, and peripheral devices.

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 modeling and simulation in the 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 employment of software of special importance for modeling, virtual environments and simulation.

DATA ANALYSIS AND STOCHASTIC MODELING
The graduate must have the ability to apply probability, statistics, and exploratory data analysis as appropriate, 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.

VIRTUAL ENVIRONMENTS AND COMPUTER-HUMAN INTERACTION
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 included in study are: computer-human interfaces, and networking; real-time, 3D 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.

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 Navy 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.

Curriculum Sponsor and ESR Approval Authority
    Deputy Director, Space, Information Warfare, Command and Control (N6M)
    September 1996

EDUCATIONAL SKILL REQUIREMENTS
ELECTRONIC SYSTEMS ENGINEERING
CURRICULUM (590)
Subspecialty Code XX55P

1. MATHEMATICS: The officer will have a thorough knowledge of mathematical tools which are intrinsic to electrical and computer engineering, including, but not limited to differential equations, vector analysis, linear algebra, probability, numerical analysis, 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, electromagnetics, electronic devices and circuits, system theory, and modern electronic system design; also in other appropriate fields such as underwater acoustics, dynamics, fluid mechanics and thermo-dynamics which 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 circuits, and microprocessor applications.

4. ELECTRONIC AND ELECTRICAL ENGINEERING: In order 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, fiber optics, computer communications networks, and systems analysis. The officer will select elective courses to obtain breadth in his/her understanding of military electronic systems. Additionally, to achieve depth of understanding, the officer shall specialize in one of the following areas: (a) communication systems as applied to electronic counter-counter measures, low probability of intercept systems, low probability of detection systems, and other military issues; (b) guidance, navigation, and control systems; (c) radar, electro-optic, and electronic warfare systems; (d) high performance computer systems including advanced integrated circuits parallel and distributed systems, and reliable real time military platforms; (e) signal processing systems as applied to surveillance, underwater acoustic data acquisition and processing, imaging and target location, and other military issues; (f) total ship systems power engineering; (g) signals intelligence processing; (h) joint services electronic warfare..

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 objectives 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.

7. 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.

Curriculum Sponsor and ESR Approval Authority
  Commander, Space and Naval Warfare Systems Command
  May 1996

JOINT COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I) SYSTEMS PROGRAMS

Curricular Officer:
Michael Mullady
LtCol, USAF
Code 39, Root Hall
Room 103H
(408) 656-2772
DSN 878-2772
e-mail: mmullady@nps.navy.mil

JOINT COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I) SYSTEMS CURRICULUM 365

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 Command, Control, Communications, Computers, and Intelligence 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. Federal Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. Eligibility for TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required. An APC of 324 is required for direct entry. Officers not meeting the academic requirements for direct input may enter the program via one or two quarters of Engineering Science (Curriculum 460).

JOINT COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS AND INTELLIGENCE (C4I) SYSTEMS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Joint Command, Control, Communications, Computers and Intelligence (C4I) Systems Subspecialist with a subspecialty code of XX45P for U.S. Naval officers. Army graduates are awarded the 3K Special Skill Identifier. Air Force graduates fill OYTA coded billets. 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 Jobs in this Subspecialty:
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

ENTRY DATES

Joint Command, Control, Communications, Computers, and Intelligence (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 Curricular Officer for this curriculum.

Curriculum 365
Academic Associate:
William G. Kemple, Associate Professor
Code CC, Root Hall, Room 201J
(408) 656-3309, DSN 878-3309

DEGREE

Requirements for the degree Master of Science in Systems Technology [Joint Command, Control and Communications (C3)] are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD
CC2040	(3-2)	Introduction to Systems Technologies
OS2103	(4-1)	Applied Probability for Systems Technology
MA1118	(5-2)	Multi-Variable Calculus

Quarter 2

CC3101	(4-0)	Combat Analysis for C3
CC3040	(3-3)	Introduction to Joint Command and Control Systems (JCCS)
OS3604	(4-0)	Decision and Data Analysis
EO2413	(4-2)	Introduction to Communication System Engineering

Quarter 3

CC3050	(4-0)	Software Systems Engineering
OS3008	(4-0)	Analytical Planning Methodology
IS4320	(4-0)	Database System and Information Resource Management
EO3513	(4-2)	Communication Systems Engineering: Modulation

Quarter 4

CC4101	(4-2)	C4I Systems Engineering
MN3301	(4-0)	System Acquisition and Project Management
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
EO3523	(4-2)	Communication System Analysis

Quarter 5

CC4750	(3-1)	Military C4I Systems and Networks
CC4103	(2-4)	C4I Systems Evaluation
PH3052	(4-0)	Remote Sensing for C3
		Emphasis Elective

Quarter 6

NS3252	(4-0)	Joint and Maritime Strategy
CC4040	(3-3)	Advanced Joint C2 Systems
CC0810	(0-8)	Thesis Research
		Emphasis Elective

Quarter 7

CC4913	(4-0)	Policies and Problems in C3
CC0810	(0-8)	Thesis Research
CC0810	(0-8)	Thesis Research
		Emphasis Elective

SCIENTIFIC AND TECHNICAL INTELLIGENCE
CURRICULUM 823

The Scientific and Technical Intelligence curriculum is tailored to meet the billet requirements of major resource claimants, such as Unified Commanders-In-Chiefs, and to satisfy the educational skill requirements for Scientific and Technical Intelligence (XX17P). This is a rigorous curriculum which is founded in traditional applied academic disciplines of computer science, information technology management, information warfare and space systems operations. In contrast to the previous curricula offered just a few years ago, which were aimed exclusively at naval intelligence officers and a few general unrestricted line officers, the present Scientific and Technical Intelligence curriculum encompasses educational objectives suitable to all services as well as to some Federal agencies.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information (SCI). They must have a baccalaureate degree earned with above-average academic performance and a minimum APC of 223.

Typical Jobs in this Subspecialty:
Intelligence Analyst: ONI, Washington, DC
Scientific and Technical Intelligence Officer: COMINEWARCOM
Collection Requirements Officer: DIA
Scientific & Technical Intelligence Staff Officer: COMSPAWARSYSCOM

ENTRY DATES
Scientific and Technical Intelligence is a seven quarter program with a starting date in April. In addition, all students will report for a math and physics refresher in mid-February. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 823
Academic Associate:
Dan C. Boger, Professor
Code CC, Root Hall, Room 201D
(408) 656-3671, DSN 878-3671

DEGREE
Requirements for the degree Master of Science in Systems Technology (Scientific and Technical Intelligence) are met en route to satisfying the Educational Skill Requirements of the Scientific and Technical Intelligence program.

TYPICAL COURSE OF STUDY
SCIENTIFIC AND TECHNICAL INTELLIGENCE

Refresher (Six-week)
MAR117	(3-3)	Refresher: Single Variable Calculus
MAR142	(2-0)	Refresher: Matrix Algebra
MAR125	(3-0)	Introduction to Finite Mathematics
PHR110	(5-3)	Refresher Physics

Quarter 1
MA1118	(5-2)	Multi-Variable Calculus
MA2121	(4-0)	Differential Equations
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
PH2511	(4-0)	Introduction to Orbital Mechanics

Quarter 2
IW2000	(3-2)	Introduction to Information Warfare
OS2103	(4-1)	Applied Probability for Systems Technology
CS3030	(4-0)	Computer Architectures and Operating Systems
NS3000	(4-0)	War in the Modern World

Quarter 3
SS3001	(3-2)	Military Applications of Space
SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula
PH2514	(4-0)	Introduction to the Space Environment
EO2413	(4-2)	Introduction to Communication Systems Engineering

Quarter 4
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
OS3604	(4-0)	Decision and Data Analysis
SE4006	(4-0)	Technical Assessment of Weapon Systems
EO3513	(4-2)	Communication Systems Engineering

Quarter 5
IS4320	(4-1)	Database and Information Resource Management for C4I
IS4502	(3-2)	Telecommunications Networks
EO4612	(4-2)	Microwave Devices and Radar
EO3523	(4-2)	Communication Systems Analysis

Quarter 6
CC4750	(3-1)	Military C4I Systems and Networks
NS3252	(4-0)	Joint and Maritime Strategy
NS3159	(4-0)	Principles of Joint Operational Intelligence
CC0810	(0-8)	Thesis Research

Quarter 7
NS3240	(4-0)	Military Innovation and Joint Warfare
NS4141	(4-0)	Seminar in Economic Intelligence
CC0810	(0-8)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
JOINT COMMAND, CONTROL, COMMUNICATIONS,
COMPUTERS & INTELLIGENCE (C4I) SYSTEMS
CURRICULUM (365)
Subspecialty Code XX45P

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. 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 role of the commanders of the unified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

5. PRACTICE:

The graduate will demonstrate the ability to conduct independent analysis of joint command, control, communications, computers, and intelligence systems and will demonstrate 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 (J-6)
Director, Space and Electronic Warfare (N-6)
June 1997

EDUCATIONAL SKILL REQUIREMENTS
SCIENTIFIC AND TECHNICAL INTELLIGENCE
CURRICULUM (823)
Subspecialty Code XX17P

1. **MATHEMATICS:** An undergraduate-level knowledge of mathematics to include single- and multi-variable calculus, matrix algebra, and differential equations.

2. **WEAPONS SYSTEMS ASSESSMENT:** A theoretical and practical knowledge of the current technical trends in weapons systems technologies which may significantly affect warfare, to include current weapons types, weapon effects, weaponeering, directed energy weapon concepts, and future weapon concepts.

3. **SPACE SYSTEMS OPERATIONS:** A theoretical and practical knowledge of the military applications of space and the capabilities and limitations of space-based sensing to include the principles of active and passive sensors used in spacecraft, the trade-offs among various sensor techniques, and an appreciation of the natural and induced environments of space, the atmosphere, and the ocean on sensing systems.

4. **SIGNAL PROCESSING AND ELECTRONIC WARFARE:** A theoretical and practical knowledge of the principles of signal processing and signals intelligence, communications, radar, and electronic warfare to include analog signals and systems, digital signals and systems, communications systems analysis, and electronic warfare techniques and systems.

5. **COMPUTER NETWORKS AND CLIENT-SERVER ENVIRONMENTS:** A theoretical and practical knowledge of the capabilities, limitations, design, and operation of computer networks to include computer organization and architecture, operating systems, computer communications and networks, and client-server environments.

6. **INFORMATION WARFARE:** An understanding of information warfare and an understanding of command and control warfare as a military application of information warfare. Particular emphasis given to the role of intelligence in information warfare.

7. **APPLICATIONS OF TECHNOLOGY TO INTELLIGENCE SYSTEMS:** A graduate-level understanding of various intelligence disciplines which provides an intellectual framework for integrating scientific and technical information gained in non-intelligence courses to intelligence systems applications, including economic intelligence.

8. **JOINT PROFESSIONAL MILITARY EDUCATION:** A graduate-level understanding of national military capabilities and command structure, joint doctrine, joint and multi-national forces at the operational level of war, joint planning and execution, and systems integration at the operational level of war.

9. **ANALYTICAL AND RESEARCH METHODS:** A graduate-level introduction to the presentation and examination of research, including a graduate-level understanding of probability, statistics, and data analysis.

10. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Director, Naval Intelligence
April 1996

METEOROLOGY AND OCEANOGRAPHY (METOC) PROGRAMS

Curricular Officer:
Robert Glenn Handlers
CDR, USN
Code 35, Spanagel Hall, Room 302
(408) 656-2044
DSN 878-2044

METEOROLOGY
CURRICULUM 372

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The student will develop the technical expertise to assess and forecast the impact of atmospheric conditions on operations:

1) To understand the science of meteorological data and models.

2) To sample/measure, analyze and predict atmospheric conditions.

3) To operate and control data/information management systems.

4) To plan, conduct, interpret and present results of research activities.

REQUIREMENTS FOR ENTRY

This 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 as a Ph.D. 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. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Meteorology is a five or six-quarter course of study with entry dates in April and October. A six-week technical refresher in calculus, physics and introduction to Meteorology is available preceding the entry date. For further information contact the Curricular Officer. Academic questions may be referred directly to the Academic Associate.

Curriculum 372
Academic Associate:
Robert L. Haney, Professor
Code MR/Hy, Root Hall, Room 257
(408)656-4053, DSN 878-4053

DEGREE

Master of Science in Meteorology.

TYPICAL COURSE OF STUDY - FALL INPUT

Refresher

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus

Quarter 1

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
NS3252	(4-0)	Joint and Maritime Strategy
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3

MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorology Analysis/Laboratory
MRXXXX	(3-0)	Elective
MRXXXX	(4-0)	Elective

Quarter 4

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Laboratory
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR4900	(3-0)	Directed Study in Meteorology
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series

Quarter 5

MR3252	(3-4)	Tropical Meteorology/Laboratory
MR4413	(4-0)	Air-Sea Interaction
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR0810	(0-8)	Thesis Research

Quarter 6

MRXXXX	(4-0)	Elective
MRXXXX	(4-0)	Elective
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

Quarter 7

MRXXXX	(4-0)	Elective
MR4241	(3-0)	Mesoscale Meteorology
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Seminar in Meteorology

TYPICAL COURSE OF STUDY - SPRING INPUT

Refresher

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science

Quarter 1

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
NS3252	(4-0)	Joint and Maritime Strategy
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3

MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorology Analysis/Laboratory
MRXXXX	(3-0)	Elective
MRXXXX	(4-0)	Elective

Quarter 4

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Laboratory
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR4900	(3-0)	Directed Study in Meteorology

Quarter 5

MR4241	(3-0)	Mesoscale Meteorology
MR4413	(4-0)	Air-Sea Interaction
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR0810	(0-8)	Thesis Research

Quarter 6

MR3252	(3-4)	Tropical Meteorology/Laboratory
MRXXXX	(4-0)	Elective
MRXXXX	(4-0)	Elective
MR0810	(0-8)	Thesis Research

Quarter 7

MRXXXX	(4-0)	Elective
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Seminar in Meteorology

METEOROLOGY AND OCEANOGRAPHY (METOC)
CURRICULUM 373

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:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.

2) 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.

3) 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.

4) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.

5) 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. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

METOC SUBSPECIALTY

Completion of this curriculum qualifies an officer as a METOC Subspecialist with a subspecialty code of XX47P. The Curriculum Sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:
METOC Officer: CV/LHD/LHA/LPH
Submarine Group Staff
Fleet Staff
CRUDESGRU Staff
OIC Naval Meteorology and Oceanography Command Detachment
NAVMETOCCOM Center/Facility
NIMA
Office of Naval Research

ENTRY DATES

METOC curriculum is a nine-quarter course of study with entry dates in April and October. A six-week technical refresher in calculus, physics, and Introduction to Meteorology, is available preceding these entry dates. If further information is needed, contact the Curricular Officer. Academic questions may be referred directly to either of the Academic Associates.

Curriculum 373
Academic Associates:
Robert L. Haney, Professor
Code MR/Hy, Root Hall, Room 257
(408) 656-4053 DSN 878-4053

Mary Batteen, Associate Professor
Code OC/Bv, Spanagel Hall, Room 346
(408) 656-3265, DSN 878-3265

DEGREE
Master of Science in Meteorology and Physical Oceanography.

TYPICAL COURSE OF STUDY - FALL INPUT

Refresher
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 1
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
NS3252	(4-0)	Joint and Maritime Strategy
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3
MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorological Analysis/Laboratory
OC3240	(4-2)	Ocean Dynamics I
OC3260	(4-0)	Sound in the Ocean

Quarter 4
MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Laboratory
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4211	(4-0)	Ocean Dynamics II

Quarter 5
MR3252	(3-4)	Tropical Meteorology/Laboratory
OC4331	(4-0)	Mesoscale Ocean Variability
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OCXXXX	(3-0)	Elective

Quarter 6
MR/OCXXXX	(4-0)	Coastal Elective
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC3212	(4-0)	Polar Meteorology/Oceanography
MR/OC4900	(3-0)	Directed Study in Meteorology/Directed Study in Oceanography

Quarter 7
MR/OC4413	(4-0)	Air-Sea Interaction
MR4416	(3-0)	Atmospheric Factors in Electromagnetic and Optical Propagation
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR/OC0810	(0-8)	Thesis Research

Quarter 8
OC3902	(3-2)	Fundamentals of Mapping, Charting and Geodesy
OC3266	(3-2)	Operational Acoustic Forecasting
OC/MRXXXX	(3-0)	Elective
MR/OC0810	(0-8)	Thesis Research

Quarter 9
OC/MRXXXX	(4-0)	Elective
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Seminar in Meteorology/Thesis Seminars

TYPICAL COURSE OF STUDY - SPRING INPUT

Refresher

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
OC3140	(3-2)	Probability and Statistics for Air-Ocean Science

Quarter 1

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
NS3252	(4-0)	Joint and Maritime Strategy
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC3230	(3-1)	Descriptive Physical Oceanography
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3

MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorological Analysis/Laboratory
OC3240	(4-2)	Ocean Dynamics I
OC3260	(4-0)	Sound in the Ocean

Quarter 4

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Laboratory
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4211	(4-0)	Ocean Dynamics II

Quarter 5

MR4416	(3-0)	Atmospheric Factors in Electromagnetic and Optical Propagation
OC4331	(4-0)	Mesoscale Ocean Variability
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OCXXXX	(3-0)	Elective

Quarter 6

MR/OCXXXX	(4-0)	Coastal Elective
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR3252	(3-4)	Tropical Meteorology/Laboratory
MR/OC4900	(3-0)	Directed Study in Meteorology/Directed Study in Oceanography

Quarter 7

MR/OC4413	(4-0)	Air-Sea Interaction
MR/OCXXXX	(4-0)	Elective
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR/OC0810	(0-8)	Thesis Research

Quarter 8

OC3212	(4-0)	Polar Meteorology/Oceanography
OC3266	(3-2)	Operational Acoustic Forecasting
OC/MRXXXX	(3-0)	Elective
MR/OC0810	(0-8)	Thesis Research

Quarter 9

OC3902	(3-2)	Fundamentals of Mapping, Charts and Geodesy
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Seminar in Meteorology/Thesis Seminars

OPERATIONAL OCEANOGRAPHY
CURRICULUM 374

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:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans.

2) 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.

3) 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.

4) An educationally significant oceanographic experience at sea.

5) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.

6) A knowledge of Joint Maritime Strategic Planning.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base and is a very flexible program. The student selects a warfare specialization area in antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare, or special warfare. This program is open to Unrestricted Line (1110, 1120, 1310, 1320, 1700) Officers, 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. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

OPERATIONAL OCEANOGRAPHY SUBSPECIALTY
Completion of this curriculum qualifies an officer as an Operational Oceanography Subspecialist with a subspecialty code of XX49P. The curriculum sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:
CV ASW Module
CARGRU Staff
ASW Operations Center
Navy Laboratories
Office of Naval Research
Patrol Wing Detachments
Naval Academy Instructor
NIMA
Naval Oceanographic Office

ENTRY DATES
Operational Oceanography is an eight-quarter course of study with entry dates in April and October. A six week technical refresher in calculus, physics, and an Introduction to Meteorology is available preceding the entry dates. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 374
Academic Associate:
Ching-Sang Chiu, Associate Professor
Code OC/Ci, Root Hall, Room 106D
(408) 656-3239, DSN 878-3239

DEGREE
Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY - FALL INPUT

Refresher

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 1

OC3120	(4-3)	Biogeochemical Process in the Ocean
OC3230	(3-1)	Descriptive Physical Oceanography
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3150	(3-2)	Analysis of Air Ocean Time Series
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3
OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I
	(3-0)	Warfare Specialization Course
	(4-0)	Warfare Specialization Course

Quarter 4
SS3525	(3-2)	Air Ocean Remote Sensing for Interdisciplinary Curricula
OC4211	(4-0)	Ocean Dynamics II
OC4900	(3-0)	Directed Study in Oceanography
	(3-0)	Warfare Specialization Course

Quarter 5
OC4267	(4-0)	Ocean Acoustic Predication
MR/OC4413	(4-0)	Air-Sea Interaction
OC4220	(4-1)	Coastal Circulation
OC4331	(4-0)	Mesoscale Ocean Variability

Quarter 6
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
	(4-2)	Warfare Specialization Course
OC3266	(3-2)	Operational Acoustic Forecasting
OC0810	(0-8)	Thesis Research

Quarter 7
OCXXXX	(4-0)	Elective
OC4213	(3-1)	Nearshore and Wave Processes
	(4-2)	Warfare Specialization Course
OC0810	(0-8)	Thesis Research

Quarter 8
OCXXXX	(4-0)	Elective
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Thesis Seminars

TYPICAL COURSE OF STUDY - SPRING INPUT

Refresher
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences

Quarter 1
	(4-0)	Warfare Specialization Course
NS3252	(4-0)	Joint and Maritime Strategy
MA2138	(5-0)	Multi Variable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3150	(3-2)	Analysis of Air Ocean Time Series
OC3230	(3-1)	Descriptive Physical Oceanography
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3
OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I
	(3-0)	Warfare Specialization Course
OC3120	(4-3)	Biogeochemical Processes in the Ocean

Quarter 4

SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula
OC4211	(4-0)	Ocean Dynamics II
OC4900	(3-0)	Directed Study in Oceanography
	(3-0)	Warfare Specialization Course

Quarter 5

OC4267	(4-0)	Ocean Acoustic Prediction
MR/OC4413	(4-0)	Air-Sea Interaction
OCXXXX	(4-0)	Elective
OC4331	(4-0)	Mesoscale Ocean Variability

Quarter 6

MR/OC3570	(2-4)	Operational Oceanography and Meteorology
	(4-0)	Warfare Specialization Course
OC3266	(3-2)	Operational Acoustic Forecasting
OC0810	(0-8)	Thesis Research

Quarter 7

OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes
	(4-0)	Warfare Specialization Course
OC0810	(0-8)	Thesis Research

Quarter 8

OCXXXX	(4-0)	Elective
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Seminar

OCEANOGRAPHY
CURRICULUM 440

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:

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.

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. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Oceanography is an eight-quarter course of study with entry dates in April and October. A six-week technical refresher in calculus and physics is available preceding these entry dates. If further information is needed, contact the Curricular Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

Curriculum 440
Academic Associate:
Mary Batteen, Associate Professor
Code OC/Bv, Spanagel Hall, Room 346
(408)656-3265, DSN 878-3265

DEGREE
Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY - FALL INPUT

Refresher
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 1
OC3120	(4-3)	Biogeochemical Processes in the Ocean
OCXXXX	(3-0)	Elective
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3
OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I
OCXXXX	(3-0)	Elective
OCXXXX	(4-0)	Elective

Quarter 4
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4211	(4-0)	Ocean Dynamics II
OC4900	(3-0)	Special Topics in Oceanography
OCXXXX	(4-0)	Elective

Quarter 5
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OC4413	(4-0)	Air-Sea Interaction
OC4220	(4-1)	Coastal Circulation
OC4335	(3-2)	Naval Ocean Analysis and Prediction

Quarter 6
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR/OC4414	(3-0)	Advanced Air-Sea Interaction
OC3212	(4-0)	Polar Meteorology/Oceanography
OC0810	(0-8)	Thesis Research

Quarter 7
OCXXXX	(4-0)	Elective
OC4213	(3-1)	Nearshore and Wave Processes
OC4331	(4-0)	Mesoscale Ocean Variability
OC0810	(0-8)	Thesis Research

Quarter 8
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Seminars

TYPICAL COURSE OF STUDY - SPRING INPUT

Refresher
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1042	(2-0)	Matrix Algebra
MA1117	(5-2)	Single Variable Calculus
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science

Quarter 1
OCXXXX	(3-0)	Elective
OCXXXX	(3-0)	Elective
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC3230	(3-1)	Descriptive Physical Oceanography
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3
OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I
OC3120	(4-3)	Biogeochemical Processes in the Ocean
OCXXXX	(4-0)	Elective

Quarter 4
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4211	(4-0)	Ocean Dynamics II
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OCXXXX	(4-0)	Elective

Quarter 5
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OC4413	(4-0)	Air-Sea Interaction
OC4213	(3-1)	Nearshore and Wave Processes
OC4900	(3-0)	Directed Study in Oceanography

Quarter 6
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR/OC4414	(3-0)	Advanced Air-Sea Interaction
OCXXXX	(4-0)	Elective
OC0810	(0-8)	Thesis Research

Quarter 7
OC4220	(4-1)	Coastal Circulation
OC4335	(3-2)	Naval Ocean Analysis and Prediction
OC4331	(4-0)	Mesoscale Ocean Variability
OC0810	(0-8)	Thesis Research

Quarter 8
OC3212	(4-0)	Polar Meteorology/Oceanography
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Seminars

**EDUCATIONAL SKILL REQUIREMENTS
METOC
CURRICULUM (373)
Subspecialty Code XX47P**

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 warfare as described in "Forward...from the Sea" with particular emphasis on oceanic acoustics and electromagnetic and optical propagation.

4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy 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.

5. The officer must have a thorough understanding of the fundamentals of Global Geospatial Information and Services (GGI&S), precise time and time interval (PTTI), and astrometry.

6. The officer must successfully complete all NPS requirements for the Joint Masters Degree in Meteorology and Physical Oceanography.

Curriculum Sponsor and ESR Approval Authority
Oceanography of the Navy (N-096)
November 1996

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONAL OCEANOGRAPHY
CURRICULUM (374)
Subspecialty Code XX49P

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 an understanding of the effects of oceanic, littoral and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare as described in "Forward...from the Sea" with particular emphasis on ocean acoustics.

4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy 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.

5. The officer must successfully complete all NPS requirements for the Masters Degree in Physical Oceanography.

Curriculum Sponsor and ESR Approval Authority
Oceanography of the Navy (N-096)
November 1996

NATIONAL SECURITY AND INTELLIGENCE PROGRAMS

Curricular Officer:
Mark Machin
CDR, USN
Code 38, Glasgow Hall, Room 220
(408) 656-2845, DSN 878-2845

AREA STUDIES
CURRICULA 681-684
Area studies curricula focus on specific regions of strategic interest to the United States and its allies. Building on the history, culture, and religion of the region, each curriculum provides students with a knowledge of current issues, economic and political structures and institutions, military forces, including strategic capabilities and policy implications and geopolitical influences.

REQUIREMENTS FOR ENTRY
Prospective students must be military officers or civilian employees of the U.S. Federal Government or other nations. Students must have a baccalaureate degree earned with above-average academic performance and an APC of 365. TOEFL of 540 is required for international students.

ENTRY DATES
Area studies are six-quarter courses of study with entry dates in January and July. For U.S. Army and Air Force Officers there is a modified academic program which combines studies at the Defense Language Institute and the Naval Postgraduate School. If further information is needed, contact the Academic Associate or the Curricular Officer for these curricula.

DEGREE
Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricula.

Curricula 681-684
Academic Associate:
Dan Moran, Professor
Code NS/Md, Glasgow Hall, Room 397
(408)656-2059/2521, DSN 878-2059/2521
e-mail: djmoran@nps.navy.mil

MID EAST, AFRICA, SOUTH ASIA SUBSPECIALTY
Completion of the 681 curriculum qualifies an officer as a Mid East, Africa, South Asia Subspecialist with a subspecialty code of XX21P. The curriculum sponsor is N3/5, Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Operations Intelligence: Commander Middle East Force
POL-MIL Planner: Joint Chiefs of Staff, Washington, DC
Mid East/Southwest Asia Policy: CINCUSNAVEUR LONDON
Area Officer: DIA
Head, Middle East, Asia, Southwest Asia: CNO (N-521)
Military Assistance Program: Military Liaison Office Tunisia

FAR EAST, SOUTHEAST ASIA, PACIFIC SUBSPECIALTY
Completion of the 682 curriculum qualifies an officer as a Far East, Southeast Asia, Pacific Subspecialist with a subspecialty code of XX22P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Chief of Staff: COMNAVBASE GUAM
Staff Operations and Plans: USACOM
Faculty Member: JMIC
Assistant for Military Sales: OPNAV-FOREIGN MILITARY
Analyst: OPNAVSUPPACT, Washington, DC

WESTERN HEMISPHERE SUBSPECIALTY
Completion of the 683 curriculum qualifies an officer as a Western Hemisphere Subspecialist with a subspecialty code of XX23P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Political Military Planner: Joint Chiefs of Staff
Executive Assistant: Inter American Defense
Strategy and Policy Central and South Atlantic: USCINCLANT
Intelligence Analyst: USCINSCO
Area Officer: DIA
Assistant for Military Sale: OPNAV-FOREIGN MILITARY
CNO (N-523) Assistant Branch Head: South America

RUSSIA, EUROPE, CENTRAL ASIA SUBSPECIALTY

Completion of the 684 curriculum qualifies an officer as a Russia, Europe, Central Asia Subspecialist with a sub-specialty code of XX24P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Staff Plans: NATO
ACOS for Plans: SACLANT
POL-MIL Planner: Joint Chiefs of Staff
Geopolitical Intelligence Office: CINCUSNAVEUR LONDON
Atlantic Allied Plans: COMINEWARCOM

TYPICAL COURSE OF STUDY
MIDDLE EAST - CURRICULUM 681

Quarter 1

NS3011	(4-2)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics **AND/OR** PME Course
NS3300	(4-0)	History and Cultures of the Middle East
NS3310	(4-0)	Government and Politics in the Middle East

Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy **AND/OR** PME Course
NS3040	(4-0)	The Politics of Global Economic Relations
NS3XXX		Elective **AND/OR** PME Course

Quarter 3

NS3320	(4-0)	United States Interests and Policies in the Middle East
NS3041	(4-0)	Comparative Economic Systems
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 4

NS3360	(4-0)	Topics in Middle Eastern Politics
NS4310	(4-0)	Seminar in Middle Eastern Security Issues
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 5

NS3361	(4-0)	Topics in Middle Eastern Security
NS3902	(4-0)	Modern Revolution
NS3038	(4-0)	International Naval Power and Policy
NS0810	(0-8)	Thesis Research

Quarter 6

NS4300	(4-0)	Seminar in Middle Eastern Politics
NS4XXX	(4-0)	Elective
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
ASIA - CURRICULUM 682

Quarter 1

NS3011	(4-2)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3600	(4-0)	History and Cultures of East Asia
NS3601	(4-0)	Values and Belief Systems of Asia

Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy **AND/OR** PME Course
NS3040	(4-0)	The Politics of Global Economic Relations
NS3620	(4-0)	Asia and the Modern World

Quarter 3

NS3037	(4-0)	The Role of Congress in U.S. National Security Policy **AND/OR** PME Course
NS3041	(4-0)	Comparative Economic Systems
NS3663	(4-0)	Government and Security in Korea
NS4XXX	(4-0)	Elective

Quarter 4

NS3252	(4-0)	Joint and Maritime Strategy
NS3667	(4-0)	Government and Security in South Asia, Southeast Asia, and Oceanic Regions
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 5

NS3038	(4-0)	International Naval Power and Policy **AND/OR** PME Course
NS3661	(4-0)	Government and Security in China
NS4660	(4-0)	Seminar in Asia in World Affairs
NS0810	(0-8)	Thesis Research

Quarter 6

NS3662	(4-0)	Government and Security in Japan
NS4080	(2-0)	Research Colloquium
NS4690	(4-0)	Seminar on International Security Issues of Asia
NS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
WESTERN HEMISPHERE (LATIN AMERICA) - CURRICULUM 683

Quarter 1

NS3011	(4-2)	Policy Analysis & Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3501	(4-0)	History and Culture of Latin America
NS3510	(4-0)	Government and Politics in Latin America

Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy **AND/OR** PME Course
NS3040	(4-0)	The Politics of Global Economic Relations
NS3252	(4-0)	Joint & Maritime Strategy

Quarter 3

NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3041	(4-0)	Comparative Economic Systems **AND/OR** PME Course
NS3520	(4-0)	Latin America International Relations and Security
NS4510	(4-0)	Seminar in Latin American Government and Politics

Quarter 4

NS0810	(0-8)	Thesis Research
NS3XXX	(4-0)	Elective
NS3XXX	(4-0)	Elective AND/OR PME Course
NS4560	(4-0)	Seminar in Latin American Security Issues **OR**
SO4850	(4-0)	Regional Seminar in Low Intensity Conflict: Latin America

Quarter 5

NS0810	(0-8)	Thesis Research
NS3036	(4-0)	The Military and Politics in the Developing World
NS3038	(4-0)	International Naval Power and Policy
NS4XXX	(4-0)	Elective

Quarter 6

NS3XXX	(4-0)	Special Operations Elective
NS4XXX	(4-0)	Elective
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
RUSSIA, EUROPE, AND CENTRAL ASIA - CURRICULUM 684
TRACK 1 - WESTERN EUROPE

Quarter 1
NS3011	(4-2)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3700	(4-0)	History of Modern Europe
NS3710	(4-0)	Government and Security in Western Europe

Quarter 2
NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy **AND/OR** PME Course
NS3040	(4-0)	The Politics of Global Economic Relations
NS3720	(4-0)	European Security Institutions

Quarter 3
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3041	(4-0)	Comparative Economic Systems **AND/OR** PME Course
NS3460	(4-0)	Government and Security in Eastern Europe
NS4710	(4-0)	Seminar in European Politics

Quarter 4
NS3252	(4-0)	Joint and Maritime Strategy
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe, and Central Asia
NS4720	(4-0)	Seminar in European Security Issues
NS0810	(0-8)	Thesis Research

Quarter 5
NS3038	(4-0)	International Naval Power and Policy
NS3902	(4-0)	Modern Revolution **AND/OR** PME Course
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 6
NS3XXX	(4-0)	Elective
NS4XXX	(4-0)	Elective
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
TRACK 2 - RUSSIA, EASTERN EUROPE, CENTRAL ASIA

Quarter 1
NS3011	(4-2)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia
NS3410	(4-0)	Russia, Eastern Europe, and Central Asia in World Affairs

Quarter 2
NS3040	(4-0)	The Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy **AND/OR** PME Course
NS3401	(4-0)	Ethno-Nationalism in Russia, Eastern Europe and Central Asia
NS3024	(4-0)	Introduction to International Relations

Quarter 3
NS3041	(4-0)	Comparative Economic Systems **AND/OR** PME Course
NS3460	(4-0)	Government and Security in Eastern Europe
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS4410	(4-0)	Seminar in Security Issues of Russia, Eastern Europe, and Central Asia

Quarter 4
NS3252	(4-0)	Joint and Maritime Strategy
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
NS4720	(4-0)	Seminar in European Security Issues
NS0810	(0-8)	Thesis Research

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS3XXX	(4-0)	Elective **AND/OR** PME Course
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 6

NS3720	(4-0)	European Security Institutions
NS4XXX	(4-0)	Elective
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research

STRATEGIC PLANNING CURRICULUM 688

This curriculum provides students with a wide knowledge and thorough understanding of the complex, interrelated variables in both the domestic and international environments when evaluating strategic planning options and supportive negotiating positions in the formulation of U.S. national security policy.

REQUIREMENTS FOR ENTRY

Open to officers and civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation within the past five years. A baccalaureate degree earned with above-average academic performance and a minimum APC of 335 are required.

ENTRY DATES

Strategic Planning 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 Curricular Officer for this curriculum.

DEGREE

Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricular program.

Curriculum 688
Academic Associate:
David S. Yost, Professor
Code NS/Yo, Glasgow Hall, Room 317
(408) 656-2579/2521, DSN 878-2579/2521

STRATEGIC PLANNING AND INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS SUBSPECIALTY

Completion of the 688 curriculum qualifies an officer as a Strategic Planning Specialist with a subspecialty code of XX28P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Representative for International Negotiations: JCS
Military Assistant: U.S. Arms Control and Disarmament
Assistant for Nuclear Negotiations: OPNAV
Head Trident Strategic Weapons: OPNAV
SSBN Current Operations: USACOM War Plans: CINCUSNAVEUR

TYPICAL COURSE OF STUDY

Quarter 1

NS3000	(4-0)	War in the Modern World **OR**
NS3050	(4-0)	History of Joint and Combined Warfare
NS3023	(4-0)	Introduction to Comparative Politics
NS3011	(4-2)	Policy Analysis and Research Methods
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia

Quarter 2

NS3040	(4-0)	The Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3252	(4-0)	Joint & Maritime Strategy
NS3024	(4-0)	Introduction to International Relations

Quarter 3

NS3159	(4-0)	Principles of Joint Operational Intelligence **OR**
NS3154	(4-0)	Joint Intelligence and Military Command
NS3012	(4-2)	Forecasting and Gaming Methods for Strategic Planners

| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS3XXX | (4-0) | Non-Russian Area Studies Elective |

Quarter 4

NS3250	(4-0)	The Economics of U.S. Defense Policy
NS3280	(4-0)	Nuclear Strategy and National Security
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
NS3900	(4-0)	International Law and Organizations

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
OPTION A:		SM Department Distribution Course Requirement
OPTION B:		NS3XXX Elective
NS4280	(4-0)	Seminar in Nuclear Strategy
NS3230	(4-1)	Strategic Planning and the Military **OR**
NS3240	(4-0)	Military Innovation and Joint Warfare

Quarter 6

OS3002	(4-0)	Operations Research for Naval Intelligence
NS4900	(4-0)	Seminar in International Negotiations
OPTION A:		NS3XXX Elective
OPTION B:		SM Department Distribution Requirement
NS0810	(0-8)	Thesis Research

Quarter 7

NS4250	(4-0)	Seminar in Security Assistance and Arms Transfers
OPTION		NS4XXX Elective
SO3882	(4-0)	Deterrence, Compellance, and Crisis Management
NS0810	(0-8)	Thesis Research

Quarter 8

NS4230	(4-0)	Seminar in Joint Strategic Planning
OPTION		NS4XXX Elective
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research

CIVIL-MILITARY RELATIONS AND INTERNATIONAL SECURITY CURRICULUM 689

The Civil-Military Relations Curriculum is an inter-disciplinary program, tailored for officers and civilian employees of other countries. 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 the student's own nation and the United States.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum score of 540 on the Test of English as a Foreign Language (TOEFL). Supplemental English language training is required for students who score 500-539.

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. Validation or credit by examination is encouraged.

ENTRY DATES

The Civil-Military Relations Curriculum 689 is a four-quarter (12 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

DEGREE

Master of Arts in Civil-Military Relations and International Security.

Curriculum 689
Academic Associate:
Thomas C. Bruneau, Professor
Code NS/Bn, Glasgow Hall, Room 325
(408) 656-3760, DSN 878-3760
e-mail: tbruneau@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1
NS3023	(4-0)	Introduction to Comparative Politics
NS3025	(4-0)	Introduction to Civil-Military Relations
NS3011	(4-2)	Policy Analysis and Research Methods
IT1600	(4-2)	Communications Skills for International Officers **OR**
		Elective (if waived)

Quarter 2
NS4225	(4-0)	Civil-Military Relations and Transitions to Democracy
NS3225	(4-0)	Civil-Military Relations and Defense Budgeting
NS0810	(0-8)	Thesis Research
NS3/4XXX	(4-0)	Elective **AND**
IT1500	(4-0)	Information Program Seminar for International Officers

Quarter 3
NS4880	(4-0)	Seminar in Legal and Military Responses to Political Violence
NS3252	(4-0)	Joint and Maritime Strategy
NS0810	(0-8)	Thesis Research
NS3/4XXX	(4-0)	Elective

Quarter 4
NS3/4XXX	(4-0)	Elective
NS4235	(4-0)	Seminar on Diplomacy and Strategy of Coalition Warfare and Ops Other than War
NS4800		Research Colloquium
NS4XXX	(4-0)	Elective

JOINT INTELLIGENCE CURRICULUM 824, 825

The Joint Intelligence curricula focus on two distinct areas, each of which is tailored to meet the billet requirements of major resource claimants, such as Unified Commanders-In-Chiefs, and to satisfy the educational skill requirements for one of the two subspecialties: 824- Regional Intelligence (XX18P); and 825- Operational Intelligence (XX19P). These are rigorous curricula founded in traditional academic disciplines that combine to create the field of intelligence studies. Both curricula provide an inter-disciplinary graduate education and require a thesis. The Regional Intelligence curriculum also requires satisfactory completion of language training at the Defense Language Institute (DLI) prior to award of the Masters of Arts degree and the subspecialty designator. The NPS intelligence curricula encompass educational objectives suitable to all services as well as to some federal agencies.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the past five years. They must have a baccalaureate degree earned with above-average academic performance and a minimum APC of 365 (824) and 235 (825).

ENTRY DATES

Regional Intelligence is a six-quarter program with starting dates in January and July. Language training (up to 63 weeks depending on language category) follows completion of NPS education. Operational Intelligence is a six-quarter course of study with a start date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for these curricula.

DEGREE

Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the Regional Intelligence or Operational Intelligence programs.

Curriculum 824, 825
Academic Associate:
James Wirtz, Professor
Code NS/Wz, Glasgow Hall, Room 308
(408) 656-3483/2521, DSN 878-3483/2521
e-mail: jwirtz@nps.navy.mil

INTELLIGENCE SUBSPECIALTY

Completion of any of the two curricula qualifies an officer as an Intelligence Subspecialist with one of the following intelligence subspecialty codes:

824 - Regional   XX18P
825 - Operational   XX19P

Typical Jobs in this Subspecialty:
Operations Intelligence Analyst: ONI, Washington, DC
Naval Attache: Attache Russia
Intelligence Officer: COMSUBGRU

TYPICAL COURSE OF STUDY
REGIONAL INTELLIGENCE - CURRICULUM 824

Quarter 1
NS3011	(4-2)	Policy Analysis and Research Methods
NS3159	(4-0)	Principles of Joint Operational Intelligence
NS3252	(4-0)	Joint and Maritime Strategy
NS3XXX	(4-0)	Regional Elective

Quarter 2
NS3024	(4-0)	Introduction to International Relations
NS3160	(4-0)	Human Intelligence
NS3040	(4-0)	Politics of Global Economic Relations
NS3XXX	(4-0)	Regional Elective

Quarter 3
NS4160	(4-0)	Foreign Intelligence Services
NS4141	(4-0)	Seminar in Economic Intelligence
NS3171	(4-2)	Joint Intelligence Data Systems and Connectivity
NS3XXX	(4-0)	Regional Elective

Quarter 4
NS3/4XXX	(4-0)	CINC Regional Elective
NS3020	(4-0)	Operational Level of War
NS3/4XXX	(4-0)	Regional Elective
NS4XXX	(4-0)	Regional Elective

Quarter 5
NS3023	(4-0)	Introduction to Comparative Politics
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research
NS4XXX	(4-0)	Regional Elective

Quarter 6
NS4159	(4-0)	Seminar in Joint Intelligence Support to Crisis Operations
NS3230	(4-1)	Strategic Planning and the Military
NS0810	(0-8)	Thesis Research
NS3/4XXX	(4-0)	Regional Elective

TYPICAL COURSE OF STUDY
OPERATIONAL INTELLIGENCE - CURRICULUM 825

Quarter 1
NS3011	(4-2)	Policy Analysis and Research Methods
NS3159	(4-0)	Principles of Joint Operational Intelligence
NS3252	(4-0)	Joint and Maritime Strategy
MN3105	(4-0)	Organization and Management

Quarter 2
NS3160	(4-0)	Human Intelligence
NS3024	(4-0)	Introduction to International Relations
NS3040	(4-0)	The Politics of Global Economic Relations
CC2040	(3-2)	Introduction to System Technologies

Quarter 3
NS4160	(4-0)	Foreign Intelligence Services
NS4141	(4-0)	Seminar in Economic Intelligence
NS3171	(4-2)	Joint Intelligence Data Systems and Connectivity
NS3XXX	(4-0)	CINC Regional Elective

Quarter 4

NS3020	(4-0)	Operational Level of War
NS3/4XXX	(4-0)	Regional Elective
NS4XXX	(4-0)	Regional Elective
NS3/4XXX	(4-0)	CINC Regional Elective

Quarter 5

NS3023	(4-0)	Introduction to Comparative Politics
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research
EO3911	(V-V)	Interdisciplinary Studies in Electrical and Computer Engineering

Quarter 6

NS4159	(4-0)	Seminar in Joint Intelligence Support to Crisis Operations
NS3230	(4-1)	Strategic Planning and the Military
NS0810	(0-8)	Thesis Research
NS3/4XXX	(4-0)	Regional Elective

EDUCATIONAL SKILL REQUIREMENTS
AREA STUDIES
CURRICULA (681, 682, 683, and 684)
Subspecialty Codes XX21P, XX22P, XX23P, XX24P

The goal of this curriculum is to educate military officers and civilian officials of the United States and other nations in area studies and the unique challenges involved in effective cooperation in security matters with states in other world regions. The curricula includes a core of military and diplomatic history, comparative politics and international relations, policy analysis, and the U.S. decision-making process. Each curriculum includes a specific series of courses focused on the history and culture of the region, politics and government, security structures and processes, relationships with the United States and other countries and organizations, and specific security issues. The curricula draw upon other NPS curricula including Joint Intelligence, Strategic Planning and International Organizations and Negotiations, Civil-Military Relations.

Students conduct research (including classified research) on questions of interest to the program sponsors, the U.S. Armed Services, the unified commands, and other federal agencies. Special emphasis is placed on the writing of a thesis, which gives the student the opportunity to develop the skills required for critical thought and coherent expression while producing a study of value to the Department of Defense. Graduates will posses an understanding of regional challenges to U.S. national security and of the role of U.S. national security policy in addressing such challenges. They will develop a thorough understanding of the security situation of the particular region in which they specialize, as well as U.S. foreign and defense policies.

Finally, the Area Studies curricula may incorporate the Joint Education Elective Program (JEEP) with the Phase I Joint Learning Objective necessary to satisfy the Joint Chiefs of Staff - sponsored Program for Joint Education (PJE).

ESRS COMMON TO AREA STUDIES AND STRATEGIC PLANNING

1. **ANALYTICAL SKILLS:** Graduates will be able to analyze and explain international political, economic, and military events by combining data and theory in a logical manner. They will develop their skills to formulate innovative solutions to strategic problems. Students will demonstrate writing, briefing, and computer skills in preparing and presenting their findings.

2. **INTERNATIONAL AND COMPARATIVE POLITICS:** Graduates will understand the conditions, events, and ideas that shape the interactions of nation-states and other actors in the international system. Students will study the history and major theories explaining international relations (including realism, cognitive, and cultural paradigms) and will be able to use their knowledge to analyze and explain international and domestic issues.

3. **THE INTERNATIONAL ECONOMY:** Graduates will gain a basic understanding of 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 interest affect military strategy and force structure.

4. **ENGAGEMENT AND REGIONAL SECURITY ISSUES:** Graduates will be familiar with the economic, political, social, and military characteristics of regions of strategic concern to the United States. Students will achieve substantial expertise in a specific region, including the dynamics of U.S. engagement policy affecting that area.

5. **OVERSEAS PRESENCE:** Graduates will understand the overseas presence missions of U.S. military forces as defined in the National Military Strategy of the United States. Students will examine the role of overseas presence as a means for cultivating and sustaining political relationships with foreign governments; as a basis for activities that maintain technical and doctrinal interoperability with allies and coalition partners; as an instrument for maintaining and protecting air and sea lines of communication; and as a source of support for operations other that war.

6. **NAVAL POWER AND POLICY:** Graduates will understand the role and influence of maritime power in the international system. Students will learn about regional differences in naval capabilities, roles and missions; concepts of seapower including land-based sea denial forces; and systemic trends including weapons technology, ocean law regimes, and international and regional political developments.

7. **JOINT AND MARITIME STRATEGY:** 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, joint planning, joint and service doctrine, and current defense issues.

ESRS SPECIFIC TO AREA STUDIES

1. **REGIONAL POLITICS, HISTORY AND CULTURE:** Graduates will understand major political systems, historical background, political culture, and prevalent political ideologies and their impact on regional security, as well as the influence of ethnic, cultural and religious values on security situations.

2. **MILITARY FORCES AND STRATEGIC POSTURE:** Graduates will gain an understanding of the main factors determining strategic postures of countries in their specific region, including strategic culture and goals, threat perceptions, and military forces structures.

3. **U.S. REGIONAL SECURITY POLICY:** Graduates will understand the U.S. foreign policy objectives and political, economic and military strategy for their selected region. They will study the formulation of U.S. policy regarding the region including the role of Congress and the interagency process. Students will become knowledgeable on security assistance programs and their relevance to a region.

4. **EMERGING SECURITY CHALLENGES:** Graduates will explore the major global and regional security issues, including political and military between states. Emphasis is placed on potential military conflict, insurgencies and terrorism, social and economic problems, and other issues that affect the status of nations. Graduates will examine sources of political and social instability and violence, including ethnic conflict, and their influence on regional security planning and U.S. national security policy.

Curriculum Sponsor and ESR Approval Authority
Deputy CNO for Plans, Policy and Operations (N-3/5)
January 1997

**EDUCATIONAL SKILL REQUIREMENTS
STRATEGIC PLANNING AND INTERNATIONAL
ORGANIZATIONS & NEGOTIATIONS (688)
Subspecialty Code XX28P**

The goal of this curriculum is to educate military officers and civilian officials of the United States and other nations in strategic planning and in the challenges associated with joint and coalition military operations. The curriculum includes military and diplomatic history, international relations and domestic politics, military strategy, and operational planning and analysis. The program covers the full range of military operations from overseas presence, peacekeeping, and humanitarian missions, through special operations, revolutionary warfare, and regional conflict, to major joint and combined military operations, counter-proliferation, and nuclear war. The program draws upon other NPS curricula including Joint Intelligence, Foreign Area Studies, Civil-Military Relations, Systems Management, and Joint C4I.

Students conduct research (including classified research) on questions of interest to the program sponsors, the U.S. Armed Services, the unified commands, and other federal agencies. Special emphasis is placed on the writing of a thesis, which gives the student the opportunity to develop the skills required for critical thought and coherent expression while producing a study of value to the Department of Defense. Graduates will posses the strategic vision and analytic skills necessary to conduct and supervise strategic planning for the armed services and governmental agencies of the United States and other nations.

Finally, the Strategic Planning curriculum incorporates the Joint Education Elective Program (JEEP) with the Phase I Joint Learning Objective necessary to satisfy the Joint Chiefs of Staff - sponsored Program for Joint Education (PJE).

**ESRS SPECIFIC TO STRATEGIC PLANNING
(COMMON ESRS LISTED PREVIOUSLY WITH 681-684 CURRICULA)**

1. **DEFENSE PLANNING:** Graduates will understand the political and economic dimensions of defense planning and the budget process. They will be familiar with the mechanisms by which the armed forces interact with various elements of the U.S. government, including Congress and National Command Authority. They will know the key documents regarding the institutions and processes of defense planning.

2. **PROGRAM FOR JOINT EDUCATION (PJE):** Students will demonstrate a graduate-level 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, joint and multinational forces and systems integration at the operational level of war. Knowledge of this subject is pursued in a joint learning environment.

3. **COALITIONS AND COMBINED MILITARY OPERATIONS:** Graduates will gain substantial knowledge of the facts and theories behind the principal alliances and international organizations that shape the current security environment, including their role in U.S. national strategy. Particular attention will be paid to problems of coalition warfare and combined operations across the full range of military missions, from peace operations to major war.

4. **NUCLEAR STRATEGY:** Graduates will understand the roles of nuclear forces in the security policies of the United States and other nuclear powers. Students will learn about U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present. Students also will learn about the role of nuclear weapons in alliance politics and international relations.

5. **PROLIFERATION AND COUNTERPROLIFERATION OF WEAPONS OF MASS DESTRUCTION (WMD):** Graduates will understand the implication of WMD proliferation for the security of the United States and other countries. Students will learn why states and other actors seek nuclear, chemical, and/or biological weapons and associated delivery systems, and will analyze the strategic effects in different regions. Students will gain an appreciation of the success and limitations of traditional nonproliferation efforts and of new military measures designed to counter WMD proliferation.

6. **MILITARY INNOVATION:** Graduates will understand the basic dynamics of military innovation as a social, political, strategic, and operational problem. Special emphasis will be placed on the Revolution in Military Affairs and the impact in the future warfare environment of new technologies, strategy, and organizations, and on the role of civil-military relations in shaping the way armed forces innovate and adapt to change.

7. **INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS:** Graduates will understand the history of international organizations and their role in international politics. Students will learn about international mediation and negotiations, formal and informal security arrangements, treaty regimes, and international law, and their impact on U.S. military planning and rules of engagement. Special emphasis is placed on the role on non-governmental organizations in peacekeeping and humanitarian operations.

Curriculum Sponsor and ESR Approval Authority
Deputy CNO for Plans, Policy and Operations (N-3/5)
January 1997

EDUCATIONAL SKILL REQUIREMENTS
JOINT INTELLIGENCE
CURRICULA

REGIONAL INTELLIGENCE (824)
Subspecialty Code XX18P

1. **REGIONAL EMPHASIS:** A comprehensive practical and theoretical knowledge of the political, cultural, and security aspects of one particular region of the world. Emphasis will be on a geographic CINC region.

2. **FOREIGN LANGUAGE:** A demonstrated proficiency in a language from the assigned region taught at the Defense Language Institute (DLI).

3. **GLOBAL POLITICAL AND SECURITY PROCESSES:** A graduate level knowledge of global political, economic, and security processes, including maritime world trade and terrorist threats. Particular emphasis will be on understanding the political-military aspects of selected geographic CINC regions.

4. **ECONOMICS AND ECONOMIC INTELLIGENCE:** A knowledge of economics and economic issues as a component of intelligence and intelligence support to national security policy objectives.

5. **INTELLIGENCE PROCESSES AND APPLICATIONS:** A graduate level knowledge and understanding of intelligence processes and their applications to joint and naval warfare, and an understanding of the role of the intelligence structure at the national level.

6. **INFORMATION WARFARE:** A graduate level understanding of information warfare as it applies in a civil-sector environment, and an understanding of command and control warfare as the military application of information warfare. Particular emphasis should be given to the role of intelligence in information warfare, to include case studies.

7. **REVOLUTION IN MILITARY AFFAIRS:** An understanding of the role of intelligence in RMA. Focus should be on the transformation in warfare resulting from revolutionary developments in technology, innovative operational concepts, and organizational adaptations with the armed forces.

8. **ANALYTICAL AND RESEARCH METHODS:** A graduate level knowledge of analytical and research methods as applied to intelligence to include an introduction to automated information systems principles and applications, practical research, and presentation of results.

9. **PROGRAM FOR JOINT EDUCATION (PJE):** A graduate level understanding of war fighting within the context of operational art, to include national military capabilities and command structure, joint doctrine, joint and multinational forces at the operational level of war, joint planning and execution, and systems integration at the operational level of war.

10. **THESIS:** 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 the curriculum.

Curriculum Sponsor and ESR Approval Authority
Director, Naval Intelligence
April 1996

EDUCATIONAL SKILL REQUIREMENTS
JOINT INTELLIGENCE
CURRICULA

OPERATIONAL INTELLIGENCE (825)
Subspecialty Code XX19P

1. **GLOBAL POLITICAL AND SECURITY PROCESSES:** A graduate level knowledge of global political, economic, and security processes, including maritime world trade and terrorist threats. Particular emphasis will be on understanding the political-military aspects of selected geographic CINC regions.

2. **INFORMATION WARFARE:** A graduate level understanding of information warfare as it applies in a civil-sector environment, and an understanding of command and control warfare as the military application of information warfare. Particular emphasis should be given to the role of intelligence in information warfare, to include case studies.

3. **INTELLIGENCE PROCESSES AND APPLICATIONS:** A graduate level knowledge and understanding of intelligence processes and their applications to joint and naval warfare, and an understanding of the role of the intelligence structure at the national level.

4. **REVOLUTION IN MILITARY AFFAIRS:** An understanding of the role of intelligence in RMA. Focus should be on the transformation in warfare resulting from revolutionary developments in technology, innovative operational concepts, and organizational adaptations within the armed forces.

5. **ANALYTICAL AND RESEARCH METHODS:** A graduate level knowledge of analytical and research methods as applied to intelligence to include practical applications, research, and presentation of results.

6. **AUTOMATED INFORMATION SYSTEMS:** A practical knowledge of the operation of computer networks and client server environments (CSE), with emphasis on intelligence and Global Command and Control Systems (GCCS).

7. **PROGRAM FOR JOINT EDUCATION (PJE):** A graduate level understanding of war fighting within the context of operational art, to include national military capabilities and command structure, joint doctrine, joint and multinational forces at the operational level of war, joint planning and execution, and systems integration at the operational level of war.

8. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Director, Naval Intelligence
April 1996

NAVAL/MECHANICAL ENGINEERING PROGRAMS

Curricular Officer:
Robert A. Klocek
CDR, USN
Code 34
The Mechanical Engineering Building
BLDG-245, Room 115
(408) 656-2033, DSN 878-2033

NAVAL/MECHANICAL ENGINEERING PROGRAMS
CURRICULUM 570

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. He or she 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. The schedule of classes is arranged to provide time during the final two quarters for concentration in this area of specialization.

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 via Engineering Science - Curriculum 460). 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.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of XX54P. The curriculum sponsor is Naval Sea Systems Command. 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 XX54N Subspecialty Code.

TYPICAL SUBSPECIALTY ASSIGNMENTS

Upon award of the XX54P 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
Mechanical Engineering Instructor, USNA
Tender Repair Officer (Engineering Duty Officer)
Fleet/Type Commander Staff
Board of Inspection and Survey
Propulsion Examining Board
SIMA
Chief Engineer (Ships and Submarines)

ENTRY DATES

Naval/Mechanical Engineering is an eight-quarter course of study for a 11XX officer and a nine-quarter program for a 14XX officer with preferred entry dates in April or October. Those requiring the Engineering Science Curriculum (460), or the 6 week Math/Physics refresher course, will have their time of arrival adjusted as necessary. If further information is needed, contact the Curricular Officer or the Academic Associate.

Curriculum 570
Academic Associate:
Young Shin, Professor
Code ME/Sg, Mechanical Engineering Building, Room 326
(408) 656-2568, DSN 878-2568

DEGREE

Requirements for the degree Master of Science in Mechanical Engineering are met as a milestone en route to satisfying the ESRs of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

EC1010	(1-1)	Introduction to MATLAB
ME2101	(4-1)	Engineering Thermodynamics
ME2501	(3-0)	Statics
MA1043	(2-0)	Intensive Matrix Algebra
MA1118	(5-2)	Multi-Variable Calculus

Quarter 2

ME2502	(4-1)	Dynamics
ME2601	(3-2)	Mechanics of Solids I
MA2121	(4-0)	Differential Equations
AA2440/ME2440	(3-2)	Introduction to Digital Computation/The Digital Computer as an Engineering Tool

Quarter 3

ME2201	(3-2)	Introduction to Fluid Dynamics
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MA2049	(3-0)	Vector Analysis with Applications
MS2201	(3-2)	Introduction to Materials Science and Engineering

Quarter 4

ME3150	(4-1)	Heat Transfer
ME3201	(3-2)	Intermediate Fluid Mechanics
MA3232	(4-1)	Numerical Analysis
MS3202	(3-2)	Properties, Performance & Failure of Engineering Materials

Quarter 5

ME3611	(4-0)	Mechanics of Solids II
ME3711	(4-1)	Design of Machine Elements
ME2801	(3-2)	Introduction to Engineering System Dynamics
ME3410	(2-4)	Mechanical Engineering Instrumentation and Measurement Lab

Quarter 6

ME3240	(3-3)	Reciprocating and Gas Turbine Power Plants
ME3521	(3-2)	Mechanical Vibrations
TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3801	(3-2)	Classical Control of Naval Engineering Systems
ME4XXX	(4-0)	Elective

Quarter 7

ME3220	(3-2)	Steam Power, Refrigeration, and Turbomachinery
OS3104	(4-0)	Statistics for Science and Engineering
MS3304	(3-2)	Corrosion and Marine Environmental Deterioration **OR**
MS3606	(3-2)	Introduction to Welding and Joining Metallurgy
ME4XXX	(4-0)	Elective

Quarter 8

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
EC2100	(4-2)	Circuit Analysis
ME4XXX	(4-0)	Elective

Quarter 9

EC2120	(4-2)	Introduction to Power Systems Analysis and Devices
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy

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. Some students will also receive the Degree of Mechanical Engineer or Degree of Electrical Engineer in addition to the Master's Degree. Similar opportunity is available through the Combat Systems Sciences and Technology Curriculum and the Electronic Systems Engineering Curriculum, which could lead the Mechanical Engineer or Electrical Engineer degrees. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590 curricula.

REQUIREMENTS FOR ENTRY
A baccalaureate degree in an engineering discipline is required, with an APC of 222. Students are expected to be capable of validating several undergraduate courses included in the standard 570 program. The program is open to Naval officers in the rank of LTJG through LCDR in the 11XX/14XX communities.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY
Completion of this program will lead to a subspecialty code XX54P or XX55N (or XX55N if entered from the Electronics and Computer Program; XX66P or XX66N from the Combat Systems Sciences and Technology Program.) The student will also receive an AQD (Additional Qualification Designator) for completion of the TSSE Program.

Typical Jobs in this Subspecialty:
Upon award of the subspecialty code and AQD, 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.

ENTRY DATES
Total Ship Systems Engineering is an eleven-quarter program with an entry date of October. It is a twelve-quarter program for students who have no course validations. If further information is needed, contact the Curricular Officer or the Academic Associate for this curriculum.

Curriculum
Academic Associate:
Young Shin, Professor
Code ME/SG, The Mechanical Engineering Building, Room 326.
(408)656-2568, DSN 878-2586

DEGREE
Requirements for the degrees of Mechanical or Electrical Engineer and/or Master of Science in Mechanical or Electrical Engineering or Physics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
ME2501	(3-0)	Statics
ME2101	(4-1)	Engineering Thermodynamics
MA1118	(5-2)	Multi-Variable Calculus
MA1043	(2-0)	Intensive Matrix Algebra
EC1010	(1-1)	Introduction to MATLAB

Quarter 2
ME2502	(4-1)	Dynamics
ME2601	(3-2)	Mechanics of Solids I
MA2121	(4-0)	Differential Equations
MA2049	(3-0)	Vector Analysis with Applications
EC2100	(4-2)	Circuits Analysis

Quarter 3
ME2201	(3-2)	Introduction to Fluid Mechanics
ME3611	(4-0)	Mechanics of Solids II
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
ME2440/AA2440	(3-2)	The Digital Computer as an Engineering Tool/Introduction to Digital Computation

Quarter 4
TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3150	(4-1)	Heat Transfer
ME3201	(3-2)	Intermediate Fluid Mechanics
MA3232	(4-1)	Numerical Analysis
EC2120	(4-2)	Introduction to Power Systems Analysis and Devices

Quarter 5
TS3000	(3-2)	Electrical Power Engineering
ME2801	(3-2)	Introduction to Engineering System Dynamics
ME3410	(2-4)	Mechanical Engineering Instrumentation and Measurement Lab
MS2201	(3-2)	Introduction to Materials Science and Engineering

Quarter 6
TS3002	(3-2)	Principles of Ship Design and Case Studies
TS3003	(3-2)	Naval Combat System Elements
ME3521	(3-2)	Mechanical Vibrations
MS3202	(3-2)	Properties, Performance & Failure of Engineering Materials

Quarter 7
TS4000	(3-2)	Naval Combat System Engineering
TS4001	(3-2)	Integration of Naval Engineering Systems
ME4XXX	(4-0)	Elective
ME3711	(4-1)	Design of Machine Elements

Quarter 8
ME3801	(3-2)	Classical Control of Naval Engineering Systems
TS4002	(2-4)	Ship Design Integration
OS3104	(4-0)	Statistics for Science and Engineering
ME4XXX	(4-0)	Elective

Quarter 9
ME0810	(0-8)	Thesis Research
TS4003	(2-4)	Total Ship Systems Engineering
MS3606	(3-2)	Introduction to Welding and Joining Metallurgy
ME4XXX	(4-0)	Elective

Quarter 10
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
ME4XXX	(4-0)	Elective
ME4XXX	(4-0)	Elective

Quarter 11
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
ME4XXX	(4-0)	Elective
ME3220	(3-2)	Steam Power, Refrigeration and Turbomachinery

Quarter 12
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy
ME3240	(3-3)	Reciprocating and Gas Turbine Power Plants

EDUCATIONAL SKILL REQUIREMENTS
NAVAL/MECHANICAL ENGINEERING
CURRICULUM (570)
Subspecialty Code XX54P

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 following topics. It is recognized that all students may not meet all ESRs depending on individual circumstances determined by the curricular 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, turbomachinery).

3. **DYNAMICS AND CONTROL:** Kinematic and dynamic analysis of particle, rigid-body and multi-body mechanical systems. Modeling of engineering systems, including examples from mechanical, electrical and hydraulic applications. Feedback control concepts, both classical and modern and their application to the design of ship stabilization systems, weapon direction systems and power plant control. Instrumentation for propulsion system monitoring and control.

4. **STRUCTURAL MECHANICS AND VIBRATION:** Statically determinant and indeterminant 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.

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, basic knowledge of analog and digital circuits, rotating electrical machinery, static converters, and power distribution systems and multiphased circuits. A basic understanding of automated control systems and their application to mechanical equipment, integrated electrical machinery, electric power transmission and superconductors.

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 seakeeping and survivability principles.

11. **DECISION MAKING, RELIABILITY ASSESSMENT AND QUALITY CONTROL:** A basic knowledge of concepts and applications for decision making, reliability, prediction and assessment, and quality control. A practical understanding of relevant probability theory including statistical data analysis techniques, probability distribution and characteristics and standard tests. An understanding of Maintenance Engineering concepts such as reliability, maintainability, and availability.

12. **SPECIALIZATION:** 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 through additional graduate level courses and their associated prerequisites.

13. **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.

14. **THESIS:** The graduate will demonstrate the ability to conduct independent analysis, 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.

Curriculum Sponsor and ESR Approval Authority
Deputy Commander, Engineering Directorate
NAVSEA (SEA-03)
June 1997

OPERATIONS RESEARCH PROGRAMS

Curricular Officer:
Ed Falcon
CDR, USN
Code 30, Glasgow Hall
Room 219
(408) 656-3116
DSN 878-3116
Fax (408) 656-2458

OPERATIONS ANALYSIS CURRICULUM 360

Operations Analysis 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 upon 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, physical science 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. A one-year course in college physics is highly desirable. Students lacking 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 such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONS ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Analysis Subspecialist with a subspecialty code of XX42P. The curriculum sponsor is N-81, Office of Chief of Naval Operations, Assessment Division.

Typical Billets in this Subspecialty:

Defense Resources Management	OPNAV Analyst
JCS Analyst	Director OPS Research: SACLANT
Assistant Staff OPS/PLANS: COMCARGRU	Staff OPS & PLANS: COMTHIRDFLT
BUPERS	OSD Analyst
OPS Analyst: Naval War College	Instructor: NPS
Cost Analyst	Warfare Analyst

ENTRY DATES

Operations Analysis is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 360
Academic Associate:
Alan Washburn, Professor and Associate Chair for Instruction
Code OR/Wa, Glasgow Hall, Room 204
(408) 656-3127, DSN 878-3127

DEGREE

Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

OA2200	(4-0)	Computational Methods for Operations Research I
MA1118	(5-2)	Multi-Variable Calculus
MA3042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2
OA3200	(4-0)	Computational Methods for Operations Research II
MA3110	(4-0)	Intermediate Analysis
OA3102	(4-1)	Probability and Statistics
AS3610	(4-0)	Microeconomics for Operations Research

Quarter 3
OA3201	(4-1)	Linear Programming
OA3401	(3-1)	Human Factors in System Design I
OA3301	(4-0)	Stochastic Models I
OA3103	(4-1)	Statistics

Quarter 4
OA4202	(4-0)	Network Flows and Graphs
OA3302	(4-0)	OA System Simulation
OA3104	(3-1)	Data Analysis
OA3602	(4-0)	Search Theory and Detection

Quarter 5 (First six weeks)
OA4201	(4-0)	Nonlinear Programming
OA4655	(4-0)	Air-Land-Sea Analysis
(Last six weeks)		Experience Tour Off Campus

Quarter 6
OA4654	(4-0)	Air-Land Models
OA4604	(4-0)	Wargaming Analysis
OA4301	(3-2)	Stochastic Models II
OA0810	(0-8)	Thesis Research

Quarter 7
OA4603	(3-2)	Test and Evaluation
OA0810	(0-8)	Thesis Research
OAXXXX		Elective
OA4602	(4-0)	Joint Campaign Analysis

Quarter 8
OA4702	(4-0)	Cost Estimation
OA0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy
OAXXXX		Elective

OPERATIONAL LOGISTICS CURRICULUM 361

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. A one-year course in college physics is highly desirable. Students lacking 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, such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONAL LOGISTICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Logistics Subspecialist with a subspecialty of XX43P. The curriculum sponsor is N-4, Office of Deputy Chief of Naval Operations (Logistics).

Typical Billets in this Subspecialty:
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
USNA, NPS, WARCOL - Instructor
Afloat Staffs - Logistics Planning Officer

ENTRY DATE
Operational Logistics is an eight-quarter course of study with a single entry date at the end of September. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 361
Academic Associate:
David A. Schrady, Distinguished Professor
Code OR/So, Glasgow Hall, Room 271
(408) 656-2801, DSN 878-2801
e-mail: dschrady@nps.navy.mil

DEGREE
Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
OA2200	(4-0)	Computational Methods for Operations Research I
MA1118	(5-2)	Multi-Variable Calculus
MA3042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2
OA3200	(4-0)	Computational Methods for Operations Research II
MA3110	(4-0)	Intermediate Analysis
OA3610	(4-0)	Introduction to Naval Logistics
OA3102	(4-1)	Probability and Statistics

Quarter 3
OA3201	(4-1)	Linear Programming
MN4376	(4-0)	Defense Transportation System
OA3301	(4-0)	Stochastic Models I
OA3103	(4-1)	Statistics

Quarter 4
OA4611	(4-0)	Logistics in Naval Warfare
OA3302	(4-0)	OA System Simulation
OA3104	(3-1)	Data Analysis
OA4202	(4-0)	Network Flows and Graphs

Quarter 5 (First six weeks)
OA4201	(4-0)	Nonlinear Programming Systems Simulation
OA4655	(4-0)	Air-Land-Sea Analysis
(Last six weeks)		Experience Tour Off Campus

Quarter 6
AS3610	(4-0)	Microeconomics for Operations Research
OA4301	(3-2)	Stochastic Models II
OA0810	(0-8)	Thesis Research
OA4612	(4-0)	Logistics Models

Quarter 7
OA4602	(4-0)	Joint Campaign Analysis
OAXXXX		Elective
OA0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 8

OA4604	(4-0)	Wargaming Analysis
OA0810	(0-8)	Thesis Research
OA4302	(4-0)	Reliability and Weapons System Effectiveness Measurement
OAXXXX		Elective

ADVANCED SCIENCE (APPLIED MATHEMATICS)
CURRICULUM 380

This program is designed to meet the needs of the Department of Defense for graduates who are skilled in the 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 Subspecialist with a subspecialty code of XX41P. The curriculum sponsor is the U.S. Naval Academy Department of Mathematics. The 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 DATES

Advanced Science (Applied Mathematics) is an eight-quarter course of study with preferred entry dates in winter and summer quarters. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 380
Academic Associate:
Guillermo Owen, Professor
Code MA/On, Glasgow Hall, Room 361
(408) 656-2720, DSN 878-2720
e-mail: owen@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Applied Mathematics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

EC1010	(1-1)	Introduction to MATLAB
MA1118	(5-2)	Multi-Variable Calculus
MA2121	(4-0)	Differential Equations
MA3025	(5-1)	Logic and Discrete Mathematics

Quarter 2

MA3110	(4-0)	Intermediate Analysis
MA2049	(3-0)	Vector Analysis with Applications
MA3042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 3

MA3400	(4-0)	Mathematical Modeling Processes
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MA3232	(4-1)	Numerical Analysis
OA3102	(4-1)	Probability and Statistics

Quarter 4

MA3605	(3-0)	Fundamentals of Analysis I
MA3675	(3-0)	Theory of Functions of a Complex Variable I
MA3560	(3-0)	Modern Applied Algebra
OA3103	(4-1)	Statistics

Quarter 5
MA3606   (3-0)   Fundamentals of Analysis II
MAXXXX   Option Requirement
MA3046   (4-1)   Matrix Analysis
NS3252   (4-0)   Joint and Maritime Strategy

Quarter 6
MA4693   (3-0)   Topics in Analysis
MA4391   (4-0)   Analytical Methods for Fluid Dynamics
MA3301   (4-1)   Linear Programming
MA0810   (0-8)   Thesis Research

Quarter 7
MA0810   (0-8)   Thesis Research
MA4311   (3-0)   Calculus of Variations
XX4XXX   Option Requirement
MAXXXX   Option Requirement

Quarter 8
XX4XXX   Option Requirement
MA4103   (3-0)   Thesis Topics Seminar
MA4372   (3-0)   Integral Transforms
MA0810   (0-8)   Thesis Research
MA0810   (0-8)   Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONS ANALYSIS
CURRICULUM (360)
Subspecialty Code XX42P

1. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have a knowledge of development and execution of military strategy and 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.

2. **DATA ANALYSIS:** The graduate will be well-versed in probability and statistics and their applications to Operations Analysis 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. **HUMAN ENGINEERING:** 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.

6. **LOGISTICS:** The graduate will be conversant with Operations Analysis models in logistics. Military analysis for years was most highly developed in the logistical area. Concern for logistics remains an important facet in analysis of warfighting capability.

7. **WARFARE ANALYSIS:** The graduate will be familiar with U.S./Allied and potential enemy capabilities, doctrine, and tactical 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.

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. **BASICS:** The graduate will possess the mathematical skills required to support graduate study in operations research and have the ability to use the mainframe and microcomputer as a tool to aid in analysis.

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 (N-81)
September 1995

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONAL LOGISTICS
CURRICULUM (361)
Subspecialty Code XX43P

1. **MODELING UNCERTAINTY:** The graduate will be well versed in probability and statistics and their application to Operations Research (OR) problems.

2. **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.

3. **STOCHASTIC MODELING:** The graduate will be able to formulate and solve problems involving processes (processes with uncertainty over time) and also be familiar with the major applications of such models.

4. **TRANSPORTATION:** The graduate will have an understanding of transportation systems and the constraints they place on operations, especially strategic airlift and sealift.

5. **LOGISTICS:** The graduate will understand all aspects of the Naval logistics system and Joint planning systems, and the use of analysis in all aspects of planning for the development and analysis of forces at sea.

6. **WARFARE ANALYSIS:** The graduate will be familiar with U.S./Allied and potential enemy capabilities, doctrine, tactical and logistics support concepts and will be able to model and analyze military operations using OR techniques. He/she will further be able to develop new tactical and logistics concepts based on theory and analysis.

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. **BASICS:** The graduate will possess the mathematics skills required to support graduate study in or have the ability to use a mainframe and microcomputer as tools to aid in analysis.

9. **PRACTICE:** The graduate will have gained experience working on all aspects of an analytical study in the field of operational logistics. Specifically, he/she will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

10. **JOINT MARITIME STRATEGY:** The graduate will have a knowledge of development and execution of military strategy and 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 reorganization.

Curriculum Sponsor and ESR Approval Authority
Deputy CNO Logistics (N-4)
September 1995

EDUCATIONAL SKILL REQUIREMENTS
APPLIED MATHEMATICS
CURRICULUM (380)
Subspecialty Code XX41P

1. **BASIC SKILLS:** The graduate will have a sufficient foundation in linear algebra, calculus of one and several variables, ordinary differential equations, probability, statistics, discrete mathematics, modern applied algebra, numerical analysis, and mathematical modeling to teach mathematics at the upper division undergraduate level and to model and solve applied problems with complex mathematical content.

He/she will be able to use mainframe or workstation computers and microcomputers as a tool to aid in analysis. He/she will have advanced skills in at least one mathematical computer software package.

He/she will have had exposure to the basic physical and technological principles underlying a diversity of real-world problems of importance to the military which the student may be called upon to model and analyze.

2. **FUNDAMENTAL AREAS:** The graduate will have developed an understanding, at the graduate level, of the following fundamental areas of mathematics:

probability	ordinary differential equations
linear algebra and vector analysis	applied mathematics
algebraic structures	partial differential equations
real or complex analysis	mathematical modeling
numerical analysis	modern applied algebra

3. **APPLICATIONS:** The graduate will be well-versed in the applications of mathematics to real- world problems of interest to the military. Example areas of application include mechanical and electrical systems, stiffness and buckling of beams and plates in double-hulled ships, space systems and orbital problems, numerical weather prediction, ship routing, acoustics, wave propagation, nonacoustic ASW and robotics.

4. **COMPUTER SKILLS:** A working knowledge of at least one higher level mathematical computer software package and the operating system for a computer which supports that language. Be able to use the computer for numerical and symbolic computation of a wide variety of military and industrial problems, including parallel computing.

5. **PRACTICE:** Have experience in organizing and presenting mathematical ideas, by oral and written means, to students and faculty. Includes, but is not limited to, the ability to present mathematics to students in a classroom environment. The graduate will demonstrate the ability to conduct independent analysis in applied mathematics and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority
Chairman, Mathematics Department, USNA
August 1994

SPECIAL OPERATIONS PROGRAMS

Curricular Officer:
Mark Machin
CDR, USN
Code 38, Glasgow Hall
Room 220
(408) 656-2845
DSN 878-2845

SPECIAL OPERATIONS CURRICULUM 699
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 close 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" in Latin America, Asia, and the Middle East, the history of irregular warfare, and contemporary perspectives on low intensity conflict resolution. These curriculum specific requirements are supported by a larger program of study which provides the graduate with a broad background in the areas of international relations, comparative strategy, 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. Federal 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.

ENTRY DATES
The Special Operations Curriculum is a six quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 699
Academic Associate:
Gordon H. McCormick, Associate Professor
Code CC/Mc, Root Hall, Room 207
(408)656-2933, DSN 878-2933

DEGREE
Requirements for the degree Master of Science in Defense Analysis are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. The program currently offers nine specialty tracks. Other specialty tracks can be tailored to meet student interests. The current tracks include Irregular Warfare, Operations Analysis, C4I: Communications, C4I: Command and Control, Financial Management, National Security Affairs, and Aeronautics and Astronautics.

SPECIAL OPERATIONS SUBSPECIALTY
Completion of the 699 curriculum qualifies an officer as a Special Operations Subspecialist with a subspecialty code of XX29P. The curriculum sponsor is Commander in Chief, Special Operations Command.

Typical Jobs in this Subspecialty:
Chief, Political Strategy: USCINCSOC
Asst Missions/Readiness: ASD (SO/LIC)
Special Warfare Plans: CINCLANT/CINCPAC/NAVEUR
Chief Intel/Plans: COMNAVSPECWARCOM
Joint Plans/Doctrine: COMNAVSPECWARCOM
Staff Plans: CNSWG-1
Action Officer: JCS, J-3 SOD

TYPICAL COURSE OF STUDY: IRREGULAR WARFARE TRACK

Quarter 1
CC3111	(4-0)	C4I Mission and Organization
SO3802	(4-0)	Seminar in Guerrilla Warfare
MN3105	(4-0)	Organization and Management
SO2410	(4-0)	Modelling for Special Operations I

Quarter 2

SO3882	(4-0)	Deterrence, Compellance & Crisis Management
IW3102	(4-0)	Psychological Operations and Deception
SO3410	(4-0)	Modeling for Special Operations II
SO3800	(4-0)	Theory and Practice of Social Revolution

Quarter 3

SO3880	(4-0)	History of Special Operations
SO3600	(4-0)	Analytical Methods
CSXXXX	(4-0)	Computer Simulation for Special Operations
NS4280	(4-0)	Seminar in Nuclear Strategy

Quarter 4

NS3252	(4-0)	Joint and Maritime Strategy
OA4602	(4-0)	Campaign Analysis
SO3801	(4-0)	International Terrorism
IW3101	(4-0)	Warfare in the Information Age

Quarter 5

SO48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (1st)*
SO4500	(4-0)	Special Topics in Special Operations and Low Intensity Conflict
XXXXXX	(4-0)	Emphasis Elective
SO0810	(0-8)	Thesis Research

Quarter 6

SO48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (2nd)*
XXXXXX	(4-0)	Emphasis Elective
SO0810	(0-8)	Thesis Research
SO0810	(0-8)	Thesis Research

*Four courses in Low-Intensity Conflict covering different regions of the world will be offered; students will select two of the three.

EDUCATIONAL SKILL REQUIREMENTS
SPECIAL OPERATIONS (SO)
CURRICULUM (699)
Subspecialty Code XX29P

1. JOINT MARITIME AND STRATEGIC PLANNING AFTER THE COLD WAR
A close knowledge of the system and procedures for national and service strategic formulation and operational planning after the Cold War. Attention should be given the organizational and procedural bases of the strategic and operational planning establishment, the varied roles played in the formulation, execution, and review of military plans by the Office of the Secretary of Defense, the Joint Staff, and the unified and specified commands. Attention should also be given to the independent and joint roles, missions, and doctrines of the individual services and the direction these have taken since the end of the Cold War. While special attention should be devoted to examining post Cold War developments, this should take place within the context of the larger evolution of service and joint service military doctrine since World War II. The strengths and limitations of joint service planning should be discussed in the context of evolving U.S. defense policy.

2. THE DYNAMICS OF INTER-STATE AND INTRA-STATE CONFLICT
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, 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
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
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
A detailed and conception 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 and missions and strengths and limitations of military power in the emerging multipolar environment.

6. CRISIS MANAGEMENT AND THE CONTINGENT USE OF MILITARY POWER
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 a 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

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

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 21st 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

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 21st 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 COUNTERPROLIFERATION

Students will have an understanding of the developing problem of WMD proliferation and counterproliferation. 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 this areas. Close attention should also be given to the problem of counterproliferation 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 a 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 special operations community, so an interdisciplinary approach is required. Each student will develop a course of study that permits he or she to pursue a disciplinary orientation that best suits their particular academic background and interests within the substantive limits of the other ESRs.

Curriculum Sponsor and ESR Approval Authority
    Commander in Chief, U.S. Special Operations Command
    May 1995

SYSTEMS MANAGEMENT PROGRAMS

Curricular Officer:
William J. Platt
CDR, SC, USN
Code 36, Ingersoll Hall
Room 219
(408) 656-1101, DSN 878-1101

INFORMATION TECHNOLOGY MANAGEMENT
CURRICULUM 370

This curriculum provides officers with the 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 Technology Management 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 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 GRE (Graduate Record Examination) or GMAT (Graduate Management Admission Test), indicate a capability for graduate level work. A minimum TOEFL of 540 (500-539 with supplemental language training) is required for international students. While previous computer, communications or information systems experience is certainly helpful, it is not essential.

INFORMATION TECHNOLOGY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a Navy officer as an Information Technology Management Subspecialist with a subspecialty code of XX89P. Other services have analogous coding. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:
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, SPAWARSYSCOM
OIC, NAVMEDINFORMGMTCENDET
Data Base Management Officer, Naval Security Group
Plans and Programs, COMNAVCOMTELCOM

ENTRY DATES

Information Technology Management is an eight-quarter course of study with entry dates in March and September. 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 Curricular Officer for this curriculum.

Curriculum 370
Academic Associate:
Carl Jones, Professor
Code SM/Js, Ingersoll Hall, Room 307
(408) 656-2995, DSN 878-2995
e-mail: crjones@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Information Technology Management are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Refresher

MAR117	(3-3)	Refresher: Single Variable Calculus
CSR100	(2-1)	Refresher for Beginning Programming
CSR101	(2-1)	Refresher for Laboratory Systems

Quarter 1
CS2970   (4-1)   Structured Programming with Ada
IS2000   (3-1)   Introduction to Information Technology Management
MN2155   (4-0)   Accounting for Management
OS3105   (4-1)   Statistical Analysis for Management I

Quarter 2
CS3030   (4-0)   Computer Architecture and Operating Systems
IS3170   (4-0)   Economic Evaluation of Information Systems I
EO2413   (4-2)   Introduction to Communication Systems Engineering
OS3004   (5-0)   Operations Research for Computer Systems Managers

Quarter 3
EO3513   (4-2)   Communications Systems Engineering
IS3171   (4-1)   Economic Evaluation of Information Systems II
IS4183   (4-1)   Applications of Database Management Systems
IS3020   (3-2)   Software Design

Quarter 4
EO3523   (4-2)   Communications Systems Analysis
IS4200   (4-2)   Systems Analysis and Design
IS4185   (4-1)   Decision Support Systems
IS3502   (3-2)   Computer Networks: Wide/Local Area

Quarter 5
IS3112   (4-1)   Information Technology Management in DoD
IS4502   (3-2)   IS Design Project
CS3600   (4-0)   Introduction to Computer Security
IS4300   (3-2)   Software Engineering and Management

Quarter 6
IS4502   (3-2)   IS Design Project
MN3105   (4-0)   Organization and Management
-----------   (4-0)   Focus Area Choice (See note)
IS4601   (4-0)   Research Methods for Information Technology Evaluation

Quarter 7
NS3252   (4-0)   Joint and Maritime Strategy
MN3307   (4-0)   Information Technology Acquisition
MN4125   (4-0)   Managing Planned Change in Complex Organizations
IS0810   (0-8)   Thesis Research for Information Technology Management Students

Quarter 8
IS4182   (4-0)   Information Systems Management
MN3154   (4-0)   Financial Management in the Armed Forces
IS0810   (0-8)   Thesis Research for Information Technology Management Students
---------   (4-0)   Focus Area Choice (see note)

NOTE: Students with a strong education and background in any of the above topics can request validation of those courses and thereby avail themselves of additional course work. Typical courses include, but are not limited to:

CC4750   Military C4I Systems and Networks
CS3310   Artificial Intelligence
CS4202   Computer Graphics
IS3000   Distributed Computer Systems
IS3100   Analysis of Microcomputers and Microprocessors
IS3503   Microcomputer Networks
IS3504   Modern Network Ops System: Planning, Technology & Operations
IS4184   Information Resource Management in DoN/DoD
IS4186   Knowledge-Based Systems and Artificial Intelligence
IS4187   Information Networking & Distributed Decision Technologies
IS4503   Internet to Sea
IS4800   Directed Study in Advanced Information Systems
MN3374   Production Management: A TQM/L Perspective
MN4105   Strategic Management
MN4151   Internal Control and Auditing
MR2419   Atmospheric Factors in C3
OS3404   Man-Machine Interaction

TRANSPORTATION LOGISTICS MANAGEMENT
CURRICULUM 813

This curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration into an understanding of the process by which the defense mission is accomplished. Inputs from the Navy are from the Supply Corps. The programs is designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, it is 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 this subspecialty area.

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.

Supply Corps Officers from the U.S. Navy start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION LOGISTICS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Material Movement Subspecialist, subspecialty code 1304P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:
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

ENTRY DATE

Transportation Logistics Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 813
Academic Associate:
Donald Eaton, Logistics Chair (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(408) 656-3616, DSN 878-3616

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Domestic Transportation Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy and Budgeting
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management

Quarter 4

IS3183	(4-0)	Management of Information Technology
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3154	(4-0)	Financial Management in the Armed Forces
MN3221	(2-0)	Principles of Acquisition and Program Management I

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN3377	(4-0)	Inventory Management
MN3222	(3-2)	Principles of Acquisition and Program Management II
MN3372	(4-0)	Material Logistics

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
NS3252	(4-0)	Joint and Maritime Strategy
MN3371	(4-0)	Contracts Management and Administration

Quarter 7

MN0810	(0-8)	Thesis Research
MN4105	(4-0)	Strategic Management
OA3610	(4-0)	Introduction to Naval Logistics
MN3375	(4-0)	Materials Handling Systems Design

TRANSPORTATION MANAGEMENT
CURRICULUM 814

The objectives of this curriculum are to prepare officers for naval logistics system positions, emphasizing worldwide transportation aspects. Graduate logistics courses cover topics such as the transportation system within CONUS, warehouse siting, materials management, production management, inventory management (both Navy and private sector), materials handling, purchasing and physical distribution. Students take additional courses in transportation in the private sector and military transportation in support of contingencies, as well as, options in corporate financial management, production management, or logistics engineering.

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.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Transportation Management Subspecialist with a subspecialty code of XX35P. The Curriculum Sponsor is The Navy Military Sealift Command Headquarters.

Typical Jobs in this Subspecialty:
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

ENTRY DATE

Transportation Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 814
Academic Associate:
Donald Eaton, Logistics Chair (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(408) 656-3616, DSN 878-3616

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Domestic Transportation Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy and Budgeting
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management

Quarter 4
IS3183	(4-0)	Management of Information Technology
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3301	(4-0)	Systems Acquisition and Project Management
MN3372	(4-0)	Material Logistics

Quarter 6
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3111	(4-0)	Personnel Management Processes
MN3371	(4-0)	Contracts Management and Administration
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 7
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3375	(4-0)	Materials Handling Systems Design
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student selects option from the following courses:
MN3374	Production Management: A TQM/L Perspective
MN4310	Logistics Engineering
OA3610	Introduction to Naval Logistics
OA4611	Logistics in Naval Warfare

ACQUISITION AND CONTRACT MANAGEMENT
CURRICULUM 815
The Acquisition and Contract Management Curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, finance, behavioral science, management theory, operations/systems analysis and specific courses in acquisition and contracting. Student input includes officers and civilians from all DoD services, the Coast Guard and other nations. The curriculum is designed to provide officers and civilians with the skills to serve effectively in hardware 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, as is a minimum TOEFL score of 540 (500-539 with supplemental language training) for international students.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

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 97, and Marine Corps officers with a 9656 MOS. The Curriculum Sponsor is the Deputy to the Assistant Secretary of the Navy (Research, Development and Acquisition) for Acquisition, and Business Management. The curriculum satisfies the mandatory Defense Acquisition University (DAU) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

Typical Jobs in this Subspecialty:

Contracting Officer:
    Navy Inventory Control Point, Mechanicsburg, PA
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), Washington, DC
    Army Material Command
    Major Subordinate Commands (e.g. ATCOM, MICOM, TACOM)
Business/Financial Manager (B/FM):
    Hardware Systems Commands (NAVAIR, NAVSEA,SPAWAR), Washington, DC
Contracts and Business Policy:
    Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)
    Staff of Assistant Secretary of the Army (Research, Development and Acquisition)
    Staff of Under Secretary of Defense (Acquisition & Technology)
Administrative Contracting Officer (ACO):
    Defense Contract Management Command (DCMC)
    Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)

ENTRY DATES

Acquisition and Contract Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 815
Academic Associate:
David V. Lamm, Associate Professor
Code SM/Lt, Ingersoll Hall, Room 331A
(408) 656-2775, DSN 878-2775

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY (Except U.S. Army and U.S. Marine Corps)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 2
MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 3
MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(3-0)	Contract Law
MN3105	(4-0)	Organization and Management
NS3252	(4-0)	Joint and Maritime Strategy
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3305	(3-0)	Contract Administration
MN3306	(3-0)	Acquisition Management
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4301	(4-0)	Contracting for Major Systems
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
OS3006	(4-0)	Operations Research for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
-----------	(4-0)	Curriculum Option*
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

*Curriculum options:

MN3384	Principles of Acquisition Production and Quality Management
MN4152	Corporate Financial Management
MN4162	Cost Management
MN4302	Defense Resource Policy and Management
MN4305	Defense Technology Policy
MN4310	Logistics Engineering
MN4372	Seminar in Acquisition and Contract Management
MN4470	Strategic Planning and Policy for the Logistic Manager
MN3155	Financial Management for Acquisition Managers **AND**
MN4161	Management Control Systems

TYPICAL COURSE OF STUDY (U. S. Marine Corps)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 3

MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(3-0)	Contract Law
MN3105	(4-0)	Organization and Management
MN3221	(2-0)	Principles of Acquisition and Program Management I
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3305	(3-0)	Contract Administration
MN3306	(3-0)	Acquisition Management
MN3222	(3-2)	Principles of Acquisition and Program Management II
IS3183	(4-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4304	(2-0)	Defense Systems Contracting
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
NS3252	(4-0)	Joint and Maritime Strategy
OS3006	(4-0)	Operations Research for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4145	(4-0)	Policy Analysis
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

TYPICAL COURSE OF STUDY (U.S. Army)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN3221	(2-0)	Principles of Acquisition and Program Management I
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 3

MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(3-0)	Contract Law
MN3105	(4-0)	Organization and Management
MN3222	(2-0)	Principles of Acquisition and Program Management II
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3305	(3-0)	Contract Administration
MN3306	(3-0)	Acquisition Management
OS4601	(4-0)	Test and Evaluation I
IS3183	(4-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4304	(2-0)	Defense Systems Contracting
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3309	(4-0)	Acquisition of Embedded Weapon Systems Software
OS3006	(4-0)	Operations Research for Management
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4145	(4-0)	Policy Analysis
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-2)	Seminar for Acquisition and Contracting Students

SYSTEMS ACQUISITION MANAGEMENT
CURRICULUM 816

The Systems Acquisition Management Curriculum is an interdisciplinary program designed to integrate business principles, management theory, operations/systems analysis, and engineering applications. It is uniquely tailored to Defense acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curriculum present the structure of acquisition management, the decisions and problems

facing the defense 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, the Coast Guard and other 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, as is a TOEFL minimum score of 540 (500-539 with supplemental language training) for international students.

Officers from the U.S. Services, international officers and DoD civilian employees enter the curriculum with widely varied academic backgrounds. Each student's prior academic work and related experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credit may be transferred. Validation or credit by examination is encouraged where knowledge of the material has been acquired by experience or Service courses.

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 requirements for the Advanced Program Management Course (APMC) (PMT302) at the Defense Systems Management College (DSMC). The Curriculum Sponsor is the Military Deputy to the Assistant Secretary of the Army (Research, Development and Acquisition).

Typical Jobs in this Subspecialty:
Program Manager/Deputy Program Manager:
      Army/Navy/Marine Corps Aircraft, Missile, Vehicle and Ship programs
Class Desk Officer:
      Naval Air Systems Command
Program Executive Officer (PEO) staff
Matrix Organization staff:
      Army Aviation Troop Command
      Naval Air Systems Command
      Naval Sea Systems Command
      Army Missile Command
      Army Communications - Electronics Command
      Marine Corps Systems Command
Test and Evaluation Officer
Logistics Officer:
      Marine Corps Logistics Base

ENTRY DATES
Systems Acquisition Management is a seven-quarter course of study (six quarters for U.S. Army Students) with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 816
Academic Associate:
David V. Lamm, Associate Professor
Code SM/Lt, Ingersoll Hall, Room 331A
(408)656-2775, DSN 878-2775

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY (Except U.S. Army)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN2303	(0-2)	Seminar for Program Management Students **

Quarter 2
MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory

MN3301	(4-0)	Systems Acquisition and Program Management **
OS3105	(4-1)	Statistical Analysis for Management
MN2303	(0-2)	Seminar for Program Management Students **

Quarter 3

MN3105	(4-0)	Organization and Management
MN3371	(4-0)	Contracts Management and Administration **
IS3183	(4-0)	Management of Information Technology
OS3006	(4-0)	Operations Research for Management
MN2303	(0-2)	Seminar for Program Management Students **

Quarter 4

MN4310	(4-0)	Logistics Engineering **
MN4145	(4-0)	Policy Analysis
MN3384	(5-1)	Principles of Acquisition Production and Quality Management **
MN3155	(2-0)	Financial Management for Acquisition Managers **
MN2303	(0-2)	Seminar for Program Management Students **

Quarter 5

MN3172	(4-0)	Public Policy and Budgeting
MN3309	(4-0)	Acquisition of Embedded Weapon Systems Software **
OS3302	(4-0)	Quality Assurance and Reliability Methods **
-----------	(4-0)	Curriculum Option*
MN3311	(1-2)	Program Management Exercise **

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
OS4601	(4-0)	Test and Evaluation **
MN4307	(4-0)	Program Management Policy and Control **
EO4011	(3-2)	Systems Engineering for Acquisition Managers **
MN2303	(0-2)	Seminar for Program Management Students **

Quarter 7

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
NS3252	(4-0)	Joint and Maritime Strategy
MN2303	(0-2)	Seminar for Program Management Students **

*One additional course must be selected from the following curriculum options:

IS3020	Software Design
MN3111	Personnel Management Processes
MN3307	Information Technology Acquisition
MN3801	Technology Transfer
MN4302	Defense Resource Policy and Management
MN4305	Defense Technology Policy
MN4372	Seminar in Acquisition and Contract Management
MN4470	Strategic Planning and Policy for the Logistic Manager
MN4942	The Structure, Conduct and Performance of the Defense Industries
OA4702	Cost Estimation
OS3301	Systems Effectiveness Concepts and Methods
OS3401	Human Factors Engineering
OS3702	Manpower Requirements Determination
OS4701	Manpower and Personnel Models

**Acquisition Courses

TYPICAL COURSE OF STUDY (U.S. Army)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN2303	(0-2)	Seminar for Program Management Students

Quarter 2

| MN3161 | (4-0) | Management Accounting |
| MN3140 | (4-0) | Microeconomic Theory |

MN3301	(4-0)	Systems Acquisition and Program Management
MN3303	(4-0)	Principles of Acquisition and Contract Management
MN2303	(0-2)	Seminar for Program Management Students

Quarter 3

IS3183	(4-0)	Management of Information Technology
MN3304	(5-2)	Contract Pricing and Negotiations
OS3105	(4-1)	Statistical Analysis for Management
MN3105	(4-0)	Organization and Management
MN2303	(0-2)	Seminar for Program Management Students

Quarter 4

MN4310	(4-0)	Logistics Engineering
EO4011	(4-0)	Systems Engineering for Acquisition Managers
MN4145	(4-0)	Policy Analysis
MN3172	(4-0)	Public Policy and Budgeting
MN3155	(2-0)	Financial Management for Acquisition Managers
MN2303	(0-2)	Seminar for Program Management Students

Quarter 5

MN3309	(4-0)	Acquisition of Embedded Weapon Systems Software
MN0810	(0-8)	Thesis Research for Systems Management Students
OS3006	(4-0)	Operations Research for Management
OS3302	(4-0)	Quality Assurance and Reliability Methods
MN3311	(1-2)	Program Management Exercise

Quarter 6

MN4105	(4-0)	Strategic Management
MN4307	(4-0)	Program Management Policy and Control
OS4601	(4-0)	Test and Evaluation
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2303	(0-2)	Seminar for Program Management Students

DEFENSE SYSTEMS ANALYSIS
CURRICULUM 817

These programs provide officers with the fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management. The curricula educate students to evaluate others' research and analysis and to develop in them sound management and leadership skills.

These curricula are interdisciplinary programs which integrate mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are determined after consultation with the Academic Associate.

REQUIREMENT 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.

Officers from the U.S. Services, and DoD employees, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experiences are evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES

The 817 curricula for USCG, USMC and DoD civilians are six-quarter courses of study with entry dates in January and July. If further information is needed, contact the Academic Associates for these curricula or the Curricular Officer.

Curriculum 817
Academic Associate:
USCG and DoD Civilians - Systems Management
USMC - Defense Systems Analysis
James E. Suchan, Associate Professor
Code SM/Sa, Ingersoll Hall, Room 215A
(408) 656-2905, DSN 878-2905

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY (U.S. Coast Guard)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN3111	(4-0)	Personnel Management Processes
MN3172	(4-0)	Public Policy and Budgeting
MN4161	(4-0)	Management Control Systems
MN4125	(4-0)	Managing Planned Change in Complex Organizations

Quarter 4
MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management of Information Technology
OS3006	(4-0)	Operations Research for Management

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 6
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

TYPICAL COURSE OF STUDY (U.S. Marine Corps)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN3172	(4-0)	Public Policy and Budgeting
MN3221	(2-1)	Principles of Acquisition and Program Management I
OS3006	(4-0)	Operations Research for Management
IS3183	(4-0)	Management Information Technology
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 4
MN3154	(4-0)	Financial Management in the Armed Forces
MN4145	(4-0)	Policy Analysis

| MN3222 | (4-0) | Principles of Acquisition and Program Management II |
| MN4163 | (4-0) | Decision, Cost and Policy Analysis |

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
OA4702	(4-0)	Cost Estimation

Quarter 6
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

TYPICAL COURSE OF STUDY (DoD Civilian Program)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN4999	(4-0)	Curriculum Option*
MN3172	(4-0)	Public Policy and Budgeting
MN4999	(4-0)	Curriculum Option*
OS3006	(4-0)	Operations Research for Management

Quarter 4
MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management of Information Technology
MN4999	(4-0)	Curriculum Option*

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

Quarter 6
MN4999	(4-0)	Curriculum Option*
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student must consult with Academic Associate to select additional courses that meet student and sponsor needs.

DEFENSE SYSTEMS MANAGEMENT - INTERNATIONAL
CURRICULUM 818

This program is designed to provide the officers with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management, and to enable the officers to evaluate the written research, study and analysis products of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required to effectively manage.

The curriculum integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are selected by the student by their choice of course options.

International students are free to choose any of the specific management curricula available. Most choose the more general Defense Systems Management International Curriculum. The 818 curriculum 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, logistics, human resources and organization, 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.

REQUIREMENT 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; international students require a minimum TOEFL score of 540 (500-539 with supplemental language training).

International officers start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES
The 818 curriculum for International officers is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 818
Academic Associate:
International Officers - Systems Management
Roger Evered, Professor
Code SM/Ev, Ingersoll Hall, Room 201
(408) 656-2646, DSN 878-2646

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY
INTERNATIONAL OFFICERS (818)

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I
IT1500	(4-0)	Information Program Seminar for International Officers
IT1600	(4-2)	Communication Skills for International Officers

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
OS3006	(4-0)	Operations Research for Management

Quarter 4
MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management of Information Technology
MN4999	(4-0)	Curriculum Option*

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student must consult with academic associate to select additional courses that meet student and sponsor needs.

SYSTEMS INVENTORY MANAGEMENT
CURRICULUM 819

This curriculum emphasizes the management of Navy owned inventories at all levels. Curriculum 819 students take additional courses in general inventory model development and the specific details of the Navy's inventory models, spanning the three levels of wholesale, intermediate and retail customer support. Officers are responsible for developing procedures for establishing, maintaining and controlling inventories of material, distributing that material to the Navy customer, and developing the budgets for financing these inventories.

The Systems Inventory Management curriculum is 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.

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; international students require a minimum TOEFL of 540 (500-539 with supplemental language training).

Officers from the Navy's Supply Corps start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

SYSTEMS INVENTORY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Systems Inventory Management Subspecialist with a subspecialty code of 1302P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:
Inventory Control Methods and Requirements: Fleet and Industrial Support Center
Stock Control: Naval Air Station
Director of Program Support Office, Ships Parts Control Center, 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

ENTRY DATES

Systems Inventory Management is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 819
Academic Associate:
Donald Eaton, Logistics Chair, (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(408) 656-3616, DSN 878-3616.

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

*TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3105	(4-1)	Statistical Analysis for Management
MN3172	(4-0)	Public Policy and Budgeting

Quarter 3

IS3183	(4-0)	Management of Information Technology
MN3372	(4-0)	Material Logistics
MN3105	(4-0)	Organization and Management
OS3006	(4-0)	Operations Research for Management

Quarter 4

OA3501	(4-0)	Inventory I
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
MN4312	(4-0)	Simulation Modeling for Managerial Decision Making

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
NS3252	(4-0)	Joint and Maritime Strategy
OA4501	(4-0)	Seminar in Supply Systems

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN3154	(4-0)	Financial Management in the Armed Forces
MN3371	(4-0)	Contracts Management and Administration

*If a course is validated, an alternate course may be selected from the following list:

MN3301	(4-0)	System Acquisition and Project Management
MN3374	(4-0)	Production Management: A TQM/L Perspective
MN3375	(4-0)	Materials Handling Systems Design
MN3111	(4-0)	Personnel Management Processes

RESOURCE PLANNING AND MANAGEMENT FOR INTERNATIONAL DEFENSE
CURRICULUM 820

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 is made up of a combination of existing courses within the Systems Management and National Security Affairs departments 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.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum score of 540 on the Test of English as a Foreign Language (TOEFL). Supplemental English language training is required for students who score 500-539.

Officers and civilian employees in defense agencies of allied countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Validation or credit by examination is encouraged.

ENTRY DATES

Resource Planning and Management for International Defense Curriculum 820 is a six-quarter (18 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

Curriculum 820
Academic Associate:
Roger Evered, Professor
Code SM/Ev, Ingersoll Hall, Room 201
(408) 656-2646, DSN 878-2646

DEGREE
Master of Science in International Resource Planning and Management

TYPICAL COURSE OF STUDY

Quarter 1
MN2150	(4-0)	Financial Accounting
NS3023	(4-0)	Introduction to Comparative Politics
MN2039	(4-0)	Basic Quantitative Methods in Economic Analysis
IT1500	(4-0)	Information Program Seminar for International Officers
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Management Accounting
NS3030	(4-0)	American National Security Policy
MN3140	(4-0)	Microeconomic Theory
MN3172	(4-0)	Public Policy and Budgeting

Quarter 3
MN3333	(4-0)	Managerial Communication Skills in the DoD Management
NS3036	(4-0)	The Military and Politics in the Developing World
NS3041	(4-0)	Comparative Economic Systems
MN3105	(4-0)	Organization and Management

Quarter 4
IS3183	(4-0)	Management of Information Technology
NS3900	(4-0)	International Law and Organizations
MN4145	(4-0)	Policy Analysis
MN3111	(4-0)	Personnel Management Processes

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Elective

Quarter 6
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
NS4240	(4-0)	Seminar on Regional Security Planning Problems

MATERIAL LOGISTICS SUPPORT MANAGEMENT
CURRICULUM 827
The Material Logistics Support Management curriculum emphasizes all of the aspects for providing integrated logistics support of weapons systems. Besides study in mathematics, accounting, economics, behavioral science, management theory and operations analysis, the curriculum delves into production management, inventory management, integrated logistic support, procurement and contract administration, systems acquisition, and project management. Skills resulting from the curriculum 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 phaseout.

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.

Officers from the U.S. Services, as well as others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

MATERIAL LOGISTICS SUPPORT MANAGEMENT SUBSPECIALIST
Completion of this curriculum qualifies an officer as a Material Logistics Support Management Subspecialist, subspecialty code XX32P. The Curriculum sponsor is Naval Air Systems Command Headquarters.

Typical Jobs in this Subspecialty:
Aircraft Intermediate Maintenance: Naval Air Stations and Aircraft Carriers
Project Management Staff: Naval Air Systems Command, Washington, DC
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

ENTRY DATES
Material Logistics Support Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 827
Academic Associate:
Donald Eaton, Logistics Chair, RADM Ret
Code SM/Et, Ingersoll Hall, Room 241
(408) 656-3616, DSN 878-3616.

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3101*	(4-1)	Statistical Analysis for Management
MN3172	(4-0)	Public Policy and Budgeting
MN3221	(2-0)	Principles of Acquisition and Program Management I

Quarter 3
MN3372	(4-0)	Material Logistics
MN3222	(3-2)	Principles of Acquisition and Program Management II
OS3006	(4-0)	Operations Research for Management
MN3105	(4-0)	Organization and Management

Quarter 4
MN3371	(4-0)	Contracts Management and Administration
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
IS3183	(4-0)	Management of Information Technology

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3374	(4-0)	Production Management
MN4999	(4-0)	Curriculum Option**

Quarter 6
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN3154	(4-0)	Financial Management in the Armed Forces
NS3252	(4-0)	Joint and Maritime Strategy

*OS3105 may be taken instead of OS3101. This substitution will allow certain curriculum option courses below to be taken from the Operations Research Department. The decision to take OS3105 must be made early in the first quarter.

**One additional course must be selected from the following curriculum options:
    MN3111   Personnel Management Processes
    MN3373   Domestic Transportation Management
    MN3375   Materials Handling Systems Design
    MN3377   Inventory Management (required for Supply Corps Officers)
    OA3401   Human Factors in Systems Design I
    OA3501   Inventory I
    OA4302   Reliability and Weapon Systems Effectiveness Measurement
    OA4303   Sample Inspection and Quality Assurance

**(OA3401, 3501, 4302 and 4303 may only be taken after OS3104 is taken.)

FINANCIAL MANAGEMENT
CURRICULUM 837

The objective of the Financial Management Curriculum is to prepare officers for business and financial positions within the Navy. Financial Managers assist the Navy's decision-making processes at all levels by providing accurate, timely and relevant information. They are concerned with the optimal allocation of human, physical and financial resources to achieve the Navy's goals and objectives while assuring efficient and effective expenditure of public funds.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting, internal control, auditing, management planning and control systems, quantitative techniques used in planning and control, and the Planning Program and Budgeting System used within the Department of Defense.

Graduates of the Financial Management Curriculum will be prepared for assignment to positions in budgeting, accounting, business and financial management, and internal control and auditing.

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; for international students, a minimum TOEFL of 540 (500-539 with supplemental language training) is required.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

FINANCIAL MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Financial Management Subspecialist, subspecialty code XX31P. The Curriculum Sponsor is N-82, Fiscal Management Division.

Typical Jobs in this Subspecialty:
Comptroller: Naval Air Stations
Budgeting: Commander, Naval Medical Command, Washington, DC
Accounting: Commander, Naval Medical Command, Washington, DC
Budget Officer: Commander, Naval Air Forces Atlantic, Norfolk, VA
Comptroller: Naval Supply Depots/Naval Supply Centers
Fiscal Officer: Naval Supply Depots/Naval Supply Centers
Public Works Officer: Weapons Stations, CONUS
Cost Analysis: Office of Secretary of the Navy, Washington, DC
Special Assistants: Program, Planning Office (NAVY), Fiscal Management Division (N-82)

ENTRY DATES

Financial Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 837
Academic Associate:
Douglas Moses, Associate Professor
Code SM/Mo, Ingersoll Hall Room 303
(408) 656-3218, DSN 878-3218.

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2
MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3
MN4161	(4-0)	Management Control Systems
MN3172	(4-0)	Public Policy and Budgeting
MN4162	(4-0)	Cost Management
OS3006	(4-0)	Operations Research for Management
IS0125	(0-2)	Computer Skills Development II

Quarter 4
MN3154	(4-0)	Financial Management in the Armed Forces
MN4163	(4-0)	Decision, Cost and Policy Analysis
MN4151	(2-0)	Internal Control and Auditing
IS3183	(4-0)	Management of Information Technology
MN4153	(2-0)	Seminar in Financial Management

Quarter 5
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4XXX	(4-0)	Curriculum Option*
NS3252	(4-0)	Joint and Maritime Strategy

Quarter 6
MN3301	(4-0)	Systems Acquisition and Project Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4XXX	(4-0)	Curriculum Option*

*The student will select two courses from the following curriculum options:
MN4122	Planning and Control: Measurement and Evaluation
MN4152	Corporate Financial Management
MN4153	Seminar in Financial Management
MN4159	Financial Reporting and Analysis
MN4302	Defense Resource Policy and Management
MN4305	Defense Technology Policy
OA4702	Cost Estimation

MANPOWER SYSTEMS ANALYSIS
CURRICULUM 847
Officers enrolled in the Manpower Systems Analysis (MSA) curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill the leadership roles in military manpower personnel and training management. The XX33P 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. As such, the curriculum emphasizes mathematical, statistical and other quantitative methods. Successful completion of the curriculum yields an officer skilled in conducting manpower personnel and training policy analysis.

The areas covered in the MSA curriculum include an understanding of manpower, personnel, and training policy development, 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 as well as military manpower organizations and issues.

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; for international students, a minimum TOEFL of 540 (500-539 with supplemental language training) is required.

Prospective students electing MSA as a curriculum must be adequately prepared by their undergraduate course work and comfortably oriented to a quantitatively rigorous graduate curriculum.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Validation by examination is encouraged.

MANPOWER SYSTEMS ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Manpower Systems Analysis Subspecialist, subspecialty code XX33P. The Curriculum Sponsor is PERS-2, Assistant Chief of Naval Personnel for Personnel Policy and Career Progression.

Typical Jobs in this Subspecialty:

Head, Enlisted Plans Branch, ACNP for Military Personnel Policy and Career Progression (Pers 222)
Head, Joint Manpower Management Branch, JCS (J-1) Head, Manpower Resources Branch, Director Total Force Programming/Manpower (N122)
Special Assistant for Recruiting, Deputy Assistant Secretary of the Navy (DASN)
Manpower and Training Analyst, DCNO (Resources, Warfare Requirements and Assessment (N801D)
Manpower Plans, CINCPACFLT
Commanding Officer, Naval Personnel Research and Development Center (NPRDC)
Executive Officer, Naval Manpower Analysis Center (NAVMAC)
Director, Personnel Plans and Policy, BUMED
Personnel and Manpower Management, Naval Medical Center, San Diego, CA

ENTRY DATES

Manpower Systems Analysis is a seven-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 847
Academic Associate:
Stephen Mehay, Professor
Code SM/Mp, Ingersoll Hall, Room 343
(408) 656-2643, DSN 878-2643

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN2111	(0-2)	Seminar in Manpower, Personnel and Training Issues I
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development I

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3101	(4-2)	Statistical Analysis for Management
MN3902	(2-2)	MPT Computer Skills Enhancement

Quarter 3

MN3760	(4-0)	Manpower Economics I
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MN4110	(4-1)	Multivariate Manpower Data Analysis I
MN3105	(4-0)	Organization and Management
MN2112	(0-2)	Seminar in Manpower, Personnel and Training Issues II

Quarter 4

MN3111	(4-0)	Personnel Management Processes
MN4111	(4-1)	Multivariate Manpower Data Analysis II
OS3006	(4-0)	Operations Research for Management
MNXXXX	(4-0)	Manpower Elective*

Quarter 5

MN4115	(4-0)	Training Foundations and Management
MN4761	(4-0)	Applied Manpower Analysis
OS4701	(4-0)	Manpower and Personnel Models
IS3183	(4-0)	Management of Information Technology

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3172	(4-0)	Public Policy and Budgeting
MN4106	(4-0)	Manpower/Personnel Policy Analysis

Quarter 7

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
NS3252	(4-0)	Joint and Maritime Strategy

*Students will select from the following courses:

MN4112	(4-0)	Personnel Testing and Selection
MN4114	(4-0)	Sociological and Psychological Perspective on Military Service

LEADERSHIP EDUCATION AND DEVELOPMENT
CURRICULUM 856

The Leadership Education and Development (LEAD) curriculum prepares officers to develop leadership in others through knowledge of managing organizations, diagnosing individual and group performance, understanding learning processes, motivating subordinates, providing feedback, and serving as positive role models. The curriculum was designed in response to a need for graduate education for Company Officers at the United States Naval Academy (USNA). The coursework provides knowledge and skills that officers will use as Company Officers and in other leadership roles as they become more senior in their careers.

The LEAD curriculum is taught at USNA by Naval Postgraduate School faculty in one- to two-week modularized courses over a one-year period. Courses include topics related to ethics, leadership, DoD policy and resource analysis, quantitative analysis, educational theory, and organizational behavior.

REQUIREMENTS FOR ENTRY
Prospective students must have a baccalaureate degree earned with above-average academic performance and an APC of 365.

LEADERSHIP EDUCATION AND DEVELOPMENT SUBSPECIALTY
Completion of this curriculum qualifies an officer for subspecialty code XX38P. The Primary Curriculum Sponsor is the Chief of Naval Education and Training. The Secondary Curriculum Sponsor is the United States Naval Academy.

Typical Jobs in this Subspecialty:
Currently this program qualifies the graduate to serve as a Company Officer at USNA. Eventually, other jobs could include billets at ROTC units, in recruit training and school houses, and other locations where officers develop leadership in junior members of military organizations.

ENTRY DATES
The Leadership Education and Development program is a one-year course of study with entry in June. If further information is needed, contact the Academic Associate for this curriculum.

Curriculum 856
Academic Associate:
Alice Crawford, Senior Lecturer
Code SM/Cr, Ingersoll Hall, Room 232
(408) 656-2481, DSN 878-2481
e-mail: acrawford@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Human Resource Development are met as a result of satisfying the Educational Skill Requirements of the program.

TYPICAL COURSE OF STUDY

Month 1

		Student Orientation
MN3109	(3-0)	Ethics and Moral Development
MN3101	(2-0)	Models of Leadership in Complex Organizations

Month 2

MN3170	(4-0)	DoD policy and Resource Analysis
MN0123	(0-1)	Computer Skills Development
MN0107	(0-1)	Stress Management

Month 3

| MN3160 | (3-0) | Methods of Inquiry |
| MN3162 | (3-0) | Tools for Inquiry |

Month 4

MN4143	(2-0)	Defense Manpower and Personnel analysis
MN4129	(2-0)	Performance Assessment
MN0163	(0-1)	Thesis Writing Workshop

Month 5

| MN3104 | (1-0) | Motivation and Empowerment |
| MN4080 | (2-0) | Research Colloquium |

Month 6

MN3135	(3-0)	Educational Theory
MN3137	(1-0)	Instructional Design
MN3102	(2-0)	Military Leadership

Month 7

MN3138	(2-0)	Adult Development
MN3129	(2-0)	Organization Design
MN4113	(2-0)	Military Sociology and Psychology

Month 8

| MN4120 | (3-0) | Managing Diversity |
| MN3103 | (2-0) | Group Dynamics |

Month 9

| MN3106 | (1-0) | Conflict Management |
| MN3333 | (4-0) | Managerial Communication Skills in the DoD |

Month 10

MN3112	(2-0)	Counseling
IS3181	(3-0)	Integrating and Leveraging Information Technologies
MN4101	(2-0)	Leadership in the Military Culture

Month 11

| MN4104 | (3-0) | Strategic Management |
| MN4124 | (3-0) | Defense Management of Change |

Month 12

| MN0810 | (0-8) | Final Phase of Thesis Research |

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION TECHNOLOGY MANAGEMENT
CURRICULUM (370)
Subspecialty Code XX89P

With the Information Age has come a revolution in command and control, communications, computers, weapons and Command and Control Warfare. From classical ADP systems to tactical systems there are increased needs for horizontal integration, common databases, massive communications needs, and better management and command and control decision making. Both afloat and ashore, graduates of the Information Technology Management curriculum have the expertise and leadership to efficiently and effectively set requirements and design, implement, operate and evolve information and C4I systems using the ever changing information technology base. These graduates are a critical success factor in the adaptation of information technology to the needs of military users. They provide the integration of information systems necessary to support the push and pull of voice, video and data across the battlefield and throughout the spear of war--from the "pointy end" to the "support tail."

The Information Technology Management graduate shall have the knowledge skills and competencies to:

(1) Engineer Information Systems afloat and ashore;
(2) Manage Information Systems, centers and commands afloat and ashore; and
(3) Solve Information Systems engineering and management problems individually and in teams.

These general education skill requirements are supported by the following topical educational skill requirements.

1. **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; planning to ensure Joint and Allied interoperability; the U.S. maritime component of the National Military Strategy; the organizational structure of the U.S. defense establishment; the role of Unified Commanders in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategic objectives.

2. **INFORMATION SYSTEMS TECHNOLOGY.** The officer must have a thorough knowledge of information systems technology to include:

   a. Computer System Components: central processing units, input/output devices, storage devices, operating systems, programming languages, distributed computer systems, and computer security.

   b. Computer Networks: fiber optics, wide- and local-area network hardware, software, components and systems, physical layer interfaces and protocols, and network management protocols.

   c. Communication Systems and Networks: PCM systems, AM, FM, TV, modulation, SATCOM, HF, microwave systems, error control coding, antijam communications, low probability of intercept communications, GPS, data encryption, communications software, and communications security.

   d. Software Engineering: Methodologies for the analysis, design, development, prototyping, testing, implementation and maintenance of software; software metrics and reliability; productivity analysis and software cost estimation and planning; CASE and ICASE tools.

   e. Database Management Systems: Database technologies (including object oriented) and technical and administrative issues involved in the design, implementation and maintenance of database management systems.

   f. Decision Support and Expert Systems: Problem identification, formulation, and design of systems to support decision making; application of artificial intelligence technology to preserve perishable

expertise and enhance distributed expertise; understanding the design of executive information systems, office automation, group decision support systems and crisis management systems, and their potential impacts on organizations and missions.

3. **INFORMATION SYSTEMS ANALYSIS AND MANAGEMENT.** The officer must master the following concepts to effectively manage information system assets:

   a. Managerial Concepts: Decision-making theory, microeconomics, operations analysis, financial management, organizational development, and research methodologies.

   b. Evaluation of Information Systems: Cost-performance (effectiveness) analysis; selection, evaluation, acquisition, installation and effective utilization of information systems hardware and software; risk assessment; information system architectures involving alternative system concepts.

   c. Systems Analysis and Design: Information systems feasibility studies and life cycle management including fact-finding techniques for determining system requirements and specifications, system performance evaluation, conversion and maintenance of legacy systems and the post-implementation evaluation, man-machine interfaces, system ergonomics, and security analysis of information systems.

   d. Management of Information Systems: Information systems facilities planning, production planning and control, requirements determination of information systems personnel, human resource management, budgeting and financial control of computer centers, design of effective organization structure and information systems, and control and security (INFOSEC) policies.

   e. Adapting to Technological, Organizational, and Economic Changes: Evaluation of potential impacts of new technology on information systems planning and development and on organizational strategy; appraisal of evolving responsibilities of information systems managers.

   f. Military Use of Commercial Telecommunications Systems: Architectural integration, cost-performance (effectiveness), and geopolitical-legal aspects.

4. **MILITARY APPLICATIONS.** The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include:

   a. DoD Decision Making Process on Information Systems: DoD, DoN, OMB, and congressional decision making on information systems matters.

   b. Information Technology Acquisition Management: Acquisition policies and procedures of the DoD, including the planning, programming and budgeting system; project management.

   c. DoD Computer and Telecommunications: Architectures and specifications of Navy and DoD systems, computers, telecommunications networks and services, including the DISN; Navy fleet communications systems including satellite communications, JMCIS, GCCS, and the Navy Telecommunications System (NTS); Decision Support Systems.

   d. C4ISR and C2W: Concepts and application to strategic, operational and tactical level operations including support.

5. **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
Commander, Naval Computer and Telecommunications Command
December 1996

EDUCATIONAL SKILL REQUIREMENTS
MATERIAL MOVEMENT
CURRICULUM (813)
Subspecialty Code 1304P

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. **CONTRACT AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD process for contracting for material and services. The graduate will also have an understanding of the processes to be followed for a major weapon system's procurement and its support.

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 for transportation services.

5. **TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, type of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.

6. **TRANSPORTATION RESOURCE MANAGEMENT:** The graduate will have the ability to manage transportation resources to move material from the Navy and DoD supply depots to the fleet customers.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Supply Systems Command
October 1995

EDUCATIONAL SKILL REQUIREMENTS
TRANSPORTATION MANAGEMENT
CURRICULUM (814)
Subspecialty Code XX35P

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. **MANAGEMENT OF PERSONNEL:** The graduate will have the ability to apply current innovations in personnel management to the management of civilian and military personnel involved in DoD transportation activities.

4. **CONTRACTS AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD processes for contracting for transportation and other services. An in-depth knowledge of the DoD project management processes will allow the graduate to participate in MSC/NAVSEA projects for procurement of new MSC ships.

5. **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 for transportation services.

6. **TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, types of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.

7. **TRANSPORTATION SYSTEM DESIGN TO SUPPORT STRATEGIC SEALIFT AND MOBILIZATION:** The graduate will have a detailed understanding of the plans and processes of the Navy and DoD for providing support of strategic sealift and mobilization. The graduate will be able to determine, obtain, and schedule the transportation and materials handling resources to support strategic sealift operations and to move material to the operating fleet and troop units in the event of a mobilization.

8. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

9. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Commander, Military Sealift Command
March 1996

EDUCATIONAL SKILL REQUIREMENTS
ACQUISITION & CONTRACT 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 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.

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 small purchase contracting 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 defense/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, and 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. JOINT AND MARITIME STRATEGY: 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: 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.

Curriculum Sponsor and ESR Approval Authority
Assistant Secretary of the Navy (RD&A)
October 1995

EDUCATIONAL SKILL REQUIREMENTS
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 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. **PROGRAM MANAGEMENT PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of program management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using cost, schedule and performance parameters over the entire life cycle of a project.

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 manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated 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 military acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **JOINT AND MARITIME STRATEGY:** 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: 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.

Curriculum Sponsor and ESR Approval Authority
Military Deputy to the Assistant Secretary of the Army (RD&A)
October 1995

EDUCATIONAL SKILL REQUIREMENTS
SYSTEMS INVENTORY MANAGEMENT
CURRICULUM (819)
Subspecialty Code 1302P

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 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. These are essential for the officer graduate to be an effective leader in any of the agencies of the Navy and DoD.

3. **INTEGRATED LOGISTICS SUPPORT MANAGEMENT:** The graduate will have a detailed understanding of the processes associated with designing an integrated 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 which has adequate integrated support.

4. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial and 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. **INVENTORY MANAGEMENT:** The graduate will have an in-depth understanding of inventory management theory and application within DoN and DoD. As a consequence, the graduate will be able to make decisions on the validity of new models and management procedures being proposed for use by the Joint Logistics Support Center, Navy and Defense Logistics Agency Inventory Control Points, Fleet and Industrial Supply Centers, and Fleet and Shore based customers.

6. **MATERIALS AND PHYSICAL DISTRIBUTION MANAGEMENT:** The graduate will be able to apply the techniques of material 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 insure that cost-effective and efficient.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Supply Systems Command
October 1996

EDUCATIONAL SKILL REQUIREMENTS
MATERIAL LOGISTICS SUPPORT MANAGEMENT
CURRICULUM (827)
Subspecialty Code XX32P

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 material management and physical distribution management in designing and operating of fleet and troop support systems for both peacetime and rapidly developing wartime contingencies. This will include acquiring material and transportation assets to insure that the distribution of material is both cost-effective and efficient.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **THESIS:** 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.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
June 1996

EDUCATIONAL SKILL REQUIREMENTS
FINANCIAL MANAGEMENT
CURRICULUM (837)
Subspecialty Code XX31P

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 private and public sector organizations, as well as military subunits and activities.

2. **FEDERAL AND DEFENSE BUDGETING:** The graduate will understand the roles of the executive and legislative branches in setting federal 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, and Budgeting 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 nonappropriated 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 Financial Accounting Systems and the Federal Accounting Standards Advisory Board are relevant.

4. **INTERNAL CONTROL AND AUDITING:** In accordance with the auditing standards of the U.S. General Accounting 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 procedures and techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.

5. **ACQUISITION MANAGEMENT:** The graduate will understand the purpose and concepts of the Defense systems acquisition process and the application of project management methods within this process.

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, and application of relevant Defense instructions.

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 Standard for major suppliers of goods and services to the federal government.

8. **STRATEGIC PLANNING AND CONTROL:** The graduate will have knowledge of strategic planning and management control concepts for setting 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. The graduate will be able to assess existing management systems and determine appropriate policies, procedures, organization structure, and information systems to ensure optimal use of available human, physical, and financial resources to satisfy the mission.

9. **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.

10. INNOVATION AND CREATIVITY: The graduate will demonstrate initiative and creativity in performing independent research. This includes specifying research questions, formulating a research program, performing the research, and presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to the financial management curriculum.

Curriculum Sponsor and ESR Approval Authority
Director, Budgets and Reports (N-82)
April 1996

EDUCATIONAL SKILL REQUIREMENTS
MANPOWER SYSTEMS ANALYSIS
CURRICULUM (847)
Subspecialty Code XX33P

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 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.

2. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will be able to apply mathematical, statistical, accounting, economic and other quantitative techniques and concepts to day-to-day military management issues. 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.

3. **ADVANCED QUANTITATIVE ANALYSIS:** The graduate will have the ability to apply a wide range of advanced economics, statistical, and mathematical techniques and concepts to manpower and personnel polices and issues. These include complex econometric techniques in the quantitative analysis of large-scale DoN/DoD manpower and personnel databases and Markov models in the analysis of force structure and manpower planning, forecasting and flow models.

4. **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, and Budgeting System (PPBS) and the ability to analyze the impact of budgetary changes on DoN/DoD manpower and personnel programs and polices.

5. **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 with mainframe and microcomputer systems to interactively apply a variety of methods to large-scale DoN and DoD databases.

6. **MANPOWER SYSTEMS ANALYSIS - FUNDAMENTAL CONCEPTS:** The graduate will have an understanding of the fundamental concepts and basic functional areas of manpower, personnel and training (MPT) within DoN/DoD including topics such as:

   MANPOWER: Requirements determination; billet authorizations; billet costs; end strength planning; and total force planning and programming.

   PERSONNEL: Recruiting; accession plans and policies; officer and enlisted community management; attrition; retention; compensation; and readiness.

   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.

7. **MANPOWER SYSTEMS ANALYSIS - POLICY ANALYSIS:** The graduate will have the ability to analyze critically the strengths and weaknesses of proposed MPT polices and to suggest alternatives that recognize the potential impact on DoN/DoD program planning, resources and objectives.

8. **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, the processes for formulating U.S. policy, the roles of military forces, joint planning, and current issues in the defense organization.

9. 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, or training 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
Assistant Chief of Personnel for Military Personnel Policy and Career Progression (PERS-2)
December 1996

EDUCATIONAL SKILL REQUIREMENTS
LEADERSHIP EDUCATION AND DEVELOPMENT
CURRICULUM (856)
Subspecialty Code XX38P

1. **MANAGEMENT FUNDAMENTALS - LEADERSHIP, MANAGEMENT, AND ORGANIZATION:** Officers will have the ability to apply basic management and leadership practices to organizational operations.

   Officers will understand the fundamental principles of leadership and management in military organizations. They will be able to implement appropriate structures for organizations and jobs; they will understand state-of-the-art information technologies and planning and budgeting tools; they will become skilled in spoken and written communications; and they will understand the higher-level leadership skills and the systems perspective of organizations in which day-to-day organizational operations and strategy formulation occur.

2. **EVALUATING AND IMPROVING GROUP PERFORMANCE:** Officers will become skilled at analyzing and improving group morale, cohesion, and performance.

   Graduates of the program will have the ability to analyze and improve group effectiveness through leadership practices that also develop the leadership abilities of subordinates. This ability will be based on knowledge of managing people from diverse backgrounds, teambuilding, conflict management, group dynamics and management of change. Officers will be exposed to varied approaches for building strong shared values within the military.

3. **MOTIVATING SUBORDINATES:** Officers will effectively motivate subordinates to achieve high standards in all military endeavors.

   Program graduates will have the ability to motivate subordinates in order to provide focus and encouragement as they face the rigorous requirements and goals of the military. This ability requires an understanding of how effective leaders use goal setting, equitable discipline, reward systems, analysis of individual needs, empowerment, coaching, and high expectations to achieve peak performance from individuals.

4. **EVALUATING AND IMPROVING INDIVIDUAL PERFORMANCE:** Officers will become skilled in analyzing and improving the performance of individuals.

   The officers will have the ability to evaluate the performance of subordinates and provide appropriate feedback and counseling. This includes activities that range from formal performance appraisal to informal assessment on an ongoing basis. These skills require knowledge of basic performance measurement and giving feedback, as well as knowledge of how to deal with performance outside of the norms that may lead to violations of military rules and regulations.

5. **BEING A ROLE MODEL FOR SUBORDINATES:** Officers will model and otherwise communicate the information about the military that subordinates will need to know to successfully transition to Naval and Marine Corps Leaders.

   Officers will utilize the operational experience they bring to the job, in addition to a broader base of knowledge created through the program, to visibly embody the high standards and values of Naval and Marine Corps officers. The Officer will communicate knowledge of the military culture, current policy and operations, and future plans for the Navy and joint operations in the Department of Defense. These abilities are based on a knowledge of the military in a democratic society, managing organizational cultures, DoD policy, and the behaviors of good role models and mentors.

6. **MANAGING EDUCATIONAL PROCESSES:** Officers will have a foundation of knowledge about educational processes that will enable them to effectively teach and develop their subordinates.

   The program graduate will have the ability to formulate and answer research questions about educational experiences within the Navy and Marine Corps. Through the thesis process, the officer will explore important issues while concurrently broadening his/her knowledge of training and education in the military.

Curriculum Sponsor and ESR Approval Authority
United States Naval Academy
September 1995

UNDERSEA WARFARE, SPACE SYSTEMS, AND INFORMATION WARFARE PROGRAMS

Curricular Officer:
Michael T. McMaster
CDR, USN
Code 37, Root Hall
Room 103K
(408) 656-2135/6
DSN 878-2135/6

SPACE SYSTEMS OPERATIONS
CURRICULUM 366
The Space Systems Operations curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, comprehensive, practical as well as theoretical knowledge of the operation, tasking and employment of space surveillance, communications, navigation and atmospheric/oceanographic/ environmental sensing systems and a knowledge of payload design and integration.

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. Students lacking this background may matriculate through the Engineering Science program (Curriculum 460). A TOP SE-CRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

SPACE SYSTEMS OPERATIONS (INTERNATIONAL)
CURRICULUM 364
A course of study modeled after Curriculum 366 is available for international students. Further information is available from the Curricular Officer or Academic Associate.

SPACE SYSTEMS OPERATIONS SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of XX76P. The curriculum sponsors are N63, Navy Space Systems Division and J6, Director for Command, Control Communications and Computer Systems.

Typical Jobs in this Subspecialty
OPNAV (N63) TENCAP Assistant
SPAWAR Space Systems Project Officer
NAVSPACECOM Staff Officer
USSPACECOM Staff Officer
NAVSECGRUs/DETs

ENTRY DATES
The Space Systems Operations curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 364 & 366
Academic Associate:
Donald Wadsworth, Senior Lecturer
Code EC/Wd, Spanagel Hall, Room 222
(408) 656-3456, DSN 878-3456

DEGREE
Requirements for the degree Master of Science in Space Systems Operations are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA1118	(5-2)	Multi-Variable Calculus
OS2103	(4-1)	Applied Probability for Systems Technology
CC2040	(3-2)	Introduction to System Technologies
PH1322	(5-0)	Electricity and Magnetism
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 2

EO2413	(4-2)	Introduction to Communications Systems Engineering
OS3604	(4-0)	Decision and Data Analysis
PH2511	(4-0)	Introduction to Orbital Mechanics
SS2041	(4-0)	Space Systems and Operations I
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 3

EO3513	(4-2)	Communications Systems Engineering
OS3008	(4-0)	Analytical Planning Methodology
CC3050	(4-0)	Software Systems Engineering
MN3301	(4-0)	Systems Acquisition and Program Management
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 4

EO3523	(4-2)	Communications Systems Analysis
OS3603	(3-1)	Simulation and War Gaming
SS3041	(4-0)	Space Systems and Operations II
PH2514	(4-0)	Introduction to the Space Environment
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 5

SS0810	(0-8)	Thesis Research/Experience Tour
SS3051	(4-0)	Space Institutions, Organizations and Policy
SS4041	(3-2)	Military Space Systems and Technology I

Quarter 6

AA4830	(3-2)	Spacecraft Systems I
SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula
SS9999	(4-0)	Specialization Elective
SS4051	(3-2)	Military Space Systems and Technology II
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 7

AA4831	(3-2)	Spacecraft Systems II
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
SS0810	(0-8)	Thesis Research
SS9999	(0-8)	Specialization Elective
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 8

SS0810	(0-8)	Thesis Research
SS0810	(0-8)	Thesis Research
SS9999	(4-0)	Specialization Elective
NS3252	(4-0)	Joint and Maritime Strategy
SS4000	(0-1)	Space Systems Seminars and Field Trips

UNDERSEA WARFARE
CURRICULUM 525

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. This interdisciplinary program divides naturally into four major academic areas, allowing the student to specialize in the area of choice and to complete a Master of Science in Engineering Acoustics (with emphasis on underwater acoustics and weapons effects), Physical Oceanography (with emphasis on environmental factors affecting acoustic surveillance), Electrical Engineering (with emphasis on signal processing), Operations Research (with emphasis on tactical applications and decision analysis), Applied Mathematics, Computer Science or in other disciplines depending on the student's academic background.

UNDERSEA WARFARE (INTERNATIONAL)
CURRICULUM 526

A course of study modeled after curriculum 525 is available for international students. Further information is available from the Curricular Officer or Academic Associate.

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 Engineering Science (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

UNDERSEA WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of XX44P. The curriculum sponsors are N87 (Submarine Warfare) and N85 (Expeditionary Warfare).

Typical Jobs in this Subspecialty:

Naval Undersea Warfare Center	COMINEWARCOM
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

ENTRY DATES

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 525 & 526
Academic Associate:
James V. Sanders, Assoc. Professor
Code 33A, Spanagel Hall, Room 202
(408) 656-3884, DSN 878-3884

DEGREE

Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for Master of Science in Engineering Acoustics, Physical Oceanography, Electrical Engineering, Applied Mathematics, Operations Research, Computer Science or other disciplines, depending upon academic qualifications, the specialization sequence selected, and the thesis. Students complete two quarters of study prior to electing a specialization track.

TYPICAL COURSE OF STUDY

Quarter 1

MA2138	(5-0)	Multi variable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography
EC2400	(3-1)	Discrete Systems
UW0001	(0-1)	Seminar

Quarter 2

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OS2103	(4-1)	Applied Probability for Systems Technology
UW0001	(0-1)	Seminar
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
EC2410	(3-1)	Analysis of Signals and Systems

Quarter 3

UW3303	(4-1)	Modeling and Simulation for Undersea Warfare
OS3604	(4-0)	Decision and Data Analysis
OC3240	(4-2)	Ocean Dynamics I
UW0001	(0-1)	Seminar
EC3400	(3-1)	Digital Signal Processing

Quarter 4

OA3602	(4-0)	Search Theory and Detection
NS3252	(4-0)	Joint and Maritime Strategy
PH3479	(4-0)	Physics of Underwater Weapons
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 5

OA4607	(4-0)	Tactical Decision Aids
OC3260	(4-0)	Sound in the Ocean
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 6

OC3266	(3-2)	Operational Acoustic Forecasting
OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
UW0810	(0-8)	Thesis Research Group/Project
EC4450	(4-1)	Sonar Systems Engineering
UW0001	(0-1)	Seminar

Quarter 7

PH3002	(4-0)	Non-Acoustic Sensor Systems
UW0810	(0-8)	Thesis Research Group/Project
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 8

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project
UW0810	(0-8)	Thesis Research Group/Project
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

SPACE SYSTEMS ENGINEERING
CURRICULUM 591

The Space Systems Engineering program provides officers, through graduate education, with a comprehensive scientific and technical knowledge of military and Navy space systems. This curriculum is designed to equip officers with the theoretical and practical skills required to design and integrate 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 time required will vary with the candidate's background. For those undertaking the electrical engineering program, the officer will have earned the equivalent of an accredited BSEE. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students.

SPACE SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of XX77P. The curriculum sponsor is N-63, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

LT level
    Project Engineer: SPAWAR
    Communications Engineer: NAVSOC
    Fleet Information Warfare Center: Little Creek, Va

LCDR - CDR level
    Assistant Project Management: SPAWAR
    Joint Interoperability Division D6: DISA
    Space Warfare Center: USSPACECOM, Colorado Springs
    NCCOSC RDTE: San Diego

ENTRY DATES

Space Systems Engineering is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 591
Academic Associate:
Oscar Biblarz, Professor
Code AA/Bi, Halligan Hall, Room 234
(408) 656-3096, DSN 878-3096

DEGREE
Requirements for one of five technical degrees are met as a milestone en route to satisfying the Educational Skill
Requirements of this curricular program. The possible degrees are: Master of Science in Electrical Engineering,
Physics, Astronautical Engineering, Computer Science or Mechanical Engineering. Degrees in other disciplines are
available for students with appropriate backgrounds, on a case by case basis.

TYPICAL COURSE OF STUDY - FALL ENTRY

Quarter 1
MA2121	(4-0)	Differential Equations
PH1322	(5-0)	Electricity and Magnetism
EC2400	(3-1)	Discrete Systems
AA2440	(3-2)	Introduction to Digital Computation
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 2
PH2514	(4-0)	Introduction to Space Environment
PH2511	(4-0)	Introduction to Orbital Mechanics
AA2820	(3-2)	Introduction to Spacecraft Structures
EC2410	(3-1)	Analysis of Signals and Systems
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 3
EC2820	(3-2)	Digital Logic Circuits
EC2500	(3-2)	Communication Systems
SS9999	(4-0)	Specialization Elective
AA3815	(3-2)	Introduction to Spacecraft Dynamics
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 4
AA3851	(3-2)	Spacecraft Propulsion
EC2300	(3-2)	Control Systems
SS9999	(4-0)	Specialization Elective
SS3001	(4-0)	Military Applications of Space
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 5
SS3035	(3-2)	Microprocessors for Space Applications
AA3818	(3-2)	Spacecraft Attitude, Dynamics and Control
SS9999	(4-0)	Specialization Elective
PH3360	(4-1)	Electromagnetic Waves Propagation
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 6
SS0810	(0-8)	Thesis Research
EO3205	(3-1)	Space Power and Radiation Effects
AA3804	(3-0)	Thermal Control of Spacecraft
SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula

Quarter 7
AA4870	(4-0)	Spacecraft Design and Integration
EO3535	(3-2)	Spacecraft Communication Engineering
SS9999	(4-0)	Specialization Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 8
MN3301	(4-0)	Systems Acquisition and Program Management
AA4871	(2-2)	Spacecraft Design and Integration II
SS9999	(4-0)	Specialization Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 9

NS3252	(4-0)	Joint and Maritime Strategy
SS9999	(4-0)	Specialization Elective
SS9999	(4-0)	Specialization Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminars and Field Trips

INFORMATION WARFARE
CURRICULUM 595

This curriculum provides the services with officers thoroughly knowledgeable in the technical and operational aspects of the role of information warfare as a vital, integral part of modern warfare. It is designed to provide an understanding of the principles underlying the broad field of Information Warfare and Command and Control Warfare.

REQUIREMENTS FOR ENTRY

Students wishing to undertake studies in this curriculum require a baccalaureate degree with above-average grades and completion of mathematics courses through integral calculus. Those lacking the background may matriculate via the Engineering Science Program (Curriculum 460). An APC of 324 is required for direct entry.

INFORMATION WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Information Warfare Subspecialist with a code of XX46P. The Curriculum Sponsor is Commander, Naval Security Group.

Typical Jobs in this Subspecialty:
Fleet and Group Staffs
Systems Commands
Navy Information Warfare Activity
Fleet Information Warfare Centers
Joint Staffs
Joint Command and Control Warfare Center

ENTRY DATE

This Information Warfare curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Curricular Officer or Academic Associate for this curriculum.

Curriculum 595
Academic Associate:
Carl Jones, Professor
Code SM/Js, Ingersoll Hall, Room 307
(408) 656-2995, DSN 878-2995
e-mail: crjones@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Systems Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Refresher

MAR118	(3-3)	Refresher: Multivariable Calculus
MAR142	(2-0)	Refresher: Matrix Algebra
PHR110	(5-3)	Refresher Physics

Quarter 1

MA2129	(5-0)	Differential Equations and Vector Analysis
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
IW2000	(3-2)	Introduction to Information Warfare
EO2413	(4-2)	Introduction to Communications Systems Engineering
IW0002	(0-1)	Seminar

Quarter 2

MA2121	(4-0)	Differential Equations
OS3104	(4-0)	Statistics for Science and Engineering
IW3001	(3-2)	Psychological Operations and Deception
EO2652	(4-1)	Field, Waves, and Electromagnetic Engineering
IW0002	(0-1)	Seminar

Quarter 3

CS3030	(4-0)	Computer Architecture and Operating Systems
OS3003	(4-0)	Operations Research for Information Warfare
PH3802	(3-2)	Weapons, Weapons Effects, and Weaponeering
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
IW0002	(0-1)	Seminar

Quarter 4

IS3502	(3-2)	Computer Networks: Wide Area/Local Area
EO4612	(4-2)	Microwave Devices and Radar
EC3750	(3-2)	SIGINT Systems
EO3402	(4-1)	Signals and Noise
IW0002	(0-1)	Seminar

Quarter 5

CS3600	(3-2)	Introduction to Computer Security
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics
IW4001	(3-2)	IW Planning and Assessment
EO3512	(3-2)	Communications and Countermeasures
IW0002	(0-1)	Seminar

Quarter 6

IW0810	(0-8)	Thesis Research/Experience Tour
EC4010	(3-2)	Principles of Systems Engineering
IW4500	(3-2)	IW Systems Engineering

Quarter 7

IW0810	(0-8)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategy
PH3204	(3-2)	Electro-Optic Systems and Countermeasures
IW9999		Elective
IW0002	(0-1)	Seminar

Quarter 8

IW0810	(0-8)	Thesis Research
IW0810	(0-8)	Thesis Research
EO4622	(3-2)	Information Warfare Systems
CS4602	(4-0)	Advanced Computer Security
IW0002	(0-1)	Seminar

ELECTRONIC WARFARE (INTERNATIONAL)
CURRICULUM 596

This curriculum provides the services with officers thoroughly knowledgeable in the technical and operational aspects of the role of information warfare as a vital, integral part of modern warfare. It is designed to provide an understanding of the principles underlying the broad field of information warfare.

REQUIREMENTS FOR ENTRY

International students must meet the 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. TOEFL is required.

ENTRY DATES

This Electronic Warfare Curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

Curriculum 596
Academic Associate:
David Jenn, Associate Professor
Code EC/Jn, Spanagel Hall, Room 414
(408) 656-2254, DSN 878-2254

TYPICAL COURSE OF STUDY

Quarter 1

PH1322	(5-0)	Electricity and Magnetism
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics

Quarter 2
CS3200	(3-2)	Computer Architecture
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

Quarter 3
IT1500	(4-0)	Information Program Seminar for International Officers
OS3604	(4-0)	Decision and Data Analysis
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
EO2413	(4-2)	Introduction to Communications System Engineering

Quarter 4
EC2170	(4-2)	Electrical Engineering Fundamentals
PH3204	(3-2)	Electro-Optic Systems and Countermeasures
EO4612	(4-2)	Microwave Devices and Radar
EO3512	(3-2)	Communications and Countermeasures

Quarter 5
CS3600	(3-2)	Introduction to Computer Security
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
EO2402	(4-1)	Introduction to Linear Systems
EO3402	(4-1)	Signals and Noise

Quarter 6
IW9999	(3-2)	Approved Elective
MR2416	(2-0)	Meteorology for Electronic Warfare
IW0810	(0-8)	Thesis Research/Group Project
EC3700	(3-2)	Introduction Services Electronic Warfare

Quarter 7
IW9999	(3-2)	Approved Elective
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/Group Project
IW0810	(0-8)	Thesis Research/Group Project

EDUCATIONAL SKILL REQUIREMENTS
SPACE SYSTEMS OPERATIONS
CURRICULUM (366)
Subspecialty Code XX76P

1. **JOINT AND MARITIME STRATEGIC PLANNING**
   American and world military history and joint 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.

2. **MILITARY OPERATIONS INVOLVING SPACE**
   The ability to derive, assess, and articulate: cost-effective requirements for the design, performance, and operational use of space systems; strategies, plans, doctrine, tactics, and operational concepts for the employment of space systems; the nature of space warfare, including the options available to protect U.S. and Allied assets and to deny the hostile use of space to others; the roles, responsibilities, and relationships of national, DoD, and Navy organizations involved in the design, acquisition, and operation of space systems; the policies of these organizations governing the management of military operations in space; intelligence collection and analysis processes and information systems and their interactions with command and control systems.

3. **COST EFFECTIVENESS AND ANALYTIC MODELING TECHNIQUES**
   An understanding of, and the ability to perform, cost-effective trade-offs involving alternate system concepts or system architectures, among elements of spacecraft design and system operations and tasking, including the space and terrestrial segments.

   The ability, through simulation, modeling, and other analytic techniques, to evaluate the contribution of space systems to warfare and to determine and define the role of space systems in strategic and tactical command and control architectures at both Navy and national levels.

4. **ORBITAL MECHANICS, SPACE ENVIRONMENT AND REMOTE SENSING**
   An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Perturbations due to non-spherical earth and due to atmospheric drag. Relationships of orbits to mission requirements.

   An understanding of 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.

   An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

5. **PROJECT MANAGEMENT**
   An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships; financial management and control; and the Planning, Programming, and Budgeting System (PPBS).

6. **COMPUTER SYSTEMS**
   General knowledge of the design and operation of computer systems, to include basic computer organization and architecture, software engineering and database management methodologies, and a rudimentary skill in at least one widely used high-level programming language, including ADA.

7. **COMMUNICATION SYSTEMS**
   A systems level understanding of digital and analog communications systems and their integration into a complete, networked communication system in multiple environments to include C3CM and electronic warfare.

8. SPACECRAFT DESIGN AND SYSTEMS INTEGRATION
A basic understanding of the major factors in and constraints on spacecraft design, including guidance and control, dynamics and structures, propulsion and power, and thermal control, and their interactions with the remainder of the space and terrestrial segments.

9. CONDUCT AND REPORT INDEPENDENT RESEARCH
The graduate will demonstrate the ability to conduct independent analysis in space systems operations and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority
Director, Navy Space Systems Division (N-63)
Director, C4 Systems (J-6)
June 1995

EDUCATIONAL SKILL REQUIREMENTS
UNDERSEA WARFARE
CURRICULUM (525)
Subspecialty Code XX44P

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. **JOINT AND MARITIME STRATEGIC PLANNING**
   The officer will have a knowledge of 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.

7. **PROBLEM SOLVING AND PRACTICAL APPLICABILITY**
   The graduate will demonstrate the ability to conduct independent analysis in undersea warfare and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority
Director, Submarine Warfare Division (N-87)
October 1993

EDUCATIONAL SKILL REQUIREMENTS
SPACE SYSTEMS ENGINEERING
CURRICULUM (591)
Subspecialty Code XX77P

1. **JOINT AND MARITIME STRATEGIC PLANNING**

   A graduate level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

2. **ORBITAL MECHANICS AND SPACE ENVIRONMENT**

   An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Perturbations due to nonspherical earth and due to atmospheric drag.

   An appreciation of 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.

   An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

3. **SPACECRAFT COMMUNICATIONS AND SIGNAL PROCESSING**

   An appreciation of signal processing techniques, both digital and analog, as applied to spacecraft communications, surveillance, and SEW.

4. **COMPUTERS: HARDWARE AND SOFTWARE**

   A programming skill in at least one high level computer programming language, such as ADA, PASCAL or FORTRAN.

   An understanding of the fundamentals of digital logic and digital system design. An ability to design simple digital computer subsystems.

   Knowledge of a typical computer architecture, such as one of the common 16-bit or 32-bit micro-processor systems. Understanding of the ways in which computers are used in complex systems such as guidance, signal processing, communications and control systems.

5. **SPACECRAFT GUIDANCE AND CONTROL**

   An understanding of the field of attitude dynamics and control which includes: Classical Newtonian Dynamics, 3 axis attitude stabilization, dual spin stabilization, nutation damping control; momentum wheels, gravity gradient booms, attitude beam pointing accuracy and thrust vector books and thrust vector control. Knowledge of minimum fuel and time type control systems.

6. **SPACECRAFT STRUCTURES, MATERIALS AND DYNAMICS**

   An understanding of the engineering of space structures including simplified sizing calculation and analytical modeling of advanced materials which can be incorporated in system design and integration.

   An ability to apply reliability and maintainability to testing, evaluation, and manufacturing which can be used to predict the functional dependability of spacecraft structures.

7. **PROPULSION SYSTEMS**

   An understanding of the operating principles of current and proposed propulsion devices for space applications; including launch, orbit changing and maneuvering engines.

   An understanding of the interaction between mission requirements and propulsion requirements.

8. **SPACECRAFT THERMAL CONTROL AND POWER**

An understanding of the principles of heat transfer by radiation and of the variations in the radiative properties of surfaces with respect to wavelength and temperature.

A knowledge of the sources of heat in space (solar, terrestrial, reflected solar, internal vehicle generation) and their variation as a function of vehicle orbit.

A 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. An understanding of the role of energy storage devices in power systems design.

9. **SPACECRAFT DESIGN AND INTEGRATION**

An understanding of 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. An appreciation of system design criteria from stated performance requirements, trade-offs between payload and other spacecraft subsystems, and a familiarity with test and evaluation procedures will be included.

10. **MILITARY OPERATIONS IN SPACE**

An appreciation of space weapons, space support to Fleet tactical operations, space defense and warfare; including options available to protect space assets and to deny the use of space to others. A familiarity with the role, responsibilities and relationships of national and Joint DoD organizations in establishing policies, priorities, and requirements for space systems; and in the design, acquisition and operation of spacecraft and supporting ground systems. An understanding of the capabilities and use of space systems to enable and support Joint air, land, and sea military operations.

11. **PROJECT MANAGEMENT**

An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships, contract management, financial management and control and the Planning, Programming and Budgeting System (PPBS).

12. **CONDUCT AND REPORT INDEPENDENT RESEARCH**

The ability to conduct independent research on a space systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

Curriculum Sponsor and ESR Approval Authority

Director, Navy Space Systems Division
May 1995

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION WARFARE
CURRICULUM (595)
Subspecialty Code XX46P

1. INFORMATION WARFARE
The officer will have an in-depth understanding of IW/C2W and the disciplines needed to support them.

2. 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.

3. INFORMATION SYSTEMS
The officer will have a systems level understanding of information systems and their vulnerabilities as well as capabilities.

4. 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.

5. INTELLIGENCE
The officer will understand the concepts, principles, methods and capabilities of joint operational intelligence, with emphasis on the operational requirements levied upon the intelligence community to support IW/C2W.

6. 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.

7. 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.

8. JOINT AND MARITIME STRATEGIC PLANNING
The officer will have an understanding of the American and world military history and joint maritime planning including the origins and evolution of national and allied strategy.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Security Group
October 1995

ACADEMIC DEPARTMENTS, GROUPS, COMMITTEES AND COURSES

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Chairman:
Gerald H. Lindsey
Professor
Code AA/Li, Halligan Hall
Room 139
(408) 656-2311
DSN 878-2311

Brij N. Agrawal, Professor of Aeronautics and Astronautics (1989)*; PhD, Syracuse University, 1970.

Robert E. Ball, Distinguished Professor of Aeronautics and Astronautics (1967); PhD, Northwestern University, 1962.

Oscar Biblarz, Professor of Aeronautics and Astronautics (1968); PhD, Stanford University, 1968.

M.S. Chandrasekhara, Research Professor and Associate Director, Navy-NASA Joint Institute of Aeronautics (1987); PhD, University of Iowa, 1983.

Daniel J. Collins, Professor of Aeronautics and Astronautics (1967); PhD, California Institute of Technology, 1961.

Russell W. Duren, Associate Professor of Aeronautics and Astronautics (1996), PhD, Southern Methodist University, 1991.

Garth Hobson, Associate Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Richard M. Howard, Associate Professor of Aeronautics and Astronautics (1987); PhD, Texas A & M University, 1987.

Isaac I. Kaminer, Assistant Professor of Aeronautics and Astronautics (1992); PhD, University of Michigan, 1992.

Gerald H. Lindsey, Chairman and Professor of Aeronautics and Astronautics (1965); PhD, California Institute of Technology, 1966.

David W. Netzer, Distinguished Professor of Aeronautics and Astronautics and Dean of Research (1968); PhD, Purdue University, 1968.

Conrad F. Newberry, Professor of Aeronautics and Astronautics (1990); D.Env., University of California at Los Angeles, 1985.

Max F. Platzer, Distinguished Professor of Aeronautics and Astronautics and Associate Chair of Instruction (1970) and Director, Navy-NASA Joint Institute of Aeronautics; Dr. Tech. Science, Technical University of Vienna, Austria, 1964.

I. Michael Ross, Assistant Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Sandra Scrivener, Assistant Professor of Aeronautics and Astronautics (1993), PhD, Pennsylvania State University, 1993.

Raymond P. Shreeve, Professor of Aeronautics and Astronautics (1971); PhD, University of Washington, 1970.

E. Roberts Wood, Professor of Aeronautics and Astronautics (1988); D. Eng, Yale University, 1967.

Edward Ming-Chi Wu, Professor of Aeronautics and Astronautics (1984); PhD, University of Illinois, 1965.

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

The Department of Aeronautics and Astronautics provides advanced education in Aeronautical and Astronautical Engineering to develop technical subspecialists in the field. Upper division undergraduate and graduate courses are offered in aerodynamics, structures, guidance and control, flight mechanics, propulsion and design, with applications to rotary wing and fixed wing aircraft, missiles and spacecraft.

Students specializing in either Aeronautical Engineering (Curriculum 610) or Aeronautical Engineering/Avionics (Curriculum 611) receive the degree Master of Science in Aeronautical Engineering, as well as select students in Combat Systems Sciences and Technology (Curriculum 533). Students in the 533 curriculum may also get a Master of Science degree in Engineering Science with an option in Aeronautics. A Master of Science degree in Astronautical Engineering is offered to students in Space Systems Engineering (Curriculum 591). Selected students may be eligible to pursue the degree Aeronautical and Astronautical Engineer, Doctor of Philosophy or Doctor of Engineering.

The Department of Aeronautics and Astronautics and the degree Master of Science in Aeronautical Engineering have been accredited by the Accreditation Board for Engineering and Technology since 1949. The degree Master of Science in Astronautical Engineering has been accredited by the Accreditation Board for Engineering and Technology since 1995.

ENTRANCE REQUIREMENTS TO STUDY AERONAUTICAL AND ASTRONAUTICAL ENGINEERING
The entrance requirement for graduate study in the Department of Aeronautics and Astronautics is a baccalaureate in the field, earned with above-average academic performance. For those without this preparation, this requirement can be met by taking the equivalent of an undergraduate major in aeronautical engineering at NPS before embarking upon graduate study. This may require up to 2 1/2 years total to obtain the Master's degree, depending upon background. Students who have not majored in aeronautics, or who have experienced a significant lapse in continuity with previous academic work, will initially take preparatory courses in aeronautical engineering and mathematics at the undergraduate upper division level, which may extend through as much as the first three academic quarters. Final approval of programs leading to degrees in aeronautical engineering must be obtained from the Chairman, Department of Aeronautics and Astronautics.

Subject coverage specifically to be approved includes mathematics and basic science, engineering science, including adequate laboratory and computer experience, and engineering design, including at least one capstone graduate level design course.

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING
The Master of Science degree requires a minimum of 36-credit hours of graduate courses in aeronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in aeronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

In very exceptional circumstances, the thesis requirement may be waived by the Department Chairman, in which case 10 hours of 4000 level courses, normally in Aeronautical Engineering, will be required in addition to those specified above, increasing the total requirement to 46 quarter hours of graduate-level credits.

MASTER OF SCIENCE IN ENGINEERING SCIENCE
Students may elect Aeronautics or Astronautics as a specialization option and receive the degree Master of Science in Engineering Science. The program must include at least 36 credit hours of graduate work in engineering, science and mathematics, at least 12 of which must be at the 4000 level. Of these 36 hours at least 20, including work at the 4000 level, must be in the Department of Aeronautics and Astronautics. Cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Aeronautics and Astronautics.

The program must contain at least 12 hours at the graduate level in courses other than those presented in the Department of Aeronautics and Astronautics.

The candidate must present an acceptable thesis on a topic which is given prior approval by the Department of Aeronautics and Astronautics. Final approval of the program leading to the Master of Science in Engineering Science with specialization in Aeronautics or Astronautics shall be obtained from the Chairman of the Department of Aeronautics and Astronautics.

MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING
The Master of Science degree in Astronautical Engineering requires a minimum of 36 credit hours of graduate courses in astronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics and Astronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in astronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

In very exceptional circumstances, the thesis requirement may be waived by the Department Chairman, in which case 10 hours of 4000 level courses, normally in Astronautical Engineering, will be required in addition to those specified above, increasing the total requirement to 46 quarter hours of graduate-level credits.

AERONAUTICAL AND ASTRONAUTICAL ENGINEER

The degree Aeronautical and Astronautical Engineer is offered in the department of Aeronautics and Astronautics and requires a minimum of 72 hours of graduate course credit. The degree also requires a graduate QPR of 3.5, with hours distributed as follows: at least 39 credit hours must be at the 4000 level, of which at least three must be in mathematics; not less than 64 graduate credit hours shall be in the disciplines of engineering, physical science or mathematics; a minimum of 36 hours must be in the Department of Aeronautics and Astronautics and at least 12 hours must be in other departments. An acceptable thesis is required for the degree, and six course equivalents, spread over four quarters, will be allowed in the program for it.

Formal application to work toward the degree must be made by memorandum to the Department of Aeronautics and Astronautics prior to commencement of thesis research, and it is required that the applicant document a graduate QPR of 3.5, an approved program of study, which contains no overloads during the quarters of thesis research, a thesis advisor and an approved Engineer's Thesis research project.

Students admitted to work for the degree Aeronautical and Astronautical Engineer may satisfy requirements for the Master of Science in Aeronautical Engineering or the Master of Science in Astronautical Engineering degree concurrently. The respective master's degrees may be conferred at the time of completion of the requirements for that degree.

An appropriate allowance will be made for work performed while earning the master's degree at another institution, not to exceed the maximum waivers in required graduate level courses specified in Section 5.3 of the Academic Council Policy Manual. Final approval of the program leading to the degree Aeronautical and Astronautical Engineer shall be obtained for each student from the Chairman, Department of Aeronautics and Astronautics.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING IN AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautics and Astronautics offers programs leading to the doctorate in the fields of gas dynamics, flight structures, flight dynamics, propulsion, aerospace physics and aerospace vehicle design.

Entrance into the doctoral program may be requested by officers currently enrolled in the Aeronautical and Astronautical Engineers Degree Program who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The Department of Aeronautics and Astronautics also accepts officer students selected in the Navy-wide Doctoral Study Program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Aeronautics and Astronautics shall submit current GRE results, transcripts of their previous academic and professional records to the Director of Admissions Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100. Upon receipt, the application shall be reviewed by the Aeronautics and Astronautics Committee for Advanced Studies. Following a successful review, the candidate is admitted to work toward the Aeronautical and Astronautical Engineer's Degree as an interim step before being formally admitted to study for the doctorate. As soon as feasible, the student shall take a screening examination, which if successfully completed, will admit him or her to study for the doctorate. A doctoral committee will then be appointed to oversee the student's study and research program.

A distinctive 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 installation of the Federal Government. The degree requirements are outlined in general school requirements for the doctor's degree.

In the event that a student is unable to finally satisfy the above requirements for the doctorate, but has in the course of his or her doctoral studies actually completed all of the requirements for the degree of Aeronautical and Astronautical Engineer, he or she shall be awarded the latter degree.

AERONAUTICAL ENGINEERING LABORATORIES

Eight major laboratory divisions support instructional and research programs in subsonic aerodynamics, gas dynamics, rocket and ramjet propulsion, turbomachinery, computer-aided engineering, flight mechanics, structures, composite materials and space systems.

The Subsonic Aerodynamics Laboratory consists of two low-speed wind tunnels, a large continuous-flow visualization tunnel and a 15x20 inch water tunnel. Standard wind tunnel techniques are used in the 32x45 inch and 42x60 inch tunnels and helium bubble filaments are used in the 5x5x12 foot test section of the three-dimensional flow visualization tunnel.

The Gas Dynamics Laboratory includes a 4x4 inch blowdown supersonic wind tunnel, a cold driven, three-inch double-diaphragm shock tube, a 2x2x18 foot open-circuit oscillating flow tunnel and a vertically mounted, supersonic free jet. Laser interferometers, schlieren systems, hot wire anemometry and laser-doppler anemometers are used. Ruby, He-Ne, Argon and CO lasers are available. Extensive use is made of laser holography. An electro-hydrodynamic research facility permits studies of electric power generation, turbulence and fuel sprays into gas turbine combustors.

The Combustion Laboratory consists of an instrumented control room, a propellant evaluation laboratory, a high-pressure air facility and three test cells equipped with diagnostic apparatus and motor hardware for investigating solid, liquid, gaseous and hybrid rocket, solid fuel ramjet and gas turbine combustion. Vitiated air heaters are used to generate temperatures to 1300°F. Several CW and one pulsed laser with holocamera, high-speed motion picture cameras, light scattering and transmission measurement systems, schlieren systems, sampling probes and a dark room equipped for holographic reconstruction and data retrieval are utilized.

The Turbo-Propulsion Laboratory (TPL) 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 10x60 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 1800°F is provided. Model experiments and equipment for instrumentation development are located in a separate laboratory. Data acquisition from 400 channels of steady state and 16 channels of non-steady state measurements at up to 100kHz is controlled by the laboratory's HP 1000 series computer system. On-line reduction and presentation of data with time sharing terminals are available to multiple users. Terminals for HP 9845 and the central AMDAHL 5990-5N computers are available for data analysis or flow computation.

The Computational Instruction Laboratory consists of 18 SGI Indigos, 6 Sun workstations, and 10 microcomputer systems. At the Distance Learning Facility at the Naval Air Systems Command, there are 3 SGI workstations and 4 personal computers that are all Unix based machines.

The Flight Mechanics Laboratory consists of a general-aviation flight simulator and the Unmanned Air Vehicle Flight Research Laboratory (UAV FRL). The simulator is used for teaching flight test engineering. The UAV FRL conducts flight research with scaled radio-controlled aircraft to study problems identified with current fleet UAVs and to test new concepts for manned and unmanned aircraft application. Research vehicles include fixed-wing, VTOL and rotary wing aircraft. The department's wind tunnels are also used for aircraft performance, stability and control measurements.

The Structural Test Laboratory contains testing machines for static and dynamic tests of materials and structures and a MTS electrohydraulic closed-loop machine for fatigue testing. Aircraft components as large as an actual aircraft wing are accommodated on a special loading floor where static and vibration tests are conducted. An adjacent strain gage facility provides support to test programs and instruction in structural testing techniques.

The Mechanics of Materials for Composites Laboratory is equipped with fabrication and testing facilities for characterizing the mechanical behavior of fiber-reinforced composites. The fabrication facilities include an oven and press with provisions for computer control of temperature and pressure profile for fabrication of laminates and strands. The testing facilities include five mechanically driven universal testing machines for general testing and for life testing. These testing facilities are supported by a wide array of modern data acquisition instruments including computer-controlled data loggers, digital voltmeters, acoustic emission analyzer and laser diffraction instruments. Personal computers and a VAX-725 provide ample capacity for analytical interpretation of data and for model formulation.

The Dynamics and Nondestructive Evaluation Laboratory is equipped for research on vibration of structures, particularly lightweight components for space structures made from composite materials like graphite/epoxy. It contains shaker tables, a four channel FFT analyzer, microcomputers with model analysis software and associated accelerometer instrumentation. For the study of wave propagation in these structures, the laboratory has high-speed transient recorders, narrow and wideband transducers, pulse generators and an arbitrary waveform generator. Static and fatigue loading of samples can be carried out on the 100 kip servo hydraulic MTS machine. The detection of flaw growth during a test can be accomplished using the acoustic emission analyzer. A 2x4 foot ultrasonic C-scan tank can be used for post-test imaging of internal damage. Phase locked loop and quadrature phase detector circuitry allow precise spatial location of flaws. This instrumentation can also be used for very accurate wavespeed measurements.

The Controls Laboratory presently consists of five experimental apparatuses with associated computers and graphic interfaces. Each experiment is a physical device which possesses, for example, input limitations, hysteresis effects and dead-space, among other effects. A computer interface and software program permits the design of a wide range of controllers for the experiments. The purpose of the laboratory is to improve understanding of control theory by design of controllers for physical devices.

The Avionics Lab is used in the design, analysis and integration of the avionics systems for unmanned air vehicles. The Lab's five workstations and three PC's are equipped with the hardware and software necessary for the development of navigation, guidance and control algorithms, as well as the complete process of testing these algorithms; first on the nonlinear simulation, then on the hardware in-the-loop simulation, and finally the flight test. The Avionics Lab is also getting involved in the design and real-time, 3D testing of cockpit display concepts.

164

SPACECRAFT LABORATORIES

There are four spacecraft laboratories within the department, viz., the FLTSATCOM laboratory, the Spacecraft Test Laboratory, the Spacecraft Attitude Dynamics and Control Laboratory and the Spacecraft Design Laboratory. The FLTSATCOM laboratory houses a qualification model of the Navy's communication satellite (which provides global UHF coverage) along with the associated hardware and software used to test the satellite's subsystems. The test laboratory contains a vibration shaker system and a thermal vacuum chamber system. The former is used for testing typical vibration loads on a spacecraft, and is capable of simulating both low frequency (swept sinusoidal) and random vibrations. The latter is used to test the operation of spacecraft materials/subsystems under the combined conditions of space vacuum (below 10-5 torr) and thermal environment. The third laboratory contains a scaled model of a generic flexible spacecraft and simulates the pitch motion. It is used to study the interaction between the attitude control and the dynamics of flexible spacecraft, where the flexibility may be due to structures and/or liquid propellants. It also has experiments on vibration isolation and antenna shape control using smart structures. The fourth laboratory contains computer-aided spacecraft design tools and a spacecraft design library.

NAVY-NASA JOINT INSTITUTE OF AERONAUTICS

Through a Memorandum of Understanding with the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA), a Joint Institute of Aeronautics was established in July 1986. The purpose of the Institute is to provide NPS students with opportunities to perform their thesis research in an ARC Laboratory, to involve NPS faculty and students in NASA scientific and engineering projects, to develop special courses and seminars for NPS and ARC scientists and engineers to refresh and strengthen professional knowledge at NPS and ARC, and to encourage the enrollment of federal employees for graduate study at NPS with the possibility of performing the thesis research at ARC. Information about research opportunities and admission procedures can be obtained from the Institute Director, Dr. M.F. Platzer, or the Associate Director, Dr. M.S. Chandrasekhara.

AERONAUTICAL AND ASTRONAUTICAL COURSE DESCRIPTIONS

AAR242 THERMODYNAMICS/FLUID MECHANICS REFRESHER (NO CREDIT) (Meets last six weeks of quarter.) (5 - 0).
This course is intended for students returning to school after a prolonged absence and will be taught as refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered include the first and second laws of thermodynamics, entropy, perfect gas laws, conservation of mass/momentum/energy from a control-volume point of view with constant density, and external viscous flow including both laminar and turbulent flows.

AAR261 SOLID MECHANICS REFRESHER (NO CREDIT) (Meets last six weeks of quarter.) (5 - 0).
This course is intended for the student returning to school after a prolonged absence and will be taken as a refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered include centroids, moments of inertia, equilibrium and free-body diagrams, bending and torsion, shear and moment distributions, stress and strain.

AA0020 AERONAUTICAL ENGINEERING PROGRAM PLANNING (NO CREDIT) (0 - 1).
Oral presentations to prospective thesis students by the department faculty, covering thesis research opportunities in specialty areas of Aeronautical Engineering.

AA0810 THESIS RESEARCH (0 - 8).
Represents an equivalent of one four hour course spent in thesis research. Every student working on a thesis will enroll in this course, and more than one call may be made for the course in any given quarter.

AA2021 INTRODUCTION TO FLIGHT STRUCTURES (4 - 1).
Engineering analytical stress analysis methods for wing and fuselage structures, beginning with the field equations for solid bodies and specializing to calculations of multiaxial bending and shear stresses of composite structures, with temperature loading, in open and multicelled closed sections. PREREQUISITE: ME2601.

AA2035 BASIC AERODYNAMICS (3 - 2).
Conservation equation for inviscid incompressible flow; dimensional analysis; fundamentals of potential flow theory; source flow, doublet flow, vortex flow; Kutta-Joukowski theorem; airfoil theory; finite wing theory; panel and vortex lattice method; slender body theory.

AA2036 PERFORMANCE AND STATIC STABILITY (3 - 2).
Concepts of aircraft thrust, power, range, endurance and energy management are developed with application to propeller-driven and jet-powered aircraft. Longitudinal and lateral-directional static stability and flight control principles are derived, with relevant issues such as canards and longitudinal instability considered. Applications of Navy aircraft (P-3, A-6, A-7, E-2C, F-14, F-16 and F/A-18) and needs for future military aircraft are treated. PREREQUISITE: AA2035.

AA2042 FUNDAMENTALS OF THERMO & FLUID DYNAMICS (3 - 2).
Review of zero, first and second laws of thermodynamics; entropy and irreversibilities. Equations of state for gases. Control volume formulations to determine properties of fluids. Principles of continuity, momentum and energy applied to incompressible fluids. Carnot and Brayton power cycles. Viscous flow in ducts; boundary layer concepts; flow separation and drag. PREREQUISITE: MA1118.

AA2043 FUNDAMENTALS OF GAS DYNAMICS (3 - 2).
Concepts of compressible flows, adiabatic/isentropic flow; normal shocks, moving and oblique shocks, Prandtl-Meyer flow; Fanno and Rayleigh flow; introduction to reaction propulsion systems. Design problems include a supersonic intake and engine design point selection. PREREQUISITE: AA2042.

AA2339 AEROSPACE SYSTEM DYNAMICS (3 - 2).
A general class of frequency-domain-based and state space control theories for aircraft and missile guidance and control are covered. Various feedback stabilization schemes are investigated with practical application to flight control system design. Examples of using classical control techniques to design a typical autopilot are given.

AA2440 INTRODUCTION TO DIGITAL COMPUTATION (3 - 2).
Introduction to system operations and program development on the department UNIX work stations 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. PREREQUISITE: MA1118.

AA2801 AERO-LABORATORIES (3 - 2).
An introduction to modern experimental techniques and instrumentation. Lectures and demonstrations in the use of sensing devices and data acquisition systems, data reduction and analysis, and report writing. Selected experiments from all aeronautical disciplines. PREREQUISITES OR CONCURRENTLY: AA2021, AA2035, AA2043.

AA2820 INTRODUCTION TO SPACECRAFT STRUCTURES (3 - 2).
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.

AA3101 FLIGHT VEHICLE STRUCTURAL ANALYSIS (3 - 2).
Energy methods of analytical structural analysis applied to aircraft structures, buckling of stiffeners and longerons in the elastic and plastic range, column buckling theory applied to stiffened and unstiffened wing skins; introduction to finite element theory through the truss, beam and constant strain triangle element. PREREQUISITE: AA2021.

AA3202 AIRCRAFT STRUCTURAL FAILURE, FRACTURE AND FATIGUE (3 - 2).
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 aircraft fatigue tracking and monitoring. PREREQUISITE: AA2021.

AA3251 AIRCRAFT COMBAT SURVIVABILITY (4 - 1).
This course brings together all of the essential ingredients in a study of the survivability of fixed wing aircraft, rotary wing aircraft, and cruise missiles in a hostile (non nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of survival in a AAA/SAM environment are presented in some detail. Topics covered include: current and future threat descriptions; the mission/threat analysis; combat analysis of SEA and Desert Storm losses; vulnerability reduction technology for the major aircraft systems; susceptibility reduction concepts, including stealth; vulnerability, susceptibility, and survivability assessment; and trade-off methodology. In-depth studies of the survivability of several fixed wing and rotary wing aircraft will be presented. (May be taken for 3 credits through self study as AA3250). PREREQUISITE: U.S. Citizenship and SECRET clearance.

AA3260 INTRODUCTION TO AVIONICS SOFTWARE ENGINEERING (3 - 2).
This course will introduce students to the concepts of software engineering with particular emphasis on avionics applications. Software development, management and process improvement as described in DoD-STD-2176A, MIL-STD-498, and the SEI Capability Maturity Model will be presented. The design of real-time embedded avionic systems will be discussed with particular attention to mission-critical and safety-critical software. Avionics architectures and interfaces will be examined. Languages and automated tools used for software engineering on avionics projects will be reviewed. Program examples will be presented in ADA, C++ and MIL-STD-1750 assembly language. PREREQUISITE: AA2440.

AA3272 INTRODUCTION TO SYSTEMS ENGINEERING (3 - 2).
This course uses system engineering as a design methodology throughout the formal system acquisition life-cycle process: mission need, concept exploration & definition, demonstration & validation, engineering & manufacturing development, production, deployment and operations support. It includes quality function deployment (QFD), Taguchi methods, review processes, test & evaluation, survivability, modeling, simulation, and cost functions associated with the development of all airborne systems. Attention is given to requirement analysis, functional analysis/allocation and synthesis. Students become familiar with design software in their emphasis area (aircraft, missiles, engine or helicopter) of choice. Students form an Integrated Process and Product Development (IPPD) Team for the purpose of initiating a response to a given Request-for-Proposal (RFP) associated with a major aeronautical system. Application of systems engineering concepts to an airborne system/subsystem RFP. PREREQUISITES: AA3101, AA3341, AA3451 and AA3501 or their equivalents.

AA3276 INTRODUCTION TO AVIONICS (3 - 2).
This course will introduce the students to the general functional and system architecture of a typical avionics system. It will then proceed to discuss in greater detail the tools necessary to better understand such systems. In particular the course will cover topics related to commonly used coordinate systems and transformations for modern aircraft guidance and navigation. We will discuss the inertial measurement sensors and how they can be used to compute the aircraft's inertial position. The errors associated with this approach will be analyzed. The course will then cover the external navigation aids such as LORAN, TACAN, DME/VOR and GPS. The lab demonstrating the GPS receiver will be included. Next, the students will be introduced to Kalman filtering as a way to integrate onboard inertial measurement sensors with external navigation aids. PREREQUISITES: AA2339 or equivalent, AA4641 concurrently or permission of the instructor.

AA3340 DYNAMIC STABILITY OF AEROSPACE VEHICLES (3 - 2).

Eigenvalue-problem solutions for undamped and damped systems with free and forced responses are developed. Aircraft dynamic equations of motion are derived to analyze longitudinal and lateral-directional flight modes using state-space methods. Military aircraft problems considered include inertial cross-coupling, limit-cycle wing rock, and yaw damper feedback. A short introduction to spacecraft dynamics is also included.

AA3341 CONTROL OF AEROSPACE VEHICLES (3 - 2).

This course will introduce students to basic concepts of linear systems such as controllability, observability, detectability and stabilizability. The course will then present the fundamentals of realization theory and will go on to discuss internal and input/output stability of linear systems. The course will also investigate the effect of white noise excitation on aerospace vehicles through covariance analysis based on Lyapunow equation. The course will then proceed to introduce the Linear Quadratic Regulator and Kalman Filtering Theory. All the concepts in the course will be done for both continuous and discrete-time systems. Relevant military examples will be presented at each step of the material development. PREREQUISITES: AA2339, AA3340.

AA3402 HELICOPTER AEROMECHANICS (3 - 2).

This course introduces the student to the fundamentals of helicopter aeromechanics which includes: (1) aerodynamics; (2) dynamics; (3) vibrations; (4) aeroelasticity; and (5) controls. Aerodynamics of the helicopter. Hover and vertical flight. Actuator disk, momentum theory, blade element theory, tip loss, rotor flow states, autorotation, hover and forward flight analysis, rotor trim, and performance analysis. Helicopter dynamics, rotor blade motion and control, rotor-as-a-filter, blade dynamic response, coupled blade-fuselage response, ground and air resonance, vibration control devices, and higher harmonic control. PREREQUISITE: AA2035.

AA3451 AIRCRAFT AND MISSILE PROPULSION (3 - 2).

Overview of engine types. Introduction to rocket propulsion and performance prediction. Solid propellant selection, combustion and nozzle flow analyses for Sidewinder-type missiles. Ideal theory, design point selection and off-design performance of turbo-jet, ramjet, turbo- fan, turbo-prop and turbo-shaft engines. Application to multi-purpose fighter aircraft, ocean-surveillance aircraft and helicopter propulsion. Use of design and off-design computer codes. Basic analysis of engine components, including inlets, compressors and fans, combustors, turbines, after-burners and nozzles. PREREQUISITE: AA2043.

AA3501 AERODYNAMIC ANALYSIS (3 - 2).

Conservation equations for viscous compressible flow; incompressible boundary layer theory for steady airfoil flows; laminar boundary layer solutions, Blasius and Falkner-Skan; transitional and turbulent boundary layers; turbulence modeling; Cebeci-Smith model; finite-difference boundary layer code; compressible subsonic airfoil theory; Prandtl-Glauert rule; sweep effect; transonic flow effects; area rule; supercritical airfoils; linearized supersonic airfoil theory; supersonic wing theory; fundamentals of hypersonic flow theory. PREREQUISITES: AA2035, AA2043.

AA3701 MISSILE AERODYNAMICS (4 - 1).

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. PREREQUISITE: AA2043.

AA3705 AIR DEFENSE LETHALITY (4 - 1).

This course examines the design and effectiveness of anti-aircraft guns and missiles, both surface based and airborne. The techniques and procedures for target detection, target tracking, and propagator flyout (both guided and ballistic) are presented and quantified. Target signatures for radar, IR, and visually directed systems are examined. The types of warheads and fuzes on small arms, anti-aircraft artillery, and guided missiles are presented. Vulnerability of the target to the damage mechanisms is examined, and the procedures for assessing the measures of target vulnerability are described. Total system lethality is evaluated by determining the probability of target kill given a single shot and given an encounter. Countermeasures used by the target for reducing air defense lethality are also described.

AA3802 AERONAUTICAL MEASUREMENT TECHNIQUES (3 - 2).

Hands-on exposure to modern laboratories including measuring and evaluation techniques. Introduction to test facilities at NASA and aerospace industry relevant to research, development and testing phases (RDT&E) of military hardware. Topics vary somewhat from offering to offering but cover significant current laboratory work within aerospace disciplines. PREREQUISITE: AA2801.

AA3804 THERMAL CONTROL OF SPACECRAFT (3 - 0).

Conduction, radiation, thermal analysis, isothermal space radiator, lumped parameter analytical model, spacecraft passive and active thermal control, heat pipes, and louvers.

AA3811 SPACE SYSTEMS LABORATORY (1 - 2).
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. PREREQUISITE: Consent of Instructor.

AA3815 INTRODUCTION TO SPACECRAFT DYNAMICS (3 - 2).
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: PH1121, PH2511, MA2121.

AA3818 SPACECRAFT ATTITUDE, DYNAMICS AND CONTROL (3 - 2).
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, AA3815.

AA3820 DYNAMICS OF SPACE SYSTEMS (3 - 2).
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. PREREQUISITE: MA2121.

AA3851 SPACECRAFT PROPULSION (3 - 2).
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_2/O_2 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. PREREQUISITE: Graduate standing in science or engineering.

AA3852 PROPULSION FOR LAUNCH VEHICLES (4 - 0).
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. PREREQUISITES: AA2042, AA2043.

AA3900 SPECIAL TOPICS IN AERONAUTICS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman. Graded Pass/Fail.

AA4000 AERONAUTICAL ENGINEERING SEMINAR (NO CREDIT) (1 - 0).
Oral presentations on subjects not covered in formal courses, which treat a wide spectrum of topics ranging from reports of current research to survey treatments of Navy issues and problems of scientific and engineering interest.

AA4103 MECHANICS OF COMPOSITE MATERIALS (3 - 2).
A course covering the mechanics of multi-phased composite materials. Prediction of composite properties from the constituent fiber/matrix properties. Design of composite structural components including laminates and sandwich construction. Fabrication and manufacturing techniques for aircraft, missiles and ship structures. Survey of strength theory, damage and repair. PREREQUISITE: AA2021 or ME3611.

AA4201 RELIABILITY ENGINEERING AND SYSTEM SAFETY MANAGEMENT (4 - 0).
An introduction to System Safety based on the foundations of statistical sampling and probability modeling with applications to military standard requirements. Mathematical foundations (probability, set theory, Boolean algebra, distribution functions); reliability testing (experimental planning via Monte Carlo simulations, parameter estimation); safety analysis (hazard analysis, fault-tree analysis, monolithic and redundant components) safety criteria and life cycle considerations. Application to aircraft maintenance, repair and retirement strategies.

AA4273 AIRCRAFT DESIGN (3 - 2).
Conceptual military and/or military related aircraft design methodology utilization and application centers around a student team design project focused on a military need defined by a Request-For-Proposal. Performance, cost

supportability, deployment, manufacturing, product quality and environmental consideration are all included in the design process. The project draws on all of the aeronautical disciplines and provides students with experience in the application of the aerospace disciplines to military aircraft design. PREREQUISITE: Completion of the Aero Graduate Core.

AA4276 AVIONICS SYSTEM DESIGN (3 - 2).

This course will take students through each stage involved in the design, modelling and testing of a core avionics system, i.e., guidance, navigation and control (GNC) systems. Students will be asked to choose an airplane, model its dynamics on a nonlinear simulation package such as SIMULINK and then design a GNC system for this airplane. The complete design is to be tested on SIMULINK. Course notes and labs will cover all the relevant material. PREREQUISITES: AA3276, AA4641.

AA4304 HELICOPTER STABILITY AND CONTROL (3 - 2).

This course is especially important to students who will later be involved in helicopter flight testing or helicopter design. Rotorcraft general equations of motion. Rotor blade forces and motions in hover and forward flight. Derivation of trim equations and stability derivatives. Rotorcraft static and dynamic stability requirements. State space and frequency response methods of analysis. Control response. Helicopter flight simulation using real-time "FLIGHTLAB" code. Design of helicopter to meet military flying quality requirements as set forth in MIL-H-8501 and ADS-33 specifications. PREREQUISITE: AA3402.

AA4305 V/STOL AIRCRAFT TECHNOLOGY (3 - 2).

Types of V/STOL aircraft, fundamental principles, main performance characteristics, and propulsion requirements; STOL technology: mechanical and powered high-lift devices, jet flaps, augmentor wings; VTOL technology: flow vectoring devices, lift engine and lift fan technology, airframe/propulsion system interactions, ground interference effects; review of past and current military V/STOL aircraft programs, Joint Strike Fighter and V-22 programs. PREREQUISITES: Undergraduate core.

AA4306 HELICOPTER DESIGN (3 - 2).

A capstone course in helicopter design where students complete preliminary design of a helicopter to meet mission and military specification requirements. The course is conducted as part of national AHS/Industry competition. It begins with vehicle design trade-off selection to meet speed, range, maneuver, and air transportability requirements. Rotor design for solidity aerodynamic, autorotation, and blade dynamics. Includes design for physical parameters, aircraft structure, armament/weapons system, cockpit cooling, engine and drive train system, weights and balance, performance, handling qualities, combat survivability, safety and crash worthiness, maintainability, and determination of production and direct operating costs. PREREQUISITE: AA4304.

AA4318 HELICOPTER AND AIRCRAFT AERODYNAMICS AND AEROELASTICITY (4 - 0).

Helicopter aerodynamics; momentum theory; blade element theory; vortex theory; static aeroelasticity; types of flutter; unsteady inviscid flow theory; indicial and oscillatory aerodynamics; subsonic and supersonic flutter analysis; dynamic response phenomena and prediction methods, buffet and stall flutter, helicopter blade interference and higher harmonic control effects. PREREQUISITE: Undergraduate Core.

AA4323 FLIGHT TEST ENGINEERING (3 - 2).

Methods for pilot-static calibration, cruise and climb performance, stall testing, longitudinal static and dynamic stability, maneuvering stability, lateral-directional stability, and transonic flying qualities, are treated. An introduction to parameter-estimation methods is presented with military aircraft as examples. PREREQUISITES: AA2036, AA3340.

AA4342 ADVANCED CONTROL FOR AEROSPACE SYSTEMS (3 - 2).

This course is a continuation of AA3341. Here the students will be introduced to more recent developments in control theory. First, the course will concentrate on the analysis of the feedback systems. Such ideas as induced norms, small gain theorem, Kharitonov Theorem and structured singular value as well as Bode gain-phase relationship will be introduced. The course will then proceed to discuss the recently developed H infinity synthesis technique. Applications of these techniques to the design and analysis of fighter and missile control systems will be presented. Whenever possible, the development will be done for both continuous and discrete-time systems. PREREQUISITE: AA3341.

AA4431 TURBOMACHINES: ANALYSIS, DESIGN & EXPERIMENT (3 - 2).

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. PREREQUISITE: AA2043.

AA4451 AIRCRAFT ENGINE DESIGN (3 - 2).
The conceptual and preliminary component design of military, or military related, airbreathing engines is experienced within student design teams. The course is focused on a team response for a Request-for-Proposal (RFP) for an airbreathing 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 aeronautical disciplines and provides students with experience in the integration and application of these disciplines to military air breathing engine design. PREREQUISITES: AA3451 and AA3501.

AA4452 TACTICAL MISSILE PROPULSION (4 - 0).
Applications and analysis 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 of rockets and ramjets. Introduction to insensitive munitions and plume signature considerations. Use of NATO/AGARD performance calculation and plume classification methods. PREREQUISITES: AA2042 or PH2724, AA2043.

AA4502 HIGH-SPEED AERODYNAMICS (4 - 0).
Transonic, vortex lift, and unsteady aerodynamics. Elements of hypersonic flow, area rule, supercritical airfoils, plus other topics of current military research importance. Numerical techniques as well as perturbation methods of solution. PREREQUISITE: AA3501.

AA4505 LASER/PARTICLE BEAM TECHNOLOGIES (3 - 2).
Elements of lasers and particle beams are presented together with a survey of their technologies. High energy lasers, including electrical, gas dynamic, excimer and chemical lasers, are typically treated. Concepts in beam management, propagation and damage mechanisms are discussed. Current military applications and future trends are covered as special topics. PREREQUISITES: Aero Preparatory Phase or equivalent.

AA4506 RAREFIED GAS DYNAMICS (4 - 0).
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: Aero Preparatory Phase or equivalent.

AA4507 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER (3 - 2).
The emphasis will be on the 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 flight and propulsion problems. PREREQUISITE: MA3232 or MA3243.

AA4641 DIGITAL AVIONICS SYSTEMS (3 - 2).
A design-project oriented course, utilizing microprocessor technology with emphasis on aeronautical engineering applications. Both software and hardware aspects of system integration will be considered for engineering tradeoffs during problem definition and solution. PREREQUISITE: Avionics core or equivalent.

AA4703 MISSILE FLIGHT ANALYSIS (4 - 1).
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. PREREQUISITE: AA3701.

AA4704 MISSILE DESIGN (3 - 2).
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 of all of the aeronautical disciplines, including 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: AA3701, AA4452 and AA4703.

AA4816 DYNAMICS AND CONTROL OF SMART STRUCTURES (4 - 0).
Principles of Lagrange's equation, Kane's equation, finite element method, structural natural frequencies and mode shapes, controllability and observability, optimal control, and observers. Equations of motion for a flexible spacecraft simulator. Smart sensors, actuators, and finite element models of smart structures. Application of smart structures to active vibration and shape control of space structures. PREREQUISITES: EC2300 or equivalent and AA2820 or equivalent.

AA4830 SPACECRAFT SYSTEMS I (Intended for curriculum 366.) (3 - 2).
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.

AA4831 SPACECRAFT SYSTEMS II (Intended for curriculum 366.) (3 - 2).
In this course, students will be involved in a group project to design a spacecraft to meet mission requirements. Material presented in AA4830 as well as AA4831 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. PREREQUISITE: AA4830.

AA4844 HYPERSONIC FLIGHT (4 - 0).
Trajectories and characteristic features of flow over re-entry and hypersonic flight vehicles. Effects of Mach number, high enthalpy and low density. Analysis and computational methods for blunt and slender bodies, and for practical vehicle shapes. Ground simulation of re-entry and sustained flight environments. Waverider aircraft and missiles. The hypersonic air breathing SSTO vehicle and potential military derivatives. PREREQUISITES: AA2035 or consent of instructor, AA2043.

AA4850 SPACECRAFT PERFORMANCE AND OPTIMIZATION (3 - 2).
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, state-space formulation, vehicle and environmental models, performance measures, problem of Bolza, Maximum Principle, Hamiltonian and transversability conditions, and the Bang-Bang Principle. The course is focused on a number of problems in Astronautics such as the Goddard problem, bi-linear tangent steering, Single-Stage-To-Orbit problem, Low-Earth-Orbit maintenance, Moon-landing problem, aerobraking and aerocapture. Where appropriate, the course will illustrate systems aspects of mission design. PREREQUISITES: PH2511, PH2514, AA3341, AA3815, AA3851, or equivalent.

AA4870 SPACECRAFT DESIGN AND INTEGRATION I (4 - 0).
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: AA2820, AA3804, AA3851, AA3818, EC3230, PH2511.

AA4871 SPACECRAFT DESIGN AND INTEGRATION II (2 - 2).
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. PREREQUISITE: AA4870.

AA4900 ADVANCED STUDY IN AERONAUTICS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman. Graded Pass/Fail.

COMMAND, CONTROL AND COMMUNICATIONS (C3) ACADEMIC GROUP

Chairman:
Dan C. Boger, Professor
Code CC, Root Hall
Room 201D
(408) 656-3671/2535 (Voice)
DSN 878-3671/2535
(408) 656-3679 (Fax)

Dan C. Boger, Chairman and Professor (1979)*; PhD, University of California at Berkeley, 1979.

Rex A. Buddenberg, Lecturer (1993); MS, Naval Postgraduate School, 1986.

Ralph N. Channell, Senior Lecturer (1987); MA, Boston University, 1964.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Donald P. Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

John H. Gibson, Lt Col, U.S. Air Force, Lecturer (1995); MS, Naval Postgraduate School, 1990.

Wayne P. Hughes, Jr., Senior Lecturer (1979); MS, Naval Postgraduate School, 1964.

Steven J. Iatrou, LCDR, U.S. Navy, Lecturer (1996); MS, Naval Postgraduate School, 1992.

Carl R. Jones, Professor (1965); PhD, Claremont Graduate School, 1965.

Frank B. Kelly, CAPT, U.S. Navy, Lecturer (1996); MA, Naval Postgraduate School, 1977.

William G. Kemple, Associate Professor (1990); PhD, University of California at Riverside, 1991.

David Kleinman, Visiting Professor (1994); PhD, Massachusetts Institute of Technology, 1967.

Hershel H. Loomis, Jr., Professor and Chairman for Electrical and Computer Engineering (1981); PhD, Massachusetts Institute of Technology, 1963.

Orin E. Marvel, Visiting Associate Professor and Chair in Command, Control and Communications (1994); PhD, University of Illinois, 1970.

Gordon McCormick, Associate Professor (1992); PhD, Johns Hopkins University, 1985.

Paul H. Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Michael Mullady, Lt Col, U.S. Air Force, Curricular Officer (1997); MA, Webster University, 1986.

John Osmundson, Associate Professor (1995); PhD, University of Maryland, 1968.

Patrick J. Parker, Professor (1974); MBA, University of Chicago, 1955.

Gary R. Porter, Research Assistant Professor (1993); MS, Naval Postgraduate School, 1980.

Craig Rasmussen, Associate Professor (1991); PhD, University of Colorado at Denver, 1990.

Nancy C. Roberts, Professor (1986); PhD, Stanford University, 1983.

Timothy J. Shimeall, Associate Professor (1988); PhD, University of California at Irvine, 1988.

Michael G. Sovereign, Professor (1970); PhD, Purdue University, 1965.

Donald van Z. Wadsworth, Senior Lecturer (1988), PhD, Massachusetts Institute of Technology, 1958.

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

The Command, Control and Communications (C3) Academic Group is an interdisciplinary association of faculty. The C3 Academic Group has responsibility for the academic content of the Joint Command, Control, Communications, Computers and Intelligence curriculum, the Scientific and Technical Intelligence curriculum, and a C4I research program. Thesis topics are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree Master of Science in Systems Technology (Command, Control and Communications) or the degree Master of Science in Systems Technology (Scientific and Technical Intelligence) will be awarded at the completion of the appropriate interdisciplinary program carried out in accordance with the following degree requirements.

The Master of Science in Systems Technology (Command, Control and Communications) or the Master of Science in Systems Technology (Scientific and Technical Intelligence) requires 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 of the Command, Control and Communications Academic Group.

SYSTEMS TECHNOLOGY LABORATORIES (STL)

The NPS Systems Technology Laboratories provide centrally managed, supported, and funded facilities where students and faculty can conduct research and instruction using tomorrow's C4I systems technologies today. The facilities provide for classified and unclassified capabilities for students and faculty to use for immediate classroom reinforcement, student projects, and theses and for faculty and students to conduct leading edge research in their fields. The labs, through advanced telecommunications and networking, allow local platforms of various types to communicate at very high data rates with each another over the NPS backbone and with other national laboratories and research facilities worldwide using Internet, SIPRNET, and ATM networks, such as DARPA's Leading Edge Services ATM network, the California Research and Education Net (CALREN), Defense Research and Evaluation Net (DREN), and other wideband wide area networks that define the nation's information infrastructure. Using these capabilities, researchers can collaborate with leading researchers and can participate in systems technology research efforts of national prominence.

The NPS Systems Technology Laboratories contain (or have distributed access to) actual command and control systems for exercises and experiments. The prime example of this is a fully-functional CINC version of the Global Command and Control System (GCCS) with SECRET interconnectivity to all CINCs and supporting sites. GCCS permits CINCs to complete crisis action plans including assessment, evaluation, and development of options, as well as selection, dissemination and monitoring of execution. The STL routinely conducts experiments with humans in the loop. Operational teams of officer-students can be trained/tested using wargames as stimuli and using data collection techniques to evaluate performance under varied, but controlled, conditions. Insights into requirements for new doctrine, training and other aspects of the joint environment may be identified that will speed the acceptance of new approaches to decision-making and training.

COMMAND, CONTROL AND COMMUNICATIONS (C3) COURSE DESCRIPTIONS

CC0001 SEMINARS, VIDEOTELECONFERENCES, AND FIELD TRIPS FOR C4I STUDENTS (0 - 3).
Seminars (consisting of guest lectures, videoteleconferences, and field trips) are scheduled to provide background information on specific Joint C4I systems and activities.

CC0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

CC2040 INTRODUCTION TO SYSTEM TECHNOLOGIES (3 - 2).
This course is a technical introductory course for students in the Systems Technology curricula. It discusses the GCCS Common Operating Environment (COE) as it relates to modern C4I technology and combat, as well as selected relevant emerging technologies in operational information processing. It addresses the elements of COTS (Commercial Off-The-Shelf) workstations, architectures, operating systems, and National Information Infrastructure (NII). Students are provided relevant experiences through a focused introduction to GCCS, C programming, Unix operating systems, and Internet applications in the secure Systems Technology Lab. This is a required course for all Joint C4I Systems Curriculum and Space Systems Operations Curriculum students. PREREQUISITE: None. Taking CC3000 concurrently is recommended.

CC3000 INTRODUCTION TO COMMAND, CONTROL, COMMUNICATION, COMPUTER AND INTELLIGENCE SYSTEMS IN DOD (4 - 0).
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 wargaming. PREREQUISITES: Enrollment in the Joint C4I systems curriculum, OS2103 concurrently, and SECRET clearance.

CC3040 INTRODUCTION TO JOINT COMMAND AND CONTROL SYSTEMS (JCCS) (3 - 3).
This course introduces students to the principles, methods, and various joint command and control systems that enable our military commanders to plan and successfully execute their assigned new world order missions. It features use of the Global Command and Control System (GCCS) in a lab environment to provide practical reinforcement to theory and principles taught in the classroom. This classified real-time world-wide C4I system will allow students to plan and conduct joint operations and exercises using actual military data. It also allows students to observe how actual combatant commanders plan and conduct their missions and exercises on a real-time collaborative basis. PREREQUISITES: U.S. citizenship, a SECRET clearance, and CC2040. CC3000 or NS3252, or equivalent, is also recommended.

CC3101 COMBAT ANALYSIS FOR C3 (4 - 0).
Introduction to combat modeling and analysis for C4I students. Emphasis is on the use of mathematical models of search and attack on land and sea to help operational and tactical commanders solve wartime problems or improve the effectiveness of their forces. 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. PRE-REQUISITES: CC3000, and OS2103 (may be concurrent).

CC3111 C4I MISSION AND ORGANIZATION (4 - 0).
A survey of command, control and communications organizations within OSD, JCS, and the Service headquarters. Execution of National Security Policy and planning for joint employment of general purpose forces are discussed. Service combat organization and service tactical C3 systems are covered. Emphasis is on description of existing C4I organizations and systems, with brief historical perspective. PREREQUISITE: SECRET clearance.

CC3900 SPECIAL TOPICS IN COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE SYSTEMS (V - 0).
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. PREREQUISITE: Consent of Group Chairman. Graded on Pass/Fail basis only.

CC4004 C3 IN NATO (4 - 0).
Application of C4I principles to the special problems of NATO. The range of alternatives to improving arms stability in Europe will be explored, including high-tech solutions such as FOFA, low-tech "green" barriers and militia, as well as arms negotiations. C4I planning and evaluation will be covered in application. PREREQUISITES: U.S. citizenship and SECRET clearance; CC4103 or equivalent.

CC4006 ADVANCED C2 ANALYTICAL CONCEPTS (4 - 0).
The study of the combat organization's C2 in equilibrium and disequilibrium. The use of Petri Nets in understanding equilibrium is emphasized. The role of catastrophe and chaos theory in understanding disequilibrium is covered. PREREQUISITE: CC4103 or equivalent.

CC4040 ADVANCED JOINT COMMAND AND CONTROL SYSTEMS (JCCS) (3 - 3).
Advanced instruction in the integration of various existing and emerging joint command and control systems that enable military commanders to plan and successfully execute their missions. Hands-on use of the Global Command and Control System (GCCS), both existing and emerging applications, in a lab environment to provide practical reinforcement to theory and principles covered in lectures. Students will plan, conduct, and analyze joint operations and exercises using real-time, current military data. Students will observe how combatant commands plan and conduct their missions and exercises on a real-time collaborative basis. PREREQUISITES: CC3040, CC4103 (concurrently) and SECRET clearance.

CC4101 SYSTEMS ENGINEERING FOR JOINT C4I SYSTEMS (4 - 2).
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. PRE-REQUISITES: CC3000, OS3604, and TOP SECRET clearance with eligibility for SI/SAO.

CC4103 C4I SYSTEMS EVALUATION (2 - 4).
Experiments in determining C4I system effectiveness using war gaming and simulation. Design of experiments. Survey of current C4I systems evaluation techniques. PREREQUISITES: CC4101, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4200 COMBAT SYSTEMS ENGINEERING (4 - 0).
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. The contribution of the technical disciplines to the statement and solution of decision problems in design, priority setting, and scheduling are explored through the use of currently outstanding issues. PREREQUISITES: Consent of the Instructor, basic probability and statistics, 4th quarter standing, SECRET clearance. Graded on a Pass/Fail basis only.

CC4750 MILITARY C4I SYSTEMS AND NETWORKS (3 - 1).
By means of case studies of tactical and strategic military C4I systems, student familiarity is developed concerning system aspects such as network architecture, joint and combined interoperability, measures of performance, and vulnerability to ECM. Models and simulations in current use by DoD are used to determine the operational constraints imposed on the commander by system technical parameters, including environmental factors, under both limited objective and major combat scenarios. A required course for the 365 curriculum. PREREQUISITES: EO3523 (may be concurrent) or equivalent, and SECRET clearance.

CC4900 ADVANCED STUDY IN COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE SYSTEMS (V - 0).
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. PREREQUISITE: Consent of Group Chairman. Graded on a Pass/Fail basis only.

CC4913 POLICIES AND PROBLEMS IN C3 (4 - 0).
Study of the fundamental role C3 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. Specifically for students in the 365 curriculum. PREREQUISITES: CC4103, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

DEPARTMENT OF COMPUTER SCIENCE

Chairman:
Dan C. Boger
Code CS, Spanagel Hall
Room 513
(408) 656-2449

**Academic Associate of
Computer Science Curriculum**
Yutaka Kanayama
Code CS/Ka, Spanagel Hall
Room 512
(408) 656-2095

**Associate Chairman for
Research**
Neil Rowe
Code CS/Rp, Spanagel Hall
Room 514
(408) 656-2462

**Associate Chairman for
Instruction**
Robert McGhee
Code CS/Mz, Spanagel Hall
Room 511A
(408) 656-2026

**Academic Associate of
MOVES Curriculum**
Michael J. Zyda
Code CS/Zk, Spanagel Hall
Room 516
(408) 656-2305

Eric Bachmann, Lecturer (1997); MS, Naval Postgraduate School, 1995.

Wolfgang Baer, Research Assistant (1994); Ph.D., University of California at Berkeley, 1972. Physics. Real word database generation and real world simulation.

Valdis Berzins, Professor (1986); Ph.D., Massachusetts Institute of Technology, 1979. Software engineering, specification languages, computer-aided design and engineering databases.

John Daley, LCDR, USN; Instructor (1992); MS, Naval Postgraduate School, 1992.

Rudy Darken, Assistant Professor (1996); DSc, George Washington University, 1995. Computer graphics.

John Falby, Senior Lecturer (1991); MS, Naval Postgraduate School, 1986.

Richard W. Hamming, Senior Lecturer (1976); Ph.D., University of Illinois, 1942. Coding theory, numerical methods and philosophy of science.

Debra Hensgen, Associate Professor (1995); Ph.D., University of Kentucky, 1989. Distributed parallel operating systems; tools for distributed/parallel processing, including performance analysis, automatic concurrency control, and task assignment and scheduling.

Michael J. Holden, CDR, USN; Instructor (1995); MS, Naval Postgraduate School, 1995. Computer science, underwater robotics, software engineering, artificial intelligence.

Cynthia E. Irvine, Assistant Professor (1994); Ph.D., Case Western University, 1975. Computer security, trusted systems methodologics, operating systems.

Yutaka J. Kanayama, Professor and Academic Associate for Computer Science Curriculum (1990); Ph.D., Tokyo University, 1965. Robotics, artificial intelligence, and mathematical foundation of computer science.

Taylor Kidd, Associate Professor (1995); Ph.D., University of California at San Diego, 1991. Distributed systems, heterogeneous systems, probability and uncertainty as applied to computer systems, and stochastic systems theory.

Ted Lewis, Professor (1993); Ph.D., Washington State University (1971), Parallel Computing, object-oriented frameworks, and software engineering.

Nelson Ludlow, MAJOR, USAF, Assistant Professor (1995); Ph.D., University of Edinburgh, 1990. Artificial intelligence, natural language processing, image understanding, cognitive science, medical informatics, and complexity theory.

G.M. Lundy, Associate Professor (1988); Ph.D., Georgia Institute of Technology, 1988. Data communications, computer networks, formal models of communications protocols.

Luqi, Professor (1986); Ph.D., University of Minnesota, 1986. Software engineering, scientific computing, rapid prototyping and real-time embedded systems.

Robert B. McGhee, Professor and Associate Chair for Instruction (1986); Ph.D., University of Southern California, 1963. Robotics and artificial intelligence.

David R. Pratt, Associate Professor (1993); Ph.D., Naval Postgraduate School, 1993. 3D computer graphics, virtual worlds and environments, user interfaces and computer architecture.

Neil C. Rowe, Associate Professor and Associate Chair for Research (1983); Ph.D., Stanford University, 1983. Artificial intelligence: path planning, database interfaces, vision and tutoring.

Timothy J. Shimeall, Associate Professor (1988); Ph.D., University of California at Irvine, 1988. Software engineering: testing, fault-tolerance, empirical evaluation techniques.

Man-Tak Shing, Associate Professor (1988); Ph.D., University of California at San Diego, 1981. Design and analysis of algorithms, real-time system scheduling, rapid prototyping and embedded systems.

Dennis M. Volpano, Associate Professor (1991); Ph.D., Oregon Graduate Institute, 1986. Programming language foundations and type theory.

Thomas C. Wu, Associate Professor (1985); Ph.D., University of California at San Diego, 1983. Multimedia database systems, object-oriented data modeling and programming, and user interface design.

Geoffrey Xie, Assistant Professor (1996); Ph.D., University of Texas at Austin, 1996. Networks and multimedia systems.

Michael J. Zyda, Professor and Academic Associate of MOVES Curriculum (1984); DSc, Washington University, 1984. Computer graphics: virtual worlds and visual simulation systems.

* The year of joining the Naval Postgraduate School faculty is indicated in parenthesis.

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 degree of Master of Science or Doctor of Philosophy. The requirements to complete either program are rigorous and are comparable to those of other major universities.

MASTER OF SCIENCE IN COMPUTER SCIENCE
The degree Master of Science in Computer Science is awarded upon the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

> a. At least 40 quarter hours of graduate-level work of which at least 12-quarter hours must be at the 4000 level.

> b. Completion of an approved sequence of courses constituting specialization in an area of Computer Science.

> c. Completion of an acceptable thesis in addition to the 40-quarter hours of course work.

MASTER OF SCIENCE IN SOFTWARE ENGINEERING
The Master of Science in Software Engineering 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 by the completion of 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.

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION
The degree Master of Science in Modeling, Virtual Environments and Simulation is awarded upon satisfactory completion of a program, approved by the Chairman of the Modeling, Virtual Environments and Simulation Curriculum Committee, which satisfies, as a minimum, the following degree requirements:

> a. At least 40 quarter hours of graduate-level work, of which at least 12 quarter hours must be at the 4000 level.

> b. Completion of an approved sequence of courses constituting specialization in an area of Modeling, Virtual Environments and Simulation.

> c. Completion of an acceptable thesis in addition to the required course work.

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE
The Department of Computer Science has a program leading to the degree Doctor of Philosophy. Areas of special strength in the department are artificial intelligence & engineering, and computer systems & architectures. 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 doctor's degree.

COMPUTER SCIENCE LABORATORIES
Laboratory Overview
There are currently seven laboratories:
- Computer Science Academic Laboratory
- Artificial Intelligence and Robotic Laboratory
- Computer Systems and Security Laboratory
- Computer Graphics and Video Laboratory
- Microcomputer Systems Laboratory
- Software Engineering Laboratory
- Visual Database and Interface Laboratory

These laboratories are configured in a complex network system with remote file system access and resource sharing facilities. A backbone network also provides a gateway to the Internet.

Computer Science Academic Laboratory
The laboratory provides a general purpose, time-sharing environment for a variety of programming languages and software tools. Approximately half of the client workstations are located within the laboratory for student access while the remaining client workstations are distributed to individual faculty and staff offices.

Artificial Intelligence and Robotic Laboratory
The Artificial Intelligence Laboratory consists of Unix and IRIS based, general purpose workstations. They are outfitted with LISP, Prolog and various knowledge-based software tools. The Autonomous Mobile Robots "Yamabico" and "Shepherd" with an image-grabbing capability color TV camera are fundamental research tools in robotics and AI. This laboratory also supports the research of planning, navigation, dynamics and control of Autonomous Underwater Vehicle sponsored by NAVSEA.

Computer Systems and Security Laboratory
The Computer Systems and Security Laboratory has three distinct sub-laboratories: the Database Systems Lab, the Multimedia DBMS Lab and Computer Security Lab. The Database System Lab has a focus on multi-back end database machines. The multimedia DBMS Lab has a focus on utilizing low-cost workstations and PC technology for the intelligent storage and retrieval of multimedia data. The Computer Security Lab has a focus on a secure heterogeneous, distributed computing environment.

Computer Graphics and Video Laboratory
The Graphics and Video Laboratory consists of several Silicon Graphics, Inc. IRIS workstations used to provide instructional support for the Computer Graphics and Visual Simulation track of the Department of Computer Science and to provide research support for efforts in virtual world and visual simulation system construction. The laboratory is equipped with a variety of video and multimedia support hardware. Recent efforts of the laboratory currently revolve around the NPSNET system, a low- cost, workstation-based, 3D visual simulator that utilizes SIMNET databases and networking formats.

Microcomputer Systems Laboratory
The Microcomputer Systems Laboratory is used for instruction in beginning programming with the Department of Defense's standard computer language Ada. The PCs are also used for research and instruction in microprocessor programming, microprocessor architectures, networking and distributed systems. The PCs are networked together to provide access to shared resources such as printers. The laboratory also supports ongoing research on transputer applications to real-time embedded military systems.

Software Engineering Laboratory
The purpose of this laboratory is to provide a state-of-the-art educational environment for graphics-based software development automation. Current work in the laboratory is on rapid prototyping, specification languages and computer-aided software system design, software verification and testing, software safety and computer-aided instruction.

Visual Database and Interface Laboratory
The Visual Database and Interface Laboratory is used for research and instruction in human-computer interfaces for data retrieval systems. The main project in the laboratory is a visual query language for databases project sponsored by the Naval Weapons Station, Concord.

COMPUTER SCIENCE COURSE DESCRIPTIONS

CSR100 REFRESHER FOR BEGINNING PROGRAMMING (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 1).
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.

CSR101 REFRESHER FOR LABORATORY SYSTEMS (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 1).
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 CSR100. Not graded.

CS0001 COLLOQUIUM (NO CREDIT) (0 - 1).
Departmental lecture series. Attendance is required by students in their fourth quarter. Graded on Pass/Fail.

CS0102 REVIEW FOR DIRECT INPUT STUDENTS (NO CREDIT) (Meets entire quarter.) (2 - 1).
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.

CS0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

CS2101 INTRODUCTION TO THE MODERN PC (3 - 1).
This course is designed to introduce to students the 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 window 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. This section covers some of the popular applications, including Microsoft Office, Eudora, Netscape, Adobe Photoshop, and FrameMaker. This class combines classroom theory, demonstration, discussion, and plenty of hands-on experience with the latest PC technology. The material covered in this course is targeted to students at any level of prior PC experience. PREREQUISITE: None.

CS2920 INTRODUCTORY TOPICS IN COMPUTER SCIENCE (Hours vary 2-4 to 4-1.) (V - V).
Designed to support introductory subject matter of special interest, dependent upon faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture/lab oriented or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS2970 INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING WITH ADA (4 - 2).
This course is designed as an introductory course to teach students problem solving techniques and the object-oriented programming paradigm with the language Ada. The topics covered include problem-solving, object-oriented programming, data types, statements, operators, control structures, procedures and functions, access types (pointers), documentation, encapsulation and Input/Output. Weekly programming projects aimed at practicing these techniques are assigned during the course PREREQUISITE: None.

CS2971 INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING WITH C++ (4 - 2).
This course is designed as an introductory course to teach students problem solving techniques, the object-oriented programming paradigm and the programming language C++. The topics covered include: problem-solving, object-oriented programming, native types and statements, operators, structures, functions, pointers, object-oriented programming, documentation (design decisions, functionality, class, etc.), encapsulation (class and objects), and I/O. Weekly programming or written assignments required. PREREQUISITE: None.

CS2973 INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING WITH JAVA (4 - 2).
An introduction to object-oriented programming for the Internet with the Java programming language. The course is open to non-CS majors and aims to provide the skills necessary to write significant Web applications in JAVA. Topics include the basics of writing Java programs, Java objects and threads of control, writing Java Applets, Applet user interfaces, GUI standard components, the Java API, communication, and security restrictions. The properties of a well-designed Applet will be emphasized. The lab portion of the course requires writing a series of Java Applets and exploring the limitations and power of this emerging programming paradigm. PREREQUISITE: None.

CS3010 COMPUTER SYSTEMS PRINCIPLES (4 - 0).
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 (For Non-CS students.) (4 - 0).
This course, designed for non-computer science majors, 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: CS2971 or consent of instructor.

CS3050 SOFTWARE DEVELOPMENT FOR COMBAT SYSTEMS (3 - 2).
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 inter-process 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: CS2970 or consent of instructor.

CS3111 PRINCIPLES OF PROGRAMMING LANGUAGES (4 - 0).
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: CS2971 or consent of instructor.

CS3113 INTRODUCTION TO COMPILER WRITING (3 - 2).
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. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS3130 SOFTWARE DESIGN FOR MOBILE COMPUTERS (3 - 2).
Designing applications for portable, hand held, personal digital assistants (PDAs) and organizers is much different than designing and implementing applications for desktop and/or departmental computers due to their novel architectures, network connectivity (wireless), and requirements for rapid development cycles. For example, languages like Newton Script are functional and object-oriented rather than procedural; Telescript is a software agent language which implements security features not found in most languages, and Magic Cap C is a "slot language" which shares features with both functional and object-oriented languages. This course introduces the student to rapid application development environments, programming languages, and operating systems used by commercial off-the-shelf hand held computers running operating systems such as Newton Intelligence, Magic Cap, GEOS, and PalmOS. Lab programming exercise for one PDA-class operating system platform. PREREQUISITE: CS3300.

CS3200 COMPUTER ARCHITECTURE (3 - 2).
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 CS2971, or permission of instructor.

CS3202 INTRODUCTION TO MULTIMEDIA PRODUCTION (3 - 2).
This is the first of a two-course sequence in multimedia production. The course introduces students to fundamentals of 2-D/3-D graphics, sound and animation. Basic principles of multimedia production are covered including pre-press, file formats, image filtering, morphing, distortions, textures, geometry, and perspective in a lecture format, and practical skill development in a hands-on laboratory. Scripting in an event-driven programming language is a major portion of the course. PREREQUISITE: None.

CS3203 ADVANCED MULTIMEDIA PRODUCTION (3 - 2).
This is the second of a two-course sequence in multimedia production. The course goes into more depth than CS3202 by focusing on video production. Fundamentals of digital video tape, CD-ROM, and camera hardware, video multimedia software, and file formats are covered in addition to the tools and design techniques used to do professional quality movie production. It is expected that the material will change rapidly in the next few years, hence the content will also undergo rapid change. PREREQUISITE: CS3202.

CS3300 DATA STRUCTURES (3 - 2).
The purpose of this course is to introduce modern techniques for design, analysis, and implementation of data structures. This includes: theoretical material (time and space analysis, abstract data types); current practice (applications to memory management, compiler design, sorting/searching algorithms); programming techniques (information hiding, packages, programming from specifications, testing); programming practice (non-trivial assignments which emphasize pointers, file I/O, recursion, and teamwork). Weekly programming projects are required in this course PREREQUISITE: CS2971 or consent of instructor.

CS3310 ARTIFICIAL INTELLIGENCE (4 - 0).
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: MA3025, MA3030 or consent of instructor.

CS3315 LEARNING SYSTEMS (3 - 1).
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. PREREQUISITE: A programming course.

CS3320 DATABASE SYSTEMS (3 - 1).
This course presents an up-to-date introduction to database systems including database system architectures, data models, query languages, and design of databases. PREREQUISITE: CS3300 or consent of instructor.

CS3450 OPERATING SYSTEMS (3 - 2).
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. PREREQUISITES: CS2972, CS3200 and CS3300, or consent of instructor.

CS3460 SOFTWARE METHODOLOGY (3 - 1).
Introduction to the software life cycle. Methods for requirements definition, design, and testing of software. Basic concepts of software engineering, including stepwise refinement, decomposition, information hiding, debugging, and testing. PREREQUISITES: CS2972 and CS3300.

CS3502 COMPUTER COMMUNICATIONS AND NETWORKS (4 - 0).
An introduction to the structure and architecture of computer networks. The physical, data link and network layers of the ISO model are covered, as well as some aspects of the higher layers. Several important communication protocols are studied, including the currently used models for their specifications and analysis. Local Area Networks, such as Ethernet and Token Ring, are also covered. Term papers and/or a project are an important aspect of this course. PREREQUISITES: CS3200 and CS3010 and a basic course in probability.

CS3505 THE INTERNET AND THE INFORMATION HIGHWAY (3 - 0).
Recent advances in telecommunications and computers have resulted in an explosive growth in the Internet. This growth in computer networking has already had a major impact on the world. In this class, the Internet and related technologies are explored. Major objectives are (1) to learn what the Internet and the "Information Highways" are; (2) to learn how to use the Internet for both business, academic and personal uses; (3) to learn what is the current and especially future direction the Internet is going. Students will gain experience in exploring the World Wide Web, 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 developed is also presented. Lectures also discuss the origins of the Internet, and the various physical and software layers which make up the Internet are also discussed. The class requires a series of laboratory assignments. PREREQUISITE: None. Open to all graduate students.

CS3600 INTRODUCTION TO COMPUTER SECURITY (3 - 2).
This course is concerned with fundamental principles of computer and communications security for modern monolithic and distributed systems. It covers privacy concerns, data secrecy and integrity issues, as well as DoD security

policy. Security mechanisms introduced will include access mediation, cryptography, authentication protocols, and multilevel secure systems. Students will be introduced to a broad range of security concerns including both environmental as well as computational security. Laboratory facilities will be used to introduce students to a variety of security-related technologies including, discretionary access controls in Class C2 systems, mandatory access controls in both low and high assurance systems, identification and authentification protocols, the use of cryptography in distributed systems, and database technology in trusted systems. PREREQUISITE: Either CS3010, CS3030, or the consent of instructor.

CS3601 THEORY OF FORMAL LANGUAGES AND AUTOMATA (4 - 0).
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 undecidability are covered. PREREQUISITE: MA3025, MA3030 or equivalent.

CS3650 DESIGN AND ANALYSIS OF ALGORITHMS (4 - 0).
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: CS3300, MA3025, MA3030 or equivalent.

CS3651 COMPUTABILITY THEORY AND COMPLEXITY (3 - 1).
This course covers the concepts needed to argue about 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.

CS3670 MANAGEMENT OF SECURE SYSTEMS (4 - 0).
This course is intended to provide students with an understanding of management concerns associated with computer-based information systems. Students will examine the security concerns associated with managing a computer facility. The impact of configuration management on system security, the introduction of software that must be trusted with respect to computer policies, environmental considerations, and the problems associated with transitions to new systems and technology will be studied in the context of Federal government and especially DoD ADP systems. PREREQUISITE: CS3600.

CS3675 INTERNET SECURITY RESOURCES AND POLICY (3 - 2).
This course covers the threats currently facing organizations that access the Internet, the technological basis for such threats and policy options for dealing with such threats. The course is designed to involve students directly in the composition of meaningful security policies. Lab exercises will be used to improve the student's detailed knowledge of security threats and of the options for dealing with such threats. PREREQUISITE: None.

CS3680 BUILDING DEFENSIBLE COMPUTER SYSTEMS (3 - 2).
This course will focus on the threats to computer systems. External attacks, malicious artifacts, such as Trojan Horses, and techniques to eliminate or contain them will be addressed. Assurance methods to create trusted computing bases for both monolithic and distributed systems will be presented. Leveraging high assurance policy enforcement mechanisms in the design of applications will be discussed. System architecture considerations, the application of information security policies in networked systems, the importance of cryptographic methods of communication in distributed systems, and critical topics in database security will be presented. Demonstrations, exercises and experiments with techniques for achieving defensible computer systems will be presented. Building applications for trusted systems will be addressed. Students will examine the use of COTS product to meet system security requirements. Students will gain hands-on experience with methods of distributed identification and authentication and various uses of cryptography as it complements trusted systems. PREREQUISITE: CS3600.

CS3690 APPLYING INFOSEC SYSTEMS (For Non-CS; CS majors take CS4605.) (4 - 0).
This course presents an integrated view of INFOSEC disciplines in the context of today's dynamic threat environments. It will present security standards, certification, and accreditation as they relate to the management of risks and INFOSEC techniques. Students will learn about several current security policies and will study scenarios where these policies may be silent or ambiguous. Mandatory, discretionary, commercial, and dissemination policies will be addressed. Life cycle issues for INFOSEC systems and organizational impacts on security will be presented. System changes that potentially impact security will be presented such as increased threats or risks, security breaches, hardware changes, policy changes, and environmental factors. PREREQUISITE: CS3600.

CS3700 ADVANCED C++ WITH DATA STRUCTURES (4 - 2).
A second course in object-oriented programming using C++ and first course in data structures for students having an introductory-level experience with C++. Students learn to implement problem solutions involving data structures using the object-oriented language features of C++, a language used in military and government applications as well as commercial applications used by the military and government. C++ topics include: data abstraction, classes, objects, operator overloading, inheritance, containers, polymorphism, and templates. Data structure topics include: Standard Template Library, lists, stacks, queues, trees, hash tables and graphs. Weekly programming projects provide students the opportunity to implement techniques and use data structures covered in class. This class is tailored for Modeling, Virtual Environments and Simulation (MOVES) students and curriculum. PREREQUISITES: CS2971.

CS3770 ADA AS A SECOND LANGUAGE (4 - 2).
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 provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS3971 or CS3973, or 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).
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++, a language used in military and government applications as well as commercial applications used by the military and government. 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. PREREQUISITE: CS3970 or CS3973, or 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).
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 vs 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: CS3970 or CS3971, or recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3800 DIRECTED STUDY IN COMPUTER SCIENCES (Variable hours 0-2 to 0-8.) (0 - V).
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. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

CS3920 TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support subject matter of special interest, dependent upon 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 instructor.

CS3970 ADVANCED OBJECT-ORIENTED PROGRAMMING USING ADA (4 - 2).
Second course in object-oriented programming using Ada for students having an introductory-level experience with Ada. Topics include: data abstraction and encapsulation, parameterized types, packages, private types, inheritance, polymorphism, generics, numeric types, tasking and object-oriented techniques. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS2970.

CS3971 ADVANCED OJBECT-ORIENTED PROGRAMMING WITH C++ (4 - 2).
A second course in object-oriented programming using C++ for students having an introductory-level experience with C++. Students learn to implement problem solutions using the object-oriented language features of C++, a language used in military and government applications as well as commercial applications used by the military and government. Topics include: data abstraction and encapsulation, classes, objects, operator overloading, inheritance, containers, polymorphism, templates, error handling and reusable class libraries. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS2971.

CS3973 ADVANCED OBJECT-ORIENTED PROGRAM WITH JAVA (4 - 2).
The course introduces advanced features of the Java programming language and is intended for those who have taken the introductory Java course, CS2973. Topics include advanced GUI applications and Applets using the AWT API of Java, concurrency and thread manipulation, communication via UDP and TCP/IP sockets, and security issues. The lab portion of the course explores these concepts for a given Java implementation. PREREQUISITE: CS2973.

CS4112 DISTRIBUTED OPERATING SYSTEMS (3 - 2).
An advanced treatment of operating systems concepts. Major course topics include distributed operating systems, distributed operating system architectures and concurrent programming. Other topics including secure operating systems and real-time operating systems as time permits. PREREQUISITE: CS3450 or equivalent.

CS4113 ADVANCED LANGUAGE TOPICS (4 - 0).
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 or consent of instructor.

CS4114 ADVANCED TOPICS IN OBJECT-ORIENTED PROGRAMMING (3 - 2).
This course covers the area of object-oriented programming (OOP) in detail. Investigating current OOP research will be the mainstay of the class. Typical topics will include data abstraction, inheritance, encapsulation, delegation, object-oriented databases and concurrency. Object-oriented languages and applications will also be discussed. A significant programming project is also required. PREREQUISITE: Consent of instructor.

CS4118 RAPID APPLICATION DEVELOPMENT OF INFO WARFARE SYSTEMS (3 - 2).
Rapid application development of client/server information systems that play over wired and wireless networks will become increasingly important to joint forces as the battlefield becomes digitized. This course describes the field of database front-end tools, client/server applications, visual programming, and database middleware. It also provides an analysis and skill development in design and implementation of sample applications using current state-of-the-art development tools such as Optima++, Prospero, and JFactory. A key feature of this course is that it covers a variety of rapid application development approaches and tools. PREREQUISITE: IS3502.

CS4150 PROGRAMMING TOOLS AND ENVIRONMENTS (4 - 1).
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, macroprocessors and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented programming environment. PREREQUISITE: CS3460 or consent of instructor.

CS4202 COMPUTER GRAPHICS (3 - 2).
An introduction to the principles of the hardware and the software used in the production of computer generated images. The focus of the course is a major design project utilizing the departmental computer graphics facilities. The course is intended for Computer Science students proficient in the development of software systems. PREREQUISITES: CS2971, CS3300, CS3700 or consent of the instructor.

CS4203 INTERACTIVE COMPUTATION SYSTEMS (3 - 2).
This course studies the principles of human computer interfaces and their implementation techniques. Several different interfaces are covered with an emphasis on the direct manipulation interface. The principles discussed in the course will be illustrated with several commercial software systems. The main focus of the course is a design project of building simple application software system that supports human-computer interface principles. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS4310 ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MILITARY APPLICATIONS (4 - 0).
This course will survey key areas of current research and applications in artificial intelligence. Areas covered include: representation and logic, search, planning, neural nets, etc.. Students are required to complete a team project relating to a military application. PREREQUISITE: CS3310 or consent of instructor.

CS4311 EXPERT SYSTEMS (3 - 2).
This course covers fundamental issues in expert system design and construction. Topics include: knowledge representation schemes and reasoning methods, uncertainty management, system building tools and shells, and validation and measurement methods. Several projects related to these topics will be assigned throughout the course. In addition, each student will be required to complete a term project. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4312 ADVANCED DATABASE SYSTEMS (3 - 1).

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 instructor.

CS4313 ADVANCED ROBOTIC SYSTEMS (4 - 0).

This course covers the fundamental concepts, theories and practices in autonomous robotics. Especially, theories and techniques in motion planning, motion design, vehicle kinematics, sensing, guidance, learning, environmental representation, and control architectures for autonomous mobile vehicles will be discussed. The autonomous mobile robot Yamabico-II will be used for hand-on experiments. We will also discuss on several existing significant robotic research projects and control architectures in the U.S. and other countries. PREREQUISITE: CS3310 or consent of instructor.

CS4314 SYMBOLIC COMPUTING (3 - 2).

This course is concerned with symbolic computing, that is, using computers to manipulate symbols. The first part of the course will focus on the fundamentals of Lisp programming including list processing, function definition, recursion, data structures, Common Lisp Object System (CLOS), and Lisp I/O. The second part of the course will emphasize the use of Lisp to support different Artificial Intelligence applications: search techniques, neural networks, genetic algorithms, etc. Students are required to complete several homework exercises and a term project. Enrollment will be limited to ensure adequate student involvement in class presentations. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4322 ADVANCED DATABASE SYSTEMS SEMINAR (3 - 1).

This course covers the advanced and current research on database topics that have not been discussed fully in the prior database courses CS3320 and CS4312. Possible topics to be discussed in the course include object-oriented databases, database machines (especially multilingual and multibackend systems), multimedia DBMS, semantic modeling, DB security, knowledge-based DBMS, nonnormalized relations, temporal information handling, advanced data structures, real-time database systems, etc. The studies may be theoretical, pragmatic and analytical, or experimental using some advanced prototype database systems. PREREQUISITE: CS4312, or consent of instructor.

CS4450 ADVANCED COMPUTER ARCHITECTURE (4 - 0).

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. PREREQUISITE: CS3200 or equivalent.

CS4451 INTRODUCTION TO PARALLEL COMPUTING (4 - 1).

An introduction to the basic issues of parallel computing. The course brings the students to acknowledge of different models of current parallel computers, and the interconnection networks that support them. Students are introduced to metrics that describe the performance of parallel computer systems. The students are introduced to a variety of parallel algorithms to put different parallel models into perspective. A major design project utilizing NPS parallel and/ or distributed computing facilities is assigned.

CS4452 PROGRAMMING PARALLEL COMPUTERS (CS & Non-CS majors) (2 - 4).

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.

CS4470 IMAGE SYNTHESIS (3 - 2).

This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Planned topics include illumination, shading, transparency, antialiasing, shadows, raytracing, texturizing and radiosity. PREREQUISITE: CS4202 or the consent of the instructor.

CS4471 COMPUTER ANIMATION (3 - 2).

This course covers advanced topics in the state-of-the-art in animating 3D computer models. Computational techniques for real-time animation, parallel programming, motion control systems, interactive keyframe systems, motion simulation, event driven animation, kinematic methods for figure animation, dynamics for figure animation, task-level animation and other high-level approaches will be examined. Labs utilize Wavefront's Advanced Visualizer animation system, Silicon Graphics workstations, VCR, and large-screen television monitors. PREREQUISITE: CS4202 or consent of instructor.

CS4472 PHYSICALLY-BASED MODELLING (3 - 2).
A physically-based model is a mathematical representation of an object (or its behavior) which incorporates forces, torques, energies and other attributes of Newtonian physics. The goal of this course is to use such modeling to simulate, and graphically depict, the realistic behavior of flexible and rigid 3D objects. Topics covered in the course include teleological modeling, kinematic constraints, behavior functions, inverse dynamics, collision detection, distributed behavioral models, flexible bodies, energy constraints and physically-based rendering. PREREQUISITE: CS4202 or consent of the instructor.

CS4473 VIRTUAL WORLDS AND SIMULATION SYSTEMS (3 - 2).
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. COREQUISITE: CS4202 or consent of the instructor.

CS4474 VIRTUAL ENVIRONMENT NETWORK AND SOFTWARE ARCHITECTURES (3 - 2).
This course covers the design and implementation of network and software architectures for real-time, interactive 3D 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 mangers 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,...), commercial toolkits for VE development (WorldToolKit, Division's dvs, Performer,...), lag in multiprocessor virtual environments, and the HCI implications on VE network and software architectures. PREREQUISITE: CS4473 or the consent of instructor.

CS4500 SOFTWARE ENGINEERING (3 - 1).
The techniques for the specification, design, testing, maintenance and management of large software systems. Specific topics include software life cycle planning, cost estimation, requirements definition and specification, design, testing and verification, maintenance and reusability. The laboratory sessions will discuss special topics. PREREQUISITE: CS3460 or consent of instructor.

CS4510 COMPUTER-AIDED PROTOTYPING (3 - 0).
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 construction methods for increasing productivity, reliability and portability of software development in comparison with other development methods. PREREQUISITE: CS4500 or consent of instructor.

CS4520 ADVANCED SOFTWARE ENGINEERING (3 - 0).
This course is a sequel to CS4500. The methods for specifying, designing, and verifying software systems are covered in depth, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check Ada programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4530 SOFTWARE RESEARCH AND DEVELOPMENT IN DOD (3 - 0).
This course is a sequel to CS4500. It will cover the 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 and the use of Ada language for designing large, real-time embedded computer systems; automated tools for the specification, design and generation of Ada code for the applications; and existing and emerging DoD Standards for software development and acquisition. PREREQUISITE: CS4500 or consent of instructor.

CS4540 SOFTWARE TESTING (3 - 1).
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, 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: CS4500 or consent of instructor.

CS4550 COMPUTER NETWORKS II (4 - 0).
This course is a continuation of CS3502. The course study emphasizes metropolitan area networks and wide area networks, including the recently developed optical fiber network standards. Integrated networks and ISDN/BISDN are covered. The public telephone network and its relationship to computer networks. Applications of high speed networks and potential future developments. PREREQUISITE: CS3502.

CS4560 SOFTWARE EVOLUTION (3 - 0).
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 changemerging, and software re-engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4570 SOFTWARE REUSE (3 - 0).
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: CS4500 or consent of instructor.

CS4580 DESIGN OF EMBEDDED REAL-TIME SYSTEMS (3 - 0).
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 Ada 95 support for concurrent and real-time systems. PREREQUISITE: CS4500 or consent of instructor.

CS4600 SECURE COMPUTER SYSTEMS (3 - 2).
The course covers implementation of protection for both monolithic and distributed secure computer systems. The importance of system architecture to assurance methodologies for security kernels will be emphasized. Topics will include the use of protection hardware, the implementation of virtual machines through the effective use of memory management techniques including segmentation and paging, synchronization mechanisms, critical sections, software engineering methodologies as applied to the development of secure computer systems, and configuration management techniques. Critical topics in database security will be discussed. PREREQUISITES: CS3450, CS3502, CS3600.

CS4603 DATABASE SECURITY (3 - 1).
This course covers the logical issues associated with database security. Policies for integrity and confidentiality of information will be reviewed in the context of database systems. Modeling of secure database systems will be covered along with implementation issues including atomicity, serialization, and view-based control. Releasability issues in secure database design will be addressed. Security in statistical databases will be addressed along with security approaches for object oriented databases. Novel approaches to the collection and use of audit databases will be addressed including intrusion detection. PREREQUISITES: CS3600, CS3320, CS3450.

CS4605 SECURITY POLICIES, MODELS AND FORMAL METHODS (3 - 1).
The course covers the methods used to specify, model, and verify computational systems providing access control. The identification of the security policy and its interpretation in terms of a technical policy for automated systems is covered. Informal and formal security policy models are discussed and several access-control models are explored including information-flow models, the Access Matrix Model, the Bell and LaPadula Model, nondeducibility, and noninterference policy expressed in terms of the entities on a computer is reviewed. Formal models and proof of their correctness provide the bridge between a written statement of security policy and the implementation of a particular secure system. Topics include access control, information flow, safety, verification. Verification methods will be discussed. PREREQUISITES: MA3025, CS3600, CS3651.

CS4614 ADVANCED TOPICS IN COMPUTER SECURITY (3 - 1).
This course covers advanced topics in software, communications, and data security. Military and commercial information security and integrity policies will be studied, software and hardware subversions of computer systems; advances in operating systems, databases and network security, evaluation criteria for secure systems, modal logic and linear and branching-time temporal logics, cryptographic and authentication protocols and techniques for implementing supporting policies. PREREQUISITES: CS3600, CS4600, and CS4605 or consent of the instructor.

CS4800 DIRECTED STUDY IN ADVANCED COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Advanced group studies in computer science on a subject of mutual interest to student 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. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS4900 RESEARCH SEMINAR IN COMPUTER SCIENCE (0 - 2).
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 Department Chairman.

CS4901 RESEARCH SEMINAR IN MODELING, VIRTUAL ENVIRONMENTS & SIMULATION (0 - 2).
This course will examine the current and planned research of Modeling Virtual Environment & Simulation (MOVES) associated in multiple fields of study. The course is designed to support MOVES 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 final week. PREREQUISITE: MOVES student in their third quarter or consent of instructor. Graded Pass/Fail only.

CS4910 ADVANCED READINGS IN COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Directed readings in computer science on a subject of mutual interest to student 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 instructor.

CS4920 ADVANCED TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support advanced group study of subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subject 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.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Chairman:
Herschel H. Loomis, Jr.
Professor
Code EC, Spanagel Hall
Room 437A
(408) 656-2081
DSN 878-2081

Associate Chairmen:

Instruction
R. Clark Robertson
Professor
Code EC/Rc, Spanagel Hall
Room 414A
(408) 656-2383
DSN 878-2383

Student Programs
David C. Jenn
Associate Professor
Code EC/Jn, Spanagel Hall
Room 414
(408) 656-2254
DSN 878-2254

Research
Jeff Knorr
Professor
Code EC/Ko, Spanagel Hall
Room 428
(408) 656-2815
DSN 878-2815

Richard W. Adler, Senior Lecturer (1970)*; PhD, Pennsylvania State University, 1970.

Robert W. Ashton, Assistant Professor (1992); PhD, Worchester Polytechnic Institute, 1991.

Raymond Bernstein, Research Associate (1989); PhD, Naval Postgraduate School, 1995.

Jon T. Butler, Professor (1987); PhD, Ohio State University, 1973.

John G. Ciezki, Assistant Professor (1994); PhD, Purdue University, 1993.

Roberto Cristi, Associate Professor (1985); PhD, University of Massachusetts, 1983.

Monique P. Farques, Associate Professor (1989); PhD, Virginia Polytechnic Institute and State University, 1988.

Douglas J. Fouts, Associate Professor (1990); PhD, University of California at Santa Barbara, 1990.

Gurnam S. Gill, Senior Lecturer (1990); PhD, Southern Methodist University, 1981.

Tri T. Ha, Professor (1987); PhD, University of Maryland, 1977.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Robert (Gary) Hutchins, Associate Professor (1993); PhD, University of California at San Diego, 1988.

Ramakrishna Janaswamy, Associate Professor (1987); PhD, University of Massachusetts, 1986.

David C. Jenn, Associate Professor and Associate Chair for Student Programs (1990); PhD, University of Southern California, 1989.

Jeffrey B. Knorr, Professor and Associate Chair for Research (1970); PhD, Cornell University, 1970.

Jovan E. Lebaric, Visiting Associate Professor (1993); PhD, University of Mississippi, 1987.

Chin-Hwa Lee, Professor (1982); PhD, University of California at Santa Barbara, 1975.

Hung-Mou Lee, Associate Professor (1982); PhD, Harvard University, 1981.

Frederic H. Levien, Senior Lecturer and Chairman for Information Warfare Academic Group (1990); MS, Lehigh University, 1967.

Herschel H. Loomis, Jr., Chairman and Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Sherif Michael, Associate Professor (1983); PhD, University of West Virginia, 1983.

Paul H. Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Michael A. Morgan, Professor (1979); PhD, University of California at Berkeley, 1976.

Phillip E. Pace, Associate Professor (1992); PhD, University of Cincinnati, 1990.

Rudolph Panholzer, Professor, Dean of Engineering and Computational Sciences and Chairman for Space Systems Academic Group (1964); DSc, Technische Hochschule in Graz, Austria, 1961.

Ron J. Pieper, Visiting Associate Professor (1990); PhD, University of Iowa, 1984.

James R. Powell, CAPT, U.S. Navy; Chair of Information Warfare (IW), Chair of Tactical Analysis and Military Instructor (1996); MSSE, Naval Postgraduate School, 1984.

John P. Powers, Professor (1970); PhD, University of California at Santa Barbara, 1970.

R. Clark Robertson, Professor and Associate Chair for Instruction (1989); PhD, University of Texas at Austin, 1983.

D. Curtis Schleher, Professor (1994); PhD, Polytechnic University, 1975.

Michael Shields, LCDR, U.S. Navy; Assistant Professor (1992); PhD, Naval Postgraduate School, 1991.

Shridhar B. Shukla, Assistant Professor (1990); PhD, North Carolina State University, 1989.

Rasler W. Smith, Visiting Instructor (1994); MSEE and EE, Naval Postgraduate School, 1990.

Robert D. Strum, Professor Emeritus (1958); MS, University of Santa Clara, 1964.

Frederick Terman, Senior Lecturer (1983); MSEE, Stanford University, 1964.

George J. Thaler, Professor Emeritus (1951); DEng, Johns Hopkins University, 1947.

Charles W. Therrien, Professor (1984); PhD, Massachusetts Institute of Technology, 1969.

Harold A. Titus, Professor Emeritus (1962); PhD, Stanford University, 1962.

Murali Tummala, Professor (1987); PhD, India Institute of Technology, 1984.

Donald van Z. Wadsworth, Senior Lecturer (1988); PhD, Massachusetts Institute of Technology, 1958.

Todd Weatherford, Assistant Professor (1995); PhD, North Carolina State University, 1993.

Xiaoping Yun, Associate Professor (1994); ScD, Washington University, 1987.

Lawrence J. Ziomek, Professor (1982); PhD, Pennsylvania State University, 1981.

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

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic 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 Systems Technology; Information Technology Management; Command, Control, Communications, Computers and Intelligence; Space Systems Operations; Weapons Systems Engineering; Underwater Acoustics and Engineering Acoustics.

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). The department typically graduates over 80 MSEE degree candidates, four EE degree recipients and one Ph.D. per year.

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
Electronic Warfare Systems

Guidance, Navigation and Control Systems
Electromagnetic Systems
Joint Services Electronic Warfare
Power Systems
Signal Processing Systems
Signals Intelligence Systems

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The department has about forty-five faculty members either on a permanent or visiting basis contributing to the instructional and research programs.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

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 24 credits must be in Electrical and Computer Engineering and at least 3 must be in mathematics. 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.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science. 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.

ELECTRICAL ENGINEER

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.

DOCTOR OF PHILOSOPHY

The Department of Electrical and Computer Engineering has an active program leading to the degree Doctor of Philosophy. 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.

LABORATORIES

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.

The Controls Laboratory is primarily an instructional laboratory, supporting experiments in simulation and in hardware manipulation. The Circuits/Electronics Laboratory is also an instructional laboratory supporting courses in circuit analysis and design as well as electronic devices and applications.

The Digital Signal Processing Laboratory is primarily for research and thesis work. The laboratory provides a special subnetwork of SUN workstations, some of which are equipped for advanced digital, audio and image processing. A set of smaller microcomputers to support instruction in digital signal and image processing is available elsewhere in the department.

The Digital Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including an HP64000 for advanced course work and thesis research. CAD facilities

are capable of schematic capture, circuit simulation and fault detection. Major systems in the Computer Laboratory include a modem distributed server system with a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system provides resource-sharing and integrates these systems with office and laboratory microcomputers and workstations.

The VLSi Laboratory supports work in system design using integrated circuits and design of custom integrated circuits. Color graphic displays are used for layout of N- channel MOS (Metal-Oxide-Semiconductor) (NMOS) and Complementary MOS (CMOS) circuits.

The Optical Electronics Laboratory supports both research and courses in the areas of optics that use electronics. The laboratory has low and medium power lasers including CO lasers, an argon ion laser, a dye laser, a Nd:YAG laser and a variety of HeNe and diode lasers. A variety of detectors and imaging equipment is also available.

The Radar and EW Laboratories support courses and thesis work. Working radar systems and EW systems have been modified to allow student access to the signal processing portions of the equipment.

The Academic Computing Laboratories provide programming, wordprocessing, and engineering software support for students and faculty. Four (4) servers with 13 GBytes storage capacity support 24 workstations distributed throughout the department. Twenty-four (24) high-power personal computers, flatbed scanners, laser and color printers with a variety of software are available for student use. A secure computing laboratory is available for doing classified computing and word processing.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems support instructional activities and research in the frequency range from 100 MHz to 300 GHz. A high quality anechoic chamber with HP8510C Network Analyzer is available for broad band antenna pattern and impedance measurements.

The Transient Electromagnetics Scattering Laboratory supports research related to impulse antenna design and impulse radar target classification.

The Power Systems Laboratory supports research and instruction in all aspects of electric power generation, distribution and utilization for ships, submarines and other military systems.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory and the Supply and Issue Facility for the ordering of instrumentation and electronic components.

ELECTRICAL AND COMPUTER ENGINEERING COURSE DESCRIPTIONS

EC0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

EC0950 SEMINAR (NO CREDIT) (0 - 1).
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.

EC1010 INTRODUCTION TO MATLAB (1 - 1).
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.

EC2010 PROBABILISTIC ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
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. PREREQUISITE: EC2410 (may be taken concurrently).

EC2100 CIRCUIT ANALYSIS (4 - 2).
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, steady-state ac circuits, ac power, frequency response and selectivity, the Laplace transformation, two-port networks and transformers. PRE-REQUISITES: PH1322, MA1043 and MA1118 (may be taken concurrently).

EC2170 ELECTRICAL ENGINEERING FUNDAMENTALS (4 - 2).
An introductory course for non-electrical engineering majors. The course considers network principles, signal process-ing circuits, natural response, forced response, total response, steady-state ac circuits, ac power, frequency selectiv-ity, principles of magnetics, magnetic circuits and transformers. PREREQUISITES: PH1322 and MA1118 or consent of instructor.

EC2200 INTRODUCTION TO ELECTRONICS ENGINEERING (3 - 3).
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 amplifier characteristics and applications. Fabrication and the design of integrated circuits. PREREQUISITE: EC2100 or EC2170.

EC2220 APPLIED ELECTRONICS (2 - 4).
A project course covering the design and applications of analog and digital integrated circuits (ICs). Includes an introductory overview of important communications ICs and practical experimental design, constructions, and testing of circuits and systems using these devices. PREREQUISITE: EC2200.

EC2270 BASIC ELECTRONIC AND ELECTRICAL MACHINES (4 - 2).
An introductory course for non-electrical engineering majors and a continuation of EC2170. Topics include fundamen-tals of electronics, operational amplifiers, fundamentals of semiconductors, diodes and diode circuits, bipolar junction transistors and applications, junction field effect transistors and applications, principles of electromechanics, and dc machines and ac machines. PREREQUISITE: EC2170 or consent of instructor.

EC2300 CONTROL SYSTEMS (3 - 2).
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).
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. PREREQUISITE: EC2100 and ability to program in MATLAB.

EC2400 DISCRETE SYSTEMS (3 - 1).
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. PREREQUISITE: MA2051 (may be taken concurrently) and ability to program in MATLAB.

EC2410 ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
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. PREREQUISITE: EC2400.

EC2450 ACCELERATED REVIEW OF SIGNALS AND SYSTEMS (4 - 0).
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. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 COMMUNICATIONS SYSTEMS (3 - 2).
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.

EC2600 ELECTROMAGNETIC FIELDS AND WAVES (4 - 0).
Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions and plane wave propagation in vacuum and materials. PREREQUISITE: MA2051 or equivalent.

EC2610 ELECTROMAGNETIC ENGINEERING (3 - 1).
A continuation of EC2600. Topics include the analysis and design of transmission lines, waveguides, resonators, and high frequency components. Applications of military and other interest are presented in the laboratory. PREREQUISITE: EC2600.

EC2650 ACCELERATED REVIEW OF ELECTROMAGNETICS (4 - 2).
A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC2600 and EC2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC2820 DIGITAL LOGIC CIRCUITS (3 - 2).
An introductory course in the analysis and design of digital circuits. These circuits are the basis for all military computers and digital control systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, truth tables, logic gates, integrated circuit families, decoders, multiplexers, arithmetic circuits, PLAs, ROMs, design of combinational circuits using SSI and MSI components, sequential logic including latches, flip-flops, registers, counters, and memories, analysis and design of synchronous circuits using state tables and state diagrams. The laboratories are devoted to study of combinational and sequential circuits and include a sequence of design projects involving increasingly complex digital functions. PREREQUISITE: None.

EC2840 INTRODUCTION TO MICROPROCESSORS (3 - 2).
An introduction to the organization and operation of microprocessors 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 and EC2820 (may be taken concurrently).

EC2990 DESIGN PROJECTS IN ELECTRICAL ENGINEERING (0 - 8).
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. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC3130 ELECTRICAL MACHINERY THEORY (4 - 2).
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. PREREQUISITE: EC2100.

EC3150 SOLID STATE POWER CONVERSION (3 - 2).
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, transistors converters, and switching regulators. PREREQUISITE: EC2100 or consent of instructor.

EC3200 ADVANCED ELECTRONICS ENGINEERING (3 - 2).
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 Complimentary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor 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. PREREQUISITE: EC2200.

EC3210 INTRODUCTION TO ELECTRO-OPTICAL ENGINEERING (3 - 1).
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. PREREQUISITE: EC3200 (may be taken concurrently).

EC3230 SPACE POWER AND RADIATION EFFECTS (Formerly EO3205.) (3 - 1).
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. PREREQUISITE: EC2200.

EC3310 OPTIMAL ESTIMATION: SENSOR AND DATA ASSOCIATION (3 - 2).
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 USW systems. PREREQUISITES: EC2010, EC2320, MA3046.

EC3320 OPTIMAL CONTROL SYSTEMS (3 - 2).
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).
The foundations of one and two-dimensional digital signal processing techniques are developed. Topics include fast Fourier transform (FFT) algorithms (1-D and 2-D), block convolution, the use of DFT and FFT to evaluate convolution (1-D and 2-D), elements of multirate signal processing and rate conversion, and design methods for 1-D nonrecursive and recursive digital filters. Computer-aided design techniques are emphasized. Introduction to time-frequency representation through the short-time Fourier transform and wavelet transforms. 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. PREREQUISITE: EC2410.

CS3010 COMPUTER SYSTEMS PRINCIPLES (4 - 0).
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 (For Non-CS students.) (4 - 0).
This course, designed for non-computer science majors, 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: CS2971 or consent of instructor.

CS3050 SOFTWARE DEVELOPMENT FOR COMBAT SYSTEMS (3 - 2).
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 inter-process 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: CS2970 or consent of instructor.

CS3111 PRINCIPLES OF PROGRAMMING LANGUAGES (4 - 0).
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: CS2971 or consent of instructor.

CS3113 INTRODUCTION TO COMPILER WRITING (3 - 2).
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. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS3130 SOFTWARE DESIGN FOR MOBILE COMPUTERS (3 - 2).
Designing applications for portable, hand held, personal digital assistants (PDAs) and organizers is much different than designing and implementing applications for desktop and/or departmental computers due to their novel architectures, network connectivity (wireless), and requirements for rapid development cycles. For example, languages like Newton Script are functional and object-oriented rather than procedural; Telescript is a software agent language which implements security features not found in most languages, and Magic Cap C is a "slot language" which shares features with both functional and object-oriented languages. This course introduces the student to rapid application development environments, programming languages, and operating systems used by commercial off-the-shelf hand held computers running operating systems such as Newton Intelligence, Magic Cap, GEOS, and PalmOS. Lab programming exercise for one PDA-class operating system platform. PREREQUISITE: CS3300.

CS3200 COMPUTER ARCHITECTURE (3 - 2).
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 CS2971, or permission of instructor.

CS3202 INTRODUCTION TO MULTIMEDIA PRODUCTION (3 - 2).
This is the first of a two-course sequence in multimedia production. The course introduces students to fundamentals of 2-D/3-D graphics, sound and animation. Basic principles of multimedia production are covered including pre-press, file formats, image filtering, morphing, distortions, textures, geometry, and perspective in a lecture format, and practical skill development in a hands-on laboratory. Scripting in an event-driven programming language is a major portion of the course. PREREQUISITE: None.

CS3203 ADVANCED MULTIMEDIA PRODUCTION (3 - 2).
This is the second of a two-course sequence in multimedia production. The course goes into more depth than CS3202 by focusing on video production. Fundamentals of digital video tape, CD-ROM, and camera hardware, video multimedia software, and file formats are covered in addition to the tools and design techniques used to do professional quality movie production. It is expected that the material will change rapidly in the next few years, hence the content will also undergo rapid change. PREREQUISITE: CS3202.

CS3300 DATA STRUCTURES (3 - 2).
The purpose of this course is to introduce modern techniques for design, analysis, and implementation of data structures. This includes: theoretical material (time and space analysis, abstract data types); current practice (applications to memory management, compiler design, sorting/searching algorithms); programming techniques (information hiding, packages, programming from specifications, testing); programming practice (non-trivial assignments which emphasize pointers, file I/O, recursion, and teamwork). Weekly programming projects are required in this course PREREQUISITE: CS2971 or consent of instructor.

CS3310 ARTIFICIAL INTELLIGENCE (4 - 0).
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: MA3025, MA3030 or consent of instructor.

CS3315 LEARNING SYSTEMS (3 - 1).
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. PREREQUISITE: A programming course.

CS3320 DATABASE SYSTEMS (3 - 1).
This course presents an up-to-date introduction to database systems including database system architectures, data models, query languages, and design of databases. PREREQUISITE: CS3300 or consent of instructor.

CS3450 OPERATING SYSTEMS (3 - 2).
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. PREREQUISITES: CS2972, CS3200 and CS3300, or consent of instructor.

CS3460 SOFTWARE METHODOLOGY (3 - 1).
Introduction to the software life cycle. Methods for requirements definition, design, and testing of software. Basic concepts of software engineering, including stepwise refinement, decomposition, information hiding, debugging, and testing. PREREQUISITES: CS2972 and CS3300.

CS3502 COMPUTER COMMUNICATIONS AND NETWORKS (4 - 0).
An introduction to the structure and architecture of computer networks. The physical, data link and network layers of the ISO model are covered, as well as some aspects of the higher layers. Several important communication protocols are studied, including the currently used models for their specifications and analysis. Local Area Networks, such as Ethernet and Token Ring, are also covered. Term papers and/or a project are an important aspect of this course. PREREQUISITES: CS3200 and CS3010 and a basic course in probability.

CS3505 THE INTERNET AND THE INFORMATION HIGHWAY (3 - 0).
Recent advances in telecommunications and computers have resulted in an explosive growth in the Internet. This growth in computer networking has already had a major impact on the world. In this class, the Internet and related technologies are explored. Major objectives are (1) to learn what the Internet and the "Information Highways" are; (2) to learn how to use the Internet for both business, academic and personal uses; (3) to learn what is the current and especially future direction the Internet is going. Students will gain experience in exploring the World Wide Web, 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 developed is also presented. Lectures also discuss the origins of the Internet, and the various physical and software layers which make up the Internet are also discussed. The class requires a series of laboratory assignments. PREREQUISITE: None. Open to all graduate students.

CS3600 INTRODUCTION TO COMPUTER SECURITY (3 - 2).
This course is concerned with fundamental principles of computer and communications security for modern monolithic and distributed systems. It covers privacy concerns, data secrecy and integrity issues, as well as DoD security

policy. Security mechanisms introduced will include access mediation, cryptography, authentication protocols, and multilevel secure systems. Students will be introduced to a broad range of security concerns including both environmental as well as computational security. Laboratory facilities will be used to introduce students to a variety of security-related technologies including, discretionary access controls in Class C2 systems, mandatory access controls in both low and high assurance systems, identification and authentification protocols, the use of cryptography in distributed systems, and database technology in trusted systems. PREREQUISITE: Either CS3010, CS3030, or the consent of instructor.

CS3601 THEORY OF FORMAL LANGUAGES AND AUTOMATA (4 - 0).
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 undecidability are covered. PREREQUISITE: MA3025, MA3030 or equivalent.

CS3650 DESIGN AND ANALYSIS OF ALGORITHMS (4 - 0).
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: CS3300, MA3025, MA3030 or equivalent.

CS3651 COMPUTABILITY THEORY AND COMPLEXITY (3 - 1).
This course covers the concepts needed to argue about 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.

CS3670 MANAGEMENT OF SECURE SYSTEMS (4 - 0).
This course is intended to provide students with an understanding of management concerns associated with computer-based information systems. Students will examine the security concerns associated with managing a computer facility. The impact of configuration management on system security, the introduction of software that must be trusted with respect to computer policies, environmental considerations, and the problems associated with transitions to new systems and technology will be studied in the context of Federal government and especially DoD ADP systems. PREREQUISITE: CS3600.

CS3675 INTERNET SECURITY RESOURCES AND POLICY (3 - 2).
This course covers the threats currently facing organizations that access the Internet, the technological basis for such threats and policy options for dealing with such threats. The course is designed to involve students directly in the composition of meaningful security policies. Lab exercises will be used to improve the student's detailed knowledge of security threats and of the options for dealing with such threats. PREREQUISITE: None.

CS3680 BUILDING DEFENSIBLE COMPUTER SYSTEMS (3 - 2).
This course will focus on the threats to computer systems. External attacks, malicious artifacts, such as Trojan Horses, and techniques to eliminate or contain them will be addressed. Assurance methods to create trusted computing bases for both monolithic and distributed systems will be presented. Leveraging high assurance policy enforcement mechanisms in the design of applications will be discussed. System architecture considerations, the application of information security policies in networked systems, the importance of cryptographic methods of communication in distributed systems, and critical topics in database security will be presented. Demonstrations, exercises and experiments with techniques for achieving defensible computer systems will be presented. Building applications for trusted systems will be addressed. Students will examine the use of COTS product to meet system security requirements. Students will gain hands-on experience with methods of distributed identification and authentication and various uses of cryptography as it complements trusted systems. PREREQUISITE: CS3600.

CS3690 APPLYING INFOSEC SYSTEMS (For Non-CS; CS majors take CS4605.) (4 - 0).
This course presents an integrated view of INFOSEC disciplines in the context of today's dynamic threat environments. It will present security standards, certification, and accreditation as they relate to the management of risks and INFOSEC techniques. Students will learn about several current security policies and will study scenarios where these policies may be silent or ambiguous. Mandatory, discretionary, commercial, and dissemination policies will be addressed. Life cycle issues for INFOSEC systems and organizational impacts on security will be presented. System changes that potentially impact security will be presented such as increased threats or risks, security breaches, hardware changes, policy changes, and environmental factors. PREREQUISITE: CS3600.

CS3700 ADVANCED C++ WITH DATA STRUCTURES (4 - 2).
A second course in object-oriented programming using C++ and first course in data structures for students having an introductory-level experience with C++. Students learn to implement problem solutions involving data structures using the object-oriented language features of C++, a language used in military and government applications as well as commercial applications used by the military and government. C++ topics include: data abstraction, classes, objects, operator overloading, inheritance, containers, polymorphism, and templates. Data structure topics include: Standard Template Library, lists, stacks, queues, trees, hash tables and graphs. Weekly programming projects provide students the opportunity to implement techniques and use data structures covered in class. This class is tailored for Modeling, Virtual Environments and Simulation (MOVES) students and curriculum. PREREQUISITES: CS2971.

CS3770 ADA AS A SECOND LANGUAGE (4 - 2).
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 provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS3971 or CS3973, or 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).
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++, a language used in military and government applications as well as commercial applications used by the military and government. 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. PREREQUISITE: CS3970 or CS3973, or 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).
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 vs 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: CS3970 or CS3971, or recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3800 DIRECTED STUDY IN COMPUTER SCIENCES (Variable hours 0-2 to 0-8.) (0 - V).
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. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

CS3920 TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support subject matter of special interest, dependent upon 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 instructor.

CS3970 ADVANCED OBJECT-ORIENTED PROGRAMMING USING ADA (4 - 2).
Second course in object-oriented programming using Ada for students having an introductory-level experience with Ada. Topics include: data abstraction and encapsulation, parameterized types, packages, private types, inheritance, polymorphism, generics, numeric types, tasking and object-oriented techniques. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS2970.

CS3971 ADVANCED OJBECT-ORIENTED PROGRAMMING WITH C++ (4 - 2).
A second course in object-oriented programming using C++ for students having an introductory-level experience with C++. Students learn to implement problem solutions using the object-oriented language features of C++, a language used in military and government applications as well as commercial applications used by the military and government. Topics include: data abstraction and encapsulation, classes, objects, operator overloading, inheritance, containers, polymorphism, templates, error handling and reusable class libraries. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS2971.

CS3973 ADVANCED OBJECT-ORIENTED PROGRAM WITH JAVA (4 - 2).
The course introduces advanced features of the Java programming language and is intended for those who have taken the introductory Java course, CS2973. Topics include advanced GUI applications and Applets using the AWT API of Java, concurrency and thread manipulation, communication via UDP and TCP/IP sockets, and security issues. The lab portion of the course explores these concepts for a given Java implementation. PREREQUISITE: CS2973.

CS4112 DISTRIBUTED OPERATING SYSTEMS (3 - 2).
An advanced treatment of operating systems concepts. Major course topics include distributed operating systems, distributed operating system architectures and concurrent programming. Other topics including secure operating systems and real-time operating systems as time permits. PREREQUISITE: CS3450 or equivalent.

CS4113 ADVANCED LANGUAGE TOPICS (4 - 0).
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 or consent of instructor.

CS4114 ADVANCED TOPICS IN OBJECT-ORIENTED PROGRAMMING (3 - 2).
This course covers the area of object-oriented programming (OOP) in detail. Investigating current OOP research will be the mainstay of the class. Typical topics will include data abstraction, inheritance, encapsulation, delegation, object-oriented databases and concurrency. Object-oriented languages and applications will also be discussed. A significant programming project is also required. PREREQUISITE: Consent of instructor.

CS4118 RAPID APPLICATION DEVELOPMENT OF INFO WARFARE SYSTEMS (3 - 2).
Rapid application development of client/server information systems that play over wired and wireless networks will become increasingly important to joint forces as the battlefield becomes digitized. This course describes the field of database front-end tools, client/server applications, visual programming, and database middleware. It also provides an analysis and skill development in design and implementation of sample applications using current state-of-the-art development tools such as Optima++, Prospero, and JFactory. A key feature of this course is that it covers a variety of rapid application development approaches and tools. PREREQUISITE: IS3502.

CS4150 PROGRAMMING TOOLS AND ENVIRONMENTS (4 - 1).
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, macroprocessors and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented programming environment. PREREQUISITE: CS3460 or consent of instructor.

CS4202 COMPUTER GRAPHICS (3 - 2).
An introduction to the principles of the hardware and the software used in the production of computer generated images. The focus of the course is a major design project utilizing the departmental computer graphics facilities. The course is intended for Computer Science students proficient in the development of software systems. PREREQUISITES: CS2971, CS3300, CS3700 or consent of the instructor.

CS4203 INTERACTIVE COMPUTATION SYSTEMS (3 - 2).
This course studies the principles of human computer interfaces and their implementation techniques. Several different interfaces are covered with an emphasis on the direct manipulation interface. The principles discussed in the course will be illustrated with several commercial software systems. The main focus of the course is a design project of building simple application software system that supports human-computer interface principles. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS4310 ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MILITARY APPLICATIONS (4 - 0).
This course will survey key areas of current research and applications in artificial intelligence. Areas covered include: representation and logic, search, planning, neural nets, etc.. Students are required to complete a team project relating to a military application. PREREQUISITE: CS3310 or consent of instructor.

CS4311 EXPERT SYSTEMS (3 - 2).
This course covers fundamental issues in expert system design and construction. Topics include: knowledge representation schemes and reasoning methods, uncertainty management, system building tools and shells, and validation and measurement methods. Several projects related to these topics will be assigned throughout the course. In addition, each student will be required to complete a term project. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4312 ADVANCED DATABASE SYSTEMS (3 - 1).

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 instructor.

CS4313 ADVANCED ROBOTIC SYSTEMS (4 - 0).

This course covers the fundamental concepts, theories and practices in autonomous robotics. Especially, theories and techniques in motion planning, motion design, vehicle kinematics, sensing, guidance, learning, environmental representation, and control architectures for autonomous mobile vehicles will be discussed. The autonomous mobile robot Yamabico-II will be used for hand-on experiments. We will also discuss on several existing significant robotic research projects and control architectures in the U.S. and other countries. PREREQUISITE: CS3310 or consent of instructor.

CS4314 SYMBOLIC COMPUTING (3 - 2).

This course is concerned with symbolic computing, that is, using computers to manipulate symbols. The first part of the course will focus on the fundamentals of Lisp programming including list processing, function definition, recursion, data structures, Common Lisp Object System (CLOS), and Lisp I/O. The second part of the course will emphasize the use of Lisp to support different Artificial Intelligence applications: search techniques, neural networks, genetic algorithms, etc. Students are required to complete several homework exercises and a term project. Enrollment will be limited to ensure adequate student involvement in class presentations. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4322 ADVANCED DATABASE SYSTEMS SEMINAR (3 - 1).

This course covers the advanced and current research on database topics that have not been discussed fully in the prior database courses CS3320 and CS4312. Possible topics to be discussed in the course include object-oriented databases, database machines (especially multilingual and multibackend systems), multimedia DBMS, semantic modeling, DB security, knowledge-based DBMS, nonnormalized relations, temporal information handling, advanced data structures, real-time database systems, etc. The studies may be theoretical, pragmatic and analytical, or experimental using some advanced prototype database systems. PREREQUISITE: CS4312, or consent of instructor.

CS4450 ADVANCED COMPUTER ARCHITECTURE (4 - 0).

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. PREREQUISITE: CS3200 or equivalent.

CS4451 INTRODUCTION TO PARALLEL COMPUTING (4 - 1).

An introduction to the basic issues of parallel computing. The course brings the students to acknowledge of different models of current parallel computers, and the interconnection networks that support them. Students are introduced to metrics that describe the performance of parallel computer systems. The students are introduced to a variety of parallel algorithms to put different parallel models into perspective. A major design project utilizing NPS parallel and/or distributed computing facilities is assigned.

CS4452 PROGRAMMING PARALLEL COMPUTERS (CS & Non-CS majors) (2 - 4).

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.

CS4470 IMAGE SYNTHESIS (3 - 2).

This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Planned topics include illumination, shading, transparency, antialiasing, shadows, raytracing, texturizing and radiosity. PREREQUISITE: CS4202 or the consent of the instructor.

CS4471 COMPUTER ANIMATION (3 - 2).

This course covers advanced topics in the state-of-the-art in animating 3D computer models. Computational techniques for real-time animation, parallel programming, motion control systems, interactive keyframe systems, motion simulation, event driven animation, kinematic methods for figure animation, dynamics for figure animation, task-level animation and other high-level approaches will be examined. Labs utilize Wavefront's Advanced Visualizer animation system, Silicon Graphics workstations, VCR, and large-screen television monitors. PREREQUISITE: CS4202 or consent of instructor.

CS4472 PHYSICALLY-BASED MODELLING (3 - 2).
A physically-based model is a mathematical representation of an object (or its behavior) which incorporates forces, torques, energies and other attributes of Newtonian physics. The goal of this course is to use such modeling to simulate, and graphically depict, the realistic behavior of flexible and rigid 3D objects. Topics covered in the course include teleological modeling, kinematic constraints, behavior functions, inverse dynamics, collision detection, distributed behavioral models, flexible bodies, energy constraints and physically-based rendering. PREREQUISITE: CS4202 or consent of the instructor.

CS4473 VIRTUAL WORLDS AND SIMULATION SYSTEMS (3 - 2).
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. COREQUISITE: CS4202 or consent of the instructor.

CS4474 VIRTUAL ENVIRONMENT NETWORK AND SOFTWARE ARCHITECTURES (3 - 2).
This course covers the design and implementation of network and software architectures for real-time, interactive 3D 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 mangers 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,...), commercial toolkits for VE development (WorldToolKit, Division's dvs, Performer,...), lag in multiprocessor virtual environments, and the HCI implications on VE network and software architectures. PREREQUISITE: CS4473 or the consent of instructor.

CS4500 SOFTWARE ENGINEERING (3 - 1).
The techniques for the specification, design, testing, maintenance and management of large software systems. Specific topics include software life cycle planning, cost estimation, requirements definition and specification, design, testing and verification, maintenance and reusability. The laboratory sessions will discuss special topics. PREREQUISITE: CS3460 or consent of instructor.

CS4510 COMPUTER-AIDED PROTOTYPING (3 - 0).
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 construction methods for increasing productivity, reliability and portability of software development in comparison with other development methods. PREREQUISITE: CS4500 or consent of instructor.

CS4520 ADVANCED SOFTWARE ENGINEERING (3 - 0).
This course is a sequel to CS4500. The methods for specifying, designing, and verifying software systems are covered in depth, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check Ada programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4530 SOFTWARE RESEARCH AND DEVELOPMENT IN DOD (3 - 0).
This course is a sequel to CS4500. It will cover the 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 and the use of Ada language for designing large, real-time embedded computer systems; automated tools for the specification, design and generation of Ada code for the applications; and existing and emerging DoD Standards for software development and acquisition. PREREQUISITE: CS4500 or consent of instructor.

CS4540 SOFTWARE TESTING (3 - 1).
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, 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: CS4500 or consent of instructor.

CS4550 COMPUTER NETWORKS II (4 - 0).
This course is a continuation of CS3502. The course study emphasizes metropolitan area networks and wide area networks, including the recently developed optical fiber network standards. Integrated networks and ISDN/BISDN are covered. The public telephone network and its relationship to computer networks. Applications of high speed networks and potential future developments. PREREQUISITE: CS3502.

CS4560 SOFTWARE EVOLUTION (3 - 0).
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 changemerging, and software re-engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4570 SOFTWARE REUSE (3 - 0).
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: CS4500 or consent of instructor.

CS4580 DESIGN OF EMBEDDED REAL-TIME SYSTEMS (3 - 0).
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 Ada 95 support for concurrent and real-time systems. PREREQUISITE: CS4500 or consent of instructor.

CS4600 SECURE COMPUTER SYSTEMS (3 - 2).
The course covers implementation of protection for both monolithic and distributed secure computer systems. The importance of system architecture to assurance methodologies for security kernels will be emphasized. Topics will include the use of protection hardware, the implementation of virtual machines through the effective use of memory management techniques including segmentation and paging, synchronization mechanisms, critical sections, software engineering methodologies as applied to the development of secure computer systems, and configuration management techniques. Critical topics in database security will be discussed. PREREQUISITES: CS3450, CS3502, CS3600.

CS4603 DATABASE SECURITY (3 - 1).
This course covers the logical issues associated with database security. Policies for integrity and confidentiality of information will be reviewed in the context of database systems. Modeling of secure database systems will be covered along with implementation issues including atomicity, serialization, and view-based control. Releasability issues in secure database design will be addressed. Security in statistical databases will be addressed along with security approaches for object oriented databases. Novel approaches to the collection and use of audit databases will be addressed including intrusion detection. PREREQUISITES: CS3600, CS3320, CS3450.

CS4605 SECURITY POLICIES, MODELS AND FORMAL METHODS (3 - 1).
The course covers the methods used to specify, model, and verify computational systems providing access control. The identification of the security policy and its interpretation in terms of a technical policy for automated systems is covered. Informal and formal security policy models are discussed and several access-control models are explored including information-flow models, the Access Matrix Model, the Bell and LaPadula Model, nondeducibility, and noninterference policy expressed in terms of the entities on a computer is reviewed. Formal models and proof of their correctness provide the bridge between a written statement of security policy and the implementation of a particular secure system. Topics include access control, information flow, safety, verification. Verification methods will be discussed. PREREQUISITES: MA3025, CS3600, CS3651.

CS4614 ADVANCED TOPICS IN COMPUTER SECURITY (3 - 1).
This course covers advanced topics in software, communications, and data security. Military and commercial information security and integrity policies will be studied, software and hardware subversions of computer systems; advances in operating systems, databases and network security, evaluation criteria for secure systems, modal logic and linear and branching-time temporal logics, cryptographic and authentication protocols and techniques for implementing supporting policies. PREREQUISITES: CS3600, CS4600, and CS4605 or consent of the instructor.

CS4800 DIRECTED STUDY IN ADVANCED COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Advanced group studies in computer science on a subject of mutual interest to student 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. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS4900 RESEARCH SEMINAR IN COMPUTER SCIENCE (0 - 2).
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 Department Chairman.

CS4901 RESEARCH SEMINAR IN MODELING, VIRTUAL ENVIRONMENTS & SIMULATION (0 - 2).
This course will examine the current and planned research of Modeling Virtual Environment & Simulation (MOVES) associated in multiple fields of study. The course is designed to support MOVES 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 final week. PREREQUISITE: MOVES student in their third quarter or consent of instructor. Graded Pass/Fail only.

CS4910 ADVANCED READINGS IN COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Directed readings in computer science on a subject of mutual interest to student 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 instructor.

CS4920 ADVANCED TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support advanced group study of subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subject 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.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Chairman:
Herschel H. Loomis, Jr.
Professor
Code EC, Spanagel Hall
Room 437A
(408) 656-2081
DSN 878-2081

Associate Chairmen:

Instruction
R. Clark Robertson
Professor
Code EC/Rc, Spanagel Hall
Room 414A
(408) 656-2383
DSN 878-2383

Student Programs
David C. Jenn
Associate Professor
Code EC/Jn, Spanagel Hall
Room 414
(408) 656-2254
DSN 878-2254

Research
Jeff Knorr
Professor
Code EC/Ko, Spanagel Hall
Room 428
(408) 656-2815
DSN 878-2815

Richard W. Adler, Senior Lecturer (1970)*; PhD, Pennsylvania State University, 1970.

Robert W. Ashton, Assistant Professor (1992); PhD, Worchester Polytechnic Institute, 1991.

Raymond Bernstein, Research Associate (1989); PhD, Naval Postgraduate School, 1995.

Jon T. Butler, Professor (1987); PhD, Ohio State University, 1973.

John G. Ciezki, Assistant Professor (1994); PhD, Purdue University, 1993.

Roberto Cristi, Associate Professor (1985); PhD, University of Massachusetts, 1983.

Monique P. Farques, Associate Professor (1989); PhD, Virginia Polytechnic Institute and State University, 1988.

Douglas J. Fouts, Associate Professor (1990); PhD, University of California at Santa Barbara, 1990.

Gurnam S. Gill, Senior Lecturer (1990); PhD, Southern Methodist University, 1981.

Tri T. Ha, Professor (1987); PhD, University of Maryland, 1977.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Robert (Gary) Hutchins, Associate Professor (1993); PhD, University of California at San Diego, 1988.

Ramakrishna Janaswamy, Associate Professor (1987); PhD, University of Massachusetts, 1986.

David C. Jenn, Associate Professor and Associate Chair for Student Programs (1990); PhD, University of Southern California, 1989.

Jeffrey B. Knorr, Professor and Associate Chair for Research (1970); PhD, Cornell University, 1970.

Jovan E. Lebaric, Visiting Associate Professor (1993); PhD, University of Mississippi, 1987.

Chin-Hwa Lee, Professor (1982); PhD, University of California at Santa Barbara, 1975.

Hung-Mou Lee, Associate Professor (1982); PhD, Harvard University, 1981.

Frederic H. Levien, Senior Lecturer and Chairman for Information Warfare Academic Group (1990); MS, Lehigh University, 1967.

Herschel H. Loomis, Jr., Chairman and Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Sherif Michael, Associate Professor (1983); PhD, University of West Virginia, 1983.

Paul H. Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Michael A. Morgan, Professor (1979); PhD, University of California at Berkeley, 1976.

Phillip E. Pace, Associate Professor (1992); PhD, University of Cincinnati, 1990.

Rudolph Panholzer, Professor, Dean of Engineering and Computational Sciences and Chairman for Space Systems Academic Group (1964); DSc, Technische Hochschule in Graz, Austria, 1961.

Ron J. Pieper, Visiting Associate Professor (1990); PhD, University of Iowa, 1984.

James R. Powell, CAPT, U.S. Navy; Chair of Information Warfare (IW), Chair of Tactical Analysis and Military Instructor (1996); MSSE, Naval Postgraduate School, 1984.

John P. Powers, Professor (1970); PhD, University of California at Santa Barbara, 1970.

R. Clark Robertson, Professor and Associate Chair for Instruction (1989); PhD, University of Texas at Austin, 1983.

D. Curtis Schleher, Professor (1994); PhD, Polytechnic University, 1975.

Michael Shields, LCDR, U.S. Navy; Assistant Professor (1992); PhD, Naval Postgraduate School, 1991.

Shridhar B. Shukla, Assistant Professor (1990); PhD, North Carolina State University, 1989.

Rasler W. Smith, Visiting Instructor (1994); MSEE and EE, Naval Postgraduate School, 1990.

Robert D. Strum, Professor Emeritus (1958); MS, University of Santa Clara, 1964.

Frederick Terman, Senior Lecturer (1983); MSEE, Stanford University, 1964.

George J. Thaler, Professor Emeritus (1951); DEng, Johns Hopkins University, 1947.

Charles W. Therrien, Professor (1984); PhD, Massachusetts Institute of Technology, 1969.

Harold A. Titus, Professor Emeritus (1962); PhD, Stanford University, 1962.

Murali Tummala, Professor (1987); PhD, India Institute of Technology, 1984.

Donald van Z. Wadsworth, Senior Lecturer (1988); PhD, Massachusetts Institute of Technology, 1958.

Todd Weatherford, Assistant Professor (1995); PhD, North Carolina State University, 1993.

Xiaoping Yun, Associate Professor (1994); ScD, Washington University, 1987.

Lawrence J. Ziomek, Professor (1982); PhD, Pennsylvania State University, 1981.

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

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic 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 Systems Technology; Information Technology Management; Command, Control, Communications, Computers and Intelligence; Space Systems Operations; Weapons Systems Engineering; Underwater Acoustics and Engineering Acoustics.

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). The department typically graduates over 80 MSEE degree candidates, four EE degree recipients and one Ph.D. per year.

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
Electronic Warfare Systems

Guidance, Navigation and Control Systems
Electromagnetic Systems
Joint Services Electronic Warfare
Power Systems
Signal Processing Systems
Signals Intelligence Systems

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The department has about forty-five faculty members either on a permanent or visiting basis contributing to the instructional and research programs.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING
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 24 credits must be in Electrical and Computer Engineering and at least 3 must be in mathematics. 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.

MASTER OF SCIENCE IN ENGINEERING SCIENCE
Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science. 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.

ELECTRICAL ENGINEER
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.

DOCTOR OF PHILOSOPHY
The Department of Electrical and Computer Engineering has an active program leading to the degree Doctor of Philosophy. 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.

LABORATORIES
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.

The Controls Laboratory is primarily an instructional laboratory, supporting experiments in simulation and in hardware manipulation. The Circuits/Electronics Laboratory is also an instructional laboratory supporting courses in circuit analysis and design as well as electronic devices and applications.

The Digital Signal Processing Laboratory is primarily for research and thesis work. The laboratory provides a special subnetwork of SUN workstations, some of which are equipped for advanced digital, audio and image processing. A set of smaller microcomputers to support instruction in digital signal and image processing is available elsewhere in the department.

The Digital Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including an HP64000 for advanced course work and thesis research. CAD facilities

are capable of schematic capture, circuit simulation and fault detection. Major systems in the Computer Laboratory include a modem distributed server system with a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system provides resource-sharing and integrates these systems with office and laboratory microcomputers and workstations.

The VLSI Laboratory supports work in system design using integrated circuits and design of custom integrated circuits. Color graphic displays are used for layout of N- channel MOS (Metal-Oxide-Semiconductor) (NMOS) and Complementary MOS (CMOS) circuits.

The Optical Electronics Laboratory supports both research and courses in the areas of optics that use electronics. The laboratory has low and medium power lasers including CO lasers, an argon ion laser, a dye laser, a Nd:YAG laser and a variety of HeNe and diode lasers. A variety of detectors and imaging equipment is also available.

The Radar and EW Laboratories support courses and thesis work. Working radar systems and EW systems have been modified to allow student access to the signal processing portions of the equipment.

The Academic Computing Laboratories provide programming, wordprocessing, and engineering software support for students and faculty. Four (4) servers with 13 GBytes storage capacity support 24 workstations distributed throughout the department. Twenty-four (24) high-power personal computers, flatbed scanners, laser and color printers with a variety of software are available for student use. A secure computing laboratory is available for doing classified computing and word processing.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems support instructional activities and research in the frequency range from 100 MHz to 300 GHz. A high quality anechoic chamber with HP8510C Network Analyzer is available for broad band antenna pattern and impedance measurements.

The Transient Electromagnetics Scattering Laboratory supports research related to impulse antenna design and impulse radar target classification.

The Power Systems Laboratory supports research and instruction in all aspects of electric power generation, distribution and utilization for ships, submarines and other military systems.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory and the Supply and Issue Facility for the ordering of instrumentation and electronic components.

ELECTRICAL AND COMPUTER ENGINEERING COURSE DESCRIPTIONS

EC0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

EC0950 SEMINAR (NO CREDIT) (0 - 1).
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.

EC1010 INTRODUCTION TO MATLAB (1 - 1).
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.

EC2010 PROBABILISTIC ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
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. PREREQUISITE: EC2410 (may be taken concurrently).

EC2100 CIRCUIT ANALYSIS (4 - 2).
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, steady-state ac circuits, ac power, frequency response and selectivity, the Laplace transformation, two-port networks and transformers. PRE-REQUISITES: PH1322, MA1043 and MA1118 (may be taken concurrently).

EC2170 ELECTRICAL ENGINEERING FUNDAMENTALS (4 - 2).
An introductory course for non-electrical engineering majors. The course considers network principles, signal processing circuits, natural response, forced response, total response, steady-state ac circuits, ac power, frequency selectivity, principles of magnetics, magnetic circuits and transformers. PREREQUISITES: PH1322 and MA1118 or consent of instructor.

EC2200 INTRODUCTION TO ELECTRONICS ENGINEERING (3 - 3).
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 amplifier characteristics and applications. Fabrication and the design of integrated circuits. PREREQUISITE: EC2100 or EC2170.

EC2220 APPLIED ELECTRONICS (2 - 4).
A project course covering the design and applications of analog and digital integrated circuits (ICs). Includes an introductory overview of important communications ICs and practical experimental design, constructions, and testing of circuits and systems using these devices. PREREQUISITE: EC2200.

EC2270 BASIC ELECTRONIC AND ELECTRICAL MACHINES (4 - 2).
An introductory course for non-electrical engineering majors and a continuation of EC2170. Topics include fundamentals of electronics, operational amplifiers, fundamentals of semiconductors, diodes and diode circuits, bipolar junction transistors and applications, junction field effect transistors and applications, principles of electromechanics, and dc machines and ac machines. PREREQUISITE: EC2170 or consent of instructor.

EC2300 CONTROL SYSTEMS (3 - 2).
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).
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. PREREQUISITE: EC2100 and ability to program in MATLAB.

EC2400 DISCRETE SYSTEMS (3 - 1).
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. PREREQUISITE: MA2051 (may be taken concurrently) and ability to program in MATLAB.

EC2410 ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
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. PREREQUISITE: EC2400.

EC2450 ACCELERATED REVIEW OF SIGNALS AND SYSTEMS (4 - 0).
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. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 COMMUNICATIONS SYSTEMS (3 - 2).
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.

EC2600 ELECTROMAGNETIC FIELDS AND WAVES (4 - 0).
Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions and plane wave propagation in vacuum and materials. PREREQUISITE: MA2051 or equivalent.

EC2610 ELECTROMAGNETIC ENGINEERING (3 - 1).
A continuation of EC2600. Topics include the analysis and design of transmission lines, waveguides, resonators, and high frequency components. Applications of military and other interest are presented in the laboratory. PREREQUISITE: EC2600.

EC2650 ACCELERATED REVIEW OF ELECTROMAGNETICS (4 - 2).
A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC2600 and EC2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC2820 DIGITAL LOGIC CIRCUITS (3 - 2).
An introductory course in the analysis and design of digital circuits. These circuits are the basis for all military computers and digital control systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, truth tables, logic gates, integrated circuit families, decoders, multiplexers, arithmetic circuits, PLAs, ROMs, design of combinational circuits using SSI and MSI components, sequential logic including latches, flip-flops, registers, counters, and memories, analysis and design of synchronous circuits using state tables and state diagrams. The laboratories are devoted to study of combinational and sequential circuits and include a sequence of design projects involving increasingly complex digital functions. PREREQUISITE: None.

EC2840 INTRODUCTION TO MICROPROCESSORS (3 - 2).
An introduction to the organization and operation of microprocessors 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 and EC2820 (may be taken concurrently).

EC2990 DESIGN PROJECTS IN ELECTRICAL ENGINEERING (0 - 8).
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. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC3130 ELECTRICAL MACHINERY THEORY (4 - 2).
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. PREREQUISITE: EC2100.

EC3150 SOLID STATE POWER CONVERSION (3 - 2).
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, transistors converters, and switching regulators. PREREQUISITE: EC2100 or consent of instructor.

EC3200 ADVANCED ELECTRONICS ENGINEERING (3 - 2).
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 Complimentary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor 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. PREREQUISITE: EC2200.

EC3210 INTRODUCTION TO ELECTRO-OPTICAL ENGINEERING (3 - 1).
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. PREREQUISITE: EC3200 (may be taken concurrently).

EC3230 SPACE POWER AND RADIATION EFFECTS (Formerly EO3205.) (3 - 1).
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. PREREQUISITE: EC2200.

EC3310 OPTIMAL ESTIMATION: SENSOR AND DATA ASSOCIATION (3 - 2).
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 USW systems. PREREQUISITES: EC2010, EC2320, MA3046.

EC3320 OPTIMAL CONTROL SYSTEMS (3 - 2).
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).
The foundations of one and two-dimensional digital signal processing techniques are developed. Topics include fast Fourier transform (FFT) algorithms (1-D and 2-D), block convolution, the use of DFT and FFT to evaluate convolution (1-D and 2-D), elements of multirate signal processing and rate conversion, and design methods for 1-D nonrecursive and recursive digital filters. Computer-aided design techniques are emphasized. Introduction to time-frequency representation through the short-time Fourier transform and wavelet transforms. 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. PREREQUISITE: EC2410.

MA2049 VECTOR ANALYSIS WITH APPLICATIONS (3 - 0).
Review of vector algebra. Bold and index notation. 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. PREREQUISITES: MA1118 and MAR142 or MA1042.

MA2051 VECTORS AND COMPLEX VARIABLES (4 - 1).
Review of vector algebra. The calculus of vector fields; gradient, divergence and curl. Potential fields. Green's, Stokes' and the Divergence theorems. Introduction to complex functions. Differentiability and the Cauchy-Riemann equations. Cauchy's integral theorem and Cauchy's integral formula. Taylor and Laurent series. Residues. PREREQUISITES: MA1118 (or MAR118) and MA1043.

MA2121 DIFFERENTIAL EQUATIONS (4 - 0).
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: MA1118 and MA1042 concurrently.

MA2138 MULTIVARIABLE CALCULUS AND VECTOR ANALYSIS (5 - 0).
Course develops several mathematical tools for the calculus of several variables and of vector-valued functions. Infinite series and Taylor series representations; basic vector operations, vector functions of one variable; scalar functions of several variables, partial derivatives, directional derivatives, gradients; double and triple integrals with applications, line integrals with applications; divergence and curl, Green's, Stokes' and Gauss' theorems. Designed for UW and IW/EW students. No credit for both MA1118 and MA2138. PREREQUISITE: MA1117.

MA2139 INTRODUCTION TO DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (5 - 0).
This course develops mathematical tools from vector calculus and ordinary differential equations. Vector calculus topics covered include: vector fields; line and surface integrals; gradient, divergence, and curl; Green's Theorem, the Divergence Theorem, and Stokes' Theorem; and, applications to the theory of electricity and magnetism. Topics from ordinary differential equations (ODEs) include: classification and general solutions of ODEs; solution of first- and second-order homogeneous and non-homogeneous ODEs; power series solutions of ODEs; Laplace transforms; systems of finite order ODEs; and, applications to oscillations and resonance. PREREQUISITES: MA1042 and MA1118.

MA2300 MATHEMATICS FOR MANAGEMENT (5 - 0).
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).
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. PREREQUISITE: Enrollment in a 3000 level mathematics course and consent of instructor.

MA3025 LOGIC AND DISCRETE MATHEMATICS (5 - 1).
MA3025 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. PREREQUISITE: MAR125 or MA1025.

MA3026 DISCRETE MATHEMATICS WITH APPLICATIONS (5 - 0).
Graphs, trees, matchings and network flows. Introduction to combinatorial problems and counting techniques. Recurrence relations. Combinatorial circuits and introduction to finite state machines. PREREQUISITE: MA3025.

MA3030 INTRODUCTION TO COMBINATORICS AND ITS APPLICATIONS (4 - 1).
MA3030 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 combinatories 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).

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: MA1118 taken concurrently, MA1042.

MA3046 MATRIX ANALYSIS (4 - 1).

Linear algebra from a constructive point of view, important for applications. Gauss and Cholesky factorizations. Orthogonalization, linear least squares problems and the fundamental theorem of linear algebra. Hermitian eigen problems and singular value decompositions. General eigen problems. Structured and inverse problems from signal analysis and control. PREREQUISITE: MA1043, familiarity with MATLAB.

MA3110 INTERMEDIATE ANALYSIS (4 - 0).

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. PREREQUISITE: MA1118, MA3042.

MA3132 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS (4 - 0).

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. PREREQUISITE: MA2121 and vector analysis.

MA3139 FOURIER ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS (4 - 0).

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: Vector analysis and MA2121.

MA3185 TENSOR ANALYSIS (3 - 0).

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. PREREQUISITE: MA2049.

MA3232 NUMERICAL ANALYSIS (4 - 1).

Provides the basic numerical tools for understanding more advanced numerical methods, including Finite Difference, Finite Element, and Boundary Element Methods. Topics for the course include: Solution of Nonlinear Equations, Interpolation, Numerical Integration and Differentiation, Numerical Solution of ODE's and BVP's, Numerical Linear Algebra and the Eigenvalue Problem, and Analysis of Computational Errors. PREREQUISITE: MA2121, and ability to program in a high level language such as Fortran, C, or MATLAB.

MA3243 NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (4 - 1).

Course designed to familiarize the student with classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning some of the applicable algorithms, the student will be required to do some programming in FORTRAN. Topics covered include: Implicit, Explicit, and Semi-Implicit Methods in the solution of Elliptic and Parabolic PDE's, Iterative Methods for solving Elliptic PDE's (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDE's. PREREQUISITES: MA3132 and ability to program in a high level language such as Fortran, C, or MATLAB.

MA3261 BASIC PARALLEL COMPUTATION (3 - 0).

The course has two goals: First to introduce some fundamental issues such as shared vs. distributed memory, connection topologies, communication algorithms, speedup, efficiency, storage requirements, granularity, pipelining, problem scaling, 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: MA1118 or MA3025 and ability to program in a high-level language.

MA3301 LINEAR PROGRAMMING (Same as OA3201.) (4 - 1).
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. PREREQUISITES: MA3042, MA3110 and OA3200.

MA3393 TOPICS IN APPLIED MATHEMATICS (Variable hours 1-0 to 4-0.) (V - 0).
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. PREREQUISITE: Consent of instructor.

MA3400 MATHEMATICAL MODELING PROCESSES (4 - 0).
Practice model construction while demonstrating the utility and universality of mathematics. Topics include modeling using graphical analysis, the model building process, modeling using proportionality, analysis of data, modeling using dimensional analysis, dynamical models, optimization of models and simulation. Models investigated include the nuclear arms race, drag force on a submarine, optimization of inventory levels, and fuel consumption. PREREQUISITE: MA1118 or consent of instructor.

MA3560 MODERN APPLIED ALGEBRA (3 - 0).
The techniques and tools of abstract algebra. The emphasis is on group theory: classification, subgroups, conjugates, isomorphism, direct products, homomorphism, and factor groups. The course concludes with a brief look at the theory of rings and fields, especially finite fields. Applications may vary, but typically are drawn from topics of interest to DoN/DoD. These include error correcting codes, reliable and secure communications and cryptography. Satisfies the algebra ESR. PREREQUISITE: MA3025.

MA3605 FUNDAMENTALS OF ANALYSIS I (3 - 0).
The real number system and the usual topology of the real line; properties of continuous functions; differentiation. Functions of bounded variation and theory of Riemann-Stieltjes integration, convergence theorems for sequence and series of functions. Satisfies the analysis ESR for the Applied Mathematics program. PREREQUISITE: MA3110 or consent of instructor.

MA3606 FUNDAMENTALS OF ANALYSIS II (3 - 0).
Continuation of MA3605. PREREQUISITE: MA3605.

MA3610 TOPOLOGY, FRACTALS, AND CHAOTIC DYNAMICS (3 - 0).
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. PREREQUISITE: MA1118 and MA2121.

MA3675 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE I (3 - 0).
Selected topics from the theory of functions of a complex variable; complex functions, power series, Laurent series. Singularities of complex functions; contour integration and residues; zeros of analytic functions, factors of and 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. PREREQUISITE: MA1118.

MA3676 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II (3 - 0).
Continuation of MA3675. PREREQUISITE: MA3675.

MA3730 THEORY OF NUMERICAL COMPUTATION (3 - 0).
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).
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. PREREQUISITE: MA3025.

MA4027 GRAPH THEORY AND APPLICATIONS (4 - 0).
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. PREREQUISITE: MA3025.

MA4101 INCREMENTED DIRECTED STUDY (Variable hours 1-0 or 2-0.) (V - 0).
Provides the opportunity for the student enrolled in a 4000 level mathematics course to pursue the subject under faculty supervision to greater depth. One extra credit is assigned beyond the normal course credit. PREREQUISITES: Enrollment in a 4000 level math course and consent of instructor.

MA4103 THESIS TOPICS SEMINAR (3 - 0).
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. PREREQUISITE: Consent of instructor. Graded on a Pass/Fail basis only.

MA4230 NUMERICAL FUNCTIONAL ANALYSIS (3 - 0).
Linear functionals, Riesz representation theorem, Hilbert spaces, Sobolev spaces, interpolation and approximation in Hilbert spaces, nonlinear operators, Newton's method. PREREQUISITES: MA3232, MA4635.

MA4237 ADVANCED TOPICS IN NUMERICAL ANALYSIS (Variable credit, usually 4-0.) (V - 0).
The subject matter will vary according to the abilities and interest of those enrolled. Applications of the subject matter to DoD/DoN are discussed. PREREQUISITE: Consent of instructor.

MA4242 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3 - 1).
Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. PREREQUISITE: MA3232.

MA4243 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3 - 1).
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, MA4230 suggested.

MA4245 MATHEMATICAL FOUNDATIONS OF FINITE ELEMENTS (3 - 1).
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).
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.

MA4251 APPLIED APPROXIMATION THEORY (3 - 1).
Univariate and tensor product spline approximation, interpolation in Hilbert spaces, scattered data approximation, applications. PREREQUISITES: MA3232, MA4230.

MA4261 DISTRIBUTED SCIENTIFIC COMPUTING (3 - 2).
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).
Introduction to modern optimization techniques, Karesh-Kuhn-Tucker necessary and sufficient conditions for optimality, quadratic and separable programming, basic gradient search algorithms and penalty function methods. Applications to weapons assignment, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITES: OA3201 and MA3110.

MA4302 DESIGN OF EXPERIMENTS (Course taught by OR staff, same as OA4101.) (3 - 1).
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.

MA4303 REGRESSION ANALYSIS (Course taught by OR staff, same as OA4102.) (4 - 0).
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, OA3103 and OA3104.

MA4304 TIME SERIES ANALYSIS (Course taught by OR staff, same as OA4308.) (4 - 0).
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: OA3104 and OA3301.

MA4311 CALCULUS OF VARIATIONS (3 - 0).
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. PREREQUISITE: MA2121 (programming experience desirable).

MA4312 TOPICS IN CALCULUS OF VARIATIONS (3 - 0).
Topics covering extensions of concepts presented in MA4311. PREREQUISITE: MA4311 and computer programming.

MA4321 STABILITY, BIFURCATION AND CHAOS (3 - 0).
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. PREREQUISITE: MA4620.

MA4322 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS I (3 - 0).
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).
Continuation of MA4322. PREREQUISITE: MA4322.

MA4332 PARTIAL DIFFERENTIAL EQUATIONS (3 - 0).
Diffusion, wave and Laplace equations. Classification of second order equations, discontinuities and signal propagation, transform methods, Green's functions, first order equations and characteristics. PREREQUISITE: MA3132.

MA4335 LINEAR AND NONLINEAR WAVES (3 - 0).
Analysis of the two main classes of wave motion, hyperbolic waves and linear dispersive waves. Topics covered include: kinematic waves, shock waves, shock structure and shock fitting, Burger's equation, the wave equation, linear dispersive waves, wave patterns and water waves. PREREQUISITE: MA3132.

MA4340 ADVANCED MATHEMATICAL MODELING (3 - 0).
A course intended to bring advanced mathematical methods to bear on the modeling and study of physical problems. Topics to be discussed include: simple dynamic models, the phase plane, stable and unstable motion, wave motion, bifurcation, catastrophe and chaos. PREREQUISITES: MA3132 and MA3400.

MA4362 ORBITAL MECHANICS (3 - 0).
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. Codes used by the military to predict the orbits of artificial satellites and space debris. PREREQUISITE: PH2511.

MA4370 THEORY OF PLATES AND SHELLS (3 - 0).
Foundations of the mathematical theory of thin plates and shells. Analytical and numerical solution techniques. Applications to structures used by the military. PREREQUISITES: MA3132.

MA4372 INTEGRAL TRANSFORMS (3 - 0).
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).
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. PREREQUISITE: MA3132.

MA4378 ASYMPTOTIC AND PERTURBATION METHODS II (3 - 0).
Continuation of MA4377. PREREQUISITE: MA4377.

MA4391 ANALYTICAL METHODS FOR FLUID DYNAMICS (4 - 0).
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. PREREQUISITE: MA3132 or MA3139.

MA4392 NUMERICAL METHODS FOR FLUID DYNAMICS (4 - 0).
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. PREREQUISITE: MA3232 and MA4391.

MA4393 TOPICS IN APPLIED MATHEMATICS (3 - 0).
A selection of topics in applied mathematics. 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. PREREQUISITE: Consent of instructor.

MA4560 CODING AND INFORMATION THEORY (4 - 0).
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. PREREQUISITE: MA3560.

MA4565 ADVANCED MODERN ALGEBRA (3 - 0).
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. PREREQUISITE: MA3560.

MA4570 CRYPTOGRAPHY (4 - 0).
The methods of secret communication are addressed. Some 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. PREREQUISITE: MA3560.

MA4593 TOPICS IN ALGEBRA (3 - 0).
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 ESR's in a variety of curricula. PREREQUISITE: MA3560 or consent of instructor.

MA4595 MATHEMATICAL FOUNDATIONS OF FAST SIGNAL PROCESSING ALGORITHMS (3 - 0).
Advanced transform algorithms for signal processing. Generalized Cooley-Tukey, Rader prime factor, and Winograd FFT algorithms. Polynomial rings, the Chinese Remainder theorem for polynomials, quotient fields, and reduced multiplication convolution algorithms. Application to hardware and software design for signal processing systems. PREREQUISITES: EC3400 and MA3042, or consent of instructor.

MA4620 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS (3 - 0).
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).
Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesgue measure and integration theory, convergence theorems and Lp spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesgue decomposition and product measure; Daniell integrals and integral representation of linear functionals. PREREQUISITE: MA3606.

MA4636 FUNCTIONS OF REAL VARIABLES II (3 - 0).
Continuation of MA4635. PREREQUISITE: MA4635.

MA4675 COMPLEX ANALYSIS (3 - 0).
A continuation of MA3675, MA3676. Differential equations in the complex plane, transform methods, the Wiener-Hopf method, integral equations, discrete Fourier analysis. PREREQUISITES: MA3675, MA3676.

MA4693 TOPICS IN ANALYSIS (3 - 0).
A selection of topics in analysis. Content of the course varies. Students will be allowed credit for taking the course more than once. PREREQUISITE: Consent of instructor.

DEPARTMENT OF MECHANICAL ENGINEERING

Chairman:
Terry R. McNelley
Professor
Code ME/Mc
Mechanical Engineering
Bldg, Room 338
(408) 656-2589/2586
DSN 878-2589/2586
FAX (408) 656-2238

Associate Chairman:
Morris R. Driels
Professor
Code ME/Dr
Mechanical Engineering
Bldg, Room 305
(408) 656-3383
DSN 878-3383
FAX: (408) 656-2238

Academic Associate:
Young S. Shin
Professor
Code ME/Sg
Mechanical Engineering
Bldg, Room 326
(408) 656-2568
DSN 878-2568
FAX: (408) 656-2238

Charles N. Calvano, Associate Professor (1991)*; Ocean Engineer, Massachusetts Institute of Technology, 1970.

Morris R. Driels, Professor and Associate Chair (1989); PhD, City University of London, 1973.

Indranath Dutta, Associate Professor (1988); PhD, University of Texas, Austin, 1988.

Alan G. Fox, Professor (1989); PhD, University of Birmingham, United Kingdom, 1982.

Ashok Gopinath, Assistant Professor (1994); PhD, University of California, Los Angeles, 1992.

Joshua H. Gordis, Associate Professor (1992); PhD, Rensselaer Polytechnique Institute, 1990.

Anthony J. Healey, Professor (1986); PhD, Sheffield University, United Kingdom, 1966.

Matthew D. Kelleher, Professor (1967); PhD, University of Notre Dame, 1966.

Joung K. Kim, Research Assistant (1992); MS, University of Illinois, 1985.

Young W. Kwon, Associate Professor (1990); PhD, Rice University, 1985.

Minhyung Lee, Research Assistant Professor (1996); PhD, University of Texas, 1995.

Paul J. Marto, Distinguished Professor Emeritus (1965); ScD, Massachusetts Institute of Technology, 1965.

Terry R. McNelley, Chairman and Professor (1976); PhD, Stanford University, 1973.

Sarath K. Menon, Research Associate Professor (1994); PhD, Carnegie Mellon University, 1985.

Knox T. Millsaps, Jr., Assistant Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

F. Kevin Owen, Research Professor (1995); D. Phil., University of Oxford, 1969.

Fotis A. Papoulias, Associate Professor (1988), PhD, University of Michigan, 1987.

Paul F. Pucci, Professor Emeritus (1956) PhD, Stanford University, 1955.

Jon D. Raggett, Lecturer (1992); PhD, Princeton University, 1971.

David Salinas, Associate Professor Emeritus (1970); PhD, University of California, Los Angeles, 1968.

Turgut Sarpkaya, Distinguished Professor (1967); PhD, University of Iowa, 1954.

Young S. Shin, Professor and Associate Chair (1981); PhD, Case Western Reserve University, 1971.

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

The department of Mechanical Engineering provides a strong academic program which spans the disciplines of the thermal-fluid sciences, structural mechanics, dynamic systems and control, and materials science and engineering. These disciplines are blended together with a strong emphasis on naval engineering applications such as may be experienced on surface vessels and in submarines.

Programs leading to the degree Master of Science in Mechanical Engineering are accredited at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

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 must be approved by the Chairman of the Department of Mechanical Engineering at least two quarters before completion. In general, approved programs will require more than minimum degree requirements in order to conform to the needs and objectives of the United States Navy.

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

A candidate shall have completed work equivalent to the Bachelor of Science requirements of this department. Candidates who have not majored in Mechanical Engineering, or who have experienced a significant lapse in continuity with previous academic work, initially will take undergraduate courses in mechanical engineering and mathematics in preparation for their graduate program.

The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. Because the Naval Postgraduate School accepts students with a wide variety of educational backgrounds, programs are uniquely tailored to provide a firm foundation in the principles of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements below.

In addition to the stated credit hour requirements, a student seeking the Master of Science in Mechanical Engineering must demonstrate competence in a broad spectrum of the fundamental core disciplines of Mechanical Engineering. These are: fluid mechanics; thermal science; solid mechanics; vibrations; dynamic systems and controls; designs; and materials engineering. This may be accomplished by successfully completing six of the following seven courses: ME3150 Heat Transfer; ME3201 Intermediate Fluid Mechanics; ME3521 Mechanical Vibrations; ME3611 Mechanics of Solids II; ME3711 Design of Machine Elements; ME3801 Classical Control of Naval Engineering Systems; MS3202 Properties, Performance and Failure of Engineering Materials. Alternatively, competence in any of these areas may be satisfied by validation of equivalent course work, to an acceptable level, from another institution.

The Master of Science degree in Mechanical Engineering requires at least 32 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 12 of which must be at the 4000 level. In addition, at least 8 quarter hours of graduate credit must be earned outside of Mechanical Engineering and Materials Science. Officers specializing in Materials Science must have their selection of electives approved by the Chairman.

An acceptable thesis is required for the Master of Science in Mechanical Engineering degree. An acceptable thesis for the degree of Mechanical Engineer may also be accepted as meeting the thesis requirement for the master's degree. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering).

The program must include at least 36 credit hours of graduate work in the disciplines of engineering, science and mathematics, 12 of which must be at the 4000 level. Of those 36 hours, at least 20 hours (eight of which must be at the 4000 level) must be in Mechanical Engineering and Materials Science. In addition, the program must contain at least 12 hours at the graduate level in courses outside Mechanical Engineering and Materials Science.

The student seeking the degree Master of Science in Engineering Science must submit an acceptable thesis. Programs leading to this degree must be approved by the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN MATERIALS SCIENCE AND ENGINEERING

Students with acceptable backgrounds in science or engineering may enter a program leading to the degree Master of Science in Materials Science and Engineering. The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering 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 32 credit hours of graduate work in Materials Science, at least 16 of which must be at the 4000 level. In addition, 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. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MECHANICAL ENGINEER

A graduate student with a superior academic record (with a graduate QPR of 3.70 or better) may apply to enter a program leading to the degree Mechanical Engineer. A candidate is normally selected after completion of his first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer degree requires at least 60 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 30 of which must be at the 4000 level. In addition, at least 12 quarter hours of graduate level credits must be earned outside of Mechanical Engineering and Materials Science.

An acceptable thesis is required for the Mechanical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the Department of Mechanical Engineering.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM
A Mechanical Engineer degree may also be obtained as part of the Total Ship Systems Engineering program. The program objective is to provide a broad-based design- oriented education focusing on the warship as a total engineering system. Entry requirements are a baccalaureate degree in an engineering discipline with an APC of 222 and students are expected to validate several courses in the standard MSME degree program. A thesis is required that may address system design issues. The advisor and topic must have prior approval of the Chairman of the Mechanical Engineering Department.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING
The Department of Mechanical Engineering has an active program leading to the degrees of Doctor of Philosophy and Doctor of Engineering. Areas of particular strength in the department are hydrodynamics, viscous flows, heat transfer, materials science, dynamics and control, vibrations and finite element analysis and computer aided design.

Entrance into the doctoral program may be requested by officers currently enrolled who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. 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 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 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

Every applicant who is accepted for the doctoral program will initially be enrolled in the Mechanical Engineering Program under a special option which satisfies the broad departmental requirements for the Engineer's degree and which includes research work. As soon as feasible, the student must identify a faculty advisor to supervise research and to help initially in the formulation of 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.

LABORATORIES
The Mechanical Engineering 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.

MECHANICAL ENGINEERING COURSE DESCRIPTIONS

ME0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

ME0951 SEMINARS (NO CREDIT) (0 - 1).
Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government or industrial activities.

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 EIT Exam or consent of instructor. Graded on Pass/Fail basis only.

ME2001 INTRODUCTION TO ENGINEERING (3 - 0).
The origins of engineering. The role of mathematics and the physical sciences in engineering. Definition of an engineering problem, including its formulation, assumptions and method of attack. Engineering analysis. The engineering design process using the context of Naval ships and systems. Engineering communications, including graphics. This course is intended for students with a non-engineering background. PREREQUISITE: MA1117 (may be taken concurrently).

ME2101 ENGINEERING THERMODYNAMICS (4 - 1).
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. PREREQUISITE: MA1118.

ME2201 INTRODUCTION TO FLUID MECHANICS (3 - 2).
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. PREREQUISITE: ME2502.

ME2440 THE DIGITAL COMPUTER AS AN ENGINEERING TOOL (3 - 2).
Introduction to high-level programming languages including FORTRAN and MATLAB, Unix, VMS, operating system usage. Development of computer programs, subroutine organization, input and output. Application of programming techniques to the solution of selected problems in Mechanical Engineering. The laboratory includes introduction to the computing facilities at the school with emphasis on those unique to the Mechanical Engineering Department; familiarization with available software for solution of engineering problems; and various programming exercises. PREREQUISITES: MA1118, ME2101, ME2501 (all may be taken concurrently).

ME2501 STATICS (3 - 0).
Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. PREREQUISITE: MA1118 (may be taken concurrently).

ME2502 DYNAMICS (4 - 1).
Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear and space curvilinear motion. Newton's laws, work and energy, impulse and momentum, and impact. Plane motion of rigid bodies and introduction to gyroscopic motion. PREREQUISITE: ME2501.

ME2601 MECHANICS OF SOLIDS I (3 - 2).
Stress-strain. Hookes Law. Plane stress and plane strain. Stress transformation for plane stress. Mohr's circle. Principal stresses and axes. Stress analysis of bars, circular shafts, cylindrical and spherical thin walled pressure vessels. Shear and bending diagrams for beams. Stresses in beams. Failure theories. Torsion of thin walled closed tubes. Composite beams. Euler columns. Supporting laboratory work. PREREQUISITES: ME2501 and MA1118 or equivalent.

ME2801 INTRODUCTION TO ENGINEERING SYSTEM DYNAMICS (3 - 2).
Generalized system modeling principles and reduction to mathematical forms. Analogies between electrical, mechanical, fluid, and thermal systems. Response of first and second order systems, characteristics, transient response. Introduction to feedback. PREREQUISITES: ME2502 and MA2121.

ME3150 HEAT TRANSFER (4 - 1).
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 exchange analysis. Thermal radiation. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3201 INTERMEDIATE FLUID MECHANICS (3 - 2).
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 viscious laminar flow problems. Boundary-layer concepts. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3220 STEAM POWER, REFRIGERATION, AND TURBOMACHINERY (3 - 2).
The conventional Rankine cycle steam plant, including superheat, reheat, and regenerative cycles. Boiler, condenser, and feed-water heater description. Thermodynamics of refrigeration systems, Fundamentals of turbomachinery: energy and momentum equations, dimensional analysis, and velocity diagrams. Blade design and work determination from blade shape. Application to pumps, fans, compressors, and turbines. PREREQUISITES: ME2101 and ME2201.

ME3240 RECIPROCATING AND GAS TURBINE POWER PLANTS (3 - 3).
Thermodynamic analyses and performance characteristics of single and multi-stage reciprocating air compressors, spark ignition engines (Otto cycle), compression ignition engines (diesel cycle), and gas turbine engines (Brayton cycle). Gas turbine component characteristics including the aerodynamics of the compressor and turbine design, and the combustor. Ship propulsion requirements, propeller characteristics, and Ship/Propeller/Power Plant matching. The laboratory includes selected experiments demonstrating power plant performance, e.g. diesel engine and gas turbine engine. PREREQUISITES: ME2101, ME2201.

ME3410 MECHANICAL ENGINEERING INSTRUMENTATION AND MEASUREMENT LAB (2 - 4).
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: ME2601, ME2801, ME3150, ME3521 (ME3150 and ME3521 may be taken concurrently).

ME3440 ENGINEERING ANALYSIS (4 - 0).
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, ME2440, ME2502, and ME2601.

ME3521 MECHANICAL VIBRATION (3 - 2).
Free and forced vibration of discrete linear systems. Vibration isolation and suppression. Vibration of bars, shafts, and beams. Supporting laboratory work. PREREQUISITES: ME2502, ME2601; MA2121 or equivalent (may be taken concurrently).

ME3611 MECHANICS OF SOLIDS II (4 - 0).
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. PREREQUISITE: ME2601.

ME3711 DESIGN OF MACHINE ELEMENTS (4 - 1).
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. PREREQUISITE: ME2601.

ME3801 CLASSICAL CONTROL OF NAVAL ENGINEERING SYSTEMS (3 - 2).
Classical control design for linear systems with single-input, single-output design requirements. Transient response analysis, steady state error analysis. Routh, root locus and frequency response stability methods. Phase lead/lag and multimode compensation techniques. The course includes a laboratory. PREREQUISITE: ME2801.

ME4160 APPLICATIONS OF HEAT TRANSFER (4 - 0).
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. PREREQUISITE: ME3150.

ME4161 CONDUCTION HEAT TRANSFER (4 - 0).
Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. PREREQUISITE: ME3150.

ME4162 CONVECTION HEAT TRANSFER (4 - 0).
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.

ME4163 RADIATION HEAT TRANSFER (4 - 0).
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. PREREQUISITE: ME3150.

ME4202 COMPRESSIBLE FLOW (3 - 0).
Review of simple one-dimensional flow. Generalized one-dimensional flow. Two-dimensional and axisymmetric flows. Subsonic flow with small perturbations. Mach lines. Methods of characteristics. Prandtl-Meyer expansion waves. Oblique shocks. Unsteady, one-dimensional flow. Introduction to compressible boundary layer. PREREQUISITE: ME3201 or equivalent compressible flow coverage.

ME4211 APPLIED HYDRODYNAMICS (4 - 0).
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. PREREQUISITE: ME3201.

ME4220 VISCOUS FLOW (4 - 0).
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. PREREQUISITE: ME3201 and instructor's permission.

ME4240 ADVANCED TOPICS IN FLUID DYNAMICS (4 - 0).
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.

ME4420 MARINE GAS TURBINES (4 - 0).
Thermodynamic analyses of gas turbine cycles, including airbreathing and closed cycle engines. Internal aerodynamics of compressor and turbine design. Combustor and source heat exchanger design. Materials considerations. Operational controls and instrumentation. Lubrication and fuels systems. Inlet, exhaust, and silencing systems. Propulsion of surface effect, hydrofoil, and conventional surface ships. Installation arrangements. Waste heat recovery systems and combined cycles (COGAS, CODOG). Auxiliary power generation. Repair and maintenance. PREREQUISITE: ME3240.

ME4522 SHIPBOARD VIBRATION AND NOISE (4 - 0).
Mechanical impedance, transfer matrices and their application to transmission of vibratory motion from machinery sources to hull plating. Acoustic signal generation at the hull-fluid interface. Characteristics of viscoelastic materials and their use in vibration isolation. Multi-isolator mounts. Study of accordian and flexural vibration of ship hulls using one-dimensional finite element modeling. Military vibration specifications. Use of vibration measurements for machinery condition monitoring. PREREQUISITE: ME3521.

ME4525 NAVAL SHIP SHOCK DESIGN AND ANALYSIS (4 - 0).
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. PREREQUISITE: ME3521 or equivalent.

ME4550 RANDOM VIBRATIONS AND SPECTRAL ANALYSIS (3 - 2).
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. PREREQUISITE: ME3521 or equivalent.

ME4612 ADVANCED MECHANICS OF SOLIDS (4 - 0).
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. PREREQUISITE: ME3611.

ME4613 FINITE ELEMENT METHODS (4 - 0).
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 the instructor.

ME4620 THEORY OF CONTINUOUS MEDIA (4 - 0).
Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. PREREQUISITES: ME3201 and ME3611.

ME4731 ENGINEERING DESIGN OPTIMIZATION (4 - 0).
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: ME2440, ME3150, ME3201, ME3611.

ME4811 MULTIVARIABLE CONTROL OF SHIP SYSTEMS (3 - 2).
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. PREREQUISITE: ME3801.

ME4812 FLUID POWER CONTROL (3 - 2).
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 ADVANCED DYNAMICS (3 - 2).
Newtonian mechanics: kinematics and dynamics of three dimensional motion of complex systems using Newton-Euler's method, analytical mechanics, generalized coordinates, virtual work, Lagrange's equations, calculus of variations, Hamilton's principle. PREREQUISITE: ME3521.

ME4823 DYNAMICS OF MARINE VEHICLES (4 - 0).
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. Seakeeping consideration in ship design. PREREQUISITE: ME3201.

ME4825 MARINE PROPULSION CONTROL (3 - 2).
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 (Variable hours 1-0 to 6-0.) (V - 0).
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. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

MS2201 INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING (3 - 2).
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 & FAILURE OF ENGINEERING MATERIALS (3 - 2).
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. PREREQUISITE: MS2201 or equivalent or consent of instructor.

MS3214 INTERMEDIATE MATERIALS SCIENCE AND ENGINEERING (4 - 0).
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).
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. PREREQUISITE: MS2201 or equivalent or consent of instructor.

MS3505 MATERIALS SELECTION FOR MILITARY APPLICATIONS (4 - 0).
This course deals in depth with selection of the optimum material for a given application. Consideration is also given to evolution of new applications for existing materials, and to materials development for new and old applications. A variety of application areas are covered, including marine structures, aerospace applications, nuclear reactors, electronics, high temperature cryogenic services, and others. Sources of information, methodology, and basic rationale for materials selection decisions are presented. Emphasis is put on the variation in properties of a given material with processing history, and on variation of properties in service. PREREQUISITE: MS2201, MS3202 or consent of instructor.

MS3606 INTRODUCTION TO WELDING AND JOINING METALLURGY (3 - 2).
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. PREREQUISITE: MS2201 and MS3202 or consent of the instructor.

MS4215 PHASE TRANSFORMATIONS (3 - 2).
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. PREREQUISITE: MS3214 or equivalent or consent of instructor.

MS4312 CHARACTERIZATION OF ADVANCED MATERIALS (3 - 2).
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. PREREQUISITE: MS3202 or consent of instructor.

MS4811 MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS (4 - 0).
The response of structural materials to stress is discussed, including elastic and plastic deformation and fracture. Topics include elastic response and the modules of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application to materials development is also considered. PREREQUISITE: MS3202, and MS3214 or consent of the instructor.

MS4822 THE ENGINEERING AND SCIENCE OF COMPOSITE MATERIALS (4 - 0).
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 (Variable 1-0 to 6-0.) (V - 0).
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. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

TS3000 ELECTRICAL POWER ENGINEERING (3 - 2).
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. PREREQUISITE: EC2270.

TS3001 FUNDAMENTAL PRINCIPLES OF NAVAL ARCHITECTURE (3 - 2).
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.

TS3002 PRINCIPLES OF SHIP DESIGN AND CASE STUDIES (3 - 2).
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 illustrative. PREREQUISITE: TS3001.

TS3003 NAVAL COMBAT SYSTEM ELEMENTS (3 - 2).
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: ME2502, EC2170 or equivalent. SECRET clearance.

TS4000 NAVAL COMBAT SYSTEM ENGINEERING (3 - 2).
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. SECRET clearance.

TS4001 INTEGRATION OF NAVAL ENGINEERING SYSTEMS (3 - 2).
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, TS3002.

TS4002 SHIP DESIGN INTEGRATION (2 - 4).
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. SECRET clearance.

TS4003 TOTAL SHIP SYSTEMS ENGINEERING (2 - 4).
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. PREREQUISITE: TS4002. SECRET clearance.

DEPARTMENT OF METEOROLOGY

Robert T. Bluth, Research Assistant (1996); BS, Cal-State Northridge, 1986.

Lester E. Carr, Commander, U. S. Navy, Assistant Professor (1992)*; PhD, Naval Postgraduate School, 1989.

Chih-Pei Chang, Professor (1972); PhD, University of Washington, 1972.

Jeng-Ming Chen, Research Assistant Professor (1989); PhD, University of California at Los Angeles, 1989.

Kenneth L. Davidson, Professor and Associate Chair for Research (1970); PhD, University of Michigan, 1970.

Philip A. Durkee, Professor (1984); PhD, Colorado State University, 1984.

Russell L. Elsberry, Distinguished Professor (1968); PhD, Colorado State University, 1968.

Paul Finn, Research Assistant (1996); BS, University of Kansas, 1982.

George W. Haltiner, Distinguished Professor Emeritus (1946); PhD, University of Wisconsin, 1948.

Robert L. Haney, Professor and Associate Chair for Curricular Matters (1970); PhD, University of California at Los Angeles, 1971.

Patrick A. Harr, Research Assistant Professor (1989); MS Colorado State University, 1978; Ph.D. Naval Postgraduate School, 1993.

Bao-Fong Jeng, Research Assistant (1993); MS, National Taiwan University, 1986.

Haflidi H. Johnson, Research Assistant Professor (1996); PhD, State University of New York at Albany , 1988.

Tianming Li, Research Assistant Professor (1997); PhD, University of Hawaii, 1993.

Frank L. Martin, Professor Emeritus (1947); PhD, University of Chicago, 1941.

Douglas Miller, Research Assistant Professor (1997); PhD, Purdue University, 1996.

James T. Murphree, Research Assistant Professor (1991); PhD, University of California at Davis, 1989.

Wendell A. Nuss, Associate Professor (1986); PhD, University of Washington, 1986.

Patricia M. Pauley, Research Associate Professor (1990); PhD, Purdue University, 1985.

Robert J. Renard, Distinguished Professor Emeritus (1952); PhD, Florida State University, 1970.

Supachai (Pom) Sirayanone, Research Associate Professor (1993); PhD, Iowa State University, 1988.

Willem van der Bijl, Professor Emeritus (1961); PhD State University, Utrecht, 1952.

Qing Wang, Assistant Professor (1995); PhD, Pennsylvania State University, 1993.

Carlyle H. Wash, Chairman and Professor (1980); PhD, University of Wisconsin, 1978.

Forrest R. Williams, Senior Lecturer (1983); MS, Massachusetts Institute of Technology, 1972.

Roger T. Williams, Professor (1968); PhD, University of California at Los Angeles, 1963.

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

Chairman:
Carlyle H. Wash
Professor
Code MR/Wx, Root Hall
Room 252
(408) 656-2517
DSN 878-2517

Associate Chairmen:

Research
Kenneth L. Davidson
Professor
Code MR/Ds, Root Hall
Room 244
(408) 656-2309
DSN 878-2309

Curricular Matters
Robert L. Haney
Professor
Code MR/Hy, Root Hall
Room 257
(408) 656-4053
DSN 878-4053

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, midlatitude, and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has 28 faculty (9 tenure track, 14 non-tenure track, 1 military, and 4 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 forecasting, coastal meteorology, 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 among its recent graduates.

DEPARTMENT REQUIREMENTS FOR DEGREES

MASTER OF SCIENCE IN METEOROLOGY
Entrance to a program leading to a Master of Science degree in Meteorology requires a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics.

The degree Master of Science in Meteorology 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 degree Master of Science in Meteorology and Physical Oceanography 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 degree of Master of Science in Meteorology and Physical Oceanography 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) 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.

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 16 image analysis and graphics workstations and more than 100 gigabytes of disk storage. 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 weather analysis and forecast products are received via the Navy Oceanographic Data Distribution System (NODDS) and National Weather Service analyses and forecasts are received via PC-based DIFAX facsimile systems and UNITATA internet distribution. Satellite imagery can be animated with a PC-based digital satellite image processing system connected to GOESTAP. Current weather observations are accessible through the COMEDS and a RADAC Weather Radar Receiver. Level II NEXRAD data will be available through a direct real-time link to the National Weather Service, San Francisco Bay Office soon. The unique combination of Navy and civilian weather observations and products available in the lab provide students with the opportunity to examine and forecast the weather over the entire globe.

The Marine Atmospheric Measurements Laboratory utilizes in-situ and remote sensing instrumentation systems for both teaching and research. Instrumentation includes: 915 MHz Doppler radar wind profiler with radio acoustic sounding system (RASS); rawinsonde systems with Omega and LORAN navigational aids; three-axis monostatic SODAR; and a fully instrumented surface weather station. A Navy Automated Surface Observing System (ASOS) is planned to be deployed. 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. Calibration facilities include a temperature/humidity calibration chamber and access to a wind tunnel.

The department also has a Joint Tactical Laboratory designed to assist students in applying and testing in an operational setting the oceanographic and meteorological principles learned in the classroom. The Joint Tactical Laboratory is a classified lab equipped with the same receiver units used aboard aircraft carriers, permitting real-time access and manipulation of environmental data and satellite imagery. The Joint Tactical Laboratory also has eight computer workstations that run the full suite of Geophysical Fleet Mission Planning Library (GFMPL) programs used by Navy oceanographers to facilitate analysis and forecasting in support of fleet operations. The lab supports a number of classified research projects, and theses, in addition to classroom instruction.

METEOROLOGY COURSE DESCRIPTIONS

MRR210 REFRESHER, INTRODUCTION TO METEOROLOGY/LAB (NO CREDIT) (Meets last six weeks of quarter.) (4 - 2).
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).
Every student conducting thesis research will enroll in this course.

MR0999 SEMINAR IN METEOROLOGY (NO CREDIT) (2 - 0).
Students present results of thesis or other approved research investigation. PREREQUISITE: Concurrent preparation of thesis or other acceptable research paper.

MR2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (2 - 2).
Introduction to programming and NPS computing facilities as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

MR2200 INTRODUCTION TO METEOROLOGY (4 - 0).
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. PREREQUISITE: Department approval.

MR2210 INTRODUCTION TO METEOROLOGY/LABORATORY (4 - 2).
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. PRE-REQUISITE: Department approval.

MR2262 ELEMENTS OF WEATHER FORECASTING (1 - 2).
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).
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).
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).
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. PREREQUISITE: Calculus.

MR3150 ANALYSIS OF AIR/OCEAN TIME SERIES (3 - 2).
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).
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).
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).
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 osotach analysis techniques, satellite interpretation, and vertical cross-section analyses. PREREQUISITES: MR3420 or MR3480, MR/OC3321.

MR3230 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY (4 - 0).
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 concurrent).

MR3234 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY/LABORATORY (4 - 4).
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).
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).
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).
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).
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).
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).
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: MA2049, MA2051 or MA2138.

MR3420 ATMOSPHERIC THERMODYNAMICS (3 - 0).
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. PREREQUISITE: MA1118 or equivalent.

MR3421 CLOUD PHYSICS (3 - 0).
Basic principles of cloud and precipitation physics and application to cloud formation and optical properties. PRE-REQUISITE: MR3420.

MR3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2 - 2).
Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermo-dynamic 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).
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's 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 the instructor.

MR3480 ATMOSPHERIC THERMODYNAMICS AND RADIATIVE PROCESSES (4 - 1).
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. Basic solar and terrestrial radiation theory; atmospheric energy budgets; climate change; radiative effects of clouds and aerosols. PREREQUI-SITE: MA1117 or equivalent.

MR3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4 - 0).
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).
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).
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).
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumenta-tion. 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.

MR4240 COASTAL METEOROLOGY (3 - 1).
Mesoscale circulations of the coastal atmosphere are examined from theoretical, observational, and model perspec-tives. Thermally-driven circulations, orographically-driven circulations and mesoscale circulations due to the interac-tion 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).
Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesos-cale 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).
Theories and observations of equatorial waves and low-frequency oscillations; energy sources and instabilities; monsoon circulations. Tropical cyclone models and forecasting; selected topics in diagnostic and theoretical studies of tropical flows. PREREQUISITE: MR3250 and consent of instructor.

MR4250 ATMOSPHERIC GENERAL CIRCULATION (3 - 0).
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. PREREQUISITE: MR4322 and consent of instructor.

MR4322 DYNAMIC METEOROLOGY (4 - 0).
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. PRE-REQUISITES: MR3420, MR/OC3321, MA2049, MA2121 or equivalent.

MR4323 NUMERICAL AIR AND OCEAN MODELING (4 - 2).
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, MA3132; MA3232 desirable.

MR4324 ADVANCED NUMERICAL WEATHER PREDICTION (3 - 0).
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. PREREQUI-SITE: MR/OC4323 or consent of instructor.

MR4331 ADVANCED GEOPHYSICAL FLUID DYNAMICS I (3 - 0).
Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. PREREQUISITE: Consent of instructor.

MR4332 ADVANCED GEOPHYSICAL FLUID DYNAMICS II (3 - 0).
Normal mode and baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves; symmetric instability. PREREQUISITE: Consent of instructor.

MR4413 AIR-SEA INTERACTION (4 - 0).
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 in air-sea interaction. PREREQUISITE: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

MR4414 ADVANCED AIR/SEA INTERACTION (3 - 0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

MR4415 ATMOSPHERIC TURBULENCE (3 - 0).
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. PREREQUISITE: MR/OC3150 or consent of instructor.

MR4416 ATMOSPHERIC FACTORS IN ELECTROMAGNETIC AND OPTICAL PROPAGATION (3 - 0).
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. PREREQUISITE: MR/OC4413 or MR4415 (may be taken concurrently).

MR4520 TOPICS IN SATELLITE REMOTE SENSING (3 - 0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

MR4800 ADVANCED TOPICS IN METEOROLOGY (Variable credit 1-0 to 4-0.) (V - 0).
Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of Department Chairman and instructor.

MR4900 DIRECTED STUDY IN METEOROLOGY (Variable credit 1-0 to 4-0.) (V - 0).
Directed study of selected areas of meteorology to meet the needs of the individual student. PREREQUISITE: Consent of Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

Chairman and
PME/PJE Coordinator:
Frank C. Petho
CAPT, MSC, USN
Code NS/Pe, Glasgow Hall
Room 319
(408) 656-2521
DSN 878-2521
FAX ext. 2949

Associate Chairs:

Instruction
Douglas Porch
Professor
Code NS/Pd, Glasgow Hall
Room 312
(408) 656-1038
DSN 878-1038

Research
Donald Abenheim
Associate Professor
Code NS/Ah, Glasgow Hall
Room 315
(408) 656-2208
DSN 878-2208

Academic Associates:

Intelligence
James J. Wirtz
Associate Professor
Code NS/Wz, Glasgow Hall
Room 308
(408) 656-3483
DSN 878-3483

Area Studies
Daniel Moran
Associate Professor
Code NS/Md, Glasgow Hall
Room 316
(408) 656-2059
DSN 878-2059

Strategic Planning
David Scott Yost
Professor
Code NS/Yo, Glasgow Hall
Room 317
(408) 656-2579
DSN 878-2579

Civil Military Relations
Thomas C. Bruneau
Professor
Code NS/Bn, Glasgow Hall
Room 325
(408) 656-2903
DSN 878-2903

Donald Abenheim, Associate Professor and Associate Chair for Research (1985)*; PhD, Stanford University, 1985.

Sherman Wesley Blandin, Jr., Professor Emeritus (1968); PhD, University of Santa Clara, 1977.

Jan S. Breemer, Associate Professor (1988); PhD, University of Southern California, 1987.

R. Mitchell Brown, III, Lecturer (1989); MA, Naval Postgraduate School, 1980; MBA, Wharton, 1976.

Thomas C. Bruneau, Professor and Academic Associate for Civil Military Relations and International Security (1987); PhD, University of California at Berkeley, 1970.

Claude A. Buss, Senior Lecturer (1976); PhD, University of Pennsylvania, 1927.

Mary P. Callahan, Assistant Professor (1995); PhD, Cornell University, 1995.

Ralph Norman Channell, Senior Lecturer (1987); MA, Boston University, 1964.

Dana P. Eyre, Instructor (1991); PhD, Stanford University, 1995.

Ahmad Ghoreishi, Lecturer (1994); PhD, University of Colorado, 1965.

Boyd Francis Huff, Professor Emeritus (1958); PhD, University of California at Berkeley, 1955.

Terry Johnson, Lecturer (1993); MA, Georgetown University, 1979.

Frank B. Kelly, Captain, U.S. Navy (1996); Senior Military Instructor and Intelligence Program Coordinator; MA, Naval Postgraduate School, 1977.

Roman A. Laba, Associate Professor (1990); PhD, University of Wisconsin, 1989.

Peter Lavoy, Assistant Professor (1993); PhD, University of California at Berkeley, 1995.

Cynthia Levy, Lecturer (1994); MA, Maxwell School at Syracuse University, 1991.

Robert Edward Looney, Professor (1979); PhD, University of California at Davis, 1969.

Ralph Harry Magnus, Associate Professor (1976); PhD, University of California at Berkeley, 1971.

Rodney Kennedy Minott, Senior Lecturer (1990); PhD, Stanford University, 1960.

Daniel Moran, Associate Professor and Academic Associate for Area Studies (1994); PhD, Stanford University, 1982.

Maria Moyano, Associate Professor (1993); PhD, Yale University, 1990.

Edward Allan Olsen, Professor (1980); PhD, The American University, 1974.

Bertrand M. Patenaude, Lecturer (1992); PhD, Stanford University, 1987.

Frank Petho, Captain, U.S. Navy, Chairman and Assistant Professor (1991); PhD, University of Vermont, 1979.

Douglas Porch, Professor and Associate Chair for Instruction (1996); PhD, Cambridge, 1972.

Glenn Edward Robinson, Associate Professor (1991); PhD, University of California at Berkeley, 1992.

Tjarck Gralf Roessler, Colonel (GS), German Army (1996); MA, University of Freiburg, 1976.

Kamil T. Said, Senior Lecturer (1975); MA, San Jose State College, 1967.

Paul N. Stockton, Associate Professor and Director, Center for Civil Military Relations (1990); PhD, Harvard University, 1986.

Frank Michael Teti, Associate Professor (1966); PhD, Syracuse University, 1966.

Scott D. Tollefson, Assistant Professor (1988); PhD, Johns Hopkins University SAIS, 1991.

Mikhail Tsypkin, Associate Professor (1987); PhD, Harvard University, 1985.

James J. Wirtz, Associate Professor and Academic Associate for Intelligence Programs (1990); PhD, Columbia University, 1989.

David Scott Yost, Professor and Academic Associate for Strategic Planning (1979); PhD, University of Southern California, 1976.

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

The Department of National Security Affairs supports programs of study in six major fields, supporting nine different curricula. The five major fields encompass Strategic Planning and International Organizations and Negotiations, Joint Intelligence, Geographic Area Studies, Resource Planning and Management for International Defense, and Civil-Military Relations and International Security. The area studies are subdivided into five groups as follows:

- Middle East, Africa and South Asia
- Far East, Southeast Asia and the Pacific
- Western Hemisphere
- Western Europe
- Russia/Europe/Central Asia

Individual programs in the Area Studies focus on security issues in one of the subregions listed or contain a blend of all subregions in the area. The Area Studies program also may include a program of study in a language of the area at the Defense Language Institute, located in Monterey.

The interdisciplinary Strategic Planning program includes conventional and nuclear strategic planning, and the role of related international organizations and processes. Individual programs focus on the evolutionary history of the planning process, strategies for national security, maritime strategy, operations research, management and planning methodologies.

The Joint Intelligence programs include three related curricula. Scientific and Technical is an interdisciplinary program which integrates political science, mathematics, operations analysis, oceanography, aeronautical engineering, electrical engineering, physics, information systems and managerial economics into an understanding of intelligence. Regional Intelligence focuses on area-specific knowledge from an intelligence perspective. The General Military Intelligence/Economic track focuses on economic and regional intelligence issues of joint intelligence concerns.

The Resource Planning for International Defense (RePMID) program is offered jointly with the Systems Management Department. Intended specifically for officers and civilian employees in defense agencies of allied countries and emerging democracies, the RePMID program focuses on economic analyses; management of financial, material, and human resources; domestic and international political institutions; civil-military relations; and the role of international law.

The curriculum in Civil-Military Relations and International Security is tailored to the needs of officers and civilian employees from defense and other ministries of other countries. The core of the program is a set of courses designed to identify and analyze the central issues of civil-military relations in all parts of the world. The program also emphasizes comparative studies, political analysis, international law, and the students write a thesis on a topic relevant to their country and its challenges. It is anticipated that the graduate will be qualified to return to his country and succeed in either policy-making in the field of civil-military relations or teaching in this area.

Course work in the department addresses four broad fields: defense technology, analysis, management and national security affairs. The defense technology courses are designed to address the special problems of warfare technology, emphasizing technical literacy and the ability to communicate concerning technological and environmental problems. This sequence seeks to provide the perspective that will assist assessment of the reality and significance of technical and environmental data, as well as ensure familiarity with the resources in these fields that may be applied to intelligence, strategic planning and joint warfare-related problems.

The analysis and management course work provides the student with a grounding in quantitative techniques, substantive research methods and the concepts of resource management. Students are introduced by various means to structure given problems, formulate possible solutions, organize and compile supporting data, assess the data reliability and communicate the significance of the results obtained.

Graduate courses in National Security Affairs outline the interface between warfare, international politics, national security objectives, resource management and weapons technology. The sequence synthesizes the political, technological, economic, cultural, social and ideological forces that influence the actors in the international system and models varying scenarios of interaction between them.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

1) At least 44 units of approved graduate study pertinent to the field of National Security Affairs, of which at least 16 units must be at the 4000 level.

2) The completion of an approved sequence of courses in one of the areas of concentration:

   a. Area Specialization/Regional Intelligence: Completion of graduate courses in the geographic area of specialization, including two 4000 level courses.
   b. Functional Specialization: Completion of graduate courses in GMI/Economic Intelligence, Strategic Planning and International Organizations and Negotiations, or Civil-Military Relations and International Security, including two 4000 level courses.

3) Successful completion of departmental comprehensive examination or completion of an acceptable thesis.

4) Language proficiency, when applicable, for geographic area or Regional Intelligence specialization.

Professional Military Education (PME) and Joint Professional Military Education (JPME) Certification

The Chief of Naval Operations has granted Intermediate Level Service Professional Military Education (PME) equivalence for selected NPS curricula, intended initially for U.S. students in NSA Department curricula in Strategic Planning, Area Studies, Joint Intelligence and Special Operations. The Chairman, Joint Chiefs of Staff (CJCS) has granted Program for Joint Education (PJE) Phase I certification for those officers who complete the NPS Joint Education Electives Program (JEEP), a course sequence which covers the Learning Objectives required by Phase I PJE. Transcripts of those students who complete all curriculum ESRs, including the PJE courses, will be annotated to verify their qualification for Intermediate Level PME and Phase I PJE credit.

To ensure all CJCS Phase I PJE Learning Objectives are fully met, the NPS JEEP (currently under revision) specifies a minimum of four courses must be completed. This course coverage formally began in AY 95: NS3252 and three others from a menu of six alternative courses cover all current Phase I Learning Objectives. CJCS-approved NSA Department PJE courses for AY 95/96 and AY 96/97 are:

1) NS3252 "Joint and Maritime Strategy"

2) NS3000 "War in the Modern World"
   NS3050 "History of Joint and Combined Warfare"

3) NS3154 "Joint Intelligence and Military Command"
   NS3159 "Principles of Joint Operational Intelligence"

4) NS3230 "Strategic Planning and the Military"
   NS3240 "Military Innovation and Joint Warfare"

NATIONAL SECURITY AFFAIRS COURSE DESCRIPTIONS

NS0001 SEMINAR (NO CREDIT) (0 - 1).
Distinguished lecturer series. Lectures discuss matters and issues related to joint intelligence. Attendance is required by students every quarter. PREREQUISITE: TS/SCI clearance.

NS0810 THESIS RESEARCH (0 - 8).
Students conducting thesis research will enroll in this course.

NS0811 PREPARATION FOR COMPREHENSIVE EXAMINATION (NO CREDIT) (0 - 0).
Students preparing for comprehensive examinations will enroll in this course.

NS0855 EXPERIENCE TOUR (0 - 0).
Thesis research assignment to the National Maritime Intelligence Center (NMIC) and other Washington area intelligence organizations, for selected students in Track 1 and Track 3A of the Intelligence curriculum. PREREQUISITE: Approval of Academic Associate for Intelligence. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS3000 WAR IN THE MODERN WORLD (4 - 0).
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; levels of war, with particular emphasis on the operational level; the impact of military doctrine on warfighting; allocation of resources and coordination of effort among land, sea, and air forces; national strategic cultures or styles of war, and their implications for strategic practice. This course covers various objectives specified by CJCS Phase One Program for Joint Education (PJE) criteria. PREREQUISITE: None. CLASSIFICATION: None.

NS3011 POLICY ANALYSIS AND RESEARCH METHODS (4 - 2).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3012 FORECASTING AND GAMING METHODS FOR STRATEGIC PLANNERS (4 - 2).
Survey of concepts and methods employed in forecasting, wargaming, and simulation that are available for use by military planners and strategists. Includes historical development and recent forecasting, analytical gaming, and modeling, and simulation techniques applicable to national security planning. Examines a variety of forecasting and gaming methodologies including the Integrated Theater Engagement Model, the Army's JANUS system, and others. Emphasis is on current and potential uses in the development of strategy, plans and policy. PREREQUISITE: NS3011. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3023 INTRODUCTION TO COMPARATIVE POLITICS (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3024 INTRODUCTION TO INTERNATIONAL RELATIONS (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3025 INTRODUCTION TO CIVIL-MILITARY RELATIONS (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3030 AMERICAN NATIONAL SECURITY POLICY (4 - 0).
An institutional and functional analysis of the national and international factors which 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. PREREQUISITE: None. CLASSIFICATION: None.

NS3036 THE MILITARY AND POLITICS IN THE DEVELOPING WORLD (4 - 0).
This course examines the diverse political roles played by the military and paramilitary establishments of the developing world. Particular attention is given to the character of Third World civil-military relations and the pressures, motivations, and consequences of military coups against the established political order. The course examines the different classes of military involvement, the relationship between national political culture and military roles, and the varying methods of influence open to the armed forces. The course will conclude with an examination of different types of military governments, the consequences of military rule for national stability, problems inherent in the transition to civilian rule, and the consolidation of democratic regimes. Case studies are drawn from Africa, Latin America, the Middle East, and the Far East with the intention of identifying common and regional patterns in the character of civil-military relations in the developing world. PREREQUISITE: NS3023 or consent of instructor. CLASSIFICATION: None.

NS3037 THE ROLE OF CONGRESS IN U.S. NATIONAL SECURITY POLICY (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3038 INTERNATIONAL NAVAL POWER AND POLICY (4 - 0).
This course examines the role of international maritime power in peace, crisis and war. It reviews the evolution of the post-World War II global balance of naval power, the roles, missions and capabilities of the principal regional navies (e.g., Japan, India, China, Western Europe, Brazil, and Argentina), and the impact of technological innovation on regional maritime strategies, threats and risks. Specific threat capabilities covered include the proliferation of underwater threat systems (e.g., submarines, mines) and precision-guided weapons. The course focuses on regional, non-superpower naval developments, and their implications for U.S. maritime policy and strategy. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3040 THE POLITICS OF GLOBAL ECONOMIC RELATIONS (4 - 0).
Examination of the world economy. Focuses on implications for the United States of 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. PREREQUISITE: None. CLASSIFICATION: None.

NS3041 COMPARATIVE ECONOMIC SYSTEMS (4 - 0).
An 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. PREREQUISITE: NS3040. CLASSIFICATION: None.

NS3050 HISTORY OF JOINT AND COMBINED WARFARE (4 - 0).
This course examines the place of joint and combined warfare in the history of military conflict. After a broad overview of key conflicts that were marked by joint and/or combined strategies, operations and command structures, selected case histories are studied for the critical factors that appear to have made the difference between success and failure. Critical factors that will be examined include: the impact of different national interests on grand-strategic and strategic planning between coalition partners; the impact of different institutional interests and "styles" on joint planning and warfighting; the impact of doctrine on how war has been conducted at the tactical and the operational level; the impact of technology on joint and combined operations; the problem of intelligence sharing between combined partners; and the impact of personalities on cooperative behavior. Covers various objectives specified by CJCS Phase One PJE criteria. PREREQUISITE: NS3252 taken concurrently or permission of instructor.

NS3079 DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Credit 1-0 to 4-0.) (V - 0).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS3152 JOINT WARFARE: THREAT ASSESSMENT (4 - 0).
This course concentrates on identifying the key warfare issues for successful accomplishment of the U.S. Navy's missions. The evolution of threats in examined in the context of present and future U.S. Strategy. PREREQUISITE: U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3154 JOINT INTELLIGENCE AND MILITARY COMMAND (4 - 0).
This course provides an overview of intelligence and related C4I requirements and issues affecting the planning and conduct of joint and combined operations. The Intelligence Community and C4I structure is studied with emphasis on students knowing the process and application of intelligence and C4I capabilities to support military Commands during Joint and combined operations at all levels of war. The organization and functions of the various elements of the national intelligence community are considered. Includes an introduction to systems and organizations supporting the collection, analysis, production, and dissemination of intelligence to support decision makers. The course is intended for the non-intelligence specialist to make them aware of national intelligence organizations and their capabilities in acquiring necessary intelligence support for joint commanders. This course covers various learning objectives specified by the CJCS to meet Phase One PJE criteria. PREREQUISITE: NS3252 (may be taken concurrently). U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3155   INTELLIGENCE AND DEMOCRACY (4 - 0).
This course examines how civilian authorities in emerging democracies can establish strong, effective controls over their intelligence agencies, and minimize the risk that these agencies will undermine democractic governance. The course begins by examining the potential problems that intelligence agencies can pose to the process of democratization. Next,, students will analyze the mechanisms used by the United States, the United Kingdom, 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 other mechanisms. Students will also examine the recent efforts by democracies in Latin America, Central Europe and the former Soviet Union to establish their own democratic controls over intelligence and the challenges that such nations will face in the future. PREREQUISITE: None. CLASSIFICATION: Unclassified.

NS3159 PRINCIPLES OF JOINT OPERATIONAL INTELLIGENCE (4 - 0).
This course examines the problems encountered by an intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under joint and naval operational conditions. Lectures are provided on the joint intelligence organization with emphasis on the operational aspects of warfighting, on the theory and modern history of operational intelligence, on intelligence in support of battle and amphibious group operations, on support to joint and naval operations from national and theater level assets, and on the Copernicus and C2WC concepts. Students are required to prepare and present current intelligence briefings and staff intelligence studies emphasizing joint threat analysis and assessments, and the direction of joint collection assets. Readings are from classified material and from selected literature. This course covers various learning objectives specified by the CJCS to meet Phase One PJE criteria. PREREQUISITE: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS3160 HUMAN INTELLIGENCE (4 - 0).
This course familiarize 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. PREREQUISITE: Student must be a US citizen holding a TOP SECRET clearance with eligibility for access to Sensitive Compartmented Information. CLASSIFICATION: TOP SECRET (SCI).

NS3171 JOINT INTELLIGENCE DATA SYSTEMS AND CONNECTIVITY (4 - 2).
This course explores the principles and concepts involved in the use of data systems for joint intelligence support. Systems examined include those used in support of joint intelligence operations afloat and ashore with attention to those used for expeditionary warfare and in the Joint Intelligence Centers. Emphasis is on understanding these systems as assets for operational intelligence officers in joint operations. Lectures will be provided on the general structure of computers, LAN's, and communications links as they apply to joint intelligence data systems, on joint and naval systems ashore and afloat, and on systems connectivity. Students will be given the opportunity during lab sessions to conduct "hands on" experiments with a modern UNIX based micro workstation and with the new Joint Deployable Intelligence Support System (JDISS). PREREQUISITES: Open to students in the 825 curriculum and to intelligence specialists. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. NS3159 or permission of instructor required. CLASSIFICATION: TOP SECRET (SCI).

NS3225 CIVIL-MILITARY RELATIONS AND DEFENSE BUDGETING (4 - 0).
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. CLASSIFICATION: None.

NS3230 STRATEGIC PLANNING AND THE MILITARY (4 - 1).

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. PREREQUISITE: NS3000, NS3154, NS3159, NS3152 may be taken concurrently. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3240 MILITARY INNOVATION AND JOINT WARFARE (4 - 0).

This course examines military innovations that have produced a joint solution to strategic, tactical and technical problems. It explores organizational concepts, command relationships affecting planning and execution, including strengths, weaknesses and other conditions that can foster or retard military innovation and jointness. Includes study of U.S. military forces in selected joint and combined commands, and Joint Task Forces. The influence of national policy and strategy, and the NSC system on joint and combined planning is investigated with respect to PPBS, JSPS and JOPES requirements. Nascent issues that lend themselves to a joint approach, including both deliberate and time-sensitive planning processes are examined. This course covers various learning objectives specified by CJCS Phase One Program for Joint Education (PJE) criteria. PREREQUISITES: NS3252 (may be taken concurrently) and SECRET clearance.

NS3250 THE ECONOMICS OF U.S. DEFENSE POLICY (4 - 0).

An examination of the manner in which economic constraints affect the defense allocation process in the United States. Emphasis is placed on the macroeconomic environment in which the budget process is undertaken. Topics include: factors affecting defense expenditures, budgeting for defense, the impact of defense spending on the economy, manpower, and the structure, conduct and performance of defense industries. PREREQUISITE: NS3040 or permission of the instructor. CLASSIFICATION: None.

NS3252 JOINT AND MARITIME STRATEGY (4 - 0).

This course provides students with a graduate level understanding of defense strategy in general, and joint and maritime strategy in particular. Major themes include: the development of strategic theory in modern times and its influence on contemporary military organization, force planning, and operations; the roles and missions of land, sea, aerospace and special operation forces; joint organization and doctrine; the interaction between military strategy, foreign policy, and alliance systems; the impact of technological developments on warfare; domestic policy-making processes affecting the armed forces of the United States; joint planning for acquisitions (PPBS) and operations; current defense reform and reorganization issues. Primary strategic planning documents are introduced and dis-cussed. Required for all U.S. officer students at NPS. This course covers various learning objectives specified by CJCS Phase One Program for Joint Education (PJE) criteria. PREREQUISITES: U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3280 NUCLEAR STRATEGY AND NATIONAL SECURITY (4 - 0).

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. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3300 HISTORY AND CULTURES OF THE MIDDLE EAST (4 - 0).

Introduction to the basic geography, culture, society, economy, and religions of the major ethnic and linguistic groups in the Middle East. The course will introduce students to important events and developments, such as the changing concepts of politics in Islam; the evolving sociological bases of states and societies in the Middle East; and the early impact of Europe on the Middle East, first through trade and then through colonialism. PREREQUISITE: None. CLASSIFICATION: None.

NS3310 GOVERNMENT AND POLITICS IN THE MIDDLE EAST (4 - 0).

This introductory course is designed to familiarize students with the politics of the contemporary Middle East. The course will cover such topics as the various types of political systems found in the Middle East, the political economy of development, and ethno-nationalist and Islamicist political movements. PREREQUISITE: None. CLASSIFICATION: None.

NS3320 UNITED STATES INTERESTS AND POLICIES IN THE MIDDLE EAST (4 - 0).
The course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on a variety of issues that have occupied American interests, such as: the Arab-Israeli conflict, the security of oil resources, revolutionary change, regional conflicts, and international rivalry of external powers. PREREQUISITE: None. CLASSIFICATION: None.

NS3360 TOPICS IN MIDDLE EASTERN POLITICS (4 - 0).
This course will examine various topics of central importance in contemporary Middle Eastern politics. These include, for example, nationalism and the state in the Middle East, the politics of Islamicist movements, and the politics of oil. PREREQUISITE: None. CLASSIFICATION: None.

NS3361 TOPICS IN MIDDLE EASTERN SECURITY (4 - 0).
This course will examine topics of central importance to contemporary Middle Eastern security. It will focus on security issues in at least one of the following: the Maghreb, Israel, the Northern Tier, and the Arabian Peninsula and the adjacent areas. PREREQUISITE: None. CLASSIFICATION: None.

NS3400 GOVERNMENT AND POLITICS IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4 - 0).
An examination of the role of domestic politics in Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy. PREREQUISITE: None. CLASSIFICATION: None.

NS3401 ETHNO-NATIONALISM IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4 - 0).
This course introduces the students to the states and societies of Russia, Ukraine, Belarus, Latvia, Lithuania, Moldova, Georgia, Azerbaijan, Armenia, Kazakhstan, Uzbekistan, Turkmenistan, and Kirgiztan. It also serves as a basic introduction to the broader study of ethnicity and nationalism. PREREQUISITE: None. CLASSIFICATION: None.

NS3410 RUSSIA, EASTERN EUROPE AND CENTRAL ASIA IN WORLD AFFAIRS (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3450 MILITARY STRATEGY IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4 - 0).
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 warfighting 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. PREREQUISITE: NS3252. CLASSIFICATION: None.

NS3460 GOVERNMENT AND SECURITY IN EASTERN EUROPE (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3501 HISTORY AND CULTURES OF LATIN AMERICA (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3510 GOVERNMENT AND POLITICS IN LATIN AMERICA (4 - 0).
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. PREREQUISITE: None. Classification: None.

NS3520 LATIN AMERICA INTERNATIONAL RELATIONS AND SECURITY (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3600 HISTORY AND CULTURES OF EAST ASIA (4 - 0).
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 19th century. PREREQUISITE: None. CLASSIFICATION: None.

NS3601 VALUES AND BELIEF SYSTEMS OF ASIA (4 - 0).
An introduction to the values and belief systems that have shaped the civilizations of East, South, and Southeast Asia. This course addresses the development and practices of Hinduism, Buddhism, Confucianism, Islam, Shintoism and other belief systems, and the ways they influenced traditional and modern Asia. PREREQUISITE: None. CLASSIFICATION: None.

NS3620 ASIA AND THE MODERN WORLD (4 - 0).
An analysis of major national and international developments within Asia, and between Asia and the non-Asian world from the mid-19th century to the late mid-20th century. Includes an examination of U.S. relations with Asia. PREREQUISITE: None. CLASSIFICATION: None.

NS3661 GOVERNMENT AND SECURITY IN CHINA (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3662 GOVERNMENT AND SECURITY IN JAPAN (4 - 0).
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 an examination of U.S. relations with Japan. PREREQUISITE: None. CLASSIFICATION: None.

NS3663 GOVERNMENT AND SECURITY IN KOREA (4 - 0).
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3667 GOVERNMENT AND SECURITY IN SOUTH ASIA, SOUTHEAST ASIA, AND OCEANIC REGIONS (4 - 0).
This course examines domestic issues and foreign relations among the states in the region of South Asia, Southeast Asia, Australia, New Zealand and Melanesia. Analyzes the importance of the Indian Ocean and Southwestern Pacific ocean area, and the strategic interests of the major powers, including the United States. PREREQUISITE: None. CLASSIFICATION: None.

NS3700 HISTORY OF MODERN EUROPE (4 - 0).
Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present. PREREQUISITE: None. CLASSIFICATION: None.

NS3710 GOVERNMENT AND SECURITY IN WESTERN EUROPE (4 - 0)
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. PREREQUISITE: None. CLASSIFICATION: None.

NS3720 EUROPEAN SECURITY INSTITUTIONS (4 - 0).
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. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4 - 0).
This course provides an overview of insurgency and counter-insurgency. It reviews the theoretical literature and offers an operational focus, by examining the alternative models of insurgency provided by the doctrine of "people's war," "foco theory," and the urban guerrilla. It also examines the roots and development of U.S. counterinsurgency doctrine, the difference between the "hearts and minds" and systems prescriptions of counterinsurgency, and alternative British, French, and Soviet concepts of counterinsurgency. Four special topics are also analyzed: the role of terror in revolutionary warfare, the relationship between narcotics and insurgency, the questions of guerrillas in power, and a

comparison of U.S. counterinsurgency strategy in Vietnam and El Salvador with that currently pursued elsewhere. The course concludes with an examination of the future of guerrilla warfare. PREREQUISITE: NS3023 or permission of instructor. CLASSIFICATION: None.

NS3801 INTERNATIONAL TERRORISM (4 - 0).
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: NS3023 or permission of the instructor. CLASSIFICATION: None.

NS3880 THE HISTORY OF SPECIAL OPERATIONS (4 - 0).
Review and analysis of the history of Special Operations. Case studies of the use of Special Operations Forces by the U.S. and other countries will be examined. PREREQUISITES: NS3023, NS3024 (may be taken concurrently) and permission of the instructor.

NS3881 INTERVENTION AND MID-LEVEL CONFLICT (4 - 0).
This course provides an overview of the history and current role of (a) military force as a political instrument and (b) contingent intervention in U.S. foreign policy. It examines the nexus between unconventional and conventional warfare concepts and capability. The course is divided into two parts. Part one reviews the political or signaling role of military forces, notably naval forces, short of war. Part two examines the history of U.S. armed intervention and contingent operations in the Third World. The course examines the planning process underlying these and similar actions, and the special decision making problems posed by the need for unanticipated military action in the face of an unclear intelligence picture. PREREQUISITE: NS3800 or permission of the instructor. Classification: None.

NS3882 DETERRENCE, COMPELLANCE, AND CRISIS MANAGEMENT (4 - 0).
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: NS3252. CLASSIFICATION: None.

NS3900 INTERNATIONAL LAW AND ORGANIZATIONS (4 - 0).
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 multi-national and transnational organizations. PREREQUISITE: None. CLASSIFICATION: None.

NS3902 MODERN REVOLUTION (4 - 0).
A study of a general framework and historical cases of modern revolution. Examines the most important revolutions of modern times, including the testing of the methods of systematic analysis. PREREQUISITE: None. CLASSIFICATION: None.

NS4030 SPECIAL TOPICS IN NATIONAL SECURITY POLICY (4 - 0).
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. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4031 SPECIAL TOPICS IN INTERNATIONAL SECURITY AFFAIRS (4 - 0).
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. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4032 SPECIAL TOPICS IN INTERNATIONAL RELATIONS (4 - 0).
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. PREREQUISITE: Permission of the instructor. Classification: None.

NS4033 SPECIAL TOPICS IN U.S. FOREIGN POLICY (4 - 0).
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. PREREQUISITE: Permission of instructor. CLASSIFICATION: None.

NS4034 SPECIAL TOPICS IN AMERICAN GOVERNMENT (4 - 0).
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. PREREQUISITE: Permission of the instructor.

NS4035 SPECIAL TOPICS IN JOINT INTELLIGENCE (4 - 0).
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. PREREQUISITE: Permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4079 ADVANCED DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit, from 1-0 to 4-0.) (V - 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. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4080 RESEARCH COLLOQUIUM (2 - 0).
A research colloquium in which NSA/Intelligence/Speciation Operations students present the main findings from their master's thesis research for critical analysis and discussion. PREREQUISITE: None. CLASSIFICATION: None. GRADING: Pass/Fail.

NS4152 JOINT WARFARE: INTELLIGENCE ANALYSIS (4 - 0).
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. PREREQUISITE: NS3159 or permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4159 SEMINAR IN JOINT INTELLIGENCE SUPPORT TO CRISIS OPERATIONS (4 - 0).
This course examines problems encountered by an intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under joint and naval operational conditions. Lectures are provided on advanced aspects of operational intelligence in support of joint and naval warfare including strategic nuclear, counterinsurgency, operational deception, and wargaming. Students study and critique classified case studies from recent joint operations. The course culminates in a joint operational intelligence to include use of the Joint Deployable Intelligence Support System (JDISS). Course readings are from classified material, selected literature, and statements by leading intelligence officials. The course is conducted at the TOP SECRET SCI level. PREREQUISITE: Open to students in the 825 curriculum and to intelligence specialists. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. NS3159 and NS3171, or permission of instructor required. CLASSIFICATION: TOP SECRET (SCI).

NS4160 FOREIGN INTELLIGENCE SERVICES (4 - 0).
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 permission of the instructor. PREREQUISITE: NS3160 or permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4200 SEMINAR IN THE NATIONAL INTEREST (4 - 0).
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: NS3252 and NS3030. CLASSIFICATION: None.

NS4225 CIVIL-MILITARY RELATIONS AND TRANSITIONS TO DEMOCRACY (4 - 0).
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. PREREQUISITE: NS3025 or permission of instructor. CLASSIFICATION: None.

NS4230 SEMINAR IN JOINT STRATEGIC PLANNING (4 - 0).
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: NS3030 and NS3230 or permission of the instructor. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS4235 SEMINAR ON DIPLOMACY AND STRATEGY OF COALITION WARFARE AND OPERATIONS OTHER THAN WAR (4 - 0).
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. PREREQUISITE: NS4225 or permission of instructor. CLASSIFICATION: None.

NS4240 SEMINAR IN REGIONAL SECURITY PLANNING PROBLEMS (4 - 0).
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. PREREQUISITE: Completion of previous REPMID courses, or consent of instructor. CLASSIFICATION: None.

NS4250 SEMINAR IN SECURITY ASSISTANCE AND ARMS TRANSFER (4 - 0).
An analysis of the patterns, purposes and effects of cross-national security assistance, including arms sales and the transfer of technology. Special topics include: factors dominating the arms transfer policies of the major powers; the design, execution and evaluation of security assistance programs. PREREQUISITE: NS3030. CLASSIFICATION: None.

NS4251 SEMINAR IN NET ASSESSMENT (4 - 0).
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: NS3230, NS3252, NS3280, and NS3450. U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4253 TECHNOLOGY AND STRATEGIC PLANNING (4 - 0).
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. PREREQUISITE: NS3030, or NS3230, or NS3252, or permission of the instructor. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS4261 SURVEY OF STRATEGIC STUDIES (4 - 0).
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. PREREQUISITE: NS3030 or permission of the instructor. CLASSIFICATION: None.

NS4280 SEMINAR IN NUCLEAR STRATEGY (4 - 0).
A follow-up course to NS3280 that examines selected issues in nuclear strategy, the proliferation of weapons of mass destruction, and deterrence. In addition to theoretical issues of deterrence, this course will specifically investigate the role and importance of nuclear force planning and strategy formulation in deterrence, stability, and foreign policy implementation. PREREQUISITE: NS3280. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4300 SEMINAR IN MIDDLE EASTERN POLITICS (4 - 0).
A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. PREREQUISITE: NS3300 or permission of the instructor. CLASSIFICATION: None.

NS4310 SEMINAR IN MIDDLE EASTERN SECURITY ISSUES (4 - 0).
A research seminar on security issues in the contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. PREREQUISITE: NS3310 or permission of the instructor. CLASSIFICATION: None.

NS4410 SEMINAR IN SECURITY ISSUES IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4 - 0).
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. PREREQUISITE: NS3400 or NS3410, or NS3450, or permission of the instructor. CLASSIFICATION: None.

NS4451 SEMINAR IN RUSSIAN/CENTRAL EURASIAN NAVAL AFFAIRS (4 - 0).
Advanced study in emerging Russian/Central Eurasian naval and maritime affairs in the context of a changing international security environment. Topics include: politico-military decision-making processes, scenario building, military doctrines and strategies, strategic missions, naval operational art, warfare capabilities and support systems, data bases and gaming, threat and net assessment, and arms control. PREREQUISITE: NS3252 and/or NS3450. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4510 SEMINAR IN LATIN AMERICA GOVERNMENT AND POLITICS (4 - 0).
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. PREREQUISITE: NS3510 or NS3520, or permission of the instructor. CLASSIFICATION: None.

NS4560 SEMINAR IN LATIN AMERICAN SECURITY ISSUES (4 - 0).
A research seminar on security issues in contemporary Latin America. Students conduct and present original research on selected issues concerning Latin American security. PREREQUISITE: NS3510 or NS3520, or permission of the instructor. CLASSIFICATION: None.

NS4660 SEMINAR IN ASIA IN WORLD AFFAIRS (4 - 0).
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. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor. CLASSIFICATION: None.

NS4690 SEMINAR IN INTERNATIONAL SECURITY ISSUES OF ASIA (4 - 0).
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. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor. CLASSIFICATION: None.

NS4710 SEMINAR IN EUROPEAN POLITICS (4 - 0).
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. PREREQUISITE: NS3710 or permission of the instructor. CLASSIFICATION: None.

NS4720 SEMINAR IN EUROPEAN SECURITY ISSUES (4 - 0).
A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. PREREQUISITE: NS3720 or permission of the instructor. CLASSIFICATION: None.

NS4830 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: MIDDLE EAST (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in the Middle East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Middle East-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Middle East. PREREQUISITES: NS3036, NS3800 and NS3880 or permission of the instructor.

NS4850 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: LATIN AMERICA (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in Latin America. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Latin America. PREREQUISITES: NS3036, NS3800 and NS3880 or permission of the instructor.

NS4860 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: ASIA (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in Asia. 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 Asia. PREREQUISITES: NS3036, NS3800 and NS3880 or permission of the instructor.

NS4880 SEMINAR IN LEGAL AND MILITARY RESPONSES TO POLITICAL VIOLENCE (4 - 0).
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. PREREQUISITE: NS3036 or permission of instructor. CLASSIFICATION: None.

NS4900 SEMINAR IN INTERNATIONAL NEGOTIATIONS (4 - 0).
Advanced study in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security. PREREQUISITE: NS3900 or permission of the instructor. CLASSIFICATION: None.

NS4902 SEMINAR IN MODERN REVOLUTION (4 - 0).
A research seminar on modern revolution. Students conduct and present original research on selected issues concerning modern revolution. PREREQUISITE: NS3902 or permission of the instructor. CLASSIFICATION: None.

DEPARTMENT OF OCEANOGRAPHY

Mary Louise Batteen, Associate Professor (1985)*; PhD, Oregon State University, 1984.

Robert Hathaway Bourke, Chairman and Professor (1971); PhD, Oregon State University, 1972.

Ching-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Associate Professor (1986); PhD, University of Chicago, 1985.

James R. Clynch, Research Professor (1990); PhD, Brown University, 1974.

Curtis Allan Collins, Professor (1987); PhD, Oregon State University, 1967.

Newell Garfield, III, Research Assistant Professor (1989); PhD, University of Rhode Island, 1989.

Roland William Garwood, Professor and Associate Chairman for Academic Affairs, (1976); PhD, University of Washington, 1976.

Eugene Clinton Haderlie, Distinguished Professor Emeritus (1965); PhD, University of California at Berkeley, 1950.

Thomas H.C. Herbers, Associate Professor (1993), PhD, University of California, San Diego, 1990.

Lin Jiang, Research Assistant Professor (1993), PhD, University of British Columbia, 1993.

Glenn Harold Jung, Professor Emeritus (1958); PhD, Texas A & M University, 1955.

Dale Fredrick Leipper, Professor Emeritus (1968); PhD, Scripps Institution of Oceanography, 1950.

Ly Ngoc Le, Research Associate Professor (1993); PhD, State Hydromet Institute, St. Petersburg, 1976.

Wieslaw Maslowski, Research Assistant Professor (1994); PhD, University of Alaska-Fairbanks, 1994.

Julie McClean, Research Assistant Professor (1993), PhD, Old Dominion University, 1993.

Jeffrey Dean Paduan, Associate Professor (1991); PhD, Oregon State University, 1987.

Robert George Paquette, Professor Emeritus (1971); PhD, University of Washington, 1941.

Pierre Marie Poulain, Assistant Professor (1995); PhD, University of California, San Diego, 1989.

Leslie K. Rosenfeld, Research Assistant Professor (1989); PhD, Woods Hole Oceanographic Institution, 1987.

Albert Julius Semtner, Jr., Professor (1986); PhD, Princeton University, 1973.

Timothy Peter Stanton, Research Associate Professor (1978); MS, University of Auckland, 1977.

Warren Charles Thompson, Professor Emeritus (1953); PhD, Texas A & M University, 1953.

Edward Bennett Thornton, Distinguished Professor and Associate Chairman for Research, (1969); PhD, University of Florida, 1970.

Robin T. Tokmakian, Research Assistant Professor (1997); PhD, Naval Postgraduate School, 1997.

Eugene Dewees Traganza, Professor Emeritus (1970); PhD, University of Miami, 1966.

Stevens Parrington Tucker, Professor Emeritus (1968); PhD, Oregon State University, 1972.

Chairman:
Robert H. Bourke
Professor
Code OC/Bf, Spanagel Hall
Room 324
(408) 656-2673
DSN 878-2673

Associate Chairmen:

Research
Edward B. Thornton
Professor
Code OC/Tm, Spanagel Hall
Room 327
(408) 656-2847
DSN 878-2847

Academic Affairs
Roland W. Garwood, Jr.,
Professor
Code OC/Gd, Spanagel Hall
Room 308
(408) 656-3260
DSN 878-3260

Joseph John von Schwind, Professor Emeritus (1967); PhD, Texas A & M University, 1968.

Jack B. Wickham, Professor Emeritus (1951); MS, Scripps Institution of Oceanography, 1949.

James H. Wilson, Research Professor (1992); PhD, The Pennsylvania State University, 1974.

Yuxia Zhang, Research Assistant Professor (1994); PhD, Texas A&M University, 1994.

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

The Oceanography Department primarily supports curricula sponsored by the Oceanographer of the Navy: #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography.

The department focuses on Physical Oceanography, Acoustical Oceanography and Nearshore and Coastal Oceanography.

Topics include ocean dynamics, numerical ocean circulation modeling, satellite remote sensing of the ocean, air-sea interaction, Arctic oceanography, upper ocean dynamics and thermodynamics, near-shore processes, mesoscale dynamics, synoptic/mesoscale ocean prediction, coastal ocean circulation and environmental acoustics. The department also provides core courses for USW and the Space Systems curricula.

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY
Entrance to a program leading to the degree Master of Science in Physical Oceanography requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The degree Master of Science in Physical Oceanography requires:

1) 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).

2) 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 degree Master of Science in Meteorology and Physical Oceanography 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 degree Master of Science in Meteorology and Physical Oceanography 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 meteorology and oceanography.

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.

DOCTOR OF PHILOSOPHY

Department of Oceanography admission requirements for the degree Doctor of Philosophy include:

1) A master's degree (or the equivalent) in one of the physical sciences, mathematics, or engineering or,

2) A bachelor's degree with a high QPR or,

3) A highly successful first graduate year in a Master's program, with clear evidence of research ability.

The Ph.D. Program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics and nearshore 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 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

OCEANOGRAPHIC LABORATORIES

NPS is a member of UNOLS (University National Oceanography Laboratory System) and of CENCAL (Central California Cooperative). 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.

A moored-equipment laboratory provides for instruction in the practical design, deployment and recovery of state-of-the-art oceanographic instrumentation. Real-time observations of currents, temperature, salinity and sound speed structure in a variety of oceanic regimes are analyzed, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

NPS is also a member of UCAR (University Corporation for Atmosphere Research), which serves some of the computational and other research facility needs of the oceanographic community. Together with the Meteorology Department, the Oceanography Department operates the Interactive Digital Experimental Analysis Laboratory (IDEA) that is equipped with several workstations for the analysis of satellite images or other digital fields, e.g., numerical model output. In addition, the Department operates a Graphics Laboratory with 12 networked workstations for simulation and analysis of oceanographic data. This laboratory is connected to the Idea lab expanding the capabilities of this lab for instructional purposes.

NPS has recently acquired the former PT SUR SOSUS underwater acoustic array. Acoustic signals can now be brought into the classroom in real time to demonstrate signal processing, ambient noise and beam forming techniques.

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 Boundary Layer, Polar, Near shore, Acoustics, Coastal Modeling, Langrangian Drifters and Electronics and Calibration.

OCEANOGRAPHY COURSE DESCRIPTIONS

OC0810 THESIS RESEARCH (0 - 8).
Every student conducting research in Oceanography will enroll in this course.

OC0999 THESIS SEMINARS (NO CREDIT) (2 - 0).
Students in the various oceanography curricula present their thesis research. PREREQUISITE: Preparation of a thesis.

OC2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (2 - 2).
Introduction to MATLAB and FORTRAN, and the Unix environment, as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

OC3030 OCEANOGRAPHIC COMPUTING AND DATA DISPLAY (1 - 2).
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 the instructor. Graded: Pass/Fail.

OC3120 BIOGEOCHEMICAL PROCESSES IN THE OCEAN (4 - 3).
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.

OC3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3 - 2).
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. PREREQUISITE: Calculus.

OC3150 ANALYSIS OF AIR OCEAN TIME SERIES (3 - 2).
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).
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. PREREQUISITE: OC3240.

OC3212 POLAR METEOROLOGY/OCEANOGRAPHY (4 - 0).
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. PREREQUISITE: MR3222 and OC3240 or consent of instructor.

OC3230 DESCRIPTIVE PHYSICAL OCEANOGRAPHY (3 - 1).
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.

OC3231 DESCRIPTIVE REGIONAL OCEANOGRAPHY (4 - 0).
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. PREREQUISITE: OC3230 or the equivalent.

OC3240 OCEAN DYNAMICS I (4 - 2).
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 SOUND IN THE OCEAN (4 - 0).
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, MA3132 or equivalent.

OC3266 OPERATIONAL ACOUSTIC FORECASTING (3 - 2).
Course emphasizes tactical use of the environment as a force multiplier in acoustic USW. Tactical guides involving ducts, fronts, eddies and bottom structure are examined in ange-dependent propagation loss models. Emerging tactics using LFA, VLF and Fixed Distributed systems and non-acoustic methods are reviewed. PREREQUISITES: OC3260, SECRET clearance, U.S. citizenship.

OC3321 AIR-OCEAN FLUID DYNAMICS (4 - 0).
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. PREREQUISITE: MA2049, MA2051 or MA2138.

OC3325 MARINE GEOPHYSICS (3 - 0).
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. PREREQUISITE: OC3120 (may be taken concurrently).

OC3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2 - 2).
Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermo-dynamic 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).
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).
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).
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumenta-tion. 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).
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).
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).
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. PRE-REQUISITE: Consent of instructor.

OC4211 OCEAN DYNAMICS II (4 - 0).
Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. PREREQUISITES: MA3132 and OC3240.

OC4212 TIDES (4 - 0).
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. PREREQUISITE: OC4211.

OC4213 NEARSHORE AND WAVE PROCESSES (3 - 1).
Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. PREREQUISITE: OC4211 or consent of instructor.

OC4220 COASTAL CIRCULATION (4 - 1).
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. PREREQUISITE: OC4211.

OC4230 PHYSICAL OCEANOGRAPHY OF MONTEREY BAY (3 - 0).
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. PREREQUISITE: OC3240 or consent of instructor.

OC4250 GENERAL CIRCULATION OF THE ATMOSPHERE AND OCEANS (3 - 0).
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. PREREQUISITE: Consent of instructor.

OC4262 THEORIES & MODELS IN UNDERWATER ACOUSTICS (3 - 0).
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 MA3132 or equivalent.

OC4267 OCEAN ACOUSTIC PREDICTION (4 - 0).
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.

OC4323 NUMERICAL AIR AND OCEAN MODELING (4 - 2).
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, MA3132; MA3232 desirable.

OC4324 ADVANCED NUMERICAL OCEAN MODELING (3 - 0).
Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer guasi-geotrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. PREREQUISITE: MR/OC4323.

OC4331 MESOSCALE OCEAN VARIABILITY (4 - 0).
Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics for observations, theories and models. PREREQUISITE: OC4211.

OC4335 NAVAL OCEAN ANALYSIS AND PREDICTION (3 - 2).
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).
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).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4415 OCEAN TURBULENCE (3 - 0).
Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4490 OCEAN ACOUSTIC TOMOGRAPHY (Same as EC4490.) (3 - 0).
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; MA3042, MA3132 or equivalent.

OC4520 TOPICS IN SATELLITE REMOTE SENSING (3 - 0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

OC4610 WAVE AND SURF FORECASTING (2 - 2).
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.) (V - 0).
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. PREREQUISITE: Consent of the Department Chairman and instructor.

OC4900 DIRECTED STUDY IN OCEANOGRAPHY (V - 0).
Independent study of advanced topics in oceanography. PREREQUISITE: Consent of the Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF OPERATIONS RESEARCH

Paul Bloch, Lecturer (1994); MS Naval Postgraduate School, 1979.

Dan Calvin Boger, Professor and Chairman of Command, Control and Communications (C3) Academic Group (1979); PhD, University of California at Berkeley, 1979.

Gordon Hoover Bradley, Professor (1973); PhD, Northwestern University, 1967.

Gerald Gerard Brown, Professor and Associate Chair for Research (1973); PhD, University of California at Los Angeles, 1974.

Ronald L. Brown, CDR, USN, Military Instructor (1996); MS, Naval Postgraduate School, 1986.

Arnold Herbert Buss, Associate Professor, (1994); PhD, Cornell University, 1987.

Samuel Edward Buttrey, Assistant Professor (1996); PhD, University of California at Berkeley, 1996.

George Conner, Senior Lecturer and Assistant Provost, (1991); MS, Naval Postgraduate School, 1982.

Robert F. Dell, Associate Professor (1990); PhD, State University of New York at Buffalo, 1990.

James Norfleet Eagle, II, Professor and Chairman of Undersea Warfare Academic Group (1982); PhD, Stanford University, 1975.

James Daniel Esary, Professor Emeritus (1970); PhD, University of California at Berkeley, 1957.

Robert Neagle Forrest, Professor Emeritus (1964); PhD, University of Oregon, 1959.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Thomas Eugene Halwachs, Senior Lecturer and Associate Chair for Operations (1988); MS, Naval Postgraduate School, 1976.

Gilbert Thoreau Howard, Associate Professor and Director of Academic Planning (1967); PhD, Johns Hopkins University, 1967.

Wayne Philo Hughes, Jr., Senior Lecturer (1979); MS, Naval Postgraduate School, 1964.

Patricia Anne Jacobs, Professor (1978); PhD, Northwestern University, 1973.

William Glenn Kemple, Associate Professor (1990); PhD, University of California at Riverside, 1985.

Mitchell Craig Kerman, LT, USN (1997); MS, Naval Postgraduate School, 1997.

William Krebs, Assistant Professor (1996); PhD, University of Louisville, KY (1992).

Harold Joseph Larson, Professor (1962); PhD, Iowa State University, 1960.

Siriphong Lawphongpanich, Associate Professor (1987); PhD, University of Florida, 1983.

Peter Adrian Walter Lewis, Distinguished Professor (1971); PhD, University of London, 1964.

Glenn Frank Lindsay, Professor Emeritus (1965); PhD, Ohio State University, 1966.

Kneale Thomas Marshall, Distinguished Professor (1968); PhD, University of California at Berkeley, 1966.

Chairman:
Richard E. Rosenthal (OR/Rl)
Professor
Glasgow Hall
Room 239
(408) 656-2381
DSN 878-2381

Associate Chairmen:

Operations
T. Halwachs (OR/Ha)
Glasgow Hall
Room 294
(408) 656-2413
DSN 878-2413

Research
Gerald G. Brown (OR/Bw)
Glasgow Hall
Room 208
(408) 656-2140
DSN 878-2140

Instruction
Alan R. Washburn (OR/Ws)
Glasgow Hall
Room 204
(408) 656-3127
DSN 878-3127

Alan Wayne McMasters, Professor Emeritus (1965); PhD, University of California at Berkeley, 1966.

Paul Robert Milch, Professor (1963); PhD, Stanford University, 1966.

Samuel Howard Parry, Professor (1964); PhD, Ohio State University, 1971.

Frank Petho, CAPT, USN, Chairman of National Security Affairs, Assistant Professor and PME/PJE Coordinator (1991); PhD, University of Vermont, 1979.

James R. Powell, CAPT, USN, Chair of Information Warfare, Chair of Tactical Analysis and Military Instructor (1996); MSSE, Naval Postgraduate School (1984).

Peter Purdue, Professor and Dean of Operational and Applied Sciences (1986); PhD, Purdue University, 1972.

Robert Richard Read, Professor and Associate Chair for Research (1961); PhD, University of California at Berkeley, 1957.

Richard Edwin Rosenthal, Chairman and Professor (1985); PhD, Georgia Institute of Technology, 1975.

David Alan Schrady, Distinguished Professor (1965); PhD, Case Institute of Technology, 1965.

Charles H. Shaw III, LTC, USA, Military Instructor (1995); MS, Naval Postgraduate School (1989).

Rex Hawkins Shudde, Professor Emeritus (1962); PhD, U.C. Berkeley, 1956.

Michael Graham Sovereign, Professor and Acting Director of Institute for Joint Warfare Analysis (1970); PhD, Purdue University, 1965.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

Alan Robert Washburn, Professor and Associate Chair for Instruction (1970); PhD, Carnegie Institute of Technology, 1965.

Lyn R. Whitaker, Associate Professor (1988); PhD, University of California, Davis 1985.

Roger Kevin Wood, Associate Professor (1982); PhD, University of California Berkeley, 1982.

Walter Max Woods, Chairman of Mathematics and Professor (1962); PhD, Stanford University, 1961.

Mark Arthur Youngren, LTC, USA, Assistant Professor (1994); PhD, George Washington University, 1987.

Peter William Zehna, Professor Emeritus (1961); PhD, Stanford University, 1959.

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

The Operations Research Department was founded in 1961 primarily to service students in the OA (360) Curriculum. Graduates of that curriculum receive the Master of Science in Operations Research degree as do graduates of the Operational Logistics (361) Curriculum. The department consists of approximately forty faculty located in Glasgow Hall. The department operates several laboratories including the Human Systems Integration Lab located in Glasgow Hall and the Wargaming Lab in Ingersoll Hall.

In addition to being the primary department for the 360 and 361 curricula, the Operations Research Department also provides an extensive sequence of service courses for students in other curricula and is charged with teaching all probability and statistics courses at NPS. Nearly half of the department's teaching effort is devoted to these courses.

Active research areas within the department include statistics, stochastic processes, mathematical programming, human factors, wargaming, combat models, logistic systems, C4I systems, IW/EW and USW models, modeling and simulation.

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 degree Master of Science in Operations Research requires that:

1. A candidate shall previously have satisfied the requirements for the degree Bachelor of Science in Operations Research or the equivalent.

2. Completion of a minimum of 40 quarter hours of graduate level courses with:
   a. At least 18 quarter hours of 4000 level OA courses.
   b. An elective sequence approved by the Department of Operations Research.

3. Submission of an acceptable thesis on a subject previously approved by the Department of Operations Research.

DOCTOR OF PHILOSOPHY IN OPERATIONS RESEARCH
The department offers the Ph.D. degree in Operations Research. The program begins with advanced course work guided by the student's doctoral committee and leading to qualifying examinations in mathematical programming, 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 01B3, Naval Postgraduate School, Monterey, California 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 doctor's degree. Residency for this program generally requires two to three years beyond completion of a master's degree.

OPERATIONS RESEARCH COURSE DESCRIPTIONS

OAR200 INTRODUCTION TO COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 2).
Introduction to the Naval Postgraduate School personal computer laboratories and software. DOS, editing, word processing, spreadsheets, data analysis, database and presentation graphics will be introduced. Introduction to timesharing on the mainframe. PREREQUISITE: None.

OA0001 SEMINAR FOR OPERATIONS ANALYSIS STUDENTS (NO CREDIT) (0 - 2).
Guest lecturers. Review of experience tours. Thesis and research presentations.

OA0810 THESIS RESEARCH FOR OPERATIONS ANALYSIS & LOGISTICS STUDENTS (0 - 8).
Every student conducting thesis research will enroll in this course.

OA2200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH I (4 - 0).
A first course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Primary emphasis on the planning and structuring of computer programs. In depth analysis of proper program logic flow, program listings and debugging techniques. Introduction to the mathematical and statistical subroutine libraries. Assigned projects involve file management, data structures and operations research models. PREREQUISITE: None.

OA2600 INTRODUCTION TO OPERATIONS ANALYSIS (4 - 0).
A first course in Operations Analysis, covering its origins in World War II to current practice. Introduces concepts, tools and methods of analysis, with tactical examples. Emphasis is on measuring combat effectiveness and developing better tactics. PREREQUISITE: None.

OA2900 WORKSHOP IN OPERATIONS RESEARCH / SYSTEMS ANALYSIS (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Department approval. Graded on Pass/Fail basis only.

OA2910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 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).
Probability axioms and event probability. Random variables and their probability distributions. Moment generating functions, moments and other distribution characteristics, distribution families. Functions of a random variable, including the probability integral transformation. PREREQUISITE: MA1117 or equivalent.

OA3102 PROBABILITY AND STATISTICS (4 - 1).
Jointly distributed random variables, independence and conditional distributions, covariance and correlation. Functions of several random variables, sampling distributions, limiting distributions, the central limit theorem, approximations. Order statistics, the t and F distributions, the bivariate normal distribution. Point estimation, properties of estimators. PREREQUISITES: OA2200, OA3101 and MA1118 or equivalent; MA3110 taken concurrently.

OA3103 STATISTICS (4 - 1).
Interval estimation, testing statistical hypothesis. Parametric, nonparametric and graphical treatment of one and two sample univariate data, one and two way analysis of variance, and contingency tables. Applications to reliability, test and evaluation and military operations research problems. PREREQUISITE: OA3102 or equivalent.

OA3104 DATA ANALYSIS (3 - 1).
Techniques of analyzing, summarizing, and comparing sets of real data with several variables. Includes model building, and the discovery and overcoming of shortcomings in data collected in actual situations. Graphical computerized methods featured throughout. Topics include multiple regression with diagnostics, Logistic and Poisson regression, and an introduction to multivariate techniques such as categorical data analysis, principle components, and classification techniques. PREREQUISITE: OA3103.

OA3105 NONPARAMETRIC STATISTICS (4 - 0).
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 - 0).
An advanced course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Assigned projects involve advanced data structures, operations research models, numerical analysis, data analysis, basic complexity analysis, and computer simulation. PREREQUISITE: OA2200, or consent of instructor.

OA3201 LINEAR PROGRAMMING (Same as MA3301.) (4 - 1).
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. PREREQUISITES: MA3042, MA3110, and OA3200.

OA3301 STOCHASTIC MODELS I (4 - 0).
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 instructor.

OA3302 OA SYSTEM SIMULATION (4 - 0).
Discrete event digital simulation methodology. Monte Carlo techniques, use of simulation languages. Variance reduction techniques, design of simulation experiments and analysis of results. PREREQUISITES: OA3200 or equivalent, OA3103 or equivalent, OA3301.

OA3401 HUMAN FACTORS IN SYSTEM DESIGN I (3 - 1).
Provide the foundation to understand, explain, and predict human behavior. Students will be able to recognize and conceptually organize a behavioral sciences problem. Students will develop techniques in understanding how to ask a question, methodological procedures for collecting data, analyzing data, and interpreting results. Laboratory exercises will provide laboratory based demonstrations of psychological phenomena that give students a clear, "hands-on" picture of human strengths and limitations in the military workplace.

OA3402 HUMAN PERFORMANCE MEASUREMENT II (3 - 0).
The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man's motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3501 INVENTORY I (4 - 0).
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 instructor.

OA3601 COMBAT MODELS AND GAMES (4 - 0).
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. PREREQUISITES: MA3110, OA3102.

OA3602 SEARCH THEORY AND DETECTION (4 - 0).
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: OA3301.

OA3610 INTRODUCTION TO NAVAL LOGISTICS (4 - 0).
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. PREREQUISITES: SECRET clearance and approval of instructor.

OA3900 WORKSHOP IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OA3910 SELECTED TOPICS IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 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. Consent of instructor.

OA4101 DESIGN OF EXPERIMENTS (Same as MA4302.) (3 - 1).
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 REGRESSION ANALYSIS (Same as MA4303.) (4 - 0).
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, OA3103, and OA3104.

OA4103 ADVANCED PROBABILITY (3 - 0).
Probability spaces, random variables as measurable functions, expectation using the Lebesque-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).
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. PREREQUISITE: OA3103 and consent of instructor.

OA4106 ADVANCED DATA ANALYSIS (3 - 1).
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.

OA4201 NONLINEAR PROGRAMMING. (Same as MA4301.) (4 - 0).
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).
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).
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).
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. PREREQUISITES: OA3201 and OA3101 or consent of instructor.

OA4205 ADVANCED NONLINEAR PROGRAMMING (4 - 0).
Continuation of OA4201. Advanced topics in non-linear programming including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in non-linear programming. PREREQUISITE: OA4201.

OA4206 DYNAMIC PROGRAMMING AND OPTIMAL CONTROL (4 - 0).
The basic theory, including Bellman's equation and the Maximum Principle. Applications to tactical and economic problems. PREREQUISITE: OA3201.

OA4301 STOCHASTIC MODELS II (3 - 2).
Course objectives are to teach methods of stochastic modeling beyond those taught in OA3301 and to give students an opportunity to apply these tools to real world problems. Suitably selected projects that entail data collection and analysis are undertaken, with emphasis on problem formulation, choice of appropriate assumptions and attainment of practical results. Topics include renewal processes, and further topics in queuing, illustrated by several military and industrial applications. PREREQUISITES: OA3104, OA3301, OA3302.

OA4302 RELIABILITY AND WEAPONS SYSTEM EFFECTIVENESS MEASUREMENT (4 - 0).
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).
Attribute and variables sampling plans. MILSTD sampling plans with modifications. Multi-level 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 instructor.

OA4304 DECISION THEORY (3 - 0).
Basic concepts, Bayes, admissible, minimax, and regret strategies. Principles of choice. Relation of statistical decision functions to the theory of games. Application in the planning of operational evaluation trials. PREREQUISITE: OA3103.

OA4305 STOCHASTIC MODELS III (4 - 0).
Lecture topics include, non-stationary behavior of Markov processes, point process models, regenerative processes, Markovian queuing network models, and non-Markovian systems. Applications to 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 phenomenon. PREREQUISITES: OA3104, OA3301, OA4301.

OA4308 TIME SERIES ANALYSIS (Same as MA4304.) (4 - 0).
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: OA3104, OA3301.

OA4321 DECISION SUPPORT SYSTEMS (3 - 1).
An introduction to the topic; includes an overview of organizational decision making, discussion of OR techniques integral to DDS, relationships to artificial intelligence and expert systems, specialized computer languages, and non-traditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. PREREQUISITES: OA3101 and OA3200 or consent of instructor.

OA4333 SIMULATION METHODOLOGY (4 - 0).
Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on interests of students and Instructor. PREREQUISITE: OA3302.

OA4401 HUMAN PERFORMANCE EVALUATION (4 - 0).
This course provides the methods, theories and applications of classical and modern psychophysics. Investigate the fundamental processes of human vision. Overview of the other sensory processes. Investigate sensory perceptual deficits associated with simulators, virtual environments, and other man-machine devices. Laboratory exercises will provide students an opportunity to test psychophysical methodologies that pertain to the military workplace.

OA4402 SKILLED OPERATOR PERFORMANCE (3 - 2).
First part of the course is devoted to an examination of the theoretical foundations of skilled performance. The second half of the course is devoted to the study of the acquisition, development and prediction of skilled operator performance in the operational setting. PREREQUISITE: OA3401.

OA4501 SEMINAR IN SUPPLY SYSTEMS (4 - 0).
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).
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, Markow policies, optimization). PREREQUISITES: OA3102, OA3201, OA3301.

OA4601 MODELS FOR DECISION MAKING (4 - 0).
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 analysis, the value of perfect information in evaluating the worth of a forecast, measuring outputs, and resolving decision conflicts that result from multiple output measures. PREREQUISITES: OA3101 or OS2103.

OA4602 JOINT CAMPAIGN ANALYSIS (4 - 0).
The development, use and state-of-the-art of campaign analysis in actual procurement 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 the students conduct a broad gauge, quick reaction campaign analysis as team members. PREREQUISITES: A course in basic probability theory, a course in quantitative decision making, working knowledge of computer war game construction and application, and four years of military field assignments.

OA4603 TEST AND EVALUATION (3 - 2).
This course relates the theory and techniques of operations research to the problems associated with test and evaluation. Specific examples of exercise design, reconstruction, and analysis are examined. PREREQUISITE: OA3104.

OA4604 WAR GAMING ANALYSIS (4 - 0).
Analysis of problems in the design, construction and application of manual, computer and interactive gaming. Emphasis is on gaming as a means of evaluating Naval Warfare tactics. Current naval/joint facilities will be used. PREREQUISITES: OA3302, SECRET clearance and U.S. citizenship.

OA4605 OPERATIONS RESEARCH PROBLEMS IN NAVAL WARFARE (3 - 0).
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. PREREQUISITES: OA3601, OA4604.

OA4607 TACTICAL DECISION AIDS (4 - 0).
An in depth review of modern Naval Tactical Decision Aids, particularly those used in searching and tracking such as VPCAS, NODESTAR and ASWDTA. Also includes an introduction to Kalman filters. Principles of organization, computation, display and test. Projects required. PREREQUISITES: OS2103 or OS3604, OA3101 or OA3104, or an equivalent probability and statistics sequence. Working knowledge of a programming language such as MATLAB, Pascal, or C.

OA4608 FOREIGN MILITARY OPERATIONS RESEARCH (4 - 0).
This course considers military operations research (OR) 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 O/R as a point of departure for study. Asymmetries between Soviet and American military O/R are emphasized. Exploitation of such information is discussed. Course content will change as concerns change. Topics have included: Soviet military O/R textbooks, use of combat models in automated systems of troop control (Soviet C3), Soviet combat models, network models for planning and control of combat operations, target-engagement models, models for reconnaissance/intelligence processes, modelling of deception, automated artillery fire planning, strategic models. English translations of major Soviet works on military O/R will be supplied. PREREQUISITES: Course on combat modelling (e.g. OA3601 or OA4654) or consent of Instructor, SECRET clearance and U.S. citizenship.

OA4610 MOBILIZATION (4 - 0).
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.

OA4611 LOGISTICS IN NAVAL WARFARE (4 - 0).
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 strictures 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. PREREQUISITES: OA3610, MN4376, Secret clearance and approval of instructor.

OA4612 LOGISTICS MODELS (4 - 0).
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 only. PREREQUISITE: Consent of instructor.

OA4654 AIR-LAND MODELS (4 - 0).
Introduction to modeling air/ground combat operations with emphasis on detailed approaches for modeling small-scale combat. Topics include: types of models, the modeling process, verification, target acquisition models, target selection, weapon accuracy, lethality models, terrain effects, tactical decision making, and integration of these models into large scale simulation models of combat. Models currently in use in DoD analysis are used as examples through-out the course. PREREQUISITE: OA3301.

OA4655 AIR-LAND-SEA ANALYSIS (4 - 0).
Modeling of large scale air/ground combat operations using aggregated force on force combat models. Topics include: Aggregation and disaggregation, types of models used for large scale operations, firepower index and Lanchester equation approaches to attrition modeling, movement rate of advance models, air warfare models, and air allocation, logistics, C3I process models, artificial intelligence applications. Models currently in use for DoD analysis are used as examples throughout the course. PREREQUISITE: OA3301 or consent of the instructor.

OA4701 ECONOMETRICS (4 - 0).
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).
Advanced study in the methods and practice of systems analysis with emphasis on cost analysis; cost models and methods for total program structures and single projects; relationship of effectiveness models and measures to cost analysis; public capital budgeting of interrelated projects; detailed examples from current federal practices. PREREQUISITE: AS3610 or equivalent.

OA4703 DEFENSE EXPENDITURE AND POLICY ANALYSIS (4 - 0).
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: AS3610.

OA4704 O/R TECHNIQUES IN MANPOWER MODELING (4 - 0).
The most frequently applied manpower models are studied including Markov chain and renewal models using grade and/or length of service categories. Statistical techniques to estimate relevant attrition and promotion rates from cohort and census data are also included in the course to provide both longitudinal and cross-sectional views of personnel systems. Career aspects are analyzed with respect to attrition, promotion opportunity and time to promotion in hierarchical systems with or without promotion zones. Examples emphasize the personnel systems of the military services. PREREQUISITES: OA3201, OA3301, and OA3103.

OA4910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 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 departmental ap-proval.

OA4930 READINGS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OS2101 ANALYSIS OF EXPERIMENTAL DATA (4 - 0).
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.

OS2103 APPLIED PROBABILITY FOR SYSTEMS TECHNOLOGY (4 - 1).
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 MA1118 level.

OS3002 OPERATIONS RESEARCH FOR NAVAL INTELLIGENCE (4 - 0).
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.

OS3003 OPERATIONS RESEARCH FOR INFORMATION WARFARE (4 - 0).
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 (MOE). Topics covered include ESM, ECM/ECCM, strike warfare, ASMD, and cost- effectiveness tradeoffs. PREREQUISITES: Calculus and OS2103.

OS3004 OPERATIONS RESEARCH FOR COMPUTER SYSTEMS MANAGERS (4 - 1).
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. PREREQUISITES: MA2300, OS3101.

OS3006 OPERATIONS RESEARCH FOR MANAGEMENT (4 - 0).
A survey of problem solving techniques for operations research. Topics include decision theory, linear programming, models, project scheduling, inventory, queuing and simulation. PREREQUISITES: MA2300, OS3101 or OS3105.

OS3008 ANALYTICAL PLANNING METHODOLOGY (4 - 0).
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.

OS3101 STATISTICAL ANALYSIS FOR MANAGEMENT (4 - 1).
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).
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).
The first of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Skills in numerical computation are developed in laboratory periods through the use of MINITAB. Emphasis in the lectures is placed on modeling problems and interpreting results. Those aspects of probability structure that are germane to distributions such as the binomial and normal. Standard topics of statistical inference for one and two variables are introduced in the settings of both hypothesis testing and confidence interval estimation. PREREQUISITE: MA2300.

OS3302 QUALITY ASSURANCE AND RELIABILITY (4 - 0).
A technical treatment of quality assurance discipline with attention to its corresponding programmatic and managerial elements. Survey of current trends and policies in total quality management and system design, development production and logistic support. Reliability modeling, testing, growth, estimation and assessment, manufacturing qualification, process control management and improvement, quality control charts. Survey of selected current DoD instructions, handbooks and manuals.

OS3303 COMPUTER SIMULATION (4 - 1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to USW problems. War gaming 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, OS3604 or equivalent, and a working knowledge of FORTRAN programming.

OS3401 HUMAN FACTORS ENGINEERING (3 - 0).
An introduction to human factors engineering for students in fields such as engineering. Designed to give the student an appreciation of man's capacities and limitations and how these can affect the optimum design of the man-machines system. Emphasis on integration of human factors into the system development cycle considering such topics as manpower/personnel costs, control and display design, human energy expenditure, physiological costs, and evaluation systems. PREREQUISITE: A previous course in probability and statistics.

OS3403 HUMAN FACTORS IN INFORMATION WARFARE (3 - 1).
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 MAN-MACHINE INTERACTION (3 - 2).
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).
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. PREREQUISITES: OS2103, OS3604, PH2401 or consent of instructor and SECRET clearance.

OS3603 SIMULATION AND WAR GAMING (3 - 1).
This course introduces students to systemic and interactive wargame simulation models. The students will understand and play two interactive wargames 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 - OS2103, OS3604 or equivalent, and a working knowledge of computer programming language.

OS3604 DECISION AND DATA ANALYSIS (4 - 0).
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.

OS3702 MANPOWER REQUIREMENTS DETERMINATION (4 - 0).
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. PREREQUISITES: OS3006, or OA3201 and OA3301.

OS4601 TEST AND EVALUATION (4 - 0).
Designed for system technology students, this course examines problems associated with tests and evaluations of weapon systems and tactics. Included are concepts from experimental design, regression analysis. Realistic data sets and examples are discussed and analyzed. PREREQUISITE: Inferential statistics.

OS4701 MANPOWER AND PERSONNEL MODELS (4 - 0).
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: OS3006.

DEPARTMENT OF PHYSICS

Chairman:
William B. Maier, II
Senior Lecturer
Code PH/Mw, Spanagel Hall
Room 200D
(408) 656-2896
DSN 878-2896

Associate Chairmen:

Administration
Steven R. Baker
Associate Professor
Code PH/Ba, Spanagel Hall
Room 144
(408) 656-2732
DSN 878-2732

Instruction
James V. Sanders
Associate Professor
Code PH/Sd, Spanagel Hall,
Room 202A
(408) 656-3884
DSN 878-3884

Research
David D. Cleary
Associate Professor
Code PH/Cl, Spanagel Hall,
Room 142B
(408) 656-2828
DSN 878-2828

Robert Louis Armstead, Associate Professor (1964)*; PhD, University of California at Berkeley, 1964.

Steven Richard Baker, Associate Professor and Associate Chair for Administration (1985); PhD, University of California at Los Angeles, 1985.

David Dempster Cleary, Associate Professor and Associate Chair for Research (1988); PhD, Colorado, 1985.

William Boniface Colson, Professor (1989); PhD, Stanford University, 1977.

Alfred William Madison Cooper, Professor (1957); PhD, The Queen's University of Belfast, 1961.

David Scott Davis, Associate Professor (1989); PhD, Purdue University, 1976.

Richard M. Harkins, Instructor (1994), MS, Naval Postgraduate School, 1988.

Robert Charles Harney, Associate Professor (1995); PhD, University of California at Davis, 1976.

Dan Howard Holland, Senior Lecturer (1990); PhD, Stanford University, 1955.

Robert Mitchell Keolian, Associate Professor (1990); PhD, University of California at Los Angeles, 1985.

Andres Larraza, Assistant Professor (1989); PhD, University of California at Los Angeles, 1987.

James H. Luscombe, Associate Professor (1994), PhD, University of Chicago, 1983.

William B. Maier II, Chairman and Senior Lecturer (1995); PhD, University of Chicago, 1965.

Xavier K. Maruyama, Professor (1987); PhD, Massachusetts Institute of Technology, 1971.

Richard Christopher Olsen, Associate Professor (1987); PhD, University of California at San Diego, 1980.

James Vincent Sanders, Associate Professor and Associate Chair for Instruction (1961); PhD, Cornell University, 1961.

Gordon Everett Schacher, Professor (1964); PhD, Rutgers, 1961.

Kevin B. Smith, Assistant Professor (1995); PhD, University of Miami, 1991.

Joseph Sternberg, Professor Emeritus (1985); PhD, Johns Hopkins University, 1955.

Donald Lee Walters, Associate Professor (1983); PhD, Kansas State University, 1971.

Karlheinz Edgar Woehler, Professor (1962); PhD, University of Munich, 1962.

William Bardwell Zeleny, Associate Professor and Associate Chair for Administration (1962); PhD, Syracuse University, 1960.

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

Expertise in the Department of Physics and efforts in research and teaching of graduate specialization courses for the last twenty years can be summarized under the heading "physics of propagation phenomena in realistic, complex environments". Specialized course sequences are offered in the following areas:

SPECIALIZATIONS

1) Optical Signal Propagation and Detection.
2) Directed Energy Weapons Systems.
3) Nuclear Weapons and their Effects.
4) Underwater Acoustics.
5) Physics of the Space and Satellite Environments.
6) Simulation of Large Scale Systems.
7) Physical Acoustics.

All of these specializations are of obvious 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 PhD degrees in Physics and in Applied Physics. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements.

MASTER OF SCIENCE IN PHYSICS
A candidate for the degree Master of Science in Physics must complete satisfactorily a program of study which 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.

The following specific course requirements must be successfully completed for a student to earn the degree Master of Science in Physics:

1) PH3152: Mechanics of Physical Systems,
   PH3352: Electromagnetic Waves and Radiation
   PH3991: Theoretical Physics
   PH3782: Thermodynamics and Statistical Physics.
   PH4353: Topics in Advanced Electricity and Magnetism
   PH4984: Advanced Quantum Physics, or equivalents to the above courses.

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 degree Master of Science in Applied Physics, a student must complete a program which 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. In addition, the program must include a 4000 level Physics course from at least one of the following areas of physics: mechanics of continua, solid state physics, laser physics, nuclear physics, plasma physics, acoustics, or electromagnetic radiation.

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 degree Master of Science in Applied Physics must satisfy the general Postgraduate School requirements for the Master's degree, must include a thesis co-advised by a member of the Physics Department, and must be approved by the Chairman of the Department of Physics.

DOCTOR OF PHILOSOPHY
The Department of Physics offers the PhD. degree in several areas of specialization which currently include acoustics, electro-optics, free electron lasers, space physics, theoretical physics, and nuclear 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 PhD. 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 PhD; 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 PhD is contained in the booklet "Doctoral Study in Physics or in Applied Physics at the Naval Postgraduate School."

An applicant to the PhD 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 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

PHYSICS LABORATORIES
The physics laboratories are equipped to carry on instruction and research work in atomic physics, nuclear physics, electro-optics, plasma physics, spectroscopy and acoustics.

The 100 MeV electron linear accelerator provides a pulsed electron beam of one microampere average current and is used for radiation studies. This machine is augmented by a Pulserad 112 single pulse electron accelerator producing a 1.8 MeV, 40 kiloampere beam of 50 nanosecond duration. Both machines are suitable for studies of radiation effects in semiconductor devices and electromagnetic pulse generation.

The Electro-Optics Laboratory uses imaging and detecting systems from the far infrared to the visible range including instrumentation for seagoing experiments in optical propagation. The Laser Laboratory contains a giant pulse laser and associated detection equipment for the visible spectrum as well as a high power laser in the IR region.

The Acoustics Laboratory equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the underwater acoustics laboratory. The physical acoustics laboratories are equipped with a variety of modern data collection and processing equipment.

PHYSICS COURSE DESCRIPTIONS

PHR110 REFRESHER PHYSICS (NON CREDIT) (Meets last 6 weeks of quarter.) (5 - 3).
Selected topics from elementary physics for incoming students. Typical topics are kinematics, Newton's Laws of motion, work, energy, linear and angular momentum, basic concepts of fluid flow, temperature, heat, and the kinetic theory of gases. Vector algebra and some aspects of calculus are developed as needed and their use is emphasized. The two ninety-minute problem sessions are devoted to guided problem solving. PREREQUISITES: Previous college course in elementary physics and integral calculus. Refresher mathematics (calculus) is usually taken concurrently.

PH0499 ACOUSTICS COLLOQUIUM (NO CREDIT) (0 - 1).
Reports on current research, and study of recent research literature in conjunction with the student thesis. PREREQUISITE: A course in acoustics.

PH0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

PH0999 PHYSICS COLLOQUIUM (NO CREDIT) (0 - 1).
Discussion of topics of current interest by NPS and outside guest speakers.

PH1121 PHYSICS I (4 - 2).
Particle kinematics, Newton's laws of motion, particle dynamics, work and energy, conservation of energy and momentum, systems of particles, rotational kinematics and dynamics including torque and angular momentum, gravitation, stress and strain in materials, simple harmonic motion, fluids. Laboratory exercises. PREREQUISITE: A course in calculus or concurrent registration in a calculus course and approval of the instructor.

PH1322 PHYSICS II (4 - 2).
Electric charge, Coulomb's Law, electric field, Gauss' Law, electrical potential and energy, current and resistance, EMF, capacitors and dielectrics, magnetic field, Faraday's Law, Ampere's law, Maxwell's equations, wave motion. Laboratory exercises. PREREQUISITE: PH1121 or approval of the instructor.

PH1623 PHYSICS III (4 - 2).
Geometrical and physical optics, thermodynamics and kinetic theory, sound, atoms and molecules, modern physics. Laboratory exercises. PREREQUISITES: PH1322 or approval of the instructor.

PH2001 PHYSICS THESIS OPPORTUNITIES (1 - 0).
This course is designed for students interested in choosing and pursuing a Master's thesis in physics. Members of the faculty of the Department of Physics having research projects suitable for Master's degree theses will give presentations on their projects. The course is given in the pass/fail mode. PREREQUISITE: At least 7 quarter-hours of physics courses.

PH2151 PARTICLE MECHANICS (4 - 1).
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).
A course to provide physical background to wave motion, acoustics, and optics for students in the Electronic Warfare and Information 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, sound waves, optics), geometrical and wave optics. PREREQUISITE: MA2138.

PH2207 FUNDAMENTALS OF ELECTRO-OPTICS (4 - 0).
This course is designed to provide students in interdisciplinary curricula with specific prerequisite background for electro-optics courses in those curricula. Topics discussed include: matrix formulation of optics, catoptric and catadioptric systems, diffraction, behavior of Gaussian profile beams, Fourier optics and resolution, atmospheric transmission, atomic and molecular energy states, line shapes, band theory of semiconductors, the p-n junction, light emitting diodes, stimulated emission, and lasers. PREREQUISITES: MA3139 and PH2203 (or equivalent).

PH2351 ELECTROMAGNETISM (4 - 1).
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. Gauge transformations. The electromagnetic wave equation and plane waves. PRE-REQUISITES: PH1322 or equivalent, a course on multivariable calculus and a course on differential equations.

PH2401 INTRODUCTION TO THE SONAR EQUATIONS (3 - 0).
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 is intended primarily for students in the Undersea Warfare curriculum and is given in a "structured" PSI mode. PREREQUISITE: Precalculus mathematics.

PH2410 ANALOG ELECTRONICS AND SIGNAL CONDITIONING FOR ACOUSTICS (3 - 2).
Applications of simple integrated circuits to acoustical measurements including op-amp filters and amplifiers, voltage controlled oscillators, D-to-A, A-to-D, and frequency-to-voltage converters. Sources of noise (thermal and quantization) in electro-acoustic systems. Techniques of noise reduction in the frequency and time domains including signal integration and time averaging, digital and analog Fourier analysis, phase sensitive detection and time domain auto- and cross-correlation analysis. PREREQUISITES: SE2012 and EC2170.

PH2511 INTRODUCTION TO ORBITAL MECHANICS (4 - 0).
The gravitational two-body problem. Elliptic orbits and orbital elements. Orbital maneuvers and transfers. Time of flight. Ground track. Additional topics selected from the following: suborbital trajectories, hyperbolic trajectories, orbit determination from radar data, sun synchronous orbits, Molniya orbits and orbital perturbations. PREREQUISITES: A course in basic mechanics (including vectors) and a course in ordinary differential equations.

PH2514 INTRODUCTION TO THE SPACE ENVIRONMENT (4 - 0).
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. PREREQUISITE: A course in basic electricity and magnetism.

PH2601 SURVEY OF MODERN PHYSICS (4 - 1).
This is a one-term course covering the fundamentals of modern physics with selected applications. Topics include special relativity, the wave-particle duality, the Schrodinger Equation, atoms and molecules, lasers, semiconductors, and superconductors. PREREQUISITE: PH1623.

PH2652 QUANTUM PHYSICS (4 - 1).
Thermal radiation, photons, matter waves, Bohr model of hydrogen, special relativity, Schroedinger's Equation applied to barriers, wells, harmonic oscillator, and the hydrogen atom. Spin and multi-electron. PREREQUISITE: PH2151 and partial differential equations.

PH2724 THERMODYNAMICS (4 - 0).
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: PH1623 and a course in multivariable calculus.

PH2911 INTRODUCTION TO COMPUTATIONAL PHYSICS (3 - 2).
An introduction to the role of computation in modern physics with emphasis on the programming of current nonlinear physics problems and the use of graphics. Includes an introduction to C programming language as well as the UNIX and DOS operating systems. Subject matter includes projectile trajectories with air drag, nonlinear celestial mechanics, damped and driven nonlinear oscillators, molecular dynamics in solids, liquids and gases, and numerical integration methods. PREREQUISITE: A basic physics course.

PH3002 NON-ACOUSTIC SENSOR SYSTEMS (4 - 0).
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. PREREQUISITE: PH1322.

PH3052 PHYSICS OF SPACE AND AIRBORNE SENSOR SYSTEMS (4 - 0).
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. PREREQUISITE: EO2413 or equivalent .

PH3119 OSCILLATION AND WAVES (4 - 2).
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. PREREQUISITE: PH3991 or equivalent.

PH3152 MECHANICS OF PHYSICAL SYSTEMS (4 - 0).
The dynamics of rockets. Rotating coordinate systems and coriolis acceleration. Hamilton's principle and the role of physical symmetry in dynamics. Velocity dependent potentials. The inertia tensor and the rotational dynamics of rigid bodies. Small oscillations and normal PREREQUISITE: PH2151.

PH3171 EXPLOSIVES AND EXPLOSIONS (4 - 0).
Thermodynamics and thermochemistry of explosive decomposition; detonation and fireball; Rankine-Hugoniot relations; normal and oblique reflection; Mach stem; explosive strength; blast wave profile; propagation and reflection of the blast wave in air; properties of selected explosives; scaling laws; safety distances; underwater explosions; shaped charges. PREREQUISITE: PH3172 (May be concurrent).

PH3172 FLUID DYNAMICS OF WEAPONS (4 - 1).
This course is designed for the students in the Combat Systems Sciences and Technology Curriculum to provide the basic physical principles applicable to air-borne and water-borne missiles. Topics include: The stress tensor and the rate of deformation tensor. The general equations of continuity, momentum, and energy. Navier-Stokes equation for incompressible flow. Laminar boundary layers. Hydrodynamic stability and the turbulent boundary layer. Drag and lift in incompressible flow with application to torpedoes. Normal and oblique shock waves. Supersonic nozzles. Drag and lift of supersonic airfoils with application to missiles. PREREQUISITE: PH3152.

PH3204 ELECTRO-OPTIC SYSTEMS AND COUNTERMEASURES (3 - 2).
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 and their countermeasures. Topics treated include: Target signatures and backgrounds, laser radiation characteristics, atmospheric extinction, refraction, turbulence, thermal blooming and breakdown, adaptive optics, thermal radiation, target signatures, background, reticles and other trackers. Infrared detector characteristics, CCD, CID and FLIR, IRST and staring sensors; sensor performance parameters. Laboratory work provides hands-on familiarity with modern infrared devices. PREREQUISITES: PH2203, EO2413, EO2652 and MA3139 or equivalent.

PH3208 ELECTRO-OPTIC PRINCIPLES AND DEVICES (4 - 1).
This course is designed to provide students in inter-disciplinary programs with a general understanding of the principles and capabilities of the component devices comprising military electro-optic and infrared systems. Topics treated include: atmospheric extinction, turbulence, thermal blooming and breakdown, adaptive optics, thermal radiation, target signatures, backgrounds, electro-optic and acousto-optic devices, reticles and other trackers, detector characteristics, noise and cooling, television, CCD, CID and scanning imagers. Laboratory work provides hands-on familiarity with these devices. PREREQUISITES: PH2203, PH2207, MA3139 or equivalent.

PH3252 ELECTRO-OPTICS (4 - 0).
This course treats the properties of electro-optic systems together with the basic physical principles involved. Topics included are: diffraction and Fourier transform methods; optical data processing; Fresnel equations, evanescent waves, film and fiber optics; Gaussian beams and laser resonators; molecular spectra, transition probability, line widths, and laser gain; specific lasers, Q-switching and mode locking; semi-conductors, junction diodes, photo detection, light emitting diodes and diode lasers. PREREQUISITES: PH2652, PH3352.

PH3292 APPLIED OPTICS (4 - 2).
An introduction to the basic principles of optics. Geometric optics. Fermat's principle, reflection at surfaces, mirrors, lenses, optical fibers, image formation, optical instruments, aberrations, matrix ray tracing methods. Physical optics: electromagnetic wave equation in vacuum and material media, polarization, interference, Fraunhofer and Fresnel diffraction, Fourier analysis of optical systems. The course includes both problem sessions and extensive classroom/ laboratory demonstrations of key concepts covered in class. PREREQUISITES: PH2351 and PH3991, or equivalent.

PH3352 ELECTROMAGNETIC WAVES AND RADIATION (4 - 0).
Propagation of uniform plane waves in free space, in dielectric media, in conducting media (with emphasis on sea water), and in the ionosphere. Reflection and refraction. Radiation and antennas. Principles of radar. Rectangular waveguides. PREREQUISITE: PH2351.

PH3360 ELECTROMAGNETIC WAVE PROPAGATION (4 - 1).
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.

PH3400 SURVEY OF UNDERWATER ACOUSTICS (4 - 2).
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 planes 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.

PH3410 OPTICAL FIBER SENSORS AND COMMUNICATION SYSTEMS (3 - 2).
Introduction to the physics, engineering, and applications of optical fibers, electro-optic sources, sensors, and communication systems. The course will cover communication system design including component specification, data rates, power budgets, and optical amplifiers. The course will also cover sensor design including interferometric and intensity based sensors, fiber optic hydrophones, gyroscopes, and displacement sensors. PREREQUISITE: PH3292 or equivalent.

PH3451 FUNDAMENTAL ACOUSTICS (4 - 2).
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).
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. PREREQUISITE: PH3451.

PH3458 NOISE, SHOCK AND VIBRATION CONTROL (4 - 0).
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. PREREQUISITE: A course in acoustics.

PH3479 PHYSICS OF UNDERWATER WEAPONS (4 - 0).
The basic physics of underwater weapons from launch through explosion are addressed using a modern acoustic torpedo to illustrate practical applications. Topics include initial inputs, water entry, power plants, propulsors, drag and drag reduction, stability and control, guidance, acoustic search, terminal homing, exploders, and explosions. PREREQUISITE: MA3139 or equivalent.

PH3513 INTERMEDIATE ORBITAL MECHANICS (Variable hours 2-0 to 4-0.) (V - 0).
Orbital perturbations due to various sources, such as atmospheric drag and lunar tidal effects. Interplanetary trajectories. Additional topics depending on hours assigned to course. PREREQUISITE: PH2511.

PH3516 ENVIRONMENTAL FACTORS IN SPACECRAFT DESIGN & OPERATIONS (3 - 0).
The environmental effects covered in this course include spacecraft charging, space radiation effects, natural and artificial space debris, and atmospheric effects. The nature of the physical interactions is emphasized. PREREQUISITE: PH2514.

PH3653 FOUNDATIONS OF QUANTUM DEVICES (4 - 1).
Quantum statistics and identical particles; degenerate electron gas, solids, band theory of metals, insulators, and semiconductors; molecules and molecular spectra; semiconductor junctions and transistors; applications of quantum mechanical principles of radiating systems (e.g., lasers) and photon detectors; superconductivity and superconducting quantum interference devices (SQUIDs). PREREQUISITE: PH2652.

PH3782 THERMODYNAMICS AND STATISTICAL PHYSICS (4 - 0).
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 PH3653.

PH3800 INTRO TO THE EFFECTS OF CONVENTIONAL AND UNCONVENTIONAL WEAPONS (4 - 0).
Dynamic behavior of ductile and brittle materials. Hugoniots. Target failure mechanisms; penetration at high velocities; shaped charges; nuclear, chemical, and biological weapons effects. PREREQUISITE: MS2201 or consent of instructor.

PH3802 WEAPONS, WEAPONS EFFECTS AND WEAPONEERING (4 - 0).
This course is designed primarily for students of the Information Warfare Curriculum (595). The course gives an introduction to the planning and targeting process of joint air operations, followed by discussion of the current types of warheads including nuclear warheads, basic principles governing the warhead target interaction. An introduction to the principles of "Weaponeering", the estimate of target course concludes with concepts of directed energy weapons, lasers and high power microwave beams and their effects on target of interest. PREREQUISITES: Basic physics, MA1117/1118 or equivalent, U.S. citizenship and SECRET clearance.

PH3855 NUCLEAR PHYSICS (4 - 2).
This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the necessary underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes, and interaction of high energy particles with matter. The laboratory includes radiation detection techniques and statistics of counting. PREREQUISITES: PH3152, PH3352 and PH3653 or equivalent. (PH3653 may be concurrent.)

PH3921 NONLINEAR DYNAMICS, CHAOS, FRACTALS AND ALL THAT (Variable hours 2-0 to 3-0.) (V - 0).
The existence of chaotic dynamics has been discussed in the literature for many decades and is associated with names like Poincare, Birkhoff, Kolmogorov and others. However, it is only recently that the wide ranging impact of chaos has been recognized. The field is undergoing explosive growth and many applications have been made across a broad spectrum of scientific disciplines - ecology, economics, physics, chemistry, engineering, and fluid mechanics. Much effort is driven by the hope that it may be possible to find unifying principles that characterize and classify large classes of nonlinear complex systems. This course is an introduction into the concepts and the language used in this rapidly growing exciting field from a physicist's point of view. PREREQUISITE: PH2151 or equivalent.

PH3991 THEORETICAL PHYSICS (4 - 0).
Discussion of heat flow, electromagnetic waves, elastic waves, and quantum mechanical waves; applications of orthogonal functions to electromagnetic multi poles, angular momentum in quantum mechanics, and to normal modes in acoustic and electromagnetic systems. PREREQUISITE: Basic physics, multivariable calculus, vector analysis, Fourier series, complex numbers, and ordinary differential equations.

PH3998 SPECIAL TOPICS IN INTERMEDIATE PHYSICS (Variable hours 1-0 to 4-0.) (V - 0).
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).
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. PREREQUISITE: At least two quarters of thesis research.

PH4050 PHYSICS OF ELECTROMAGNETIC DETECTION I (4 - 0).
This is the first in a two-course sequence that explores the physics behind modern optical and electromagnetic sensors and devices. The topics covered are: (1) Fundamentals of radar, including the radar equation, range resolution, antenna gain, diffraction, signal-to-noise ratio, target characteristics, backscatter, pulse compression, FM chirping techniques, phased arrays and synthetic apertures; (2) Applications of basic quantum and solid state physics concepts to opto-electronic detection of visible and infrared signals, covering the following technologies: photoconductors, photovoltaic diodes, bolometers, array detectors, photomultipliers and image intensifiers; (3) The basic physics of radiative transfer, radiometry and the fundamental noise limits to detection. PREREQUISITES: PH3292, PH3352 and PH3653, or equivalent.

PH4051 PHYSICS OF ELECTROMAGNETIC DETECTION II (4 - 0).
This course is a continuation of PH4050. The topics covered are: (1) The physics of display technologies, such as CRTs, LEDs, and liquid crystal devices; (2) Laser physics, including spontaneous and simulated emission, absorption, Einstein relations, population inversion, rate equations, pumping, resonant cavities, modes, Q-switching, and device-specific laser technologies. (3) The physics and applications of optical fiber devices, including step-index and graded-index fibers, numerical aperture, single and multi-mode fibers, fiber communications systems and fiber-based transducers. (4) Applications of atomic and molecular physics, spectroscopy and spectrochemical analysis to target characterization. (5) Atmospheric effects on the propagation of electromagnetic radiation, including scattering, absorption and turbulence. PREREQUISITE: PH4050 or equivalent.

PH4054 PHYSICS OF DIRECTED ENERGY WEAPONS (4 - 0).
This course is an in-depth study into the beam weapon concepts. Topics covered are: relativistic electron beams, their equilibrium, propagation losses and stability; giant power accelerator concepts; target interaction; proton beams; neutral particle beams, their production and limitations; high power microwave beams; high energy laser beams, their production, atmospheric propagation and control and their interaction with targets. PREREQUISITES: PH2151 and PH3352 (or equivalents) and SECRET clearance.

PH4162 MECHANICS OF CONTINUA (3 - 0).
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. PREREQUISITE: PH3172 or equivalent.

PH4209 EO/IR SYSTEMS AND COUNTERMEASURES (3 - 2).
This unclassified course for students in interdisciplinary curricula treats the military applications of electro-optic systems, including IR and EO seekers and trackers, surveillance and missile warning systems, and laser rangers and designators. Scanning FLIR and IRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approaches will be discussed. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. PREREQUISITES: PH3208, MA3139.

PH4253 SENSORS, SIGNALS, AND SYSTEMS (4 - 2).
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: PH3653, PH3292, and PH3352 or equivalent.

PH4254 THERMAL IMAGING AND SURVEILLANCE SYSTEMS (4 - 0).
This course is intended as a capstone course to follow the sequence PH3252 and PH4253, or the sequence PH2207 and PH3208. It will address the system analysis and technology of infrared imaging and search/track systems, including the derivation of system performance measures such a Minimum Detectable Temperature Difference, (MDT), and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display, and human operator characteristics. Performance Prediction codes and Tactical Decision aids (TDAs) will be analyzed for current Forward Looking Infra Red (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 generation FLIR and Staring Imager development. PREREQUISITE: PH3208 or PH4253 or consent of instructor.

PH4283 LASER PHYSICS (4 - 0).
The physics of lasers and laser radiation. Topics will include: spontaneous and stimulated emission, absorption, interaction of radiation with matter; line broadening mechanisms; optical and electrical pumping; gain; properties of laser beams; Gaussian beams; stable and unstable resonators; rate equations; output coupling; mode locking; short pulsing; specifics of solid state and gas laser systems; high energy and high power lasers; laser-surface interaction; air breakdown; laser supported detonation waves; laser isotope separation; and laser fusion. PREREQUISITE: PH4051or equivalent.

PH4353 TOPICS IN ADVANCED ELECTRICITY AND MAGNETISM (4 - 0).
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).
Electromagnetic radiation from accelerating particles and antennas, including Yagi antennas and phased arrays. Radar sources such as klystrons. Radiation scattering, including Rayleigh scattering, Mie scattering and scattering from rough surfaces. Relativistic electrodynamics. PREREQUISITES: PH3352 and PH3991.

PH4371 CLASSICAL ELECTRODYNAMICS (3 - 0).
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).
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. PREREQUISITE: PH3451.

PH4453 SCATTERING AND FLUCTUATION OF SOUND IN THE OCEAN (4 - 0).
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: multipole 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. PREREQUISITE: PH3452 or consent of the instructor.

PH4454 SONAR TRANSDUCER THEORY AND DESIGN (4 - 2).
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 hydromechanical 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. PREREQUISITE: PH3452 (may be taken concurrently).

PH4455 SOUND PROPAGATION IN THE OCEAN (4 - 0).
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 Arctic ocean acoustics. PREREQUISITE: PH3452 or consent of instructor.

PH4459 SHOCK WAVES AND HIGH-INTENSITY SOUND (3 - 0).
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. PREREQUISITE: PH3451.

PH4515 PHYSICS OF THE SATELLITE ENVIRONMENT (3 - 2).
A graduate level treatment of the structure and properties of the near earth space environment and some aspects of solar physics. Topics (usually two per quarter) are chosen from: ionospheric composition, ionospheric radio wave propagation, structure of the magnetosphere, the geomagnetic field, solar structure and emissions, spacecraft/environment interactions. PREREQUISITES: PH2514 and a 3000 level course in electromagnetism. Some background in plasma physics is desirable.

PH4531 INTRODUCTION TO ASTROPHYSICS (4 - 0).
Introduction to theories of stellar structure, energy transport in stars, and stellar evolution; recent advances in solar physics; supernovae, pulsars, black holes, and the origin of the universe will be topics of discussion. PREREQUISITES: PH3152 and PH3352.

PH4661 PLASMA PHYSICS I (4 - 0).
Introduction to plasma physics; single particle dynamics (orbit theory), MHD fluid theory, electromagnetic waves, instability, diffusion, and breakdown in gases. PREREQUISITE: PH3352 or equivalent.

PH4662 PLASMA PHYSICS II (3 - 0).
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. PREREQUISITE: PH4661 or consent of instructor.

PH4750 SOLIDS AND RADIATION EFFECTS (4 - 0).
An introduction to solid state physics and radiation effects. Free electron theory, bands, semiconductors, and lattice structure are discussed. Radiation damage mechanisms, TREE, and hardening concepts are introduced. PREREQUISITE: PH4760.

PH4760 SOLID STATE PHYSICS (4 - 0).
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. PREREQUISITE: PH3653.

PH4771 STATISTICAL PHYSICS (3 - 0).
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. PREREQUISITE: PH3782.

PH4856 PHYSICS OF NUCLEAR WEAPONS (4 - 0).
This second course in the nuclear weapons effects graduate specialization sequence considers in-depth questions of weapon designs and their specific output environments which are created by the nuclear explosion. Topics are: principles affecting weapon yield efficiency; explosion phenomenology in various ambient environments, blast and shock, thermal radiation, X-rays and gamma rays, neutron fluxes, electromagnetic pulse, radioactive fallout models. PREREQUISITES: PH3855 and SECRET clearance.

PH4857 PHYSICS OF HIGH VELOCITY IMPACT PHENOMENA IN SOLIDS (4 - 0).
This course is designed for students of the Combat System Sciences and Technology Curriculum taking the Weapon Effects concentration. It gives a broad overview of the impact response of materials from the linear elastic through the nonlinear plastic and hydrodynamic deformation regimes. Emphasis is on thorough coverage of fundamentals and their application to the dynamic behavior of materials subject to intense short duration loading. Topics are stress waves in solids, limitations of elementary wave theory, elastic plastic stress waves, penetration and perforation, hypervelocity impact, material behavior at high strain rates, dynamic fracture, simulation computer models of high velocity impact. PREREQUISITES: MS2201, PH3171, PH3172.

PH4858 WEAPONS LETHALITY AND SURVIVABILITY (3 - 0).
This course will cover the principles and effectiveness of advanced conventional warheads and new armor concepts for a range of military applications. Topics will include kinetic energy penetration, shaped charges, fragmentation warheads, and selected directed energy weapons applications. Advanced armor concepts will include the use of ceramics and their behavior under high velocity impact and penetration and possible armor applications to ship protection. PREREQUISITES: PH4857 and SECRET clearance.

PH4911 SIMULATION OF PHYSICAL AND WEAPON SYSTEMS (3 - 2).
The role of computation physics in modern weapons development and combat simulations. The programming language is C within the UNIX operating systems. Applications emphasize physical principles of weapons development, and the use of graphics. Subject matter includes random number distributions, projectile and fragment dispersion, free electron laser simulation, molecular dynamics in solids, liquids and gases, wave propagation in various media, and numerical integration methods. PREREQUISITES: PH2151, PH2911, and PH3352.

PH4971 QUANTUM MECHANICS I (3 - 0).
Review of Lagrange's and Hamilton's equations of motion. Poisson brackets; general principles of non-relativistic quantum mechanics; stationary states. PREREQUISITES: PH3152, PH3653.

PH4972 QUANTUM MECHANICS II (3 - 0).
Addition of angular momenta; scattering theory; additional topics of interest to students and instructor. PREREQUISITE: PH4971.

PH4973 QUANTUM MECHANICS III (3 - 0).
General principles of relativistic quantum mechanics; properties and solutions of relativistic wave equations. PREREQUISITE: PH4972.

PH4984 ADVANCED QUANTUM PHYSICS (4 - 0).
Quantum mechanics in the Dirac format. Angular momentum, spin, 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 PH3653.

PH4991 RELATIVITY AND COSMOLOGY (3 - 0).
Einstein's general theory of relativity; the three classical tests; the Schwarzchild singularity and black holes; cosmological models and their relations with observations; introduction to modern developments; gravitational waves, problems of quantum cosmology and superspace. PREREQUISITE: PH4371.

PH4998 SPECIAL TOPICS IN ADVANCED PHYSICS (Variable hours 1-0 to 4-0.) (V - 0).
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.

SE2012 APPLIED PHYSICS LABORATORY I: FUNDAMENTALS (3 - 3).
An introduction to the analysis of experimental data and signals in the applied physics laboratory. Experimental uncertainties and error propagation in physical measurements; statistical mean and standard deviation; Gauss, Poisson, and binomial probability distributions, least-squares techniques; introduction to simple circuits; Ohm's and Kirchoff's laws; complex number and phasor representations of physical quantities; introduction to applied Fourier analysis. Laboratory exercises are based upon applications in mechanics, optics and signal processing. PREREQUISITES: Previous college courses in basic physics and mathematics.

SE2013 APPLIED PHYSICS LABORATORY II: ANALOG TECHNIQUES (3 - 3).
Continuation of the signal analysis and electronic circuit topics begun in SE2012, with an emphasis on analog signal processing. Op-amps and negative feedback, continued; semiconductor basics; PN junction diodes, bipolar transistors and field effect transistors; resonance; the Fourier transform as an extension of Fourier series to non-periodic signals; active filter circuits; transfer function and the Fourier analysis of filters; oscillators; amplitude, frequency and phase modulation techniques, and their applications to communications; phase-sensitive detection and the lock-in amplifier; principles of fiber optics communications. Laboratory exercises drawn from applications in electronic signal analysis, acoustics and optoelectronics. PREREQUISITE: SE2012 or equivalent.

SE2014 APPLIED PHYSICS LABORATORY III (3 - 3).
This course is the third in the applied physics laboratory sequence. It covers four technological areas of importance in applied physics: (1) An overview of physical mechanisms that commonly promote faulty performance and/or outright failure of electronic devices. (2) Applications of digital devices, D/A and A/D conversion, with emphasis on hands-on learning. Specific topics include: Boolean algebra and combinational logic, TTL and CMOS logic families, basic gates, flip-flops, latches, counters, shift registers, binary arithmetic devices, hybrid and data conversion devices. (3) Device-to-device and device-to-computer data communications and interfacing. Topics covered are: applications of A/D and D/A conversion, hardware interfacing fundamentals, basic microprocessor architecture and programming, and serial and parallel data communications. (4) A fusion of the earlier topics, involving a project that the student interface a working sensor system to a microcomputer, etc. PREREQUISITE: SE2013 or equivalent.

SE2020 COMBAT SYSTEMS REQUIREMENTS AND DESIGN (1 - 0).
This course develops the requirements for and investigates the conceptual system design for combat systems of contemporary interest. The operational problem selected for detailed definition and solution are at the limits of today's technology and operational arts. Examples include defense against tactical ballistic missiles, zero-collateral-damage counter-battery combat systems, and shallow water antisubmarine and mine warfare robot based systems. The system project is introduced in the first quarter of the student's curriculum. Subsequent quarters involve seminars, guest lectures, and discrete problems and subprojects integrated into the courses of the curriculum. The project is brought to completion in a systems integration course (SE4021) taught in the third quarter before graduation. PRE-REQUISITE: Enrollment in the Combat Systems Sciences and Technology Curriculum or consent of the instructor.

SE3015 APPLIED PHYSICS LABORATORY IV: SYSTEMS CONTROL (2 - 3).
This course applies the concepts of the Applied Physics I-III sequence to digital data acquisition and control systems. The course covers microprocessor architectures and digital communications using serial, RS-232, parallel, IEEE-488 interfaces, as well as digital and analog interfacing. Two key areas involve the use of small computers for the control of, and data acquisition from peripheral devices and the use of electro-mechanical servo systems for closed-loop feedback control of mechanical devices, such as positioning, pointing and tracking systems. PREREQUISITE: SE2014.

SE3301 RADIATING SYSTEMS (4 - 0).
This course for students of Operations Research and other weapon system oriented non-engineering curricula discusses the physical principles exploited by information gathering systems with emphasis on general capabilities and limitations. After a general introduction to wave propagation, topics of discussion are electromagnetic waves, radar, electro-optics including lasers and underwater sound. These topics will be applied to specific systems such as missile guidance, sonobouys, and phased arrays as appropriate to the class and instructor. PREREQUISITES: MA1118 or equivalent may be taken concurrently, or by consent of instructor.

SE4006 TECHNICAL ASSESSMENT OF WEAPON SYSTEMS (4 - 0).
This course is designed to support the Intelligence Curriculum. Current technical trends in weapon system technologies which are expected to significantly affect warfare are investigated. Topics covered are: nuclear weapons and their effects, nuclear strategic balance, satellite orbits, directed energy weapon concepts (SDI), future weapon concepts. PREREQUISITES: SE3301 or equivalent, and SECRET clearance.

SE4021 COMBAT SYSTEM PROJECT INTEGRATION (4 - 0).
This course, a continuation of SE2020, integrates the results of the subsystem studies begun in SE2020 into the design of a combat system that solves an operational problem. (See SE2020 for the types of problems studied.) The resulting solution will address the threat and operational environment; the assignment of tasks to system components; the performance of the system in terms of its coverage, fire power, reaction time, and response to counter measures; and costs. The results are presented to an experienced external review group. PREREQUISITES: SE2020 or consent of the instructor. SECRET clearance required.

SE4858 NUCLEAR WARFARE ANALYSIS (4 - 0).
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. PRE-REQUISITES: PH3171, PH4856, and SECRET clearance.

SE4859 TECHNICAL ASPECTS OF WEAPON PROLIFERATION, CONTROL AND DISPOSAL (3 - 0).
This course is designed for students of the Combat Systems Sciences and Technology Curriculum taking the Weapon Effects concentration. The 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. PREREQUISITE: Consent of instructor.

SPACE SYSTEMS ACADEMIC GROUP

Chairman:
Rudolf Panholzer
Professor
Code SP, Bullard Hall
Room 205
(408) 656-2278
DSN 878-2278

The Space Systems Academic Group is an interdisciplinary association of faculty, representing eight separate academic disciplines. The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and the Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the following academic departments: Aeronautics and Astronautics, Electrical and Computer Engineering, Mathematics, Meteorology, Oceanography, Operations Research, Physics and Systems Management. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the group Chairman in addition to the academic department granting the degree (if any).

GROUP FACILITIES
To provide laboratory experience several facilities have been developed in cooperation with other academic departments.

1) Solar Simulation Facility
2) Flash X-Ray Facility
3) Electron Linear Accelerator
4) Navigational Satellite Receiver Laboratory
5) Small Satellite Test and Development Laboratory
6) Vibro-Acoustic Test and Measurement Facility
7) FLTSATCOM Laboratory
8) Special Compartmented Information Facility for Classified Research and Theses Work.
9) Spacecraft Testing Laboratory
10) Spacecraft Attitude Dynamics and Control Laboratory

DEGREE REQUIREMENTS
The Space Systems Engineering students earn a master's degree in one of the following academic departments: Aeronautics and Astronautics, Computer Science, Electrical and Computer Engineering, Mechanical Engineering, Physics or Mathematics. Refer to degree requirements for the listed departments.

The Space Systems Operations students are awarded the degree Master of Science in Space Systems Operations. 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. There is also a requirement of three courses constituting advanced study in an area of specialization and a six week experience tour. Each student is required to write a thesis which is space oriented. The study program must be approved by the Chairman of the Space Systems Academic Group.

SPACE SYSTEMS COURSE DESCRIPTIONS

SS0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research enrolls in this course.

SS2041 INTRODUCTION TO SPACE (4 - 1).
Introduction to space mission analysis and the missions that can be performed from space with emphasis on those providing support to the military. Topics usually covered are include: The process of space mission analysis and design, orbital mechanics, space policy and organization, space environment, reliable systems, and the space mission.

SS3001 MILITARY APPLICATIONS OF SPACE (3 - 2).
Examination of the military functions which utilize space systems and the capabilities of current and future space systems with tactical or strategic applications. Tasking and use of space systems and ground support elements. Vulnerability considerations. Impact of current R&D programs. PREREQUISITES: Orbital mechanics, Fourier analysis, and TOP SECRET clearance with eligibility for SI/SAO, U.S. citizenship.

SS3035 MICROPROCESSORS FOR SPACE APPLICATIONS (3 - 2).
An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, I/O systems and interfacing, and operating systems. PREREQUISITE: EC2820.

SS3041 SPACE SYSTEMS AND OPERATIONS I (4 - 2).
Space systems mission analysis and design. Mission characterization, mission evaluation, requirements determination, cost analysis and estimating, cost and operational effectiveness analysis. PREREQUISITES: OS3604, SS2041; OS3008 (taken concurrently), SECRET clearance.

SS3051 SPACE SYSTEMS AND OPERATIONS II (Accelerated) (4 - 0).
Space systems mission analysis and design. Space systems concepts of operation and architectures. Information warfare and its relation to space systems. The role of space in command and control. Space history and space policy. PREREQUISITES: SS3041 and TOP SECRET clearance with eligibility for SI/SAO.

SS3525 AIR/OCEAN REMOTE SENSING FOR INTERDISCIPLINARY CURRICULA (3 - 2).
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.

SS3900 SPECIAL TOPICS IN SPACE SYSTEMS (Variable hours 1-0 to 5-0.) (V - 0).
Directed study either experimental or theoretical in nature. PREREQUISITE: 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.

SS4000 SPACE SYSTEMS SEMINARS AND FIELD TRIPS (0 - 1).
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.

SS4003 SPACECRAFT DESIGN STUDIES (Graded Pass/Fail) (0 - 1).
Students registered for SS4003 are typically those whose thesis is on some element of the PANSAT project. In SS4003 the systems-level aspect of the design is discussed. The format is a combination of oral presentation and discussion. The purpose of this class is to give students an appreciation of the "big picture" and to demonstrate how individual research efforts fit into the "grand scheme of things." The concurrent engineering design approach makes this class a simulation of design meetings held in a typical industrial environment. Faculty, SSAG engineering staff and students participate in the weekly meetings. PREREQUISITE: None.

SS4041 MILITARY SPACE SYSTEMS AND TECHNOLOGY I (3 - 2).
Space systems and technologies of interest to the military. Strategic and tactical imagery and SIGINT requirements. Space mission design to satisfy requirements. National systems, navigation systems, weather and communication systems. Geolocation techniques. Examples of space support to military operations. PREREQUISITES: SS3041 and SS3051 concurrent. TOP SECRET clearance with eligibility for SI/SAO.

SS4051 MILITARY SPACE SYSTEMS AND TECHNOLOGY II (3 - 2).
Space systems and technologies of interest to the military. SIGINT and imagery technologies. Geolocation techniques, payload design. Space control, theater ballistic missile defense. Launch vehicles. PREREQUISITES: SS3051 and SS4041. TOP SECRET clearance with eligibility for SI/SAO.

SS4900 ADVANCED STUDY IN SPACE SYSTEMS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study based on journal literature, experimental projects, or other sources. PREREQUISITE: 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.

SPECIAL OPERATIONS CURRICULUM COMMITTEE

Chairman:
Maurice D. Weir
Professor, Associate Provost for Instruction
CODE 01B, Root Hall
Room 100
(408)656-3059

The academic aspects of the Special Operations Curriculum are the responsibility of the Special Operations Curriculum Committee. This committee is composed of representatives from the Departments of C4I, Information Warfare, Mathematics, National Security Affairs, Operations Analysis, Systems Management, and the Institute for Joint Warfare Analysis.

MASTER OF SCIENCE IN DEFENSE ANALYSIS

The degree Master of Science in Defense Analysis will be awarded in accordance with the following degree requirements:

1) 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 three courses.

2) In addition to the 45 hours of course credit, an acceptable thesis must be completed.

3) The program must be approved by the Chair of the Special Operations Curriculum Committee and the Academic Associate for Special Operations.

The Master of Science in Defense Analysis is currently offered with the following specialties:
　　　Defense Analysis (Irregular Warfare)
　　　Defense Analysis (Operations Analysis)
　　　Defense Analysis (C4I: Command and Control)
　　　Defense Analysis (C4I: Communications)
　　　Defense Analysis (National Security Affairs)
　　　Defense Analysis (Financial Management)
　　　Defense Analysis (Aeronautics and Astronautics)

Associated Faculty and Departments:

John Arquilla (Information Warfare)
Dan Boger (Command, Control and Communications)
Carlos Borges (Mathematics)
Jan Breemer (National Security Affairs)
George Conner (Operations Research)
Greg Hildebrandt, (Systems Management)
Wayne Hughes, Jr. (Operations Research)
Eric Jansen (Systems Management)
Roman Laba (National Security Affairs)
Bard Mansager (Mathematics)
Xavier Maruyama (Physics)
Gordon H. McCormick (Command, Control and Communications)
Doug Moses (Systems Management)
Guillermo Owen (Mathematics)
Glenn Robinson (National Security Affairs)

Academic Associate:
Gordon McCormick
Associate Professor
Code CC/Mc, Root Hall, Room 207
(408) 656-2933, DSN 878-2933

SPECIAL OPERATIONS COURSE DESCRIPTIONS

SO2410 MODELLING FOR SPECIAL OPERATIONS I (4 - 0).

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 MINITAB statistical package. PREREQUISITE: College algebra.

SO3101 WARFARE IN THE INFORMATION AGE (4 - 0).

Given that the emerging information 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 upon information technologies, the principal 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, non-linear military operations, and the further blurring of the line between war and peace are examined. PREREQUISITE: None.

SO3102 PSYCHOLOGICAL OPERATIONS AND DECEPTION (4 - 0).

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 the students working in teams during this portion of the course. PREREQUISITE: None.

SO3410 MODELING FOR SPECIAL OPERATIONS II (4 - 0).

This course continues the mathematical modeling process and concepts introduced in SO2410. Whereas the first course treated deterministic models, the present course focuses on simulation models. The student learns how to replicate real world behaviors with a computer, and how to analyze data generated by a computer simulation, using probabilistic and statistical ideas in conjunction with the MINITAB statistical package. Applications include an introduction to high resolution combat models and their role in analyzing strategies for the Joint Special Operations Forces. A brief introduction to decision modeling includes decision making under both risk and uncertainty. PREREQUISITE: SO2410.

SO3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4 - 0).

This course provides an overview of insurgency and counter-insurgency. 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," 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).

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.

SO3802 SEMINAR IN GUERRILLA WARFARE (4 - 0).

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 sub-state 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.

SO3880 HISTORY OF SPECIAL OPERATIONS (4 - 0).

This course considers special operations in an historical context, with emphasis given to their impact upon war outcomes, the necessary conditions for their success, and the patterns of civil-military relations that emerge when elite forces are formed. Comparative analysis of a variety of national traditions in special operations and irregular warfare is undertaken, including the study of U.S., British, French, German, Russian and Israeli approaches to special operations. PREREQUISITE: None.

SO3882 DETERRENCE, COMPELLANCE, AND CRISIS MANAGEMENT (4 - 0).
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.

SO3900 DIRECTED STUDIES IN SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT (4 - 0).
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. PREREQUISITE: Permission of instructor.

SO4410 MODELS OF CONFLICT (4 - 0).
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.

SO4500 SPECIAL TOPICS IN SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT (4 - 0).
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. PREREQUISITES: SO3801 and SO3802 or permission of instructor.

SO4830 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: MIDDLE EAST (4 - 0).
As a part of the regional seminar series, this course examines low intensity conflict issues in the Middle East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Middle East-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Middle East. PREREQUISITE: None.

SO4840 REGIONAL SEMINAR IN LOW INTENSITY CONFLICT: EUROPE AND THE TRANSCAUCASUS (4 - 0).
Employing international relations theory (both systemic and unit-level perspectives), this course will examine the causes of ethnic/national conflicts such as those taking place today in the former Yugoslavia and the former Soviet Union. The historic background of these conflicts will be described. The course also will examine how the conflicts in the Balkans and Chechnya have been conducted militarily. After discussing the possible international consequences of these conflicts (geopolitical spill-over, refugee flows), the efficacy of outside politico-military intervention in conflicts of this type will be examined. PREREQUISITE: SO3802 or permission of instructor.

SO4850 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: LATIN AMERICA (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in Latin America. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Latin America. PREREQUISITE: None.

SO4860 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: FAR-EAST (4 - 0).
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.

SO4900 ADVANCED DIRECTED STUDIES IN SPECIAL OPERATIONS LOW INTENSITY CONFLICT (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. PREREQUISITE: SO3802 or permission of instructor.

DEPARTMENT OF SYSTEMS MANAGEMENT

Chair:

Reuben T. Harris
Professor
Code SM/Hr, Ingersoll Hall
Room 231
(408) 656-2161
DSN 878-2161

Associate Chairs:

Instruction
Gail Fann Thomas
Associate Professor
Code SM/Fa, Ingersoll Hall
Room 331-B
(408) 656-2756
DSN 878-2756

Research
Mark J. Eitelberg
Associate Professor
Code SM/Eb, Ingersoll Hall
Room 305
(408) 656-3160
DSN 878-3160

Systems Development
Shu S. Liao
Professor
Code SM/Lc, Ingersoll Hall
Room 321
(408) 656-2505
DSN 878-2505

Tarek Abdel-Hamid, Professor of Management Information Systems (1986)*; PhD, Massachusetts Institute of Technology, 1984.

Frank J. Barrett, Associate Professor of Organization and Management (1990); PhD, Case Western Reserve University, 1989.

Bob Barrios-Choplin, Visiting Assistant Professor of Management (1993); PhD, University of Texas, Austin, 1990.

Hemant K. Bhargava, Associate Professor of Information Technology (1989); PhD, University of Pennsylvania, 1989.

Dan C. Boger, Chair for Command, Control and Communications Academic Group and Professor of Economics (1979); PhD, University of California at Berkeley, 1979.

Michael W. Boudreau, COL (Ret.) U.S. Army, Senior Lecturer in Acquisition and Logistics (1995); MBA, Santa Clara University, 1966.

Terrance C. Brady, LTC, U.S. Marine Corps, Lecturer, (1997); MS, Naval Postgraduate School, 1991.

Douglas Brinkley, LCDR, U.S. Navy, Lecturer in Information Systems; MS, Naval Postgraduate School, 1990.

David G. Brown, Visiting Assistant Professor of Transportation and Logistics (1991); PhD, University of Illinois at Urbana-Champaign, 1988.

Rex A. Buddenberg, Lecturer in Information Systems (1993); MS, Naval Postgraduate School, 1986.

Tung X. Bui, Professor of Management Information Systems (1984); PhD, New York University, 1984.

Paul M. Carrick, Associate Professor of Economics, Emeritus (1969); PhD, University of California at Berkeley, 1956.

Michael D. Cook, Visiting Assistant Professor of Economics (1995); PhD, University of Maryland, 1995.

Alice Crawford, Senior Lecturer in Psychology (1988); MA, San Diego State University, 1973.

Jeffrey Cuskey, CDR, SC, U.S. Navy, Lecturer (1997); MS, Naval Postgraduate School, 1993.

Sandra M. Desbrow, Assistant Professor of Contract Management (1994); LLM, Georgetown University, 1990.

Daniel R. Dolk, Professor of Management Information Systems (1982); PhD, University of Arizona, 1982.

Julie A. Dougherty, Lecturer in Manpower Analysis (1994); MS, Naval Postgraduate School, 1991.

Richard B. Doyle, Associate Professor of Public Budgeting (1990); PhD, University of Washington, 1984.

Donald R. Eaton, RADM (Ret.), U.S. Navy, Logistics Chair and Senior Lecturer in Logistics (1994); MS, George Washington University, 1980.

Leroy E. Edwards, Visiting Assistant Professor of Organization and Management (1993); EdD, University of San Francisco, 1989.

Mark J. Eitelberg, Associate Chair for Research and Associate Professor of Public Administration (1982); PhD, New York University, 1979.

Richard S. Elster, Provost and Professor of Systems Management (1969); PhD, University of Minnesota, 1967.

James C. Emery, Associate Provost for Computer and Information Services and Professor of Management Information Systems (1993); PhD, Massachusetts Institute of Technology, 1965.

Kenneth J. Euske, Professor of Accounting (1978); PhD, Arizona State University, 1978.

Roger D. Evered, Professor of Management (1979); PhD, University of California at Los Angeles, 1973.

Jane N. Feitler, Visiting Assistant Professor of Logistics and Transportation Management (1995); PhD, University of Maryland, 1995.

Paul J. Fields, Assistant Professor of Operations Management and Logistics (1993); PhD, Pennsylvania State University, 1992.

James M. Fremgen, Professor of Accounting (1965); DBA, Indiana University, 1961.

Dana P. French, CAPT (Ret.), U.S. Navy, Senior Lecturer in Management (1997); MS, Naval Postgraduate School, 1975.

Barry A. Frew, Associate Professor of Information Systems (1984); MS, Naval Postgraduate School, 1984.

William R. Gates, Associate Professor of Economics (1988); PhD, Yale University, 1984.

Kevin R. Gue, Visiting Assistant Professor of Logistics Management (1995); PhD, Georgia Institute of Technology, 1995.

William J. Haga, Senior Lecturer in Management Information Systems (1988); PhD, University of Illinois, 1972.

Reuben T. Harris, Chairman of Systems Management and Professor of Management (1978); PhD, Stanford University, 1975.

David R. Henderson, Associate Professor of Economics (1984); PhD, University of California at Los Angeles, 1976.

Gregory G. Hildebrandt, Visiting Associate Professor of Economics (1989); PhD, Princeton University, 1976.

Susan P. Hocevar, Assistant Professor of Organization and Management (1990); PhD, University of Southern California, 1989.

Fenn C. Horton, Associate Professor of Economics, Emeritus (1964); PhD, Claremont Graduate School, 1968.

Erik Jansen, Visiting Associate Professor of Organization and Management (1994); PhD, University of Southern California, 1987.

David E. Johnson, Senior Lecturer in Ethics (1997); PhD, University of Iowa, 1965.

Carl R. Jones, Professor of Information and Telecommunications Systems (1965); PhD, Claremont Graduate School, 1965.

Lawrence R. Jones, Professor of Financial Management (1987); PhD, University of California at Berkeley, 1977.

Magdi N. Kamel, Associate Professor of Management Information Systems (1988); PhD, University of Pennsylvania, 1988.

Keebom Kang, Associate Professor of Logistics (1988); PhD, Purdue University, 1984.

James Kerber, CDR, U.S. Navy, Lecturer (1995); MS, Naval Postgraduate School, 1990.

Rakesh Lall, LT, MSC, U.S. Navy, Lecturer in Psychology (1997); PhD, Pacific Graduate School, 1994.

Steve Lamar, CAPT (Ret.), U.S. Navy, Senior Lecturer in Health Care Management (1995); PhD, Case Western Reserve University, 1982.

David V. Lamm, Associate Professor of Acquisition and Contract Management (1978); DBA, The George Washington University, 1976.

Shu S. Liao, Associate Chair for Systems Development and Professor of Accounting (1977); PhD, University of Illinois, 1971.

David F. Matthews, COL (Ret.), U.S. Army, Senior Lecturer in Acquisition Management (1994); MA, Middle Tennessee State University, 1974.

Jerry L. McCaffery, Professor of Public Budgeting (1984); PhD, University of Wisconsin, 1972.

Alan W. McMasters, Professor of Operations Research and Systems Management, Emeritus (1965); PhD, University of California at Berkeley, 1966.

Stephen L. Mehay, Professor of Labor Economics (1985); PhD, University of California at Los Angeles, 1973.

Janice M. Menker, Lecturer in Acquisition and Contract Management (1996); MEM, George Washington University, 1992.

O. Douglas Moses, Associate Professor of Accounting (1985); PhD, University of California at Los Angeles, 1983.

John E. Mutty, CAPT (Ret.), U.S. Navy, Conrad Chair and Senior Lecturer in Financial Management (1995); MS, George Washington University, 1976.

Brad Naegle, LTC, U.S. Army, Lecturer (1997); MS, Naval Postgraduate School, 1994.

Mark Nissen, Assistant Professor in Acquisition Management and Information Systems (1996); PhD, University of Southern California, 1996.

Walter E. Owen, Lecturer in Acquisition Management (1992); MS, Naval Postgraduate School, 1992.

Barbara E. Pawlowski, LtCol, USAF, Lecturer in Acquisition and Logistics Management (1995); MS, University of Southern California, 1981.

Bruce Pawlowski, Research Associate in Installation Management (1996); MPA, Texas Christian University, 1975.

Philip Quast, VADM (Ret.), U.S. Navy, Boorda Chair of Management and Analysis and Senior Lecturer (1997); Marymount College, 1984.

Benjamin J. Roberts, Adjunct Research Associate of Management and Human Resource Development (1985); PhD, Pennsylvania State University, 1977.

Nancy C. Roberts, Professor of Strategic Management (1986); PhD, Stanford University, 1983.

Joseph G. San Miguel, Professor of Accounting (1982); PhD, University of Texas, 1972.

Norman F. Schneidewind, Professor of Information Sciences (1971); DBA, University of Southern California, 1966.

Kishore C. Sengupta, Associate Professor of Management Information Systems (1989); PhD, Case Western Reserve University, 1990.

Cary A. Simon, LCDR, U.S. Navy, Lecturer in Manpower Systems Analysis (1997); MS, Naval Postgraduate School, 1996.

David A. Smith, LCDR, SC, U.S. Navy, Lecturer in Acquisition and Contracting (1996); MS, Naval Postgraduate School, 1990.

Keith F. Snider, Assistant Professor of Management (1993); PhD, Virginia Institute of Technology, 1997.

Suresh Sridhar, Assistant Professor in Information Systems (1994); PhD, Vanderbilt University, 1996.

Mark W. Stone, Assistant Professor of Acquisition and Contracting (1993); JD, Santa Clara University, 1988.

James E. Suchan, Associate Professor of Managerial Communications (1986); PhD, University of Illinois, 1980.

Katsuaki Terasawa, Associate Professor of Economics and Policy Analysis (1989); PhD, University of Kansas, 1971.

Gail Fann Thomas, Associate Chair for Instruction and Associate Professor of Management Communications (1989); EdD, Arizona State University, 1986.

George W. Thomas, Professor of Economics (1978); PhD, Purdue University, 1971.

Kenneth W. Thomas, Professor of Management (1987); PhD, Purdue University, 1971.

Greg Walls, LTC, U.S. Army, Lecturer in Acquisition Management (1996); MS, Air Force Institute of Technology, 1989.

Ronald A. Weitzman, Associate Professor of Psychology (1971); PhD, Princeton University, 1959.

David R. Whipple, Jr., Associate Provost for Innovation and Professor of Economics and Policy Analysis (1971); PhD, University of Kansas, 1971.

Leslie J. Zambo, Visiting Associate Professor of Financial Management (1986); PhD, University of Texas, 1981.

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

The Department of Systems Management has primary responsibility for four academic programs and awards four graduate degrees. The largest program is a group of curricula in Systems Management. These curricula include Acquisition and Contract Management, Systems Acquisition Management, Financial Management, Manpower Systems Analysis, Material Logistics Support Management, Systems Inventory Management, Transportation Logistics Management and Transportation Management. Graduates of these curricula are awarded the degree Master of Science in Management. This degree is accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

The other three programs for which the department is responsible are the Information Technology Management curriculum, whose graduates receive the degree Master of Science in Information Technology Management; and the Resource Planning and Management for International Defense (REPMID) curriculum; and the Leadership Education and Development (LEAD) curriculum. The REPMID program, designed for students from allied countries, is jointly offered by the Systems Management and National Security Affairs departments. Its graduates receive the degree Master of Science in International Resource Planning and Management. Graduates from the LEAD program receive a Masters of Science degree in Human Resource Development. This latter program is currently taught at the U.S. Naval Academy in Annapolis.

MASTER OF SCIENCE IN MANAGEMENT
The degree Master of Science in Management 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) 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 Chair, Department of Systems Management.

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT
The degree of Master of Science in Information Technology Management requires:

1) Completion or validation of core courses in each of the following disciplines:

   Information Systems
   Computer Science
   Electrical and Computer Engineering
   Systems Management

2) Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.

3) Completion of an acceptable thesis

4) Approval of the candidate's program by the Chair, Department of Systems Management.

MASTER OF SCIENCE IN INTERNATIONAL RESOURCE PLANNING AND MANAGEMENT
The degree Master of Science in International Resource Planning and Management requires:

1) Completion or validation of a minimum of credit hours, as indicated, in the following disciplines:

   Accounting, Financial Management, and Economics   24
   Organization and Management   20
   Domestic and International Policy Studies   24

2) 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 acceptable thesis, with at least one advisor from either the Department of Systems Management, or the Department of National Security Affairs.

4) Approval of the candidate's program by the Chair, Department of Systems Management or the Chair, Department of National Security Affairs.

MASTER OF SCIENCE IN HUMAN RESOURCE DEVELOPMENT
For further information on requirements for the degree of Master of Science in Human Resource Development, contact:

Academic Associate, LEAD Program
Department of Systems Management
555 Dyer Road, Bldg 330, Rm 231
Naval Postgraduate School
Monterey, CA 93943

SYSTEMS MANAGEMENT COURSE DESCRIPTIONS

AS3610 MICROECONOMICS FOR OPERATIONS RESEARCH (4 - 0).
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. PREREQUISITES: MA3110 and OA3201.

AS4613 THEORY AND PRACTICE OF SYSTEMS ANALYSIS (4 - 0).
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. No commercial text is available, therefore readings are based upon an NPS-developed package. PREREQUISITE: AS3610.

IS0001 SEMINAR FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (NO CREDIT) (0 - 2).
Guest lectures. Thesis and research presentations.

IS0123 COMPUTER SKILLS DEVELOPMENT I (NO CREDIT) (Accelerated first 6 weeks of quarter.) (0 - 2).
An introduction to the use and operation of microcomputers with emphasis on hardware basics, the operating system, and word processing. Emphasis on applications in systems management. Graded on Pass/Fail only.

IS0810 THESIS RESEARCH FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (0 - 8).
Every student conducting thesis research will enroll in this course.

IS2000 INTRODUCTION TO INFORMATION TECHNOLOGY MANAGEMENT (3 - 1).
Provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager.

IS3000 DISTRIBUTED COMPUTER SYSTEMS (4 - 1).
The technology, application and management of distributed computer systems. Specific topics include distributed processing, distributed data base management, communication facilities and protocols, economic and performance analysis, and managerial and organizational problems. PREREQUISITES: CS2970, CS3030, and IS3171.

IS3020 SOFTWARE DESIGN (3 - 2).
The use of structured techniques in the design and implementation of software. Topics covered include selection of programming languages, design of modules and module interfaces, testing, and program documentation techniques. Use of software metrics for determining program size, complexity and quality. PREREQUISITES: CS2970, IS2000.

IS3100 ANALYSIS OF MICROCOMPUTERS AND MICROPROCESSORS (3 - 2).
A comparative analysis of popular microcomputers-hardware and software. Analyses will be made of the following elements: microcomputer architecture; microprocessors; bus systems; operating systems and applications. Comparisons will be made both within a vendor's product line and between vendors, with respect to characteristics, strengths, limitations applications and costs. Student written and oral reports on comparative analysis. Some assembly language will be required. PREREQUISITES: CS2970, CS3030, and IS2000.

IS3112 INFORMATION TECHNOLOGY MANAGEMENT IN DOD (4 - 1).
Consideration of DoD information technology systems and their management development of a framework for understanding and managing systems based on the Technical Architecture Framework In Information Management (TAFIM). Command and control. Command and control warfare. PREREQUISITES: SECRET clearance and fifth quarter standing in the ITM curriculum.

IS3170 ECONOMIC EVALUATION OF INFORMATION SYSTEMS I (4 - 0).
Microeconomics concepts, including demand and supply, cost, competition, interest rates, present values, decision analysis and asymmetric information. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, the value of information, problem solving and strategic thinking. Defense information systems applications are stressed. PREREQUISITES: MN2155, MA1117.

IS3171 ECONOMIC EVALUATION OF INFORMATION SYSTEMS II (4 - 1).
A major challenge to DoD information technology managers is assessing the payoff from the investment in information systems. Continuation of IS3170 focusing on the study of cost benefit (effectiveness) analysis and techniques for evaluating investments in information technology and managing information. PREREQUISITES: IS3170, MN2155, and OS3105.

IS3181 INTEGRATING AND LEVERAGING INFORMATION TECHNOLOGIES (3 - 0).
The attributes of information technology are studied in conjunction with the management aspects of developing and maintaining systems in support for DoN and the Joint Services. This course is heavily project and case study oriented. Mini-cases force the student to apply theory from reading to realistic DoN settings. These case studies will force tradeoff, resource allocation decisions, development of strategy for specific problems, etc. PREREQUISITE: MN0123.

IS3183 MANAGEMENT OF INFORMATION TECHNOLOGY (4 - 0).
A survey study of what constitutes information technology and the management aspects of developing and maintaining systems in support of the Department of Defense and Joint Services. Technology aspects of hardware, operating system software, application software languages, database management, telecommunications and networking, system development processes, system integration, end-user computing, IT acquisition, IT organization and staffing issues, information privacy and security issues, and IT planning and strategies form the basis for management discussions. The course considers the IT management challenge: (1) Young technology, (2) Sustained and dramatic growth, (3) Growing complexity, (4) A number of fragmented sub-specialties (5) Downsizing and Re-engineering emphasis shifts the focus of applications being developed from transaction based systems to decision based systems. Issues are discussed from the perspective of the user of information systems and not that of the technologist. PREREQUISITES: MN3105 and IS0123.

IS3502 COMPUTER NETWORKS: WIDE AREA/LOCAL AREA (3 - 2).
Architecture, standard protocols, and technological advances in computer networks, with an emphasis on internet working and interoperability. Specific topics include open network architectures (OSI vs. DoD architecture), X.25, local area networks, TCP/IP, and a variety of distributed application services built on the client-server model. Students also gain an understanding of DDN (Defense Data Network), X.400-based DMS (Defense Message System), SDNS (Secure Data Network Service), and GOSIP (Government Open System Interconnection Profile). PREREQUISITES: CS2970, CS3030, IS2000, and OS3004.

IS3503 MICROCOMPUTER NETWORKS (3 - 2).
Theory, application, and operation of microcomputer networks. Students learn, evaluate, compare, and operate several contemporary microcomputer networks, such as IBM PC Net, IBM Token-Ring, Apple Computer Apple-Talk, 3 Comm Ethernet, mainframe emulations, and LAN internets. Students perform a variety of hands-on lab experiments on the SM department LANs to prepare them for future LAN management billets. The IEEE Local Area Network Standards will be addressed. PREREQUISITE: IS3502.

IS3504 MODERN NETWORK OPERATIONING SYSTEMS: PLANNING, TECHNOLOGY AND OPERATIONS (2 - 2).
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, multi-level network security procedures and global file server synchronization processes. PREREQUISITE: Computer Networks: Wide Area/Local Area (IS3502). Security Classification: None.

IS4182 INFORMATION SYSTEMS MANAGEMENT (4 - 0).
Capstone course for the ITM curriculum. Based on information technology playing a vital role throughout the Department of Defense. Broad range of management, economic, behavioral, and technical matters associated with the development and operation of effective information systems. Its primary focus is on the strategic and policy issues facing DoD management. Topics covered include IS functions and operations, systems development methodologies, the IS infrastructure and architecture, IS planning, process reengineering, and technology assessment. PREREQUISITE: Status as student in the final quarter of the ITM curriculum.

IS4183 APPLICATIONS OF DATABASE MANAGEMENT SYSTEMS (4 - 1).
Applications-oriented introduction to database management systems technology. Survey of current database systems and approaches to database technology. Technical and administrative considerations involved in a database design and implementation project are considered. Students will be expected to design and implement an applications system using a database management package. PREREQUISITES: CS2970, CS3030, OS3004. IS4200 taken concurrently.

IS4184 INFORMATION RESOURCE MANAGEMENT IN DON/DOD (4 - 0).
This course is concerned with understanding the major aspects of information resource management (IRM) and how it is conducted in DoD and DoN. Special attention will be paid to database administration and information engineering. Examples of IRM and DBA practice will be presented via case studies and by speakers with relevant expertise from the Navy, DoD, and private sector. PREREQUISITES: IS3112, IS4183, IS4200, and IS4300.

IS4185 DECISION SUPPORT SYSTEMS (4 - 1).
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. The latest computer-based systems, and exemplary applications in DoD, that support or involve the use of these formal methods are covered. Group project requiring the design and implementation of a decision support system for a specific problem. PREREQUISITES: IS2000, IS4200, IS4183, MN2155, MN3105, OS3004 and OS3105.

IS4186 KNOWLEDGE-BASED SYSTEMS AND ARTIFICIAL INTELLIGENCE (4 - 1).
Principles, applications and limitations of knowledge-based systems, including expert systems, as problem-solving tools. Fundamental techniques, commonly employed in designing such systems, from the field of artificial intelligence. Specific topics include knowledge representation, automated reasoning, inference and search techniques, knowledge acquisition, and expert systems architectures. Hands-on experimentation and implementation of prototype systems. Students are expected to have a strong foundation in mathematical and analytical techniques. PREREQUISITES: IS2000, IS3171, IS4185, OS3105.

IS4187 INFORMATION NETWORKING & DISTRIBUTED DECISION TECHNOLOGIES (3 - 2).
Information technologies used for developing specialized applications on enterprise-wide or global information networks such as the World Wide Web. Focal topics include methods and applications of information networking; distributed libraries of computational and decision technologies; and management of large-scale applications. Applications involving remote execution of interactive decision technologies and the organization of a large collection of such applications into a distributed digital library. Examines applications and their implementation using emerging technologies and development of applications that are scalable and maintainable. Other topics include architectures and protocols for information networks, client-server computing, electronic commerce, pricing of information products and security. PREREQUISITE: IS3171, IS3502, IS4185, and IS4502 taken concurrently.

IS4188 COORDINATION AND COLLABORATIVE SYSTEMS (4 - 1).
The nature of work in most task domains is collaborative. The efficacy with which groups coordinate their activities is an important determinant of collaborative work. This course examines different approaches to defining and studying coordination and the use of information technology to support coordination. Various technologies that are collectively labeled as groupware will be presented. Design principles underlying the construction of groupware will be studied, and different types of groupware will be used. Students work in teams to implement projects highlighting specific aspects of coordination. PREREQUISITE: Decision Support Systems (IS4185) or equivalent. Security classification: None.

IS4200 SYSTEM ANALYSIS AND DESIGN (4 - 2).
Computer-based system development, including the following concepts, methodologies, tools, and techniques for: information systems requirements analysis, technical and economic feasibility studies, systems costing and data communications hardware and software trade-off evaluations and specifications, conversion, and testing. PREREQUISITES: CS2970, CS3030, IS2000, IS3170, MN3105, OS3105, OS3004.

IS4300 SOFTWARE ENGINEERING AND MANAGEMENT (3 - 2).
The objective of this course is to educate the student in areas of great concern to the Department of Defense 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, IS3020, IS3171, IS4200, OS3004.

IS4320 DATABASE AND INFORMATION RESOURCE MANAGEMENT FOR C4I (4 - 1).
Applications-oriented study of information systems, with a focus on database management. Survey of current techniques for designing and implementing database and decision support applications. Specific topics include the relational data model, use of SQL (structured query language) database administration, and the role of database and decision support tools in information management in the DoD. Students implement a prototype database or decision support system focusing on a C4I application. PREREQUISITE: A software design course.

IS4502 TELECOMMUNICATIONS NETWORK (3 - 2).

Evaluation and analysis of technological advances, market dynamics, and regulatory trends in the telecommunication industry. Understanding of current and future telecommunication services, applicable standards, and underlying motivations. Topics to be covered include PSTN (Public Switched Telephone Network), Intelligent Network, T1/T3 Networking, ISDN, Broadband Switching Services, and PCS (Personal Communication Services). Understanding of the Department of Defense's new telecommunication architecture, DISN (Defense Information Systems Network), which will serve as an integrated infrastructure for the command and control functions on a global scale. PREREQUISITE: IS3502.

IS4503 INTERNET TO SEA (2 - 2).

Internet capabilities will radically change maritime military operations study of the technological issues involved in bringing Internet capabilities to the maritime environment. Technological issues include network protocols, security, and commercial infrastructure. Use of commercial capabilities for military communications. Policy and planning issues. PREREQUISITE: IS4502. Security Classification: Unclassified.

IS4601 RESEARCH METHODS FOR INFORMATION TECHNOLOGY EVALUATION (4 - 0).

This course surveys current issues and techniques in empirical assessment of the effectiveness of information systems. Topics include the logic of scientific inquiry, the current state of research information systems, the framing of research problems, the nature of measures, scale construction, sampling, hypothesis testing, measures of association, experimental designs, issues in data collection techniques, level of data, reliability and validity of measures, and research report writing. PREREQUISITE: OS3105. Security Classification: Unclassified.

IS4800 DIRECTED STUDY IN ADVANCED INFORMATION SYSTEMS (Variable hours.) (V - V).

Directed study in advanced topics in information systems of mutual interest to student and a 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.

IS4925 SEMINAR IN INFORMATION SYSTEMS (V - V).

Study of a variety of topics of current interest in information systems to be determined by the instructor. PREREQUISITES: A background of information systems and permission of the instructor.

MN0001 SEMINAR FOR SYSTEMS MANAGEMENT STUDENTS (NO CREDIT) (0 - 2).

Guests lectures. Thesis and research presentations.

MN0107 STRESS MANAGEMENT WORKSHOP (0 - 1).

A stress model is introduced that focuses on cognitive appraisals as key moderators to stress responses. The magnitude of workplace stress is discussed, as is the connection between stress and illness. Students identify stressors in their lives. Methods are introduced to help students revise their cognitive appraisals to prevent or reduce harmful stress responses. Several self-assessment instruments are taken and scored by students. Follow-on refresher training and evaluation is conducted after six months of practicing the stress reduction techniques. PREREQUISITE: Consent of Instructor.

MN0123 COMPUTER SKILLS DEVELOPMENT (0 - 1).

An introduction to the use and operation of computers with emphasis on applications in Systems Management. Hands-on practice is given with word processing, spreadsheets, databases, and electronic mail. PREREQUISITE: Consent of Instructor.

MN0163 THESIS WRITING WORKSHOP (0 - 1).

Guidelines for scientific writing for the thesis are integrated with concepts presented in MN3162, Tools for Inquiry, and MN3160, Methods of Inquiry, to further enhance student understanding of scientific reasoning and communicating the results of scientific research. Students are provided with examples and given opportunities for practice. PREREQUISITE: MN3160 and MN3162.

MN0810 THESIS RESEARCH FOR SYSTEMS MANAGEMENT STUDENTS (0 - 8).

Every student conducting thesis research will enroll in this course.

MN2031 ECONOMIC DECISION MAKING (4 - 0).

This a course in macroeconomics. It starts with a brief introduction to microeconomics—scarcity, production possibility curves, and supply and demand. It then proceeds to topics in macroeconomics: which include national income determination, inflation, unemployment, deficits, and the banking system. Also covered are the various schools of thought in macroeconomics: Keynesian, monetarist, rational expectations, and supply side. PREREQUISITE: MA2300 (taken concurrently).

MN2039 BASIC QUANTITATIVE METHODS IN ECONOMIC ANALYSIS (4 - 0).
This course simultaneously introduces economics and the mathematical basis required for advanced economic analysis. Math topics include algebra, graphs, differential calculus, including both single and multiple variable functions, and indefinite and definite integrals. Economics concepts include demand and supply, market equilibrium, marginal analysis and unconstrained and constrained optimization. PREREQUISITE: College algebra or consent of instructor.

MN2111 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES I (0 - 2).
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).
Continuation of MN2111. Graded on a Pass/Fail basis only. PREREQUISITE: Consent of Instructor.

MN2113 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES III (0 - 2).
An introduction to the training issues and technologies and their application in the military setting. Graded on a Pass/Fail basis only. PREREQUISITE: Consent of Instructor.

MN2150 FINANCIAL ACCOUNTING (4 - 0).
Study of basic accounting concepts and standards for reporting an organization's results of operations, financial position and cash flows. Specific topics include the accounting cycle, asset valuation, recording of liabilities and capital structure, and financial statement analysis. Includes discussion of the Defense Finance and Accounting Service and the Federal Accounting Standards Advisory Board.

MN2155 ACCOUNTING FOR MANAGEMENT (4 - 0).
Study of the fundamentals of financial and managerial accounting. Brief 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. (May not be substituted for MN2150 and MN3161.)

MN2302 SEMINAR FOR ACQUISITION AND CONTRACTING STUDENTS (0 - 2).
This course brings both Government and defense industry contract managers into the academic forum for interaction with students. Visits to Government facilities and defense plants. Thesis and research presentations. Preparation for Certified Professional Contracts Manager (CPCM) certificate examinations. Graded on a Pass/Fail basis.

MN2303 SEMINAR FOR PROGRAM MANAGEMENT STUDENTS (0 - 2).
This course brings both Government and defense industry acquisition/program managers into the academic forum for interaction with students. Guest lecturers include program executive officers, program managers, laboratory and field personnel, OSD officials, congressional members and staff personnel, and defense industry representatives. Visits to Government facilities and defense plants. Thesis and research presentations. Preparation for Program Manager Certification. Graded on a Pass/Fail basis.

MN3101 MODELS OF LEADERSHIP IN COMPLEX ORGANIZATIONS (2 - 0).
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).
Models of leadership are studied in depth in the context of how they have been used by notable military leaders. Historical and future perspectives for military leadership are analyzed. Emphasis is on self-assessment and self-development as well as the develop of subordinate leaders. PREREQUISITE: MN3101.

MN3103 GROUP DYNAMICS AND TEAMBUILDING (2 - 0).
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).

The major cognitive and behavioral theories of motivation are examined from the perspectives of the leader and sub-ordinates. 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.

MN3105 ORGANIZATION AND MANAGEMENT (4 - 0).

This course gives students a knowledge of key concepts from management theory, organization theory, organizational behavior and organizational development. Special emphasis is given to the ability to apply these concepts in an integrated fashion to management situations in DoD/DoN. Towards that end, the course makes extensive use of multiple theoretical frames, open-systems models, and DoD/DoN case studies.

MN3106 CONFLICT MANAGEMENT (1 - 0).

The impact of conflict in organizations is studied with emphasis on models of conflict management that offer students multiple conflict handling strategies. The relation of conflict to the leader's use of power and influence strategies is explored. An overview of negotiation literature is provided. Students practice using conflict management strategies and negotiation techniques. PREREQUISITE: MN3101.

MN3109 ETHICS AND MORAL DEVELOPMENT (3 - 0).

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. Reading, discussing, and writing about military virtues and their place in the everyday life of the officer. PREREQUISITE: Undergraduate course in Naval Leadership and admission to graduate standing. This course demands critical reasoning and systematic thinking at an advanced level.

MN3111 PERSONNEL MANAGEMENT PROCESSES (4 - 0).

A broad coverage of human behavior in the work situation, with key emphasis on the issues of work in the Naval 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: MN3105 and OS3101 (taken concurrently) or equivalent.

MN3112 COUNSELING (2 - 0).

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 to include empathy, confrontation, challenging, etc. PREREQUISITES: MN3104, MN3135 and MN3138.

MN3123 MILITARY SOCIOLOGY (4 - 0).

An exploration of classical theories of sociology pertaining to civilian-military relations with modern applications to command and control problems. Sexism, racism, family dissolution, unionization, bureaucratic inertia, career patterns, professionalism and other topics are considered from the perspective of sociology and implications for the military are examined in depth. PREREQUISITE: MN3105.

MN3129 ORGANIZATION DESIGN (2 - 0).

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).

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: MN3104.

MN3137 INSTRUCTIONAL DESIGN (1 - 0).

A study of the system approach as applied to the design, development, delivery/implementation, and evaluation of educational and training courses and programs. Navy and Marine Corps education and training practices, technologies, and infrastructures are studied. PREREQUISITE: MN3135.

MN3138 ADULT DEVELOPMENT (2 - 0).
The ways in which individuals differ in their development and the continuities seen among adults are studied. The effects those differences have on behavior is the focus of the course. Analysis of recent theory and empirical research data on adult development is conducted using an interdisciplinary perspective. Beginning with the transition to adulthood at age 18, the full range of adult years are examined with respect to physical, cognitive, social, and emotional development. The topic is grounded in implications for leading midshipmen and other officers. PREREQUISITE: MN3135.

MN3140 MICROECONOMIC THEORY (4 - 0).
This course reviews traditional microeconomics concepts, including demand, cost, perfect and imperfect competition public goods, externalities, and factor markets. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, problem solving and strategic thinking. Defense applications are stressed. PREREQUISITES: MA2300 or MN2039 and MN2031.

MN3154 FINANCIAL MANAGEMENT IN THE ARMED FORCES (4 - 0).
Focuses on financial management practices and concepts in DoD, with an emphasis on the Department of the Navy. Topics include appropriations, PPBS, budget formulation, review and execution, flow of funds, and accounting terminology and systems. Current financial management issues such as DFAS, DBOF and unit costing are reviewed. In-class exercises and case studies are used to develop the students ability to apply financial management concepts to real life situations. Guest speakers from the DoD/DoN financial management community provide up to date information and viewpoints. PREREQUISITE: MN2155 or MN3161.

MN3155 FINANCIAL MANAGEMENT FOR ACQUISITION MANAGERS (2 - 0).
This course is a study of financial management practices and issues associated with Department of Defense (DoD) acquisition programs. The course has emphasis on (1) the DoD 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 Defense procurement, and (3) cost estimation, analysis and evaluation as tools for sound acquisition management. PREREQUISITES: MN2150 or MN2155 and MN3301 or MN3221 or permission of the instructor.

MN3160 METHODS OF INQUIRY (3 - 0).
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: MN3101.

MN3161 MANAGEMENT ACCOUNTING (4 - 0).
Introduction to the concepts and systems of cost determination. Attention is placed on translating cost concepts into a military environment and relating them to the Defense Business Operations Fund, pertinent OMB Circulars and Defense Instruction on Economic Analysis. Topics covered include job costing systems, overhead accounting and allocation, standard costs for control, flexible budgeting, cost-volume-profit analysis, performance analysis, cost analysis for structured and unstructured decision-making, and long-term investment analysis. PREREQUISITE: MN2150.

MN3162 TOOLS OF INQUIRY (3 - 0).
Statistical methods used to explain and predict the organizational behavior of individuals and groups are developed. Particular emphases is given to developing skills in the use of regression analysis using PC software and applying the methods using DoD/DoN data. The methods developed in this course may be particularly helpful in thesis work. PREREQUISITES: MN3160 and MN0123.

MN3170 DOD POLICY AND RESOURCE ANALYSIS (4 - 0).
This seminar exposes students to the major elements shaping U.S. military policy foundation in the post Cold War environment. Significant problems confronting military decision-makers are reviewed and the decision-making processes and organizations used to address these problems are examined. Problems addressed include relating national security requirements to force structure, force development and management and resource allocation. PREREQUISITE: Experience as a naval or Marine Corps officer/knowledge of DoD fleet systems and admission to graduate standing.

MN3172 PUBLIC POLICY AND BUDGETING (4 - 0).
This course analyzes federal policy-making with emphasis on resource decision making for national defense. The roles of principal budget process participants are examined. Executive, especially in DoD and OMB, 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. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities.

MN3221 PRINCIPLES OF ACQUISITION AND PROGRAM MANAGEMENT I (2 - 1).

This course introduces the fundamental principles of DoD systems acquisition and program management by examining acquisition policy issues; planning, programming, and budgeting processes; acquisition strategies; contractual decisions; and program management philosophies, issues and concepts. The aspects of planning, organizing, staffing, directing and controlling within the program structure will be examined. Key functional areas are explored including; research & development, test and evaluation, contracting, funding and budgeting, integrated logistics support, systems engineering and legal issues. PREREQUISITE: None.

MN3222 PRINCIPLES OF ACQUISITION AND PROGRAM MANAGEMENT II (3 - 2).

This course broadens the student's understanding of the principles of DoD systems acquisition and program management gained in MN3221 by examining program management characteristics and competencies, control policies and techniques, systems analysis methods, and functional area concerns. Techniques for interpersonal relationships will be examined in exercise settings. The course structure concentrates on the activities occurring during the major milestones and acquisition phases including concept exploration, demonstration and validation, engineering and manufacturing and production/deployment. Cases involving key planning documents, activities and phase exit criteria are examined. PREREQUISITE: MN3221 or permission of instructor.

MN3301 SYSTEMS ACQUISITION AND PROGRAM MANAGEMENT (4 - 0).

This course provides the student with an understanding of the underlying philosophies and concepts of the defense systems acquisition process and the practical application of defense program management methods within this process. Topics include the evolution and current state of defense systems acquisition management; the defense systems acquisition cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing, and controlling. Emphasis is on major defense acquisition cases. PREREQUISITE: None.

MN3303 PRINCIPLES OF ACQUISITION AND CONTRACT MANAGEMENT (4 - 0).

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. Emphasis is on the unique aspects of defense acquisition and contracting. PREREQUISITE: None.

MN3304 CONTRACT PRICING AND NEGOTIATIONS (5 - 2).

This course involves the study and application of pricing theory and strategies, cost methods, defense cost and price analysis, cost principles, Cost Accounting Standards, and contract negotiations as used in DoD. Students develop and sharpen negotiating skills by participating in practical negotiation exercises with Defense corporations. PREREQUISITES: MN3140 and MN3303.

MN3305 CONTRACT ADMINISTRATION (3 - 0).

This course stresses the management skills and techniques necessary for the successful administration of Government prime contracts and subcontracts. Topics include the DoD structure for managing contract progress and performance, change control, quality control, cost/financial control, Government property, terminations, and regulatory and policy considerations. PREREQUISITES: MN3304 and MN3312.

MN3306 ACQUISITION MANAGEMENT (3 - 0).

This course focuses on the problem-solving and decision-making functions involved in the pre-award competitive proposal contracting phase with an emphasis on requirements determination, acquisition planning, source selection, and contract negotiation and award. Case studies and practical exercises are used to concentrate on typical problems and issues which arise in the pre-award process. Specific topics include: the acquisition process, forecasting requirements, ethics/standards of conduct, cost estimates, subcontracting, acquisition plans, contract strategies and types, specifications, statements of work, technical data, technology transfer, competition, source selection planning, market research, source selection evaluation factors, fact finding and negotiations, best and final offers and contract award and notification. PREREQUISITES: MN3304 and MN3312.

MN3307 INFORMATION TECHNOLOGY ACQUISITION (4 - 0).

This course is an introduction to the management principles, concepts, and issues involved in Federal Government acquisition of ADP requirements and Federal Information Processing (FIP) resources. The course focuses on the concepts of systems acquisition and program management, as they pertain to Government ADP/FIP acquisition and specific purchases of DoD computer hardware and software. PREREQUISITE: None.

MN3309 ACQUISITION OF EMBEDDED WEAPON SYSTEMS SOFTWARE (4 - 0).
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 defense software acquisition. Significant software acquisition issues and problems are examined and solutions developed. PREREQUISITE: MN3301 or MN3222.

MN3311 PROGRAM MANAGEMENT EXERCISE (1 - 2).
This course requires the student to contend with many of the current "real world" issues encountered during the systems acquisition life cycle through participation in the defense management simulation called Systems Acquisition For Executives (SAFE). This computer-assisted exercise requires the student to apply his/her analytical ability and knowledge to a sequence of program management decisions made during the acquisition of a hypothetical U.S. Army surface-to-surface conventional warhead tactical missile system called "Zebra". As part of a program management team, the student will experience critical decision-making under conditions of risk and uncertainty, within the constraints of performance, schedule and cost. Students will be able to demonstrate their understanding of typical engineering, budgeting and contracting trade off analysis needed throughout the acquisition cycle from concept exploration through production/deployment. Students will be required to draft and present formal issues papers. PREREQUISITE: MN3301 or MN3222 and MN3371.

MN3312 CONTRACT LAW (3 - 0).
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, 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 Armed Services Board of Contract Appeals (ASBCA) cases. PREREQUISITE: MN3303.

MN3333 MANAGERIAL COMMUNICATION SKILLS IN THE DOD ENVIRONMENT (4 - 0).
This course provides DoD and International military officers and civilians with the communication strategies and skills needed to manage and lead in the dynamic DoD environment. Instruction focuses on writing informative and persuasive documents, giving succinct, easy-to-understand briefings, managing team communication processes, developing associates' communication competencies through various feedback roles and strategies, and listening analytically and empathetically. DoD cases, scenarios, and readings are used to analyze complex communication situations unique to the military.

MN3334 MANAGERIAL COMMUNICATIONS LAB FOR INTERNATIONAL STUDENTS (0 - 1).
This lab complements MN3333 and is specifically designed to provide practice in oral and written communications for International students. It is particularly useful in helping students identify culturally specific differences in organization and style for oral and written communications. Furthermore, students receive highly individualized instruction to help them complete managerial communications assignments.

MN3371 CONTRACTS MANAGEMENT AND ADMINISTRATION (4 - 0).
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).
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 PREREQUISITES: MA2300 (or equivalent) and OS3101.

MN3373 DOMESTIC TRANSPORTATION MANAGEMENT (4 - 0).
Analysis of domestic U.S. transportation systems from a managerial perspective with an emphasis on freight service. After introducing fundamental transportation concepts and an overview of urban and passenger transportation, the course focuses on an analysis of the individual freight modes followed by an examination of intermodel services. Topics include the overall logistics context of freight service; carrier and modal competition; regulatory and legal

considerations; demand, cost and pricing analysis; and managerial resource problems. Carrier and shipper decision perspectives are both developed in general and then related to the DoD as a provider and consumer of freight service. This course also introduces the student to both the commercial and defense transportation professional literature. PREREQUISITE: MN3140 (may be taken concurrently).

MN3374 PRODUCTION MANAGEMENT: A TQM/L PERSPECTIVE (4 - 0).
Qualitative issues and quantitative techniques for contemporary production/operations management (POM). Qualitative issues covered include the fundamentals of total quality management/leadership, strategic considerations for quality (e.g., automation versus streamlined flow of materials) and synchronized operations (e.g., JIT techniques). Quantitative techniques include monitoring quality, forecasting, queuing, facilities planning, aggregate planning and scheduling. Actual applications of these concepts at Naval Aviation Depots and Naval Shipyards are described. Examples are included which illustrate application to DoD production and service activities. PREREQUISITE: OS3006.

MN3375 MATERIALS HANDLING SYSTEMS DESIGN (4 - 0).
A study of the principles and system concepts of materials handling and their application in the design of a materials handling system. Such systems are an essential part of an efficient military logistics organization. The Navy's NISTARS system is examined in detail. Materials handling in Desert Shield/Storm as well as materials handling on Strategic Sealift Ships are examined. A variety of current DoD materials handling problems are discussed.

MN3377 INVENTORY MANAGEMENT (4 - 0).
This course examines the organizations, functions, processes and resources that must be integrated to effectively manage DoN and DoD inventories. We will study parts of requirements determination, configuration tracking, distribution, warehousing, procurement, transportation, requisitioning, and financial management systems as they apply to military inventories. PREREQUISITES: MA2300 (or equivalent) and OS3101.

MN3384 PRINCIPLES OF ACQUISITION PRODUCTION AND QUALITY MANAGEMENT (5 - 1).
This course provides the student with an understanding of the principles and concepts of production and quality management in the acquisition environment. Topics include production/manufacturing techniques, tools, and technology; cost estimating methods; process oriented contract administration; production planning and control; progress payments; producibility issues; quality assurance and control; and contract negotiations in production/operations management. PREREQUISITE: MN3301 or MN3221 or permission of instructor.

MN3760 MANPOWER ECONOMICS I (4 - 0).
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: MN3140.

MN3801 TECHNOLOGY TRANSFER (4 - 0).
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 permission of the instructor.

MN3805 TOTAL QUALITY LEADERSHIP AND THE MILITARY (2 - 0).
This course introduces the basic concepts and principles of Total Quality Leadership/Management and discusses their application to the military setting. The different service approaches and initiatives are reviewed, and examples and cases from a variety of military organizations are examined. Emphasis is placed on: the teachings of Dr. W. E. Deming, use of a systems perspective, process orientation and fact-based·decision making to lead and manage a military organization, the difference between problem solving and process improvement, applying the scientific method and basic statistical and planning tools to process management and improvement, and how the concept of customer-supplier relationships translates into a military environment. PREREQUISITE: MN3105 or permission of the instructor.

MN3900 READINGS IN SYSTEMS MANAGEMENT (V - 0).
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 MPT COMPUTER SKILLS ENHANCEMENT (2 - 2).
An introduction to computer analysis of manpower data files. Topics include methods of file creation, storage, and transfer. Elementary programming and statistical concepts are introduced using the SAS statistical software package.

MN4080 RESEARCH COLLOQUIUM (2 - 0).
Meetings are held throughout the thesis research process to integrate course work with thesis progress and results. PREREQUISITE: Consent of Instructor.

MN4101 LEADERSHIP IN THE MILITARY CULTURE (2 - 0).
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.

MN4104 STRATEGIC MANAGEMENT (3 - 0).
Complex managerial situations requiring comprehensive integrated decision making are analyzed. Operational and strategic planning, policy formulation, and executive and environmental adaptation are examined in public sector organizations. Theory and research are applied to military organizations through case analysis. PREREQUISITES: MN3101, MN3102, MN3103, MN3104, MN3129, and MN4104.

MN4105 STRATEGIC MANAGEMENT (4 - 0).
Study and analysis of complex managerial situations requiring comprehensive integrated decision making. Topics include operational and strategic planning, policy formulation, executive control, environmental adaptation and management of change. Case studies in both the public and private sectors are used. Particular attention is given to strategic management in the military context, and in the challenging DoD, DoN organizations. PREREQUISITE: Open only to students in the final quarter of a Systems Management curriculum, or Information Technology Management, or permission of instructor.

MN4106 MANPOWER/PERSONNEL POLICY ANALYSIS (4 - 0).
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. Study of representative cases in the DoD and military services.

MN4110 MULTIVARIATE MANPOWER DATA ANALYSIS I (4 - 1).
An introduction to multivariate data analysis using the linear regression model. Topics include hypothesis testing, the organizations and analysis of large scale data bases, model specification issues, multicollinearity, dummy variables, forecasting, and estimation of binary choice models. Students apply techniques to Navy and DoD manpower databases developed at NPS. PREREQUISITE: A course in statistics.

MN4111 MULTIVARIATE MANPOWER DATA ANALYSIS II (4 - 1).
An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include an introduction to study design and sampling theory, maximum likelihood estimation, techniques for analyzing limited dependent and qualitative data, selection bias, time series data, and simultaneous equations models. Students apply techniques to Navy and DoD manpower databases developed at NPS. PREREQUISITE: MN4110, or consent of instructor.

MN4112 PERSONNEL TESTING AND SELECTION (4 - 0).
Study of methods available for evaluating and predicting training and work performance in organizations like the Navy: employment interviewing, testing, life-history data, and rating scales, with some reference to job analysis and recruitment. Special emphasis on testing concepts and models particularly in relation to the computerization of the Armed Services Vocational Aptitude Battery, equal employment opportunity, and selection decisions based on cost benefit analysis. PREREQUISITE: MN4110 or equivalent with approval of instructor.

MN4113 MILITARY SOCIOLOGY/PSYCHOLOGY: LEADERSHIP DIMENSIONS (2 - 0).
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. PREREQUISITES: MN3101 and MN3170.

MN4114 SOCIOLOGICAL AND PSYCHOLOGICAL PERSPECTIVES ON MILITARY SERVICE (4 - 0).
Exploration of the concepts, theories, and methods of military sociology and military psychology as applied histori-cally 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 classifica-tion, human factors, organizational systems, personnel security, and performance appraisal. Emphasis on representa-tive cases in DoD and the armed forces. PREREQUISITE: MN3105. Curriculum option for MSA (847) students, who are given priority enrollment.

MN4115 TRAINING FOUNDATIONS AND MANAGEMENT (4 - 0).
Analysis of issues in DoD training and education. Major course themes focus on understanding military education and training from a systems perspective; analyzing instructional program design, implementation, and technologies; and applying methods of needs analysis and program evaluation. 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.

MN4117 JOB ANALYSIS AND PERSONNEL TRAINING (4 - 0).
Study of job analysis and its use in determining training requirements. Consideration of instructional systems develop-ment and training pipeline management. Attention to cost-benefit issues involving training in regard to selection, equipment design, changing job requirements, and career development. PREREQUISITE: MN3111.

MN4119 SEMINAR IN MANPOWER ANALYSIS (Variable credit 1-0 to 4-0.) (V - 0).
Study of a variety of topics of current interest in military manpower analysis, to be determined by the instructor. PREREQUISITES: A background in manpower analysis and permission of the instructor.

MN4120 MANAGING DIVERSITY (3 - 0).
Globally, Elise Bouling refers to "the 10,000 societies living inside 169 nation states". The view here is that the out-break of cultural diversity that has emerged in the late 20th century is at once a potential crisis and a source for rich opportunity and creativity. Put simply, managing diversity may well be the biggest challenge facing organizations as we enter the 21st century. This course is focused on creating awareness of diversity issues that surround construc-tions of race, gender, class, and culture; and building skills to deal with these issues. From a sociological perspective, why has there been an emergence of identity politics in the midst of the post-industrial revolution? What are the his-torical roots of these group constructions and why have so many groups "gone public"? This course addresses the question, "How can diversity become an organizational resource in the military , and a force to increase productivity an innovation?" PREREQUISITES: MN3104 and MN3138.

MN4121 ORGANIZATION THEORY (4 - 0).
Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenom-ena 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).
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 prob-lems associated with the utilization of surrogates for measurement purposes, the analysis of the influence of assump-tions, values, and objectives on the planning and control process, budgeting, forecasting, performance evaluation, and the reward structure. PREREQUISITE: MN4161.

MN4124 DEFENSE MANAGEMENT OF CHANGE (3 - 0).
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 special-ist and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at effective implementation. 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. PREREQUISITES: MN3103, MN3104, and MN3129.

MN4125 MANAGING PLANNED CHANGE IN COMPLEX ORGANIZATIONS (4 - 0).
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 special-ist and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at

effective implementation. 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: MN3105.

MN4127 SEMINAR IN ORGANIZATION BEHAVIOR (Variable credit 1-0 to 4-0.) (V - 0).
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 permission of the instructor.

MN4129 PERFORMANCE ASSESSMENT (2 - 0).
Theory and methods of assessing the performance of individuals and organizations are studied. Applications are provided that use leadership-related data on midshipmen that are available a USNA. Students use the data to learn to assess leadership potential of subordinates. PREREQUISITES: MN3160, MN3162 and MN4143

MN4143 DEFENSE MANPOWER AND PERSONNEL ANALYSIS (2 - 0).
The course continues the development of the statistical tools developed in MN3162, Tools for Inquiry, and applies these methods in DoD manpower and personnel analysis. Topics include earnings models, manpower supply models, attrition and reenlistment models, manpower productivity and compensation systems. Several guest speakers from the DoD community will present their findings. PREREQUISITES: MN0123, MN3160, and MN3162.

MN4145 POLICY ANALYSIS (4 - 0).
The course continues MN3140. It introduces advanced microeconomics concepts, including cost benefit analysis, risk, strategic interactions and imperfect information. These concepts are used to analyze public policy issues, stressing defense-related resource allocation problems. These applications emphasize optimization, incentives, efficiency, problem solving and strategic thinking. PREREQUISITES: MN3140, MN3161, and OS3101 or equivalent.

MN4151 INTERNAL CONTROL AND AUDITING (2 - 0).
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).
The management of the finance function in industry, with particular attention to defense contractors and Navy and Defense revolving funds. Specific topics include cash and working capital management, long-term financing, and determination of optimal capital structure. PREREQUISITE: MN3161.

MN4153 SEMINAR IN FINANCIAL MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
Study of a variety of emerging financial management topics that impact the Navy's planning, programming, budgeting and operations. This will include field case studies within the Navy or other Defense organization and discussion of new Congressional, Defense, or Navy financial management policies. Topics and prerequisite background are determined. PREREQUISITE: Requires permission of the instructor.

MN4157 SEMINAR IN MANAGEMENT ACCOUNTING I (0 - 2).
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 federal income tax planning and accounting, special accounting treatment needed by partnerships, and consolidated financial statements.

MN4158 SEMINAR IN MANAGEMENT ACCOUNTING II (Continuation of MN4157.) (0 - 2).
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.

MN4159 FINANCIAL REPORTING AND ANALYSIS (4 - 0).
Advanced study of fundamental 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, measurement, amortization and valuation; alternative concepts of earnings; and discussion of controversial financial reporting questions. Course project investigating financial reporting in DoD settings. PREREQUISITE: MN3161.

MN4161 MANAGEMENT CONTROL SYSTEMS (4 - 0).
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 programing, budgeting, reporting, and performance evaluation. PREREQUISITES: MN3105 and MN3161.

MN4162 COST MANAGEMENT (4 - 0).
Review of basic standards, policies, and analytical techniques for identification, measurement, and reporting of cost information. In-depth study of alternative cost accounting systems, allocation of indirect costs to cost objectives, activity-based costing, target costing, and special problems of accounting for materials, labor and overhead costs. Specific attention is given to Navy and Defense unit costing for activities and the Defense Business Operations Fund program. Also covered are the Cost Accounting Standards for negotiated defense procurement contracts. PREREQUISITE: MN3161.

MN4163 DECISION, COST AND POLICY ANALYSIS (4 - 0).
Study of quantitative methods most useful for DoD resource management decision making and risk analysis. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are pertinent segments of DoD Instruction 7041.3, "Economic Analysis and Program Evaluation for Resource 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. The goal is to provide sufficient competency for students to apply sophisticated analytical techniques to various cost and policy analysis environments in DoD. PREREQUISITES: MN3161 and OS3101.

MN4301 CONTRACTING FOR MAJOR SYSTEMS (4 - 0).
This course is the study of the major defense contracting process, procedures, and practices. It focuses on the contracting process of the Service Systems Commands and the major defense acquisition process. 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, integrated logistics support, research and development, test and evaluation, and congressional activity. PREREQUISITES: MN3305 and MN3306.

MN4302 DEFENSE RESOURCE POLICY AND MANAGEMENT (4 - 0).
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).
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, risk management, competition, post-award systems contract administration, configuration management, warranties, industrial base, and ethics. PREREQUISITES: MN3301 or MN3222 and MN3306.

MN4305 DEFENSE TECHNOLOGY POLICY (4 - 0).
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 conversion, 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 permission of instructor.

MN4307 PROGRAM MANAGEMENT POLICY AND CONTROL (4 - 0).
This course provides the student with knowledge and understanding of major defense 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 defense acquisition environment are used. PREREQUISITES: MN3301, MN3309, MN3311, MN3371, OS4601, and EO4011.

MN4310 LOGISTICS ENGINEERING (4 - 0).
The concept of integrated logistics support and its relationships with systems engineering in the design of military weapon systems. Operational requirements, system maintenance concept, functional analysis, life-cycle costs, logistics support analysis, systems design, test and evaluation, production, provisioning and resupply of spare and repair parts are discussed. Case studies include the F/A-18 Aviation Coordinated Allowance List (AVCAL) spare parts determination and various weapon system reliability/readiness tradeoffs. PREREQUISITE: OS3006 (taken concurrently).

MN4312 SIMULATION MODELING FOR MANAGERIAL DECISION MAKING (4 - 0).
Modeling and analysis of computer simulation for managerial decision making. Case studies of simulation applications to weapon, logistics, communications and production systems. PREREQUISITE: Introductory probability and statistics.

MN4371 ACQUISITION AND CONTRACTING POLICY (4 - 0).
This course uses case studies and current acquisition issues to analyze Government and business acquisition/contracting policies. Emphasis is on defense acquisition decision-making and policy formulation/execution. PREREQUISITE: MN4301 or MN4304.

MN4372 SEMINAR IN ACQUISITION AND CONTRACT MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
This seminar involves the study of a variety of topics of current interest in defense acquisition and contracting to be determined by the instructor. PREREQUISITE: A background in acquisition and permission of the instructor.

MN4373 INTERNATIONAL TRANSPORTATION MANAGEMENT (4 - 0).
Analysis of international transportation systems from a managerial perspective. Maritime economics and operations are emphasized as background for DoD/DoN sealift responsibilities and operations. As a first graduate course in transportation research, this course is also designed to introduce the student to transportation research methods through the current transportation research literature, with an emphasis on critical thinking in the application of fundamental transportation concepts. Topics include carriers and users of the systems; carrier and modal competition; intermodel options; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. PREREQUISITE: MN3373.

MN4376 DEFENSE TRANSPORTATION SYSTEM (4 - 0).
Study and analysis of the structure and environment of the Defense Transportation System. Topics include strategic planning systems for warfare (e. g., GCCS and JOPES), organizations providing transportation support for warfare (e.g., USTRANSCOM and TCCs), the strategic lift triad and trade-offs concerning their roles and capabilities, and studies and analyses of the Defense Transportation System (e.g., MRS). No commercial text is available, therefore readings are based upon an NPS-developed package. PREREQUISITES: An active SECRET clearance and MN4373 or consent of the instructor.

MN4377 TQM/TQL: PHILOSOPHY, THEORY, TOOLS (4 - 0).
Deming's 14 points (philosophy and basic theory). The 7 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. We'll discuss how these methods, developed predominantly in the manufacturing environment, can be used in services. PREREQUISITES: Any 3000 level course in probability and statistics.

MN4470 STRATEGIC PLANNING AND POLICY FOR THE LOGISTIC MANAGER (4 - 0).
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. PREREQUISITE: Permission from the instructor.

MN4500 PRODUCTIVITY ANALYSIS (4 - 0).
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 which have higher probabilities of effecting the desired increases in program effectiveness and efficiency. PREREQUISITES: MN3105 and MN3140.

MN4650 THE MILITARY HEALTH CARE DELIVERY SYSTEM AND ANALYSIS (4 - 0).
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: Permission of the instructor.

MN4761 APPLIED MANPOWER ANALYSIS (4 - 0).
Application of theoretical models and quantitative techniques to Navy and DoD manpower, personnel, and training issues. Topics include manpower supply models, attrition and reenlistment models, manpower requirements determination, force structure analysis, manpower productivity, and compensation systems. Course uses specialized readings in DoD and Navy manpower. PREREQUISITES: MN3760 and MN4110.

MN4900 READINGS IN SYSTEMS MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
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.

MN4942 THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DEFENSE INDUSTRIES (4 - 0).
A study of selected defense industries' structures (e.g., seller concentration, product differentiation, barriers to entry, demand for products, and buyer concentration), conduct (e.g., pricing policy, product characteristics policy, and policies toward rivals and customers), and performance (e.g., efficiency, progress, and employment). The government as consumer and regulator. Typical industries include aerospace, computers, shipbuilding, and telecommunications. PREREQUISITE: MN3140 or equivalent.

MN4945 SEMINAR IN ECONOMICS (Variable hours 1-0 to 4-0.) (V - 0).
Study of a variety of topics of current interest in economics, to be determined by the instructor.

MN4970 SEMINAR IN SYSTEMS MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
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 permission of the instructor.

UNDERSEA WARFARE ACADEMIC GROUP

Chairman:
James Eagle
Professor
Code UW, Root Hall
Room 201
(408) 656-2654
DSN 878-2654

Steven Richard Baker, Associate Professor (1985)*; PhD University of California at Los Angeles, 1985.

Robert Barsanti, LCDR, U.S. Navy, Military Instructor (1997); BS, Polytechnical Institute of New York, 1982; MS, Naval Postgraduate School, 1996.

Robert Hathaway Bourke, Chairman and Professor of Oceanography (1971); BS, Naval Academy, 1960; MS, Oregon State University, 1969; PhD, Oregon State University, 1972.

Donald P. Brutzman, Assistant Professor (1995); PhD, Naval Postgraduate School, Monterey, 1994.

Ching-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

James Norfleet Eagle, II, Chairman and Professor of Operations Research (1983); PhD, Stanford University, 1975.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Henry Jones, CDR, U.S. Navy, Military Instructor (1996); BS, U.S. Naval Academy, 1979; MS, Naval Postgraduate School, 1986; MS, University of Southern California, 1983.

Robert M. Keolian, Associate Professor (1990); PhD, University of California at Los Angeles, 1985.

James Vincent Sanders, Associate Professor of Physics (1961); BS, Kent State University, 1954; PhD, Cornell University, 1961.

Clyde Scandrett, Associate Professor (1987); PhD, Northwestern University, 1985.

Kevin B. Smith, Assistant Professor (1995); PhD, University of Miami, 1991.

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

Academic Associate:
James Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 146B
(408) 656-2931, DSN 878-2931

The Undersea Warfare Academic Group is an association of faculty members representing several, distinct academic disciplines. An academic group is a less formal organization than an academic department. The Undersea Warfare Academic Group has administrative responsibility for the academic content of the Undersea Warfare 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, National Security Affairs, Oceanography, Operations Research and Physics.

MASTER OF SCIENCE IN DEGREES AVAILABLE
Depending on the specialization track selected by the student, a Master of Science will be awarded in Applied Physics, Physical Oceanography, Electrical Engineering, Operations Research, or Applied Science.

The entire program must be approved by the Chairman of the Undersea Warfare Academic Group.

UNDERSEA WARFARE COURSE DESCRIPTIONS

UW0001 SEMINAR (NO CREDIT) (0 - 1).
Special lectures, and discussion of matters related to the USW Program. PREREQUISITE: Enrollment in the USW Curriculum and SECRET clearance.

UW0810 THESIS RESEARCH GROUP/PROJECT (0 - 8).
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.

UW3000 STUDY PROJECT ON USW SYSTEMS PERFORMANCE (0 - 2).
This is a project course in which the project is a study and analysis of the performance of an assigned type of USW system under a variety of operating conditions. PREREQUISITE: Enrollment in the USW Curriculum or consent of the Group Chairman. Graded on a Pass/Fail basis only.

UW3303 MODELING AND SIMULATION FOR UNDERSEA WARFARE (4 - 1).
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 C language (as necessary), use of on-line tutorials, and use of public domain C++ compiler/simulation toolkit (g++, simpack). UW3303 provides tools, techniques and a 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 interest.

UW4999 SPECIAL STUDIES IN UW (Variable hours 1-0 to 4-0.) (V - 0).
A course designed to meet the needs of students for special work in advanced topics related to USW. PREREQUISITES: Enrollment in the USW curriculum and consent of the Group Chairman.

DEFENSE RESOURCES MANAGEMENT INSTITUTE

Marsha J. Evans, Rear Admiral, U.S. Navy; Director (1995)*; National War College, 1989.

Diana I. Angelis, Assistant Professor (1996); PhD, University of Florida, 1996.

Donald E. Bonsper, Senior Lecturer (1982); MS, Naval Postgraduate School, 1970.

Robert E. Boynton, Associate Professor (1970); PhD, Stanford University, 1968.

Philip A. Costain, Senior Lecturer (1979); MS, Naval Postgraduate School, 1971.

Jonathan E. Czarnecki, LTC, ARNG; Assistant Professor (1997); PhD, State University of New York, 1979.

John E. Dawson, Professor (1966); PhD, Syracuse University, 1971.

James C. Felli, Assistant Professor (1995); PhD, Northwestern University, 1995.

Peter C. Frederiksen, Professor (1974); PhD, Washington State University, 1974.

Gerald M. Groshek, Assistant Professor (1994); PhD, University of Denver, 1992.

Stephen F. Hurst, Lecturer (1989); MS, Naval Postgraduate School, 1985.

John E. Keller, Lecturer (1990); BA, Harvard University, 1956.

Charles J. LaCivita, Executive Director (1985); PhD, University of California at Santa Barbara, 1981.

Jon E. McIver, CDR, USN; Lecturer (1997); MS, Naval Postgraduate School, 1993.

Francois Melese, Associate Professor (1987); PhD, University of Louvain, Belgium, 1982.

Luis A. Morales, LTC, USA; Lecturer (1995); MPA, University of Missouri, 1992.

James H. Morris, Professor (1982); PhD, University of Oregon, 1976.

Mark A. Murphy, LCDR, USN; Lecturer (1997); MS, Naval Postgraduate School, 1997.

Allan C. Polley, LtCol, USMC; Lecturer (1997); MS, Naval Postgraduate School, 1990.

David J. Rose, Assistant Professor (1996); PhD, Rensselaer Polytechnic Institute, 1995.

Michael D. Stroup, Assistant Professor (1993); PhD, Florida State University, 1993.

Larry E. Vaughan, Lecturer (1992); MS, Naval Postgraduate School, 1974.

Kent D. Wall, Professor (1985); PhD, University of Minnesota, 1971.

Natalie J. Webb, Assistant Professor (1992); PhD, Duke University, 1992.

Mark Welty, Lt Col, USAF; Lecturer (1995); MS, Air Force Institute of Technology, 1984.

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

DEFENSE RESOURCES MANAGEMENT INSTITUTE
Established in 1965 as the Navy Management Systems Center and redesignated to its present title in May 1992, the Defense Resources Management Institute is a jointly staffed U.S. Department of Defense sponsored educational institution located as a tenant activity at the Naval Postgraduate School. It conducts educational programs in resources management, both in residence at Monterey and on-site, for military officers and civilian defense officials of the U.S. and cooperating foreign nations. The focus of all programs conducted by the Institute 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 the Institute are set forth in Department of Defense Directive 5010.35.

The Institute currently offers the following resident courses within its facilities at the Naval Postgraduate School:

DEFENSE RESOURCES MANAGEMENT COURSE - Four weeks in length; presented five times per year.

INTERNATIONAL DEFENSE MANAGEMENT COURSE - Eleven 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).

Descriptions of these courses are provided below; detailed information on current quota control agencies and procedures may be found in DoD Publication 5010.16C (Defense Management Education and Training Catalog) or by calling DRMI at: Commercial (408) 656-2104, DSN 878-2104.

In addition to its regularly scheduled resident programs, the Institute also provides:

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 agencies and state and local governments, upon specific request and approval.

Faculty of the Institute are members of the faculty of the Naval Postgraduate School on assignment to the Institute.

Since 1966, over 22,000 officials, of whom more than 9,700 represented 139 foreign nations, have participated in programs conducted by the Institute.

DEFENSE RESOURCES MANAGEMENT COURSE (DRMC)
Military officers of all services, grades 0-4 and above, and civilian employees GS-11 and above, are eligible to attend this course. Also civilians in accelerated career development programs may attend.

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.

Participants are not expected to become experts or technicians in the various disciplines and subjects included in the curriculum. The objectives are to provide orientation on the overall functioning of the defense management process; insights as to what defense management requires in the way of inputs and analysis for decision making; understanding of the principles, methods and techniques used; and awareness of the interfaces between management requirements of the Defense Department components and the Office of the Secretary of Defense. Course methodology includes lectures, small group discussions reinforced by illustrative case studies and problem sets, as well as selected daily reading assignments.

This course is primarily for U.S. officials, although limited numbers of international participants are normally also enrolled.

INTERNATIONAL DEFENSE MANAGEMENT COURSE (IDMC)
The course is designed for participants in the military grades of 0-4 (Major/Lieutenant Commander) through 0-6 (Colonel/Captain) and defense-related civilians of equivalent rank. Enrollment is currently limited to a maximum of 54 participants. Broad national representation is desired for this course, i.e., participation of at least 20-25 nations enhances the value of the comparative management aspects of this curriculum.

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 which concentrate on the lecture topics and associated readings, problems and cases. In the discussion groups, faculty members guide the interchange of ideas and are available to answer questions. Readings are assigned from within texts and supplemental material given to the participants to facilitate preparation for each lecture. Lecture outlines with additional suggested reading lists are provided. Occasional open seminar speakers are invited for special topics.

Throughout the course, the participants are encouraged to present and discuss information with respect to the defense management systems of their countries and to examine how the management concepts and techniques discussed by both the faculty and the participants from other countries may be applied in their own situations. Comparative study by means of interaction among participants is considered to be an extremely valuable characteristic of the course.

During the course, the Institute 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.

In the second half of the course, the general concepts of defense management are elaborated in detail during the examination of actual systems in financial, material and human resources management. At the end of the course, a general review integrates the formal course material, special topics and field trip experiences.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE (SIDMC)
Enrollment is restricted to military flag and general officers (grades 0-7 and above) and defense-related civilians of equivalent rank, except that for countries where the 0-6 grade is comparable to flag/general rank, such officials may be enrolled on a waiver basis.

Participation in this course is normally from 50 to 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 guest speakers are invited to address the class and a short field trip is conducted.

DEFENSE RESOURCES MANAGEMENT INSTITUTE
FISCAL YEAR 1998

COURSE NAME	COURSE NUMBER	LENGTH (weeks)	DATES (inclusive)
International Defense Management Course*	IDMC 97-2	11	22 SEP - 05 DEC 1997
Defense Resources Management Course	DRMC 98-1	4	05 JAN - 30 JAN 1998
International Defense Management Course	IDMC 98-1	11	02 FEB - 15 APR 1998
Defense Resources Management Course	DRMC 98-2	4	20 APR - 14 MAY 1998
Defense Resources Management Course	DRMC 98-3	4	18 MAY - 12 JUN 1998
29th Annual Senior International Defense Management Course	SIDMC 98	4	22 JUN - 17 JUL 1998
Defense Resources Management Course	DRMC 98-4	4	27 JUL - 20 AUG 1998
Defense Resources Management Course	DRMC 98-5	4	24 AUG - 18 SEP 1998
International Defense Management Course*	IDMC 98-2	11	28 SEP - 11 DEC 1998

* These courses convene in one fiscal year and continue into the next fiscal year.

SCHOOL OF AVIATION SAFETY

James M. Burin, CAPT, U.S. Navy; Director (1995); MS, Naval Postgraduate School, 1974.

Milton Harold Bank, II, Associate Director (Academic Affairs); Associate Professor of Aeronautical Engineering and Safety (1971); PhD, Georgia Institute of Technology, 1971.

Anthony P. Ciavarelli, Jr., Associate Professor of Psychology (1989); Ed.D., University of Southern California, 1988.

Robert C. Figlock, LTCOL, U.S. Marine Corps, Assistant Professor of Aviation Safety (1995); MS, University of Southern California, 1982.

Jeffrey S. Goldfinger, LCDR, U.S. Navy; Lecturer in Aviation Information Management (1996); BS (Computer Science), North Western University, 1982.

Edward John Kennedy, Senior Lecturer of Aviation Physiology (1972); MD, University of Iowa College of Medicine, 1962.

Don Lawson, LCDR, U.S. Navy; Lecturer in Mishap Investigation (1995); BA (Political Science), Iowa State University, 1982.

Clinton D. Lewis, LCDR, U.S. Navy; Lecturer in Mishap Investigation (1996); MS (Information Technology Management), Naval Postgraduate School, 1993.

David P. Lobik, MAJ, U.S. Marine Corps; Lecturer in Rotary-Wing Aeronautics (1995); MSAE, Naval Postgraduate School, 1995.

Truman E. Long, CAPT, MC, U.S. Navy; Assistant Professor of Aerospace Medicine (1993); MD, Stanford University, 1961.

Stephen J. Pollard, LCDR, U.S. Navy; Lecturer in Fixed-Wing Aerodynamics (1997); MSAE, Naval Postgraduate School, 1997.

John K. Schmidt, LCDR, MSC, U.S. Navy; Assistant Professor of Psychology (1997); PhD, University of Houston, 1987.

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

AVIATION SAFETY OFFICER COURSE
An Aviation Safety Officer (ASO) course is offered seven times each year on a temporary additional duty basis for those commands needing an Aviation Safety Officer. This course prepares the graduate to assist his or her commanding officer in conducting an aggressive mishap prevention program. When the ASO completes the course he or she will be able to organize and administer a mishap prevention program at the squadron level as defined in OPNAVINST 3750.6.

This twenty-eight instructional-day course consists of approximately 160 classroom and laboratory hours. Subjects addressed include safety programs, risk assessment and mishap prevention techniques, operational aerodynamics and aerostructures, mishap investigation and reporting, psychology, human factors, safety law and aeromedical support.

Prior completion of college-level courses in algebra and physics is highly desirable for the prospective student. Designated naval aviators and naval flight officers of the Navy and Marine Corps in the rank of Lieutenant, (USN) and Captain, (USMC) and above are eligible to attend. Exceptions must be approved by the Director, School of Aviation Safety. Details of quota control and class schedules are defined in NPSNOTICE 1520.

Resident Students
Officers regularly enrolled in other curricula of the Naval Postgraduate School may qualify for the Aviation Safety Officer Certificate by completing these required courses: AO2020, AO2030, AO3000, AO3010 and AO3040. Substitutions of equivalent courses taken in other departments for some of these courses may be made upon approval of the Director of the School of Aviation Safety. For example, AO2020 may be replaced by upper division or graduate courses in aeronautical engineering which cover the essential subject matter of the course.

AVIATION SAFETY COMMAND COURSE

An Aviation Safety Command (ASC) course is offered eight times each year on a temporary additional duty basis to commanding officers, executive officers, officers in charge of aviation detachments, officers screened for command and staff officers in the rank of Lieutenant Commander, USN, Major, USMC and above. This course is designed to provide information which will assist commanding officers in conducting an aggressive mishap prevention program and to prepare the graduate for the duties of Senior Member of a Mishap Board.

The course consists of approximately 35 classroom and laboratory hours over five instructional days, addressing subjects including safety programs, safety psychology and human factors, aviation law, aircraft systems, mishap investigation techniques, mishap and incident reports and endorsements and aerospace medicine.

No academic credit is given for this course.

SCHOOL OF AVIATION SAFETY COURSE DESCRIPTIONS

AO2020 AERODYNAMICS FOR AIRCRAFT ACCIDENT PREVENTION AND INVESTIGATION (2 - 0).
Survey of aerodynamics, performance, stability and control, with emphasis on pre-mishap hazard identification and risk management. Effects of varying designs, configurations, atmospheric conditions, crew techniques and degraded aircraft capabilities on critical areas of operation are discussed and related to current mishap experience. Introduction to current aircraft technology and future design considerations. (Taught in separate rotary-wing and fixed-wing sections).

AO2030 AIRCRAFT STRUCTURAL ANALYSIS (1 - 0).
Fundamentals of strength of materials, design criteria, and theories of failure. Buckling. Effects of stress concentrations; fatigue process. Identification of static and fatigue fractures. Introduction to composite materials technology.

AO3000 MANAGEMENT OF ACCIDENT PREVENTION PROGRAMS (2 - 1).
Management theories and practices with emphasis on planning, leading, organizing and controlling. Automatic data-processing systems and analysis of accident statistics. Organizational effectiveness theory and techniques as applied to Navy safety programs. Systems safety theories and techniques applied to hazard detection, analysis, and elimination. Group dynamics and human behavior.

AO3010 SAFETY INFORMATION MANAGEMENT (2 - 1).
Techniques of mishap investigation and reporting. Introduction to causation analysis, including deductive and inductive methods. Witness interviewing techniques. The legal doctrine of Safety Privilege. Organization and administration of investigative boards and commissions. Through case studies, laboratory and field exercises, the course provides practical experience in investigating and reporting simulated aircraft mishaps.

AO3040 SAFETY PSYCHOLOGY/HUMAN FACTORS (2 - 0).
Applied psychological and physiological principles in aircraft mishap investigation and prevention. A survey of human performance factors in mishap causation. Human factors related to safe and effective behavior in high performance/high risk environments, covering capabilities and limitations in sensation and perception, knowledge and skill acquisition motivation and emotion, stress and social adjustment, communication and interpersonal skills.

AO3100 MANAGEMENT OF ACCIDENT-PREVENTION PROGRAMS (3 - 2).
Management theories, practices, communications and controls; automatic data-processing and analysis of accident statistics; legal consideration in safety management; use of systems safety in hazard identification.

AO3120 TECHNOLOGICAL ASPECTS OF ACCIDENT-PREVENTION AND ANALYSIS (3 - 2).
Topics include case studies of technological design-related aviation mishaps; identification of structural failure modes; computer and simulator methods in aeronautics; safety-related problems of Navy weapons systems evaluation and acquisition.

DISTANCE LEARNING PROGRAMS

Deputy Associate Provost for Instruction:
Tracy Hammond
Code 01B1, Root Hall, Room 100
(408) 656-3059, DSN 878-3059
e-mail: thammond@nps.navy.mil

Established in 1994, the Distance Learning Programs at the Naval Postgraduate School offers three degree programs from the following academic departments: Aeronautics and Astronautics, Computer Science, and Electrical and Computer Engineering. The Department of Systems Management offers courses via distance learning. Among the advantages of the Distance Learning Programs are:

DoD Relevance.
Programs are designed to meet current and future DoD needs in the areas of advanced military technology and operational capability.

Custom Options.
We design custom curricula to meet an agency's specific graduate-education needs in engineering, applied sciences, operational research, or management.

Minimal Job Interference.
Although students are not physically on campus, they are virtually in residence at NPS through the latest in real-time, interactive-video-teleconferencing technology. Courses require only three to five hours per week of classroom participation and are conducted during normal working hours.

Quality Learning.
Students participate simultaneously with resident NPS students. Office hours with the professors allow a student to further clarify course concepts and homework assignments.

Cost Effectiveness.
Cost per student is highly competitive with the local universities or other distance-learning options. Courses are paid for by the sponsoring agency on a negotiated, fixed-fee basis.

ADMISSION TO DEGREE PROGRAM
Students wishing to enroll in a Distance Learning Program with the object of earning a degree must formally request admission and must be accepted in that program. Requests for admission must be accompanied by official (sealed) transcripts of all previous college work.

For more information contact:
Director of Admissions
Code 01B3, Naval Postgraduate School,
589 Dyer Road, Room 103C
Monterey, CA 93943-5100
Telephone (408) 656-3093/ DSN 878-3093
Fax: (408) 656-2891
e-mail:grad-ed@nps.navy.mil

ADMISSION TO INDIVIDUAL CLASSES
Students not enrolled in a degree program may wish to enroll in courses. This can be done by simply registering for the courses of interest. For more information, contact the Academic Department Coordinator for the appropriate department.

Aeronautics and Astronautics
Gerald Lindsey, Chair and Professor
(408) 656-2311, DSN 878-2311
Fax: (408) 656-2313
e-mail: lindsey@aa.nps.navy.mil

Electrical and Computer Engineering
Herschel Loomis, Jr., Chair and Professor
Charles Therrien, Professor
(408) 656-2081, DSN 878-2081
Fax: (408) 656-2081
e-mail: hloomis@nps.navy.mil
e-mail: therrien@ece.nps.navy.mil

Computer Science
Man-Tak Shing, Associate Professor
(408) 656-2634, DSN 878-2634
Fax: (408) 656-2814
e-mail: mantak@cs.nps.navy.mil

Systems Management
Wally Owen, Professor
(408) 656-2048, DSN 878-2048
Fax: (408) 656-2407
e-mail: wowen@nps.navy.mil

APPENDICES

APPENDIX A: DISTINGUISHED ALUMNI

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers (USN unless otherwise indicated) have attained flag rank and were on the active list as of July 1997:

Admiral Thomas J. Lopez
Admiral Joseph P. Reason

Vice Admiral Arthur K. Cebrowski
Lieutenant General George Alexander Fisher, Jr.,USA
Vice Admiral James R. Fitzgerald
Lieutenant General John A. Gordon, USAF
Vice Admiral William J. Hancock
Vice Admiral Richard D. Herr, USCG
Lieutenant General David Kenneth Heebner, USA
Vice Admiral Douglas J. Katz
Vice Admiral John A. Lockard
Lieutenant General Kenneth A. Minihan, USAF
Vice Admiral Robert J. Natter
Vice Admiral James B. Perkins, III
Vice Admiral John S. Redd
Vice Admiral George R. Sterner
Vice Admiral Patricia A. Tracey

Rear Admiral James F. Amerault
Rear Admiral Timothy R. Beard
Rear Admiral John J. Bepko, III
Rear Admiral David S. Bill, III
Rear Admiral Michael W. Bordy
Rear Admiral (S) John E. Boyington
Rear Admiral (S) John F. Brunelli
Rear Admiral Robert C. Chaplin
Rear Admiral Albert T. Church
Rear Admiral Dennis R. Conley
Rear Admiral Michael T. Coyle
Rear Admiral Joseph J. Dantone
Rear Admiral John P. Davis
Rear Admiral James C. J. Dawson
Brigadier General Robert F. Dees, USA
Rear Admiral (S) Joseph W. J. Dyer
Rear Admiral Robet L. Ellis, Jr.
Rear Admiral James B. Ferguson, III
Rear Admiral John A. Gauss
Rear Admiral Kevin P. Green
Rear Admiral Lee F. Gunn
Brigadier General Michael W. Hagee, USMC
Major General David Richard Evan Hale, USA

Rear Admiral James B. Hinkle
Rear Admiral Lowell E. Jacoby
Rear Admiral Herbert C. Kaler
Rear Admiral Stephen T. Keith, USNR
Rear Admiral Timothy W. Lafleur
Rear Admiral Keith W. Lippert
Rear Admiral Peter A. C. Long
Rear Admiral John T. Lyons, III
Rear Admiral Richard W. Mayo
Rear Admiral Justin D. McCarthy
Rear Admiral Joseph J. McClelland, Jr., USCG
Rear Admiral Dana B. McKinney
Rear Admiral Joseph S. Mobley
Rear Admiral Edward Moore, Jr.
Rear Admiral Michael G. Mullen
Rear Admiral David J. Nash
Rear Admiral Richard J. Naughton
Rear Admiral Larry D. Newsome
Rear Admiral Robert M. Nutwell
Rear Admiral (S) Kathleen K. Paige
Rear Admiral Paul M. Robinson
Rear Admiral Ronald A. Route
Rear Admiral David P. Sargent, Jr.
Rear Admiral Norman T. Saunders, USCG
Rear Admiral John T. Scudi
Major General Stephen Silvasy, Jr., USA
Rear Admiral Raymond C. Smith, Jr.
Major General James Ralph Snider, USA
Rear Admiral Paul O. Soderberg
Rear Admiral John D. Spade, USCG
Rear Admiral Robert G. Sprigg
Brigadier General William E. Stevens, USAF
Major General Joseph D. Stewart, USMC
Rear Admiral Robert Sutton
Rear Admiral James L. Taylor
Rear Admiral William J. Tinston, Jr.
Rear Admiral Paul E. Tobin, Jr.
Major General William Scott Wallace, USA
Rear Admiral William H. Wright, IV
Rear Admiral George R. Yount

APPENDIX B: AWARDS FOR GRADUATES

Monterey Peninsula Council Navy League Award for Outstanding Academic Achievement
Presented quarterly to graduating USN, USMC, USCG, or NOAA student who has maintained an outstanding academic record as exhibited by academic achievement, thesis research, motivation, and community involvement.

Naval Postgraduate School Outstanding Academic Achievement Award for Department of Defense Students
Presented quarterly to a graduating USA, USAF, or Department of Defense civilian who has maintained an outstanding academic record as exhibited by academic achievement, thesis research, motivation, and community involvement.

Naval Postgraduate School Outstanding Academic Achievement Award for International Students
Presented quarterly to a graduating military or civilian non-U.S. citizen student who has exhibited outstanding academic achievement, conducted notable thesis research, maintained motivation and a serious interest in the community, and who has interacted well with other students in the interest of international alliance.

Naval Postgraduate School Superior Service Award
Presented to a graduating student who has demonstrated outstanding dedication to service while at NPS. The award is presented on the basis of superior contributions to the student body, professional community, and local Monterey area.

Marine Corps Association Superior Service Award for Outstanding U.S. Marine Student
Presented quarterly to the graduating U.S. Marine Corps student in any curriculum for superior service. The award is presented on the basis of superior contributions to the student body, professional community, and local Monterey area.

Carl E. Menneken Research Award
Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions. Both staff members and students are eligible for this award.

Mewborn Student Research Award
Presented annually to an officer student whose thesis exhibits sound scholarship and highest research ability. Criteria of selection conforms as nearly as possible to the concept of evidence research potential which forms the basis for election of Associate Membership in the Society of Sigma Xi.

Warren Randolph Church Award
Presented annually to an officer student for outstanding performance in mathematics. The criteria for selection includes evidence of initiative, scholarly attitude and mathematical maturity.

Armed Forces Communications and Electronics Association Award
Presented to the officer graduate who has achieved academic excellence and best demonstrated professional qualities in one of the following programs: Electronics and Communications; Joint Command, Control, Communications, Computers and Intelligence (C4I) and NSA Intelligence.

Military Operations Research Society Stephen A. Tisdale Graduate Research Award
Presented in recognition of outstanding achievement in graduate research directed toward improving military force utilization. The primary award criterion is research which leads to demonstration of or potential for increased operating effectiveness of currently available or near term assets.

Chief of Naval Operations Award for Excellence in Operations Research
Presented semiannually to the outstanding USN or USMC graduate of the Operation Research program on the basis of academic achievement, experience tour performance, thesis work and demonstration of those qualities indicative of an outstanding military officer.

Army Chief of Staff Award for Excellence in Operations Research
Presented semiannually to an outstanding U.S. Army student in the Operations Research Curriculum on a basis of academic achievement, research excellence, experience tour performance, and military professionalism.

Admiral William Adger Moffett Award (Aeronautics)
Presented annually to an officer student in the Aeronautical Engineering program on the basis of academic excellence, including thesis, and career potential.

Chief of Naval Operations Communications Award
Presented in recognition of distinguished academic achievement in the Electronics Systems Engineering program to that graduate who has attained an outstanding academic record and who exhibited those qualities of an outstanding military officer.

Space and Naval Warfare Systems Command Award in Electronic Systems Engineering
Presented semiannually to a graduating student for distinguished academic achievement in the advanced Electronics Engineering program.

Naval Sea Systems Command Award for Weapons Systems Engineering and Excellence
Presented in recognition of distinguished scholastic achievement in Weapons Systems Engineering. Selection is based on marks attained, quality and applicability of thesis and demonstrated leadership potential in the field of Weapons Engineering and Excellence.

Naval Undersea Warfare Center Award for Excellence in Undersea Warfare Systems Technology
Presented annually to any NPS officer student who successfully completes a curricular program and a thesis that relates to one or more of the NSWC surface warfare product lines.

Chief of Naval Operations Electronic Warfare Award
Presented in recognition of excellence in the Electronic Warfare Systems Engineering program to that graduate who has attained and outstanding academic record and who has exhibited outstanding leadership qualities.

Joint Assistant Secretary of Navy (Research, Development and Acquisition) American Defense Preparedness Award for Excellence in Undersea Warfare Technology
Presented annually at the March graduation ceremony to an outstanding officer student who successfully completes any curricular program and a thesis which demonstrates outstanding potential for application to undersea warfare technology.

Chief of Naval Operations Undersea Warfare Award
Sponsored by the National Security Industrial Association and presented in recognition of distinguished academic achievement to the USW Curriculum graduate who has demonstrated outstanding academic performance and exhibited those qualities indicative of an outstanding military officer.

Captain John C. Woelfel Award
Presented each June to the outstanding Naval Engineering program officer graduate on the basis of academic and leadership qualities and performance. Officers from the past September, December, March and the present June graduation are considered.

Naval Sea Systems Command Award in Naval Engineering
Presented in recognition of distinguished academic achievement in the Naval Engineering Program. The criteria for the award includes demonstrated academic excellence measured by marks attained, contents of thesis, and demonstrated leadership potential in Naval Engineering.

Oceanographer of the Navy Air-Ocean Sciences Award
Awarded annually to an Air-Ocean Sciences graduate with outstanding academic performance and exhibition of those qualities indicative of an outstanding military officer.

Rear Admiral Thomas R. McClellan Award for Academic Excellence in Systems Management
Presented to a graduate of Systems Management based upon academic performance, professional commitment, and leadership potential.

Chief of Naval Operations Award for Academic Excellence in Manpower Systems Analysis
Presented annually to an outstanding U.S. Naval Officer student or OP-01 sponsored civilian in the Manpower Systems Analysis curriculum. The award is based on an outstanding academic record, thesis quality and leadership ability.

Naval Supply Systems Command Award for Academic Excellence in Systems Management
Presented semiannually to an outstanding U.S. Naval Supply Corps officer in Systems Management at the Naval Postgraduate School. The award is made on the basis of academic achievement, research excellence, contribution to the professional and civilian community and faculty recommendations.

Department of the Navy Award for Academic Excellence in Financial Management
The award is presented semiannually to a Financial Management student who demonstrates overall academic performance, academic excellence in financial management courses, high leadership potential, future ability to contribute to professional, academic and public forums while meeting the highest standards of stewardship of the national trust and thesis excellence.

Systems Management Faculty Award for Excellence in Management
Presented to a graduating student in any of the Systems Management curricula. The award is based on exceptional academic ability and is presented only when the caliber of potential nominees is considered high enough to make a presentation of award.

Conrad Scholar Award for Distinguished Academic Excellence in Financial Management
Presented semiannually to an outstanding Unrestricted Line (URL) officer in the Financial Management community who has demonstrated academic excellence, presented a financial management essay for publication, and exhibited the potential for outstanding leadership while attending the Naval Postgraduate School.

Rear Admiral Grace Murray Hopper Computer Technology Award
Presented in recognition of excellence in the Computer Technology program to the outstanding graduate in Computer Science and Information Technology Management who has demonstrated outstanding academic performance, thesis quality and leadership ability.

United States Naval Institute Award
Presented to a student in the National Security and Intelligence curricula whose thesis is judged to be of the most importance to the U.S. Navy and meets the highest standards of excellence.

Joint Chiefs of Staff Command, Control and Communications Award for Academic Achievement
Presented annually to the outstanding graduate of the Joint Command, Control, Communications, Computers and Intelligence Program in recognition of distinguished academic achievement based on marks attained, quality of thesis and overall performance.

Space Systems Operations Award for Academic Excellence
Presented annually at the September commencement exercises to an outstanding student in Space Systems Operations who has graduated since the last award. Selection criteria for this award is based on Quality Point Rating, thesis, academic achievement, and extra curricula activities.

Space Systems Engineering Award for Academic Excellence
Presented annually at the June graduation to an outstanding Space Systems Engineering student. The award is made based on grade point average, thesis work, curricular and extra-curricular activities.

Astronaut Michael J. Smith, CAPT, USN, Astronautics Award
Presented annually to an outstanding graduate of the Space Systems Engineering or Space Systems Operations curricula. The award is made on the basis of the student's academic excellence, including thesis, and career potential.

Monterey Kiwanis Club Outstanding Foreign Student Award
Presented annually at the September commencement exercises to two outstanding foreign students. Selection criteria for this award is based on academic standing and achievement, and involvement in community affairs.

Army Acquisition Corps Award for Scholastic Achievement
Presented to the graduating US Army Acquisition student who has exhibited outstanding academic excellence through academic achievement, thesis research, and leadership potential.

Systems Management Faculty Outstanding International Student Award
Presented to a graduating International student in any of the Systems Management curricula. The award is based on exceptional academic achievement and is presented only when the caliber of potential nominees is considered high enough to make a presentation of award.

American Society of Military Comptrollers Award for Excellence is Research (Graduate Level)
Presented semiannually to an outstanding graduate of the Financial Management curriculum. This award is based on the student's contributions to the field of financial management through innovative research and thesis quality.

APPENDIX C: AWARDS FOR FACULTY

The Carl E. and Jessie W. Menneken Annual Faculty Award for Excellence in Scientific Research
This monetary award is presented annually to a junior NPS faculty member in recognition of meritorious research which has significant identifiable impact on military technology. Funding for the award has been provided to the NPS Foundation by Mrs. Jessie W. Menneken. Presented at the December graduation if suitable candidates are nominated.

Carl E. Menneken Research Award
Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions. Both staff members and students are eligible for this award.

Distinguished Professor Award
Presented to a faculty member who has merited recognition for his or her scholarly accomplishments and lasting educational contributions to the Naval Postgraduate School. The recipient of this award joins a select group of faculty bearing the title of Distinguished Professor who has made significant impacts on the Naval Postgraduate School.

Rear Admiral John Jay Schieffelin Award for Excellence in Teaching
This monetary award is presented annually, at the June graduation, to recognize a faculty member who, through wide consensus, excels as a teacher. The consensus is ascertained through a ballot polling of current students and graduates. Funding for the award was provided to the NPS Foundation by a gift from Mr. William J. Schieffelin.

Index

ACADEMIC CALENDARS

FALL QUARTER
Reporting Date	Monday, 22 Sept 1997
Instruction Begins	Monday, 29 Sept
Columbus Day (Holiday)	Monday, 13 Oct
Reporting Date for Refresher	Monday, 3 Nov
Refresher Begins	Monday, 10 Nov
Veteran's Day (Holiday)	Tuesday, 11 Nov
Thanksgiving Day (Holiday)	Thursday, 27 Nov
Final Examinations Begin	Monday, 15 Dec
Graduation	Thursday, 18 Dec
Christmas Break	19 Dec 1997 - 2 Jan 1998

WINTER QUARTER
Reporting Date	Monday, 29 Dec 1997
Instruction Begins	Monday, 5 Jan 1998
Martin Luther King's Birthday (Holiday)	Monday, 19 Jan
Reporting Date for Refresher	Monday, 9 Feb
President's Day (Holiday)	Monday, 16 Feb
Refresher Begins	Tuesday, 17 Feb
Final Examinations Begin	Monday, 23 Mar
Graduation	Thursday, 26 Mar

SPRING QUARTER
Reporting Date	Monday, 23 Mar
Instruction Begins	Monday, 30 Mar
Reporting Date for Refresher	Monday, 4 May
Refresher Begins	Monday, 11 May
Memorial Day (Holiday)	Monday, 25 May
Final Examinations Begin	Monday, 15 Jun
Graduation	Thursday, 18 Jun
Summer Break	19 Jun - 3 Jul

SUMMER QUARTER
Reporting Date	Monday, 29 Jun
Independence Day (Holiday)	Friday, 3 Jul
Instruction Begins	Monday, 6 Jul
Reporting Date for Refresher	Monday, 10 Aug
Refresher Begins	Monday, 17 Aug
Labor Day (Holiday)	Monday, 7 Sep
Final Examinations Begin	Monday, 21 Sep
Graduation	Thursday, 24 Sep

FALL QUARTER

Reporting Date	Monday, 21 Sept 1998
Instruction Begins	Monday, 28 Sept
Columbus Day (Holiday)	Monday, 12 Oct
Reporting Date for Refresher	Monday, 2 Nov
Refresher Begins	Monday, 9 Nov
Veteran's Day (Holiday)	Wednesday, 11 Nov
Thanksgiving Day (Holiday)	Thursday, 26 Nov
Final Examinations Begin	Monday, 14 Dec
Graduation	Thursday, 17 Dec
Christmas Break	18 Dec 1998 - 1 Jan 1999

WINTER QUARTER

Reporting Date	Tuesday, 29 Dec 1998
Instruction Begins	Monday, 4 Jan 1999
Martin Luther King's Birthday (Holiday)	Monday, 18 Jan
Reporting Date for Refresher	Monday, 9 Feb
President's Day (Holiday)	Monday, 15 Feb
Refresher Begins	Tuesday, 16 Feb
Final Examinations Begin	Monday, 22 Mar
Graduation	Thursday, 25 Mar

SPRING QUARTER

Reporting Date	Monday, 22 Mar
Instruction Begins	Monday, 29 Mar
Reporting Date for Refresher	Monday, 3 May
Refresher Begins	Monday, 10 May
Memorial Day (Holiday)	Monday, 31 May
Final Examinations Begin	Monday, 14 Jun
Graduation	Thursday, 17 Jun
Summer Break	18 Jun - 2 Jul

SUMMER QUARTER

Reporting Date	Monday, 28 Jun
Independence Day	Sunday, 4 Jul
Instruction Begins	Monday, 5 Jul
Reporting Date for Refresher	Monday, 9 Aug
Refresher Begins	Monday, 16 Aug
Labor Day (Holiday)	Monday, 6 Sep
Final Examinations Begin	Monday, 20 Sep
Graduation	Thursday, 23 Sep