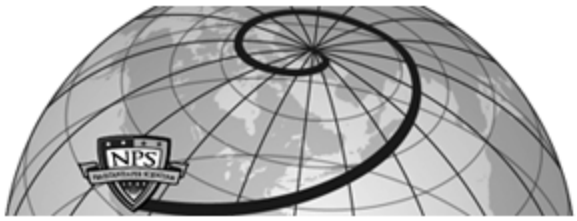
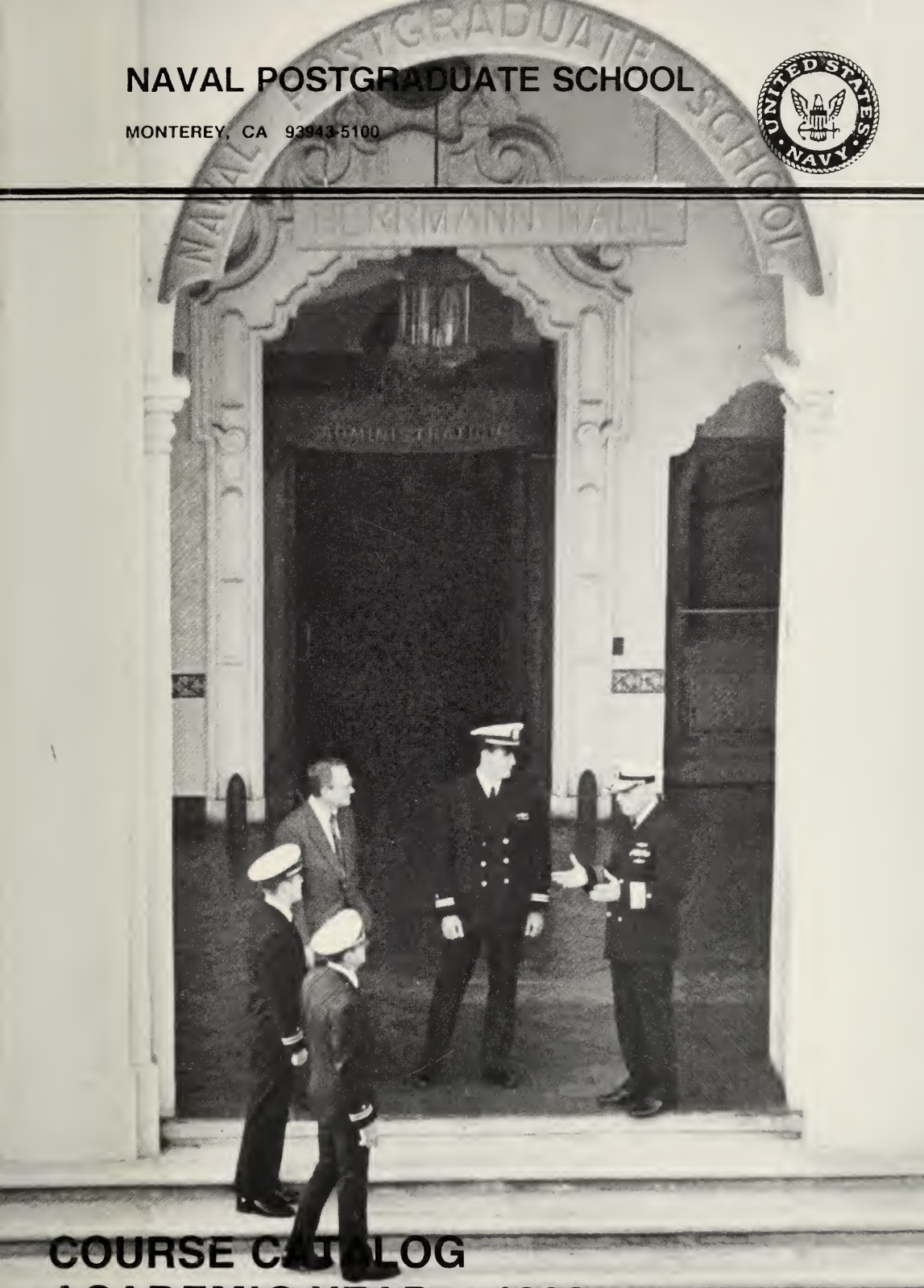


NAVAL POSTGRADUATE SCHOOL

MONTEREY, CA 93943-5100



COURSE CATALOG
ACADEMIC YEAR 1988

NAVAL POSTGRADUATE SCHOOL CATALOG

ACADEMIC YEAR 1988

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Chief of Naval Operations

Carlisle H. Trost, ADM, USN

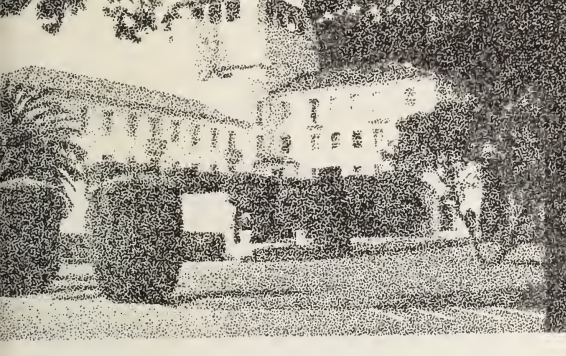
CNO GRADUATE EDUCATION POLICY

Because we face ever increasing complexities in technological, managerial, and political/economic fields which affect the Navy, we need officers with a solid intelltelectual capacity and the vision to capitalize on evolving technology, and developments. This requires officers capable of original thought and the capacity to synthesize broad areas of knowledge, analyze complex issues, and appreciate the distinction between what is theoretically possible and actually achievable. Investment in graduate education must be pursued as a priority, even in the face of fiscal austerity and competing demands for our junior officers.

The fully funded graduate education programs are intended primarily for lieutenants and lieutenant commanders who have demonstrated superior professional performance and the intellectual capability to complete a rigorous academic program. These academic programs are designed to equip officers with enhanced intellectual and analytical capacity and make them more skillful warriors and specialists. Our goal is to achieve twenty percent of the officer corps with a graduate level subspecialty.

The intention of graduate education is to prepare an officer for a long career of contributions. Therefore, the tendency to train officers for their next assignment must be balanced by graduate education which furthers their ability to contribute. Program length will normally be two years or less to limit costs.

Officers selected for fully funded graduate education will usually be assigned to study at the Naval Postgraduate School (NPS). NPS programs will be maintained with a predominant emphasis on scientific and engineering subjects. NPS will also provide a program of continuing education so prospective students can improve their knowledge and graduates can maintain currency. For those curricula not offered at NPS, officers will be sent to quality civilian or DoD institutions approved by the appropriate program sponsor.



GENERAL INFORMATION

GRADUATE EDUCATION

Any Navy's ability to capitalize on new technology is linked to its level of officer competence. Accordingly, the United States faces a significant challenge to ensure the intellectual and technical competence of its officers. Of the military services, the Navy is the most hardware intensive. This fact is related to the broad scope of its operational domains: undersea, surface, air, and space. Each levies significant and unique demands to effectively match the nation's technological opportunities to operational reality. This is a complex process that demands the highest quality of intellectual and professional skills.

The Navy's graduate education program supports fleet and shore establishment requirements for specialized education beyond the baccalaureate level. This education is directed toward filling current and future Navy needs in operational, technical and managerial areas in concert with the Officer Subspecialty System. Officers are educated to the graduate level specified by sponsors for optimum performance of duty in the particular subspecialty area. Under the fully-funded program, officers attend school full time, receive all pay and benefits and have tuition paid by the Navy. Fully-funded graduate education is provided at the Naval Postgraduate School (NAVPGSCOL), Monterey, CA and selected DoD and civilian institutions (CIVINS).

Utilization

Officers who have received Navy fully-funded graduate education will serve one tour in a validated subspecialty position as soon as possible but not later than the second tour following graduation. These officers will serve at least two tours in related subspecialty billets, and successfully completing a subspecialty tour will be viewed as an important indicator of potential for higher rank.

THE SCHOOL AND ITS MISSION

The Navy has developed at the Naval Postgraduate School an unusual academic institution in which the special purposes of the Navy are served through the use of academic programs and structure that are very similar to those of civilian universities. The student body is made up wholly of U.S. and international officers of the military services and federal civilians who are being educated to fill the managerial and technological needs of the services. It must be stressed that the School is primarily an academic institution with emphasis on programs that are relevant to Navy interests, with an accommodation to unique requirements of matching, scheduling and sequencing officers into the programs.

Mission: The Navy's needs for advanced education of Naval Officers in the fields of science, engineering, operations analysis and management are met primarily through the academic programs of the Naval Post-

graduate School. Complementing the School's programs in these fields are programs at certain civilian universities which are preeminent in areas related to the interests of the Navy.

The broad responsibility of the Naval Postgraduate School toward the advanced education of naval officers is reflected in its stated mission:

"To conduct and direct the advanced education of commissioned officers, and to provide such other technical and professional instruction as may be prescribed to meet the needs of the Naval Service, and in support of the foregoing, to foster and encourage a program of research in order to sustain academic excellence."

Goals: The mission of the Naval Postgraduate School establishes the continuing combined requirements of excellence in quality of academic programs and responsiveness to change and innovation in the technology and management in the Navy. The following educational goals of the School are dictated by this requirement:

"To enhance continually the contribution of the content of the academic programs to the Navy and the Department of Defense.

"To intensify efforts to provide the best education to the students of the Naval Postgraduate School, and to build a progressively better environment where faculty and students can come together in the search for knowledge and professional excellence.

"To nurture in students a respect for rigor in thought and discipline in work which will be a hallmark of their pursuit of excellence in their professions.

"To attract faculty who by their scholarship and fresh viewpoint will bring new life to the classroom, new vigor to the laboratory and through their research sustain a program of academic excellence."

FROM THE BEGINNING

The Naval Postgraduate School is in it 78th year of operation. The development of a naval institution of higher learning dedicated to the advanced education of commissioned officers began on 9 June 1909 when the Postgraduate Department of the U.S. Naval Academy was established at Annapolis. Ten officers made up the first class, three professors formed the faculty, and marine engineering was the one course of study. In 1919, the postgraduate department was renamed the United States Naval Postgraduate School, but still operated as a part of the Naval Academy.

With the advent of World War II, the School's activities increased substantially. There was a large growth in student enrollment and educational programs were expanded to meet the evolving needs of the Navy. Following the end of the War, plans were initiated to move the School to more suitable facilities and to enhance its academic status.

Between 1945 and 1948, Congress established the School as a separate activity under its own Superintendent, created the office of Academic Dean and granted the Superintendent the authority to award the bachelor's, master's and doctor's degrees. It also approved Monterey as the future home of the School. The Navy officially established the School on the West Coast on 22 December 1951. With its enlarged facilities, the School continued to grow in curricular programs and in student enrollment. In 1956, the Navy Management School was formed as a component of the Postgraduate School to provide graduate education in the theory and application of administrative sciences.

Currently, the Naval Postgraduate School graduates approximately 800 students per year and offers a range of curricular programs specifically tailored to impart the scientific, engineering, operational and administrative knowledge required to meet the present and projected professional needs of the Department of Defense. Its student body includes officers of all five U.S. services and approximately 25 allied services. U.S. Naval Officers constitute 60% of the student body, with 23% coming from other U.S. Services. The remaining 17% is made up of foreign officers, Also, since 1975, the Postgraduate School has enrolled civilian employees of the U.S. Federal Government.

DEGREES

The Naval Postgraduate School is authorized to confer Bachelor's, Master's, Engineer's and Doctor's degrees upon qualified graduates. Recipients of such degrees must be found qualified by the Academic Council in accordance with prescribed academic standards.

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. Degrees offered in Engineering Science and Engineering Technology are not accredited by ABET. The Administrative Sciences Curricula are accredited by the National Association of Schools of Public Affairs and Administration.

MASTER'S DEGREES

Requirements for the Master of Arts and Master of Science Degrees:

The Master's Degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meeting the degree requirements. 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:

1. 32 quarter hours of graduate level credits for which at least 20 quarter hours must be earned on campus.
2. A thesis, or its equivalent, is required. If the thesis is waived, at least 8 quarter hours of approved courses at the 4000 level, or comprehensive examinations, shall be the thesis substitute.
3. Departmental requirements for the degree in a specified subject.
4. A quality point rating of at least 3.00 in all graduate courses in the curriculum, and either 2.50 in the remaining courses or 2.75 in all courses in the curriculum.

Master of Arts Degree Offered:

National Security Affairs

Master of Science Degrees Offered:

Aeronautical Engineering
Applied Mathematics
Applied Science
Computer Science
Electrical Engineering
Engineering Acoustics
Engineering Science
Hydrographic Sciences
Information Systems
Management
Mathematics

Material Science
Mechanical Engineering
Meteorology
Meteorology and Oceanography
National Security Affairs
Oceanography
Operations Research
Physics
Systems Technology
Systems Engineering
Telecommunications Systems Management

Master's Degrees with Distinction:

The award of the Master of Science and the Master of Arts degrees may be made "With Distinction" when a student completes the degree requirements with a minimum of 32-quarter hours earned in residence and is judged to be in the upper 10% of the graduating class from the student's department.

ENGINEER'S DEGREES

Requirements: The Engineer's Degree typically represents one year of study beyond the Master's Degree. It is awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree.

Minimum Postgraduate School requirements for the degree of Engineer are as follows:

1. 72 quarter hours of graduate level courses, including at least 30 hours in courses 4000-4999.
2. An acceptable thesis.
3. One academic year in residence.
4. Departmental requirements for the degree in a specified engineering field.
5. A quality point rating of at least 3.00 in all graduate courses in the curriculum, and either 2.50 in the remaining courses or 2.75 in all courses of the curriculum.

Engineer's Degrees Offered:

Aeronautical Engineer
Electrical Engineer
Mechanical Engineer

DOCTOR'S DEGREES

Requirements: Any program leading to a Doctor's Degree shall require the equivalent of at least three academic years of study beyond the baccalaureate level, with at least one academic year being spent at the School. A requirement for admission is a Bachelor's degree that includes the prerequisites for full graduate status in the department of his major study.

A general outline of a candidate's progress through the program is as follows:

a. Application to the appropriate department and successful completion of a screening exam.
b. Appointment of the student's doctoral committee, which bears responsibility for the study program and guidance of the research program.
c. Inclusion of one or more minors in the study program.
d. For the Doctor of Philosophy, a foreign language requirement may be included at the discretion of the major department; for the Doctor of Engineering, demonstrated proficiency in computer programming is required.
e. When the study program is essentially finished, successfully complete the qualifying examination, including both oral and written parts.
f. Admission to candidacy and work on a doctoral dissertation on a subject approved by the doctoral committee.
g. Upon completion of the dissertation and acceptance by the doctoral committee, administration of a final oral examination.
h. Upon unanimous recommendation of the doctoral committee, the Academic Council recommends award of the degree.

Doctorates Offered:

Doctor of Philosophy in:
Aeronautical Engineering
Computer Science

Electrical and Computer Engineering
Engineering Acoustics
Mechanical Engineering
Meteorology
Oceanography
Operations Research
Physics

Doctor of Engineering in:
Aeronautical Engineering
Electrical and Computer Engineering
Mechanical Engineering

POSTGRADUATE SCHOOL STATISTICS

Graduate degrees granted by NPS since 1946 are given in the following table to provide perspective. Two of the degrees are no longer offered: Master of Science in Chemistry, and the undesignated Master of Science Degree. A third, Master of Science in Computer Systems Management, has been changed to Master of Science in Information Systems Management. Growth in program offerings is evident as the figures are tracked from left to right. Between 1955 and 1965 the range of degrees doubled, and by 1975 they had increased again by nearly the same number. Within recent years the populations and offerings have, on an overall basis, been stable.

Superintendent
Robert C. Austin, RADM, USN

SUPERINTENDENT'S MESSAGE

I take great pride in the Naval Postgraduate School and the work of the officers assigned to study here. The combination of their graduate education, operational experience and research pays big dividends. The aim of the School is to provide combat effectiveness to the Navy through the future contributions and professional performance of these officers. The diligent effort and study by these officers is noteworthy; it comes out of their intense interest and the realization of the importance of their future contributions. Thus our officer students combine their sea-going/field experience with insights gained through postgraduate studies to meet the challenges of the future -- to form the kind of Navy that will provide for the nation's security for the 21st century. The intent of the program at the Naval Postgraduate School is to provide the finest teaching available in the country, with faculty who are at the frontiers of knowledge which are focused on the Navy's and the nation's security interests.

POSTGRADUATE SCHOOL STATISTICS
GRADUATE DEGREES GRANTED BY CALENDAR YEARS

	1946-1955	1956-1965	1966-1975	1976-1985	1986	TOTAL
MA in National Security Affairs	.....	.....	23	659	74	756
MS in Aeronautical Engineering	.....	40	339	323	44	746
MS in Applied Mathematics	.....	.....	.....	13	2	15
MS in Applied Science	.....	.....	.....	46	2	48
MS in Chemistry	.....	21	48	.....	.....	69
MS in Computer Science	.....	.....	173	351	50	574
MS in Computer Systems Management	.....	22	541	210	.....	773
MS in Electrical Engineering	229	314	663	663	85	1,954
MS in Engineering Acoustics	.....	.....	50	68	8	126
MS in Engineering Science	.....	.....	.....	116	22	138
MS in Hydrographic Sciences	.....	.....	.....	18	7	25
MS in Information Systems	.....	.....	.....	267	73	340
MS in Management	.....	406	1,597	1,390	137	3,530
MS in Material Science	.....	5	9	.....	.....	14
MS in Mechanical Engineering	56	97	231	336	49	769
MS in Meteorology	42	93	179	61	4	379
MS in Meteorology and Oceanography	.....	.....	.....	136	21	157
MS in National Security Affairs	.....	.....	.....	.....	8	8
MS in Oceanography	.....	.....	298	105	5	408
MS in Operations Research	.....	63	854	581	58	1,556
MS in Physics	25	239	226	169	17	676
MS in Systems Engineering	.....	.....	.....	23	12	35
MS in Systems Technology	.....	.....	19	494	.....	513
MS in Telecommunications Systems Management	.....	.....	.....	108	21	129
Master of Science	17	167	81	5	54	324
Total Master's Degrees	369	1,467	5,331	6,142	753	14,062
Aeronautical Engineer	.....	4	78	35	5	122
Electrical Engineer	.....	.....	104	66	8	178
Mechanical Engineer	.....	.....	31	59	13	103
Total Engineer's Degrees	.....	4	213	160	26	403
Doctor of Philosophy	.....	15	63	45	5	128
Doctor of Engineering	.....	.....	.....	5	.....	5
Total Doctorates	.....	15	63	50	5	133
TOTAL GRADUATE DEGREES	369	1,486	5,607	6,352	784	14,598

AWARDS FOR GRADUATES

ADMIRAL WILLIAM ADGER MOFFETT AWARD

This award is presented annually by the Point Lobos Section of the American Institute of Aeronautics and Astronautics to an outstanding graduate of the Aeronautical Engineering Curriculum. The award is made on the basis of the student's academic excellence, including thesis, and his career potential.

ARMY CHIEF OF STAFF AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH

Presented semiannually to a U.S. Army Officer student in the Operations Analysis Program who possesses an outstanding academic record, including thesis and project work, and who demonstrates qualities indicative of an outstanding military officer.

ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSOCIATION HONOR AWARD

Presented to that officer graduate who has achieved academic excellence and best demonstrated professional qualities in one of the following programs: Electronics, Communications, Intelligence, Command and Control, or Computer Technology.

ASTRONAUT MICHAEL J. SMITH, CAPT, USN, ASTRONAUTICS AWARD

Astronuat and CAPT Michael J. Smith, who was an alumnus of NPS gave his life exploring space for the enrichment of mankind. This award is presented annually by the Point Lobos Section of the American Institute of Aeronautics and Astronautics 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 his career potential.

CAPTAIN JOHN C. WOELFEL AWARD

Presented each June to the outstanding Naval Engineering program officer student on the basis of academic and leadership qualities and performance. Officers from the past September, December, March and June graduation classes are considered.

CHIEF OF NAVAL OPERATIONS ANTISUBMARINE WARFARE AWARD

Sponsored by the National Security Industrial Association and presented in recognition of distinguished academic achievement to that ASW Curriculum graduate who has demonstrated outstanding academic performance and exhibited those qualities indicative of an outstanding military officer.

CHIEF OF NAVAL OPERATIONS COMMUNICATIONS AWARD

Presented in recognition of distinguished academic achievement in the Communications Engineering or Telecommunications Systems programs to that graduate who has attained an outstanding academic record and who exhibits those qualities of an outstanding military officer.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN MANPOWER, PERSONNEL AND TRAINING ANALYSIS

This award is given semiannually to a U.S. Navy, or Op-01 sponsored civilian, graduate of the Manpower, Personnel and Training Analysis curriculum who has demonstrated outstanding academic performance, thesis quality and leadership potential.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH

Presented semiannually to the outstanding USN or USMC graduate of the Operations Research Program on the basis of academic achievement, experience tour performance, thesis work and demonstration of those qualities indicative of the outstanding military officer.

DEPARTMENT OF THE NAVY AWARD FOR ACADEMIC EXCELLENCE IN FINANCIAL MANAGEMENT

This 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.

JOINT CHIEFS OF STAFF COMMAND, CONTROL AND COMMUNICATIONS AWARD FOR ACADEMIC ACHIEVEMENT

Presented to the outstanding graduate of the Command, Control and Communications Program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

MEWBORN STUDENT RESEARCH AWARD

Presented annually to an officer student whose thesis exhibits sound scholarship and highest research ability. Criteria of selection conform as nearly as possible to the concept of "evidence of research potential" which forms the basis for election to Associate Membership in the Society of Sigma Xi.

MILITARY OPERATIONS RESEARCH SOCIETY 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.

MONTEREY PENINSULA COUNCIL NAVY LEAGUE AWARD FOR HIGHEST ACADEMIC ACHIEVEMENT

Presented quarterly to the graduating USN, USMC or USCG officer who has maintained the highest academic grade average as a student at the Naval Postgraduate School.

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 include demonstrated academic excellence measured by grades attained, quality of thesis and demonstrated leadership potential in Naval Engineering.

NAVAL SEA SYSTEMS COMMAND AWARD FOR WEAPONS SYSTEMS ENGINEERING EXCELLENCE

Presented in recognition of distinguished scholastic achievement in a Weapons Engineering field of study. Selection is based upon grades attained, quality and applicability of thesis and demonstrated leadership potential in the field of Weapons Engineering.

NAVAL SUPPLY SYSTEMS AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES

Presented semiannually to an outstanding U.S. Navy Supply Corps officer in Administrative Sciences. This

award is made on the basis of academic achievement, research excellence, and contribution to the professional and civilian community.

NAVAL SURFACE WEAPONS CENTER AWARD FOR EXCELLENCE IN SURFACE WARFARE TECHNOLOGY

Presented semiannually to an officer student of high academic standing whose thesis topic and quality of supporting research demonstrates the greatest potential for contribution to surface warfare.

NAVAL UNDERWATER SYSTEMS CENTER AWARD FOR EXCELLENCE IN UNDERWATER SYSTEMS TECHNOLOGY

Presented annually to the student, who by academic standing and relevance of thesis topic, has demonstrated the greatest achievement in the field of Underwater Systems Technology.

OCEANOGRAPHER OF THE NAVY AIR-OCEAN SCIENCES AWARD

Presented to a U.S. Naval Officer graduate of the Air-Ocean Sciences Program who has demonstrated outstanding performance and exhibited those qualities indicative of an outstanding military officer.

REAR ADMIRAL GRACE MURRAY HOPPER AWARD FOR COMPUTER TECHNOLOGY

Presented to an outstanding graduate on the basis of thesis quality, academic performance and demonstrated leadership ability in the study of computer technology.

REAR ADMIRAL THOMAS R. MCCLELLAN AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES

Presented to a graduate of Administrative Sciences from the aviation community, based upon academic performance, professional commitment, and leadership potential.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONIC WARFARE TECHNOLOGY

Presented in recognition of academic achievement in the Electronic Warfare Systems Technology Program to that graduate who has attained an outstanding academic record and who has exhibited outstanding leadership qualities.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONICS SYSTEMS ENGINEERING

Presented semiannually to a U.S. Naval Officer student in recognition of distinguished academic achievement in the advanced Electronics Engineering program.

UNITED STATES NAVAL INSTITUTE AWARD

Presented each quarter to that recipient of a master's degree in National Security Affairs whose achievement has significantly advanced professional, literary or scientific knowledge in the naval or maritime services.

WARREN RANDOLPH CHURCH AWARD

Presented annually to an officer student for outstanding performance in mathematics. The criteria for selection include evidence of initiative, scholarly attitude and mathematical maturity.

GRADES

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

The grade of Incomplete is given when an identifiable portion of the course remains undone 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 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. 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.

COURSES

Courses are designated by an alphanumeric 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:

Administrative Sciences	
Service Courses	AS
Telecommunications Systems Management	CM
Defense Communications	CO
Information Systems	IS
Management	MN
Aeronautics	AE
Antisubmarine Warfare	ST
Command, Control and Communications	CC
Computer Science	CS
Electrical and Computer Engineering	EC
Electronic Warfare	EW
Mathematics	MA
Mechanical Engineering	ME
Materials Science	MS
Meteorology	MR
National Security Affairs	NS
Oceanography	
Oceanographic Sciences	OC
Hydrographic Sciences	GH
Operations Research	
Operations Analysis	OA
Service Courses	OS
Physics	PH
Science and Engineering	SE

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

0001-0999	No credit
1000-1999	Lower division college credit (Freshman - Sophmore Level)
2000-2999	Upper division college credit (Junior - Senior level)
3000-3999	Upper division college or graduate credit
4000-4999	Graduate credit

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. Laboratory hours are assigned half the value shown in calculating quarter hours for the credit value of the course. Thus a (3-2) course, having three hours lecture and two hours laboratory, will be assigned a credit value of 4 quarter hours.

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: his/her curricular officer or academic associate, the chairman of his doctoral committee, or the Dean of Academic Administration.

Overload: A student may not enroll for more than 21 total credit hours or more than four 3000 and/or 4000 courses (excluding laboratories or explicit curriculum requirements) per quarter unless he has either a total QPR of at least 3.50 or permission of the Department or Group Chairman and the Dean of Academic Administration.

Repetition of Courses: A student may repeat a course for the purpose of improving his/her grade when the grade received originally was either D or X, provided such course repetition is taken at the Postgraduate School. Approval must be granted by both the Curricular Officer and the Department Chairman concerned, and the Registrar is to be notified.

For record purpose, 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 with the quality points earned being the average of the two.

Medical Absence: The academic record of a student may be deleted completely for a given term when he/she 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 his/her 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 Dean of Academic Administration.

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 by someone designated in writing by the chairman to act for him/her in this regard. 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 appropriate for a student to complete his/her program in less than the maximum time allowed.

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

Selection for the Navy fully-funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Unrestricted Line officers being considered by statutory selection boards for promotion to Lieutenant or Lieutenant Commander are eligible for selection for fully-funded graduate education. Restricted Line and Staff Corps eligibility information is available through community newsletter or directly from assignment officers. Boards will select groups of officers considered to be professionally qualified; upon determination of academic qualification (by NAVPSGCOL), 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. Once selected, officers will be notified by COMNAVMILPERSCOM notice.

TABLE OF ACADEMIC PROFILE CODE DIGITS

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
1	Calculus sequence completed with B+ or better average
2	Calculus sequence completed with average between C+ and B
3	One calculus course with C or better
4	Two or more pre-calculus courses with B or better average
5	One pre-calculus with C or better grade
6	No pertinent college-level math with C or better grade

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	Completed calculus-based physics sequence with average between C+ and B
4	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 eighty semester hours or one hundred twenty quarter hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 80/120 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 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 thresh-

old APC for admission. A list of these is given at the beginning of the section on programs. Officers with deficient APCs can qualify for entry into these curricula by completing suitable courses from the School's Continuing Education Program or at any accredited civilian college. Transcripts (not grade reports) of work done at civilian schools must be forwarded to the Director of Admissions, Code 0145, Naval Postgraduate School, Monterey, CA 93943, to effect an APC change. The grades in all courses completed will be used to revise an officer's QPR. Only courses with B or better grades are used to upgrade either a Math Code or a Tech Code.

Continuing Education

It is recommended that all officers desiring fully-funded graduate education complete recommended preparatory courses prior to selection for resident programs. Under the guidance of the NAVPGSCOL Office of Continuing Education, preparatory refresher and credit courses are available on a self-study basis. These offerings are conducted in an individualized self-paced mode and include contact with a qualified civilian or military tutor in the local area. Available courses are listed in the Continuing Education Catalog, which is distributed annually to all ships and stations. This catalog also contains enrollment forms. Personnel may enroll in courses at any time. Further information may be obtained by writing to the Director of Continuing Education (Code 011) at the NAVPGSCOL, or telephone (408) 646-2558/2559/2984 (Autovon: 878-2558/2559/2984). Preparatory courses may be taken at local duty stations either for credit or for review only. Successful completion of preparatory courses may enhance chances of selection to graduate education, assist or improve performance in the early phases of a graduate program, and may reduce resident course requirements at NAVPGSCOL.

Academic Counseling

The NAVPGSCOL provides academic counselling services as indicated below to assist officers in developing individual educational plans.

(1) 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 Programs Section of the catalog.

(2) Officers not yet selected for graduate education and seeking general information about subspecialty codes, selection for graduate education, and preliminary information about graduate education commensurate with career fields are advised to contact the Director of Continuing Education (Code 011), NAVPGSCOL or telephone (408) 646-2558/2559/2984 (Autovon: 878-2558/2559/2984.

OTHER U.S. MILITARY OFFICES

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.

ALLIED COUNTRY MILITARY OFFICERS

Military officers from allied countries may be admitted to most curricula. Their admission is subject to availability of quotas assigned to each country. The procedures for application are contained in OPNAV INSTRUCTION 4950.1E. Correspondence must be processed through normal channels; requests from individual officers should **not** be sent directly to the Naval Postgraduate School. In

addition to fluency in English, candidates must satisfy the academic standards for each curriculum as described in this catalog.

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 four months prior to expected commencement of studies. A request should indicate the academic area of interest and degree intentions and be accompanied by a complete set of official transcripts of all previous college work. GRE and/or GMAT scores are not required but will be considered when included in the submission.

Requests for admission should be directed to the Director of Admissions, Code 0145, Naval Postgraduate School, Monterey, CA 93943. Questions about available programs or admission procedures may be telephoned to (408) 646-3093 or Autovon 878-3093.

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 or 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 may be directed by letter to the Dean of Academic Administration, Code 014, Naval Postgraduate School, Monterey, CA 93943, or telephone (408) 646-2391 or Autovon 878-2391.

Academic Dean
Kneale T. Marshall, PhD

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; consequently, the institution's governance and administration do not follow norms for civilian higher education. There is no exact correspondence with a board of trustees or regents.

GRADUATE EDUCATION REVIEW BOARD

A Graduate Education Review Board (GERB), chaired by the Chief of Naval Operations (CNO) and including the Vice Chief of Naval Operations (VCNO), the Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01), the Superintendent, Naval Postgraduate School and a representative from the Naval Systems Command (on a rotating basis) meets annually to provide policy guidance and direction for the Navy graduate education program. Prior to this meeting, a separate Graduate Education Review Group (GERG), chaired by the Vice Chief of Naval Operations (VCNO) meets in September and October to review graduate education issues and identify matters of potential interest to the Graduate Education Review Board (GERB). The GERG 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 Naval Postgraduate Education Programs and advise the Secretary of the Navy relative to its 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 renewable terms of up to four years by the Secretary of the Navy upon the recommendation of the Superintendent.

The Board meets annually at the Naval Postgraduate School, and after its meeting they submit an annual report. 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. His principle assistant is the Provost/Academic Dean who is the senior member of the civilian faculty.

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. All other Deans report to the Provost/Academic Dean.

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

ADMINISTRATIVE STAFF

Principle assistants to the Superintendent and Provost are the administrative staff, which consist of two captains of the line who serve as the Director of Programs and the Director of Military Operations and five faculty members who serve as Deans and Directors of academic functions. These currently are:

DIRECTOR OF PROGRAMS: **Howard Venezia,** Captain, U.S. Navy.
DIRECTOR OF MILITARY OPERATIONS: **William E. Held, Jr.,** Captain, U.S. Navy.
DEAN OF INFORMATION AND POLICY SCIENCE: **Kneale Thomas Marshall,** Professor of Operations Research.
DEAN OF SCIENCE AND ENGINEERING: **Gordon Everett Schacher,** PhD, Professor of Physics.
DEAN OF ACADEMIC ADMINISTRATION: **Gerald Herbert Lindsey,** PhD, Professor of Aeronautics.
DIRECTOR OF RESEARCH: **Gilbert T. Howard,** PhD, Professor of Operations Research.
DIRECTOR OF CONTINUING EDUCATION: **Robert D. Zucker,** PhD, Professor of Aeronautics.

The academic program organization is supervised by the Director of Programs, the Dean of Information and Policy Sciences, and the Dean of Science and Engineering who collaborate to share jointly the responsibilities for planning, conducting and administering the several education programs.

ACADEMIC DEPARTMENTS

Members of the faculty are organized into eleven Academic Departments and three Interdisciplinary Groups, each supervised by a Chairman. Over 80% of the teaching staff are civilians of varying professional rank and the remainder are military officers. The departments are grouped into a Division of Information and Policy Sciences and a Division of Science and Engineering. Designated Deans supervise the academic affairs of their respective divisions. Chairmen of the Interdisciplinary Groups report to the Provost.

Division of Information and Policy Sciences

- Administrative Sciences
- Computer Science
- Mathematics
- National Security Affairs
- Operations Research

Division of Science and Engineering

- Aeronautics
- Electrical and Computer Engineering
- Mechanical Engineering
- Meteorology
- Oceanography
- Physics

Academic Groups

- Antisubmarine Warfare
- Command, Control and Communications
- Electronic Warfare
- Space Systems Operations

CURRICULAR OFFICES

The Curricular Offices are organizational entities that are separate from, but interactive with, the Academic Departments in the educational operation of the School. The former are staffed by naval officers and civilian faculty members whose primary functions are threefold: (1) academic coun-

seling and military supervision of officer students; (2) curriculum development and management to insure 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 Division Deans for the integrity and academic soundness of the academic features of the Curricular Office operations. Curricular Officers ensure their curricula meet Navy needs, and ensure the proper administrative operation of their respective offices. They report to the Director of Programs, who is the senior military officer under the Superintendent responsible for all military personnel assigned to curricular or academic duties.

Officer students are grouped into the following curricular program areas:

Administrative Sciences
Aeronautical Engineering
Air-Ocean Sciences
Antisubmarine Warfare
Command, Control and Communications (C3)
Computer Technology
Electronics and Communications
National Security Affairs/ Intelligence
Naval Engineering
Operations Analysis
Weapons Engineering/ASW

FACULTY ORGANIZATIONS

The faculty has a systematic 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 Research Council reviews research proposals for, and determines allocation of, Foundation Research Program funds; the Computing Advisory Board and the Library Council function similarly. The composition of each Council and its specific functions are described in the NPS Organization and Regulations Manual.

STUDENT COUNCIL

The Student Council 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 Student Council 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 Student Council 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. Student Council representation is included in the following NPS standing Councils and Committees:

Academic Council

Faculty Council
Library Council
Computer Council

Exchange/Bookstore Committee
Recreation Committee
O'Club Committee

Public Works/Housing Committee
Medical Committee

Student Council meetings are held at least once a month and the minutes of these meetings are distributed to interested offices within the School.

SPECIAL FACILITIES

DUDLEY KNOX LIBRARY

The Library embraces an active collection of 350,000 books, bound periodicals, government documents, pamphlets, and other materials in hard copy and microform; 510,000 research reports in hard copy and microform, and over 1,800 periodicals and other serial publications currently received. These materials parallel the School's curricular fields of engineering, physical sciences, managerial sciences, operations research, naval sciences, and national security affairs.

The Reader Services Division provides the open literature sources, such as books, periodicals and journals, indexes and abstracting services, pamphlet materials and newspapers. It provides access to more than 400 computer databases in the curricular fields of interest by means of DIALOG (Lockheed Informations Systems), NEXIS (Mead Data Central), and RLIN (Research Libraries Group). It furnishes facilities for microform reading and printing and for reproduction of printed matter. It borrows publications not held in its collections from other libraries.

The Research Reports and Classified Materials Division is the principal repository for research documents received by the School. It houses the Library's classified and unclassified research reports in hard copy and microfiche. A machine information storage and retrieval system that utilizes the School's computer facilities is available for bibliographic searches of research and development documents held by the division. An SDI (Selective Dissemination of Information) Service is also available. The Division is able to perform, via its own remote terminal, computer searches of the data banks of the Defense Technical Information Center in Alexandria, Virginia, and thus to provide rapid and efficient access to the 1,000,000 plus documents held by the Center. It also accesses the CIRC (Central Information Reference and Control) System and NASA/RECON.

W.R. CHURCH COMPUTER CENTER

The many services of the Computer Center are available to all faculty,

staff, and students of the School for use in instruction, research, or administrative activities. Round-the-clock support is provided on a network of three IBM computers, specifically a 3033 Model AP (a dual-processor configuration with 16 Mbytes of processor storage), a 3033 Model U with 16 Mbytes, and a 4381-13 with 16 Mbytes. The systems share all input/output equipment and auxiliary storage devices, including four paging drums, IBM 3380 and 3350 Direct Access Storage, IBM 3420-8 Tape Drives (6,250 bpi) and IBM 3480 Tape Cartridge Units.

(In the Fall, 1988 the Center's IBM 3033 Mainframes will be replaced and other facilities upgraded significantly.)

The principal mode of access is via 550 IBM 3270 Type Terminals located in public spaces and private offices in the academic buildings and attached by coaxial cable to the computer in Ingersoll Hall. Full micro-to-mainframe communications support is provided for hard-wired or dial-up linkage. In addition, there are 20 full graphic displays available for public use. The computer network is run under the operating system VM/SP (Virtual Machine) which provides batch-processing support on MVS (Multiple Virtual Storage) and interactive computing on CMS (Conversational Monitor System). The extensive programming facilities include VS FORTRAN, WATFIV, VS COBOL, WATBOL, PL/1 Optimizer, BASIC, APL2, PASCAL, LISP and C. Most languages are available in both interactive and batch-processing modes.

The School has a heavy commitment to computers consistent with their present and future role in military operations. All of the academic curricula have been affected by the presence of computers on campus. All graduate students take at least one course in computer science. They are introduced to computers early in their curricula at the Naval Postgraduate School and encouraged to use them in subsequent course work and research.

The Computer Center supports a wide variety of specialist courses in computer science offered by the Departments of Computer Science, Electrical & Computer Engineering, Mathematics, Operations Research and Administrative Sciences.

The professional staff provides short courses, consulting services in application programming, systems programming and problem formulation assistance for students and faculty members. They participate in an active research and development program directed primarily towards improving the present operational environment or introducing new hardware and software facilities to users. Current projects include work on systems measurement, improvement of operating systems, graphical data processing, timesharing facilities, micro-to-mainframe communications and networking.

In addition to these facilities, virtually all of the academic departments have developed computing facilities and/or laboratories, mini- and microprocessor based, which provide computing support or are dedicated to specific areas of research. Micro-computers are widely used as stand-alone development tools or as processing elements imbeded in more complex systems. Many students have purchased their own personal computer.

SPECIAL PROGRAMS

FEDERAL CIVILIAN EDUCATION

Any civilian employee of the United States Government is eligible to participate in the program of the School. The individual's employing agency is expected to meet the tuition expense for regular on-campus enrollment ($1,500 per quarter per student). Costs associated with participation in the Continuing Education Program are determined on an ad hoc basis.

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 programs section describes the available curricula.

Degree Programs: For civilian students, programs can 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. This may include self-study courses from the School or courses at a local university. If the available time in residence, typically four calendar quarters or less, 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. Any of the School's regular courses are available for such efforts. 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.

Continuing Education: Approximately thirty-five short courses are delivered annually, both on-site at supporting activities and at Monterey. Attendance in these courses is open to military and civilian employees of the Federal Government. Courses given at Monterey are offered on a tuition-fee basis. A listing of planned short courses is available upon request. Civilian employees of the Federal Government may also enroll in self-study courses which can be completed off-campus for academic credit with assistance of an on-site tutor. Courses completed in this manner prior to beginning a degree program at NPS can reduce time in residency. Until further notice, no fee is charged for civilian enrollments in self-study courses. A listing of available courses, enrollment procedures, and other details of this program are provided in the Catalog of Self-Study Credit Courses, which is available at all ships and stations in the Navy. Copies of this catalog are available upon request.

There are no formal requirements for enrollment in the Continuing Education Program. For admission to either a degree or a non-degree program, the minimum qualification is an accredited baccalaureate degree with appropriate preparation for the proposed program. As described under Admissions Procedures in this Catalog,

the School will require submission of official transcripts covering all college work completed to date.

The point of contact for requests for Naval Postgraduate School Catalogs: Dean of Academic Administration, Code 014, Naval Postgraduate School, Monterey, CA 93943, or telephone (408) 646-2391 or Autovon 878-2391. Requests for information about on-campus programs or admission to resident study programs: Director of Admissions, Code 0145, Naval Postgraduate School, Monterey, CA 93943, or telephone (408) 646-3093 or Autovon 878-3093. Requests for a listing of planned short courses or Catalog of Self-Study Courses: Director of Continuing Education, Code 011, Naval Postgraduate School, Monterey, CA 93943 or telephone (408) 646-2558 or Autovon 878-2558.

CONTINUING EDUCATION

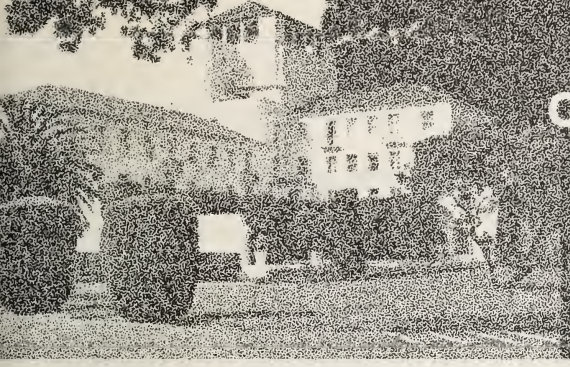
The Naval Postgraduate School Continuing Education Program was established in June 1974 as a means of providing extended educational services that will more comprehensively fulfill the School's assigned mission. These extended services include the offerings of self-study credit courses off campus; the delivery, both on and off campus, of profesionally relevant short courses; and expanded educational counseling. The self-study course offerings are listed in the Catalog of Self-Study Courses which is distributed annually to nearly all ships and stations in the Navy and to selected offices of other DOD establishments. This program is administered by the Continuing Education Office.

Selected graduate preparatory courses are delivered off campus in a self-study self-paced mode for the same academic credit as received when taken on campus. These self-study courses are delivered to officers at their current duty stations for completion during off-duty hours. They have been selected from courses normally taken in the initial phase of curricular programs at the Naval Postgraduate School. Their successful completion will enhance selection for postgraduate education, enhance performance in early phases of graduate education programs, and reduce course requirements in curricular programs at the Naval Postgraduate School. The delivery of a self-study credit course normally requires the local participation of a qualified tutor (e.g., a civilian or officer with requisite graduate education). Self-study courses taken for review do not require a tutor.

Application for enrollment in a self-study course may be made at any time. Applicants should use the appropriate form contained in the self-study catalog. Self-study courses are also available to civilian employees of the Federal Government.

Commands with available funds may arrange for delivery on site of short courses to meet specific needs on a direct reimbursable basis to the Naval Postgraduate School. Delivery costs may be obtained from the Continuing Education Office.

More information on short courses and self-study courses is available from the Continuing Education Office, Code 011, Naval Postgraduate School, Monterey, CA 93943, or telephone (408) 646-2558 or Autovon 878-2558.



CURRICULAR OFFICES AND PROGRAMS

The Curricular Office is an organizational entity unique to the Naval Postgraduate School. It supports the School's mission and objectives by providing the structure for the development, maintenance and updating of curricular programs which meet both Navy and Department of Defense needs and academic requirements. The office is composed of a Curricular Officer with possible assistants, one or more Academic Associates, and clerical personnel. The Curricular Officer is a military officer of suitable rank and experience, and the Academic Associate is a faculty member who is familiar with the curriculum. This team performs the following functions:

- — provides liaison with the curricular sponsor
- — develops and manages each curriculum
- — supervises and counsels enrolled students
- — provides counseling for future students

The Curricular Officer/Academic Associate team work with the curriculum sponsors to develop educational skill requirements and update the curriculum courses to ensure that graduates are properly educated to face the challenges of their future subspecialty utilization tours.

Curricular Officers and Academic Associates also review the records of all prospective students. Following the student's arrival, they provide both academic and professional counseling as required. This team is responsible for ensuring that each individual's academic program satisfies education skill requirements and is consistent with the individual's educational background.

Prospective students are encouraged to communicate with the cognizant Curricular Officer by letter or telephone for counseling regarding particular off-campus courses they may require to qualify for enrollment. They are also encouraged to take advantage of the Postgraduate School's Continuing Education Program which offers preparatory courses required in many of the curricula.

CURRICULAR OFFICES

Title		Autovon
Administrative Sciences	36	878-2536
Aeronautical Engineering	31	878-2491
Air-Ocean Sciences	35	878-2044
Antisubmarine Warfare	3A	878-2135
Computer Technology	37	878-2174
Electronics and Communications	32	878-2056
Joint Command, Control and Communications (C3)	39	878-2772
National Security Affairs and Intelligence	38	878-2228
Naval Engineering	34	878-2033
Operations Research	30	878-2786
Weapons Engineering	33	878-2116

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 ensure that a sufficient number of officers with subspecialty codes will be available 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
365	Joint Command, Control and Communications (C3)	325	XX45P	MS Systems Tech. (C3)
366	Space Systems Operations	324	XX76P	MS Systems Tech. (Space Sys. Ops.)
367	Computer Systems Management	335	XX95P	MS Information Systems
368	Computer Science	325	XX91P	MS Computer Science
372	Meteorology	323	XX48D	PhD Only
373	Air-Ocean Sciences	323	XX47P	MS Meteorology and Oceanography
374	Operational Oceanography	323	XX49P	MS Meteorology and Oceanography
380	Advanced Science (Applied Mathematics)	203	XX41P	MS Mathematics
440	Oceanography	323	XX49D	PhD Only
441	Hydrographic Science	324	NONE	MS Hydrographic Sciences
525	Antisubmarine Warfare Systems	323	XX44P	MS Systems Technology (ASW)
530	Weapons Systems Engineering	323	XX61P	MS Engineering Sci.
531	Weapons Systems Sciences (Physics)	323	XX63P	MS Physics
532	Nuclear Physics (Weapons & Effects)	323	XX67P	MS Physics
535	Underwater Acoustics	323	XX56P	MS Engineering Acoustics
570	Naval/Mechanical Engineering	323	XX54P	MS Mechanical Eng.
590	Electronic Systems Engineering	323	XX55P	MS Electrical Eng.
591	Space Systems Engineering	323	XX77P	MS Electrical Eng.
595	Electronic Warfare Systems Eng.	325	XX46P	MS Systems Engineering
600	Communications Engineering	323	XX81P	MS Electrical Engineering
610	Aeronautical Engineering	323	XX71P	MS Aeronautical Eng.
611	Aeronautical Engineering-Avionics	323	XX72P	MS Aeronautical Eng.
620	Telecommunications Systems Management	335	XX82P	MS Telecommunications Systems Management
681	National Security Affairs (Middle East, Africa, South Asia)	365	XX21P	MA National Security Affairs
682	National Security Affairs (Far East, South East Asia, Pacific)	365	XX22P	MA National Security Affairs
683	National Security Affairs (Europe, USSR)	365	XX24P	MA National Security Affairs
684	National Security Affairs (International Org. & Negotations)	365	XX25P	MA National Security Affairs
685	National Security Affairs (Western Hemisphere)	365	XX23P	MA National Security Affairs
686	National Security Affairs (Strategic Planning)	335	XX26P	MA National Security Affairs
813	Transportation Logistics Mgt.	345	1304P	MS Management
814	Transportation Management	345	XX35P	MS Management
815	Acquisition & Contract Mgt.	345	1306P	MS Management
819	Systems Inventory Management	345	1302P	MS Management
825	Intelligence	334	XX17P	MS National Security Affairs
827	Material Logistics Support Mgt.	345	XX32P	MS Management
837	Financial Management	345	XX31P	MS Management
847	Manpower, Personnel & Training Analysis	345	XX33P	MS Management

This section of the catalog includes descriptions of all the curricula offered at the Naval Postgraduate School which are summarized in the Table below. 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 an introductory course in set and logic theory and a programming course in BASIC on desk-top microcomputers.

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, physics, and introductory computer courses.

CURRICULA SUMMARY

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Administrative Sciences				
(Material Movement)	813	18	July	36
(Transportation Management	814	18	July	36
(Acquisition & Contract Management)	815	18	January,July	36
(Allied Officers, DOD Civilians, USA, USMC and USCG)	817	18	January,July	36
(Systems Inventory Management)	819	18	July	36
(Material Logistics Support Management)	827	18	January,July	36
(Financial Management)	837	18	January,July	36
(Manpower/Personnel Training Analysis	847	18	January,July	36
Advanced Science (Applied Mathematics)	380	24	Apr/Oct	33
Aeronautical Engineering	610	24	Apr/Oct	31
Aeronautical Engineering Avionics	611	24	Apr/Oct	31
Air-Ocean Sciences	373	24	Any Quarter	35
Antisubmarine Warfare	525	24	Apr/Oct	3A
Communications Engineering	600	21-27	Any Quarter	32
Computer Science	368	21	Apr/Oct	37
Computer Systems	367	18	Apr/Oct	37
Electronic Warfare Systems Technology	595	24	October	3A
Electronic Warfare Systems Technology (Allied Officers)	596	24	October	3A
Electronic Systems Engineering	590	21-27	Any Quarter	32
Engineering Science	460	3-6	Any Quarter	Any

Hydrographic Sciences	441	24	Any Quarter	35
Intelligence	825	18	Apr/Oct	38
Joint Command, Control and Communications (C3)	365	18	October	39
Meteorology	372	24-36	Any Quarter	35
National Security Affairs (Middle East, Africa South Asia)	681	18	January,July	38
(Far East, Southeast Asia, Pacific)	682	18	January,July	38
(Europe, USSR)	683	18	January,July	38
(International Organizations and Negotiations	684	18	July	38
(Western Hemisphere)	685	18	January,July	38
(Strategic Planning)	686	18	January,July	38
Naval Engineering	570	24-27	Any Quarter	34
Nuclear Physics (Weapons & Effects)	532	27	Apr/Oct	33
Oceanography	440	24-36	Any Quarter	35
Operational Oceanography	374	24	Any Quarter	35
Operational Logistics	361	24	October	30
Operations Analysis	360	24	Apr/Oct	30
Space Systems Engineering	591	27	Any Quarter	39
Space Systems Operations	366	24	October	39
Telecommunications Systems Management	620	18	October	32
Underwater Acoustics	535	27	Apr/Oct	33
Weapons Systems Engineering	530	27	Apr/Oct	33
Weapons Systems Science	531	27	Apr/Oct	33

ADMINISTRATIVE SCIENCES PROGRAM

Curricular Officer

John E. Jackson, CDR, SC, USN,
Code 36, Ingersoll Hall, Room 219,
(408) 646-2536, AV 878-2536.

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. These programs are designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, 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.

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 where knowledge of the material has been acquired by experience or service courses.

TRANSPORTATION LOGISTICS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Material Movement Subspecialist with a subspecialty code of 1304P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Transportation Systems
CINCLANTFLT, Norfolk, VA
Transportation Logistics
CINCUSNAVEUR, London
Deputy Chief
Military Traffic Command
Director of Material Department
Naval Supply Depot/Naval Supply Center Worldwide
Director of Storage Division
Naval Supply Depot/ Naval Supply Center Worldwide

Entry Date: Transportation Logistics Management is a six 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.

Academic Associate:

Alan W. McMasters, Assoc. Prof., Code 54Mg, Ingersoll Hall, Rm. 209, (408) 646-2678, AV 878-2678.

Degree: Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3373 (4-0)	Transportation Management I
OS 3105 (4-0)	Probability & Statistics

Quarter 3

MN 3301 (4-0)	Systems Acquisition & Project Management
MN 3172 (4-0)	Public Policy Processes
MN 3105 (4-0)	Organization & Management
OS 3106 (4-0)	Probability & Statistics II

Quarter 4

MN 4373 (4-0)	Transportation Management II
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management

Quarter 5

MN 3377 (4-0)	Inventory Management
MN 4152 (4-0)	Corporate Financial Management
MN 0810	Thesis
MN 0810	Thesis

Quarter 6

MN 4105 (4-0)	Management Policy
MN 3371 (4-0)	Contracts Management & Administration
MN 4145 (4-0)	Financial Management in The Armed Forces
MN 0810	Thesis

TRANSPORTATION MANAGEMENT CURRICULUM 814

The objectives of this curriculum are to prepare officers for logistics system positions within the Navy, and to emphasize the worldwide transportation aspects of it. 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.

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 Military Sealift Command Headquarters.

Typical Jobs in this Subspecialty:

Executive Officer
Military Sealift Command
Overseas: Guam, Okinawa, Korea, MED

Executive Officer
Military Sealift Command Office, CONCUS: Seattle, New Orleans, San Diego, Anchorage

Tanker Control Officer
Military Sealift Command

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 where knowledge of the material has been acquired by experience or service courses.

Entry Date: Transportation Management is a six 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.

Academic Associate:

Alan W. McMasters, Assoc. Prof., Code 54Mg, Ingersoll Hall, Rm. 209, (408) 646-2678, AV 878-2678.

Degree: Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3373 (4-0)	Transportation Management I
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 3372 (4-0)	Material Logistics
MN 3172 (4-0)	Public Policy Processes
MN 3105 (4-0)	Organization & Management
OS 3106 (3-1)	Statistical Analysis for Management II

Quarter 4

MN 4373 (4-0)	Transportation Management II
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management

Quarter 5

MN 3101 (4-0)	Personnel Management
MN 4942 (4-0)	Structure, Conduct & Performance of The Defense Industry
MN 0810	Thesis
MN 0810	Thesis

Quarter 6

MN 4105 (4-0)	Management Policy
MN 3301 (4-0)	Systems Acquisition & Project Management
MN 0810	Thesis
	Elective

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. Inputs from the Navy are from the Supply Corps and civilians in the 1102 series. Marine Corps, Army and Coast Guard officers also participate in the program. The curriculum is designed to provide officers with the skills to serve effectively in hardware systems procurement offices, field procurement offices, contract administration offices, and contracting policy support offices.

The following are a sample of the educational skill requirements of the curriculum as delineated by the curriculum sponsor:

- Develop, implement and coordinate acquisition strategies, policies and plans.
- Understand business finance and accounting; evaluate contractor proposals and capabilities.
- Knowledge of system life cycle, economic analysis.
- Have an in-depth comprehension of contract types.
- Ability to evaluate requirements, specifications, bids, proposals and contractor performance.
- Determine rights/obligations for settlement of controversies on government contracts.

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 where knowledge of the material has been acquired by experience or service courses.

ACQUISITION AND CONTRACT MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Acquisition and Contract Management Subspecialist with a subspecialty code of 1306P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:

- Contracting Officer
  - Ships Parts Control Center, Mechanicsburg, PA; Aviation Supply Office, Philadelphia, PA
- Director of Contracts
  - Naval Supply Depots, Naval Supply Centers, Navy Laboratories, Navy Regional Contracting Centers
- Procuring Contracting Officer, (PCO)
  - Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR), Washington, DC
- Business/Financial Manager (B/FM)
  - Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR), Washington, DC
- Contracts and Business Policy
  - Staff of Asst. Secretary of the Navy (Shipbuilding and Logistics)
  - Staff of Under Secretary of Defense (Acquisitions)
- Administrative Contracting Offices (ACO)
  - Defense Contract Administration Services (DCAS)

Naval Plant Representative Office (NAVPRO)
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.

Academic Associate:

David V. Lamm, Assist. Professor, Code 54Lt, Ingersoll Hall, Room 238, (408) 646-2775, AV 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

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management
MN 2302 (0-3)	Seminar

Quarter 2

MN 3303 (4-0)	Principles of Acquisition and Contracting
MN 3140 (4-0)	Microeconomic Theory
MN 3161 (4-0)	Managerial Accounting
OS 3105 (3-1)	Statistical Analysis for Management I
MN 2302 (0-3)	Seminar

Quarter 3

MN 3304 (4-0)	Contract Pricing and Negotiations
MN 3172 (4-0)	Public Policy Process
MN 3105 (4-0)	Organization and Management
OS 3106 (3-1)	Statistical Analysis for Management II
MN 2302 (0-3)	Seminar

Quarter 4

MN 3305 (4-0)	Contract Administration
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
MN 4151 (4-0)	Internal Control and Financial Auditing
MN 2302 (0-3)	Seminar

Quarter 5

MN 4301 (4-0)	Contracting for Major Systems
MN 3377 (4-0)	Inventory Management
OS 3006 (4-0)	Operations Research for Management
MN 2302 (0-3)	Seminar
MN 0810	Thesis

Quarter 6

MN 4371 (4-0)	Acquisition and Contracting Policy
MN 4105 (4-0)	Management Policy
MN 2302 (0-3)	Seminar
MN 0810	Thesis
MN 0810	Thesis

ADMINISTRATIVE SCIENCES (NON USN) CURRICULUM 817

These programs are 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 product of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required to effectively manage.

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 specified by ordering officers into a specific curriculum.

While Allied students are free to choose any of the specific management curricula available, nearly half choose the more general Administrative Sciences International Curriculum 817. The 817 curriculum allows students to design a program of course work that is specifically useful in effectively managing in the culture uniquely characteristic of their own 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.

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 Allied officers, and DoD employees, 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 where knowledge of the material has been acquired by experience or service courses.

Entry Dates: Administrative Sciences for USA, USCG, USMC, DOD civilians and allied 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.

Academic Associate:

USA - Management Sciences
George W. Thomas, Assoc. Prof., Code 54Te, Ingersoll Hall, Rm. 243, (408) 646-2741, AV 878-2471.

USCG & DOD Civilians - Administrative Sciences, and

USMC - Defense Systems Analysis
Kenneth J. Euske, Assoc. Prof., Code 54Ee, Ingersoll Hall, Rm. 309, (408) 646-2860, AV 878-2860.

Allied Officers - Administrative Sciences
Roger D. Evered, Professor, Code 54Ev, Ingersoll Hall, Rm. 201, (408) 646-2646, AV 878-2646.

Degree: Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY
ARMY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 1117 (5-2)	Single Variable Calculus/Laboratory

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
OA 2200 (3-2)	Computational Methods for Operations Research
OS 3104 (4-0)	Statistics for Science and Engineering

Quarter 3

MN 3172 (4-0)	Public Policy Processes
OS 3006 (4-0)	Operations Research for Management
	(Curriculum Option)
	(Curriculum Option)

Quarter 4

MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
MN 3105 (4-0)	Organization & Management
	(Curriculum Option)

Quarter 5

MN 0810	Thesis
	(Curriculum Option)
	(Curriculum Option)
	(Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 0810	Thesis
MN 0810	Thesis
	(Curriculum Option)

COAST GUARD

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communications Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization & Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 3111 (4-0)	Personnel Management Processes
MN 3172 (4-0)	Public Policy Processes
MN 4161 (4-0)	Financial Management Control Systems
OS 3106 (3-1)	Statistical Analysis for Management II

Quarter 4

MN 4110 (4-2)	Multivariate Manpower Data Analysis
MN 4145 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management
IS 3183 (4-0)	Management Information Systems

Quarter 5

MN 0810	Thesis
	(Curriculum Option)
	(Curriculum Option)
	(Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 0810	Thesis
MN 0810	Thesis
	(Elective)

MARINE CORPS

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communications Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization & Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 4154 (4-0)	Financial Management in The Armed Forces
MN 3172 (4-0)	Public Policy Processes
OS 3106 (3-1)	Statistical Analysis for Management II
MN 3301	Systems Acquisition and Project Management

Quarter 4

OA 4702 (4-0)	Cost Estimation
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management

Quarter 5

MN 0810	Thesis
MN 0810	Thesis (Curriculum Option) (Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 0810	Thesis (Elective) (Curriculum Option)

ALLIED OFFICERS

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
AS 1501 (0-4)	English Language Skills*
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization & Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 3333 (4-0)	Managerial Communication Skills
OS 3106 (3-1)	Statistical Analysis for Management II (Curriculum Option) (Curriculum Option)

Quarter 4

MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management (Curriculum Option)

Quarter 5

MN 0810	Thesis (Curriculum Option) (Curriculum Option) (Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 0810	Thesis
MN 0810	Thesis (Curriculum Option)

*DEPENDING UPON INCOMING ENGLISH LANGUAGE SKILLS

DOD CIVILIAN PROGRAM

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization and Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 3172 (4-0)	Public Policy Processes
OS 3106 (3-1)	Statistical Analysis for Management II
	(Curriculum Option)
	(Curriculum Option)

Quarter 4

MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management
	(Curriculum Option)

Quarter 5

MN 0810	Thesis
	(Curriculum Option)
	(Curriculum Option)
	(Curriculum Option or Elective)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 0810	Thesis
MN 0810	Thesis
	(Curriculum Option or Elective)

SYSTEMS INVENTORY MANAGEMENT CURRICULUM 819

This curriculum emphasizes the management of Navy owned inventories at all levels. 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.

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 where knowledge of the material has been acquired by experience or service courses.

Degree: Requirements for the degree Master of Science in Mangement are met as a milestone en route to satisfying the skill requirements of the curricular program.

SYSTEMS INVENTORY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an 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 Management
Naval Supply Depot/Naval Supply Center
Stock Control
Navy Shipyards
Head Inventory Control Point
Polaris Material Office, Bremerton/Charleston
Director of Program Support Office
Ship Parts Control Center, Mechanicsburg, PA
Director of Customer Support Office
Ships Parts Control Center, Mechanicsburg, PA
Project Officer, Inventory Control Point (ICP) Resystemization
Fleet Material Support Office, Mechanicsburg, PA
Director, Retail Management Division
Fleet Material Support Office, Mechanicsburg, PA
Project Officer, Inventory Accuracy and LOGMARS
Fleet Material Support Office, Mechanicsburg, PA
Director, ICP Design and Procedure Department
Fleet Support Material Support Office, Mechanicsburg, PA

Entry Date: Systems Inventory Management is a six 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.

Academic Associate:

Alan W. McMasters, Assoc. Prof., Code 54Mg, Ingersoll Hall, Rm. 209, (408) 646-2678, AV 878-2678

TYPICAL COURSE OF STUDY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization & Management
OS 3104 (4-0)	Statistics for Science & Engineering

Quarter 3

OA 3501 (4-0)	Inventory I
MN 3172 (4-0)	Public Policy Processes
MN 3372 (4-0)	Material Logistics
MN 3301 (4-0)	Systems Acquisition & Project Management

Quarter 4

MN 3371 (4-0)	Contracts Management and Administration
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management

Quarter 5

OA 4501 (4-0)	Seminar in Supply Systems
MN 0810	Thesis
MN 0810	Thesis (Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 4145 (4-0)	Financial Management in The Armed Forces
MN 4310 (4-0)	Logistics Engineering
MN 0810	Thesis

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.

MATERIAL LOGISTICS SUPPORT MANAGEMENT SUBSPECIALIST

Completion of this curriculum qualifies an officer as a Material Logistics Support Management Subspecialist with a subspecialty code of XX32P. The Curriculum sponsor is Naval Air Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Aircraft Intermediate Maintenance
Naval Air Stations
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
Naval Supply Depot/Naval Supply Center
Director of Storage
Naval Supply Depot/Naval Supply Center

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 where knowledge of the material has been acquired by experience or service courses.

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.

Academic Associate:

Alan W. McMasters, Assoc. Prof., Code 54Mg, Ingersoll Hall, Rm. 209, (408) 646-2678, AV 878-2678.

Degree: Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communication Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 3

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microenonomic Theory
MN 3105 (4-0)	Organization & Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 3372 (4-0)	Material Logistics
MN 3172 (4-0)	Public Policy Processes
MN 3301 (4-0)	Systems Acquisition and Project Management
OS 3106 (3-1)	Statistical Analysis for Management II

Quarter 4

MN 3371 (4-0)	Contracts Management and Administration
MN 4145 (4-0)	Policy Analysis
IS 3183 (4-0)	Management Information Systems
OS 3006 (4-0)	Operations Research for Management

Quarter 5

MN 3374 (4-0)	Production Management
MN 3377 (4-0)	Inventory Management
MN 0810	Thesis
MN 0810	Thesis

Quarter 6

MN 4105 (4-0)	Management Policy
MN 4145 (4-0)	Financial Management in The Armed Forces
MN 4310 (4-0)	Logistics Engineering
MN 0810	Thesis

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, financial auditing, operational auditing, management planning and control systems, quantitative techniques used in planning and control, and the Planning Programming 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.

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. Vali-

dation or credit by examination is encouraged where knowledge of the material has been acquired by experience or service courses.

Degree: Requirements for the degree Master of Science in Management are met en route to satisfying the skill requirements of the curricular program.

FINANCIAL MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Financial Management Subspecialist with a subspecialty code of XX31P. The Curriculum Sponsor is OP-92, 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 (OP-92)

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.

Academic Associate:

Jerry L. McCaffery, Professor,
Code 54Mm, Ingersoll Hall, Rm. 235
(408) 646-2554, AV 878-2554

TYPICAL COURSE OF STUDY

Quarter 1

MN 2150 (4-0)	Financial Accounting
MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communications Skills
MA 2300 (5-0)	Mathematics for Management

Quarter 2

MN 3161 (4-0)	Managerial Accounting
MN 3140 (4-0)	Microeconomics Theory
MN 3105 (4-0)	Organization & Management
OS 3105 (3-1)	Statistical Analysis for Management I

Quarter 3

MN 4161 (4-0)	Financial Management Control Systems
MN 3172 (4-0)	Public Policy Processes
MN 4162 (4-0)	Cost Accounting
OS 3106 (3-1)	Statistical Analysis for Management II

Quarter 4

MN 4154 (4-0)	Financial Management in The Armed Forces
MN 4145 (4-0)	Policy Analysis
OS 3006 (4-0)	Operations Research for Management (Curriculum Option)

Quarter 5

MN 0810	Thesis
MN 0810	Thesis (Curriculum Option) (Curriculum Option)

Quarter 6

MN 4105 (4-0)	Management Policy
MN 3301 (4-0)	System Acquisition & Project Management
IS 3183 (4-0)	Management Information Systems (Curriculum Option) (Curriculum Option)

MANPOWER, PERSONNEL AND TRAINING ANALYSIS CURRICULUM 847

Officers enrolled in the Manpower/Personnel/Training Analysis (MPTA) curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill the leadership roles in military manpower management. The XX33 Subspecialty has primary responsibility for developing and analyzing policies to ensure that the Navy is recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MPTA 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 policy analysis.

The areas covered in the MPTA curriculum include an understanding of MPT policy development, compensation systems, productivity analysis, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix,enlistment incentives, reenlistment incentives, training effectiveness measures and hardware/manpower trade-offs. Students gain familiarity with current models and methods of MPT analysis as well as military MPT 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. An APC of 345 is required for entry.

Prospective students electing MPTA as a subspecialty must be adequately prepared by their undergraduate curriculum 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 where knowledge of the material has been acquired by experience or service courses.

Degree: Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

MANPOWER, PERSONNEL AND TRAINING ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Manpower, Personnel and Training Analysis Subspecialist with a subspecialty code of XX33P. The Curriculum Sponsor is OP-11, Total Force Training and Education Division.

Typical Jobs in this Subspecialty:

Head, Ship Manpower Requirements Section
- Deputy Chief of Naval Operations (Manpower, Personnel & Training)
- Director Total Force Programming/Manpower Division OP-12, Washington, DC

Programmed Objective Memorandum (POM) Operations
- Deputy Chief of Naval Operations (Manpower, Personnnel & Training)
- Director Total Force Programming/Manpower Division, OP-12. Washington, DC

Manager (OP-12A)
- Deputy Chief of Naval Operations (Manpower, Personnel & Training)

Director Total Force Programming/Manpower Division OP-12, Washington, DC
Total Force Mobilization Plans Branch
Deputy Chief of Naval Operations (Manpower, Personnel & Training)
Director Military Personnel Policy Division (OP-134G), Washington, DC
Head, Officer Procurement Plans Section (OP-13OD)

Entry Dates: Manpower, Personnel & Training Analysis 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.

Academic Associate:

Stephen L. Mehay, Assoc. Prof., Code 54Mp, Ingersoll Hall, Rm. 246, (408) 646-2643, AV 878-2643.

MPTA PROGRAM

Quarter 1

MN 2031 (4-0)	Economic Decision Making
MN 3333 (4-0)	Managerial Communications Skills
MA 2300 (5-0)	Mathematics for Management
MN 2901 (0-2)	Computer Lab
MN 2111 (0-2)	Seminar in MPTA Issues I

Quarter 2

MN 2155 (4-0)	Accounting for Management
MN 3140 (4-0)	Microeconomic Theory
MN 3105 (4-0)	Organization and Management
OS 3101 (4-1)	Statistical Analysis for Management
MN 3902 (0-2)	MPT Computer Skills
MN 2112 (0-2)	Seminar in MPTA Issues II

Quarter 3

MN 3760 (4-0)	Manpower Economics
MN 3111 (4-0)	Personnel Processes
OS 3006 (4-0)	Operations Research for Management
MN 4110 (5-2)	Multivariate Manpower Data Analysis I
MN 2113 (0-2)	Seminar in MPTA Issues III

Quarter 4

MN 4761 (4-0)	Applied Manpower Analysis
MN 4500 (4-0)	Productivity Analysis
MN 4111 (5-2)	Multivariate Manpower Data Analysis II
OS 4701 (4-0)	Manpower and Personnel Models

Quarter 5

MN 3172 (4-0)	Public Policy Processes
MN 4106 (4-0)	Manpower Policy Analysis
MN 0810	Thesis
MN 0810	Thesis
MN 4904 (0-2)	Advanced MPT Research Applications

Quarter 6

IS 3183 (4-0)	Management Information Systems
MN 4105 (4-0)	Management Policy
MN 2114 (0-2)	Seminar in MPTA Issues IV
MN 0810	Thesis (Curriculum Option)

AERONAUTICAL ENGINEERING PROGRAMS

Curricular Officer:

Robert G. Bettinger, CDR, USN,
Code 31, Halligan Hall, Room 133,
(408) 646-2491, AV 878-2491.

AERONAUTICAL ENGINEERING AND AERONAUTICAL ENGINEERING WITH AVIONICS CURRICULA 610 & 611

The Aeronautical Engineering Programs are designed to meet the specific needs of the Navy's Operational Technical Managerial System (OTMS) for 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 widely varying academic backgrounds.

The Aeronautical Engineering Programs are designed to give the student a broad technical and engineering education in the four principal areas of aeronautics: gas dynamics, flight dynamics, propulsion, and flight stuctures. Additionally, officers receive graduate level instruction in aircraft/missile design and aero-computer science. Students in the 611 Curriculum receive additional emphasis on avionics systems. The programs are divided into preparatory, graduate 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, a common graduate core is completed by both the 610 and 611 students. This phase includes advanced studies in propulsion, aerodynamic analysis, structural analysis and stability and control. 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 and structures. Students in Curriculum 611 receive advanced studies in guidance and control, radar systems and electronic warfare.

Entry Dates: Aeronautical Engineering is an eight quarter course of study with entry dates in April and October. 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.

Academic Associate:

Richard W. Bell, Professor,
Code 67Be, Halligan Hall, Room 236,
(408) 646-2926, AV 878-2926.

Degree: Requirements for the degree Master of Science in Aeronautical Engineering are met as a milestone en route to satisfying the skill requirements of the curricular programs.

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 directy entry. The required APC for entry via Curriculum 460 is 334.

AERONAUTICAL ENGINEERING SUBSPECIALTY

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:

Project Officer - Power Plants
Naval Air Systems Command
Weapons Systems Manager
Naval Air Rework Facility, Pensacola, FL
Commanding Officer
Naval Plant Representative Office, Stratford, CT
Attack Aircraft Class Desk
COMNAVAIRLANT, Norfolk, VA
Aeronautical Engineer
Defense Nuclear Agency Headquarters
Instructor, Aeronautical Engineer
Deputy Project Manager for the E-2
Naval Air Systems Command
VP Program Director
Naval Air Development Center

TYPICAL COURSE OF STUDY

Quarter 1

MA	2047 (4-0)	Linear Algebra & Vector Analysis
AE	2042 (3-2)	Fundamentals of Thermo-fluid Dynamics
AE	2021 (4-1)	Introduction to Flight Structures
ME	2440 (3-0)	Modern Methods of Engineering Computation
ME	2441 (0-2)	Engineering Computational Laboratory

Quarter 2

MA	2121 (4-0)	Differential Equations
AE	2043 (3-2)	Fundamentals of Gas Dynamics
AE	2035 (3-2)	Basic Aerodynamics
EC	2170 (4-2)	Introduction to Electrical Engineering

Quarter 3

MA	3132 (4-0)	Partial Differential Equations & Integral Transforms
AE	2015 (3-2)	Engineering Dynamics
AE	2036 (3-2)	Performance & Static Stability
AE	2801 (3-2)	Aero - Laboratories I

Quarter 4

AE	3451 (3-2)	Aircraft & Missile Propulsion
AE	3340 (3-2)	Linear Vibration & Dynamic Stability
EC	2420 (3-0)	Linear Systems
AE	3802 (3-2)	Aero-Laboratories II

Quarter 5

AE	4632 (3-2)	Computer Methods in Aeronautics
AE	3501 (3-2)	Current Aerodynamic Analysis
AE	3341 (3-2)	Control of Aerospace Vehicles
AE	3101 (3-2)	Flight Vehicle Structural Analysis

Quarter 6

AE	4XXX	Advanced Elective
AE	3201 (3-2)	System Safety Management & Engineering
MS	3201 (3-2)	Materials Science & Engineering
AE	0810 (0-0)	Thesis Research

Quarter 7

AE	4XXX	Advanced Elective
AE	4XXX	Advanced Elective
MS	3202 (3-2)	Failure Analysis & Prevention
AE	0810 (0-0)	Thesis Research

Quarter 8

AE	4273 (3-2)	Aircraft Design
	or	
AE	4306 (3-2)	Helicopter Design
	or	
AE	4704 (3-2)	Missile Configuration & Design
AE	4XXX	Advanced Elective
AE	0810 (0-0)	Thesis Research
AE	0810 (0-0)	Thesis Research

AERONAUTICAL ENGINEERING WITH AVIONICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Aeronautical Engineer with Avionics Subspecialist with a subspecialty code of XX72P. The Curriculum Sponsor is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:

Weapons Officer
CVN 69 Eisenhower
VS Program Director
Naval Air Development Center
A/C Maintenance/Avionics Office
Naval Air Engineering Center
Aircraft Systems Project Pilot
Naval Weapons Center

TYPICAL COURSE OF STUDY

Quarter 1

MA	2047 (4-0)	Linear Algebra & Vector Analysis
AE	2042 (3-2)	Fundamentals of Thermo-fluid Dynamics
AE	2021 (4-1)	Introduction to Flight Structures
ME	2440 (3-0)	Modern Methods of Engineering Computation
ME	2441 (0-2)	Engineering Computational Laboratory

Quarter 2

MA	2121 (4-0)	Differential Equations
AE	2043 (3-2)	Fundamentals of Gas Dynamics
AE	2035 (3-2)	Basic Aerodynamics
EC	2170 (4-2)	Introduction to Electrical Engineering

Quarter 3

MA	3132 (4-0)	Partial Differential Equations & Integral Transforms
AE	2015 (3-2)	Engineering Dynamics
AE	2036 (3-2)	Performance & Static Stability
AE	2801 (3-2)	Aero-Laboratories I

Quarter 4

AE	3451 (3-2)	Aircraft & Missile Propulsion
AE	3340 (3-2)	Linear Vibration & Dynamic Stability
EC	2420 (3-0)	Linear Systems
MS	3201 (3-2)	Materials Science & Engineering

Quarter 5

AE	4632 (3-2)	Computer Methods in Aeronautics
AE	3501 (3-2)	Current Aerodynamic Analysis
AE	3341 (3-2)	Control of Aerospace Vehicles
AE	3101 (3-2)	Flight Vehicle Structural Analysis

Quarter 6

EC	3670 (4-2)	Principles of Radar Systems
AE	4XXX	Advanced Elective
AE	4342 (3-2)	Advanced Control for Aerospace Systems
AE	0810 (0-0)	Thesis Research

Quarter 7

EC	4670 (4-1)	Electronic Warfare
AE	4XXX	Advanced Elective
AE	4XXX	Advanced Elective
AE	0810 (0-0)	Thesis Research

Quarter 8

AE	4XXX	Avionics System Design
AE	3201 (3-2)	System Safety Management & Engineering
AE	0810 (0-0)	Thesis Research
AE	0810 (0-0)	Thesis Research

NPS/TPS COOPERATIVE PROGRAM

A Program, which combines portions of the 610 curriculum at the NPS Monterey with the complete U.S. Naval Test Pilot School syllabus is currently available to selected officers with strong undergraduate engineering backgrounds. After the completion of four 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, XX73-G, the Aeronautical Engineering subspecialty code XX71P and award of the Master's degree in Aeronautical Engineering at the completion of test pilot school.

TYPICAL COURSE OF STUDY

Quarter 1

MA	2047 (4-0)	Linear Algebra & Vector Analysis
MA	2121 (4-0)	Differential Equations
MS	3201 (3-2)	Materials Science & Engineering
ME	2440 (3-0)	Modern Methods of Engineering Computation
ME	2441 (0-2)	Engineering Computational Laboratory

Quarter 2

MA	3132 (4-0)	Partial Differential Equations & Integral Transforms
AE	2043 (3-2)	Fundamentals of Gas Dynamics
AE	2035 (3-2)	Basic Aerodynamics
MS	3202 (3-2)	Failure Analysis & Prevention

Quarter 3

AE	4632 (3-2)	Computer Methods in Aeronautics
AE	3101 (3-2)	Flight Vehicle Structural Analysis
AE	3501 (3-2)	Current Aerodynamic Analysis
AE	2801 (3-2)	Aero-Laboratories I

Quarter 4

AE	4XXX	Advanced Elective
AE	3451 (3-2)	Aircraft & Missile Propulsion
AE	3251 (4-1)	Aircraft Combat Survivability
AE	4273 (3-2)	Aircraft Design
	or	
AE	4306 (3-2)	Helicopter Design

AIR-OCEAN SCIENCES PROGRAMS

Curricular Officer

Charles K. Roberts, CAPT, USN,
Code 35, Root Hall, Room 216,
(408) 646-2044, AV 878-2044.

METEOROLOGY CURRICULUM 372

This curriculum will provide qualified non-USN personnel with a sound understanding of the science of meteorology and will develop the technical expertise to provide, and utilize meteorological and oceanographic data in support of all aspects of military operations.

REQUIREMENTS FOR ENTRY

The program is not open to officers of the U.S. Navy.

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

Entry Dates: Meteorology is a seven quarter course of study with preferred entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Academic Associate:

Robert L. Haney, Professor,
Code 63Hy, Root Hall, Room 244,
(408) 646-2308, AV 878-2308.

Degree: Master of Science in Meteorology.

TYPICAL COURSE OF STUDY

Quarter 1

MA 2047 (4-0)	Linear Algebra & Vector Analysis
MA 2121 (4-0)	Differential Equations
MR/OC 2020 (1-2)	Computer Computations in Air-Ocean Sciences
MR 3420 (3-0)	Atmospheric Thermodynamics

Quarter 2

MA 3232 (3-2)	Numerical Analysis
MR/OC 3321 (4-0)	Air-Ocean Fluid Dynamics
MR/OC 3522 (4-2)	Remote Sensing of the Atmos & Ocean Lab
MA 3132 (4-0)	Partial Diff Eq & Integral Transforms

Quarter 3

MR/OC 4413 (4-0)	Air-Sea Interaction
MR 4322 (4-0)	Dynamic Meteorology
MR 3540 (3-0)	Radiative Processes in the Atmosphere
MR/OC 3140 (3-2)	Probability & Statistics for Air-Ocean Sciences

Quarter 4

MR/OC 3150 (3-2)	Analysis of Air-Ocean Time Series
MR 3230 (4-0)	Tropospheric & Stratospheric Meteorology
MR 3235 (0-7)	Tropospheric & Stratospheric Meteorology Lab

Quarter 5

MR 3252 (3-4)	Tropical Meteorology/ Lab
MR 4241 (3-0)	Mesoscale Meteorology
MR/OC 4323 (4-2)	Num Air & Oc Modeling
MR 0810	Thesis Research

Quarter 6

MR 3262 (3-3)	Operational Atmospheric Prediction/Lab
MR 4415 (3-0)	Atmospheric Turbulence
MR 0810	Thesis Research Track Option

Quarter 7

MR 0999 (2-0)	Seminar in Meteorology
MR 0810	Thesis Research
MR 4416 (4-0)	Atmospheric Factors in EM & Optical Propagation

AIR-OCEAN SCIENCES CURRICULUM 373

Completion of this curriculum will provide a thorough understanding of the air-sea environment and will develop the technical expertise to provide and utilize meteorological, oceanographic, and mapping, charting and geodetic data in support of all aspects of military operations.

This education will further 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 general engineering and scientific principles, acquire diverse professional knowledge and develop analytical ability for practical problem solving.

REQUIREMENTS FOR ENTRY

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.

AIR-OCEAN SCIENCES SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Air-Ocean Subspecialist with a subspecialty code of XX47. The Curriculum Sponsor is OP-006, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:

Commanding Officer
Oceanographic Unit
Oceanographer
CV/BB
Submarine Group Staff
Fleet Staff
Car Gru/Cru Des Gru Staff
O in C Naval Ocean Command Detachment
NAVOCEANCOM Center
Defense Mapping Agency
Office of Naval Research

Entry Dates: Air-Ocean Sciences is an eight or nine quarter course of study with preferred entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Academic Associates:

Robert L. Haney, Professor,
Code Hy, Root Hall, Room 244,
(408) 646-2308, AV 878-2308.

Joseph Von Schwind, Assoc. Prof.,
Code Vs, Hydrographic Sciences Building 224, Room 106,
(408) 646-3271, AV 878-3271.

Degree: Requirements for the degree Master of Science in Meteorology and Oceanography are met en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1*

MA 2047 (4-0)	Linear Algebra & Vector Analysis
MA 2121 (4-0)	Differential Equations
MR/OC 2020 (1-2)	Fortran Programming
MR 3420 (3-0)	Atmospheric Thermodynamics
OC 3230 (3-0)	Descriptive Physical Oceanography

Quarter 2

MA 3132 (4-0)	Partial Differential Equations
MA 3321 (4-0)	Air-Ocean Fluid Dynamics
MR/OC 3522 (4-2)	Remote Sensing of the Atmosphere & Ocean
CH 3901 (4-2)	Mapping, Charting & Geodesy

Quarter 3

MR/OC 3140 (3-2)	Probability & Statistics for Air-Ocean Sciences
MR 4322 (4-0)	Dynamic Meteorology
MR 3222 (4-3)	Meteorological Analysis
OC 3420 (4-2)	Dynamical Oceanography

Quarter 4

MR/OC 3150 (3-2)	Analysis of Air-Ocean Time Series
OC 4211 (4-0)	Linear Wave Dynamics
MR 3230 (4-0)	Tropospheric & Stratospheric Analysis
MR 3235 (0-7)	Tropospheric & Stratospheric Analysis Lab

Quarter 5

MR 3252 (3-4)	Tropical Meteorology
MR/OC 4413 (4-0)	Air-Sea Interaction
MR 4416 (4-0)	Atmospheric Factors in EM & Optical Propagation
PH 3406 (4-2)	Physics of Sound in the Ocean

Quarter 6

MR/OC 3212 (4-0)	Polar Meteorology/ Oceanography
MR/OC 3272 (4-4)	Weather, Wave and Surf Forecasting
OC 4331 (3-0)	Mesoscale Ocean Variability
OC 4267 (4-3)	Ocean Influences in Underwater Acoustics

Quarter 7

GH 3902 (4-2)	Hydrographic and Geodetic Surveying
MR/OC 3570 (2-4)	Operational Oceanography & Meteorology
MR 4323 (4-3)	Numerical Air & Ocean Modeling
MR/OC 0810	Thesis Research

Quarter 9

Track Option	
Track Option	
Track Option	
MR/OC 0810	Thesis Research

Quarter 9

MR 3540 (3-0)	Radiative Processes in the Lower & Upper Atmosphere
Track Option	
Track Option	
MR 0810	Thesis Research

*Subject to validation

OPERATIONAL OCEANOGRAPHY CURRICULUM 374

This curriculum will provide students with an understanding of the air-sea environment and operations analysis principles to forecast atmospheric, oceanic and acoustic conditions in support of all aspects of Naval Operations including the ASW, EW and C3 problems. Primary emphasis is placed on the understanding of the impact of the environment (atmospheric, ocean and their interface) on weapons systems,

sensors and platforms. The program recognizes the importance of interactions between the atmosphere and oceans, and deals with the relationships at the air-sea interface.

REQUIREMENTS FOR ENTRY

A baccaulaureate 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 XX49. The Curriculum Sponsor is OP-006, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:

CV A.S.W. Module
Cru Des Gru/Car Gru Staff
A.S.W. Operations Center
Navy Laboratories
Office of Naval Research
SACLANT A.S.W. Research Center
La Spezia, Italy
Naval Oceanographic Research and Development Agency (NORDA)
Defense Mapping Agency

Entry Dates: Operational Oceanography 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 for this curriculum.

Academic Associates:

Robert L. Haney, Professor,
Code Hy, Root Hall, Room 244,
(408) 646-2308, AV 878-2308.

Joseph Von Schwind, Assoc. Prof.,
Code Vs, Hydrographic Sciences Building 224, Room 106,
(408) 646-3271, AV 878-3271.

Degree: Requirements for the degree Master of Science in Meteorology and Oceanography are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

	MA 2047 (4-0)	Linear Algebra & Vector Analysis
	MA 2121 (4-0)	Differential Equations
MR/OC	2020 (1-2)	Computer Computations in Air-Ocean Sciences
	MR 3420 (3-0)	Atmospheric Thermodynamics
	OC 3230 (3-0)	Descriptive Physical Oceanography

Quarter 2

	MA 3132 (4-0)	Partial Differential Equations & Integral Transforms
MR/OC	3321 (4-0)	Air-Ocean Fluid Dynamics
MR/OC	3522 (4-2)	Remote Sensing of the Atmosphere & Ocean Track Option

Quarter 3

	MR 3222 (4-3)	Meteorological Analysis/Laboratory
	MR 4322 (4-0)	Dynamic Meteorology
	OC 3240 (4-2)	Dynamical Oceanography
MR/OC	3140 (3-2)	Probability & Statistics for Air-Ocean Sciences

Quarter 4

	MR 3234 (4-3)	Tropospheric & Stratospheric Meteorology/ Lab
	OC 4211 (4-0)	Linear Wave Dynamics
MR/OC	3150 (3-2)	Analysis of Air-Ocean Time Series
	OS 3601 (4-0)	Search, Detection & Localization Models

Quarter 5

MR 3254 (3-2)	Tropical Meteorology/ Lab
MR/OC 4413 (4-0)	Air-Sea Interaction
MR 4416 (4-0)	Atmospheric Factors in EM & Optical Propagation
PH 3406 (4-2)	Physics of Sound in the Ocean

Quarter 6

MR/OC 3212 (4-0)	Polar Meteorology/ Oceanography
OC 4331 (3-0)	Mesoscale Ocean Variability
OC 4263 (4-3)	Ocean Influences and Prediction: Underwater Acoustics
MR/OC 0810	Thesis Research

Quarter 7

MR/OC 3272 (4-4)	Weather, Wave and Surf Forecasting
OC/MR 3570 (2-4)	Operational Oceanography & Meteorology
PH 3006 (4-0)	Weapons Systems & Weapons Effects
MR/OC 0810	Thesis Research

Quarter 8

OS 3602 (4-1)	Intro to Combat Models and Weapons Effectiveness
OS 3606 (3-1)	Simulation and Wargaming Track Option
MR/OC 0810	Thesis Research

OCEANOGRAPHY CURRICULUM 440

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography and develops the tehnical expertise to provide and utilize oceanographic and acoustical data in support of all aspects of military operations. Particular emphasis is placed on the understanding of oceanic efforts on the solution of the undersea warfare problem.

This education further enhances performance in operational billets, technical management assignments and policy-making positions. Students will develop sound graduate level technical ability based on general engineering and scientific principles.

Entry Dates: Oceanography 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 for this curriculum.

REQUIREMENTS FOR ENTRY

The program is not open to officers of the U.S. Navy.

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.

Academic Associate:

Joseph J. Von Schwind, Assoc. Prof.,
Code 68VS, Hydrographic Sciences
Building 224, Room 106,
(408) 646-3271, AV 878-3271.

Degree: Master of Science in Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

MA 2047 (4-0) Linear Algebra & Vector Analysis
MA 2121 (4-0) Differential Equations
OC 2020 (1-2) Computer Computations in Air-Ocean Sciences
MR 3420 (3-0) Atmospheric Thermodynamics
OC 3230 (3-0) Descriptive Physical Oceanography

Quarter 2

MA 3132 (4-0) Partial Differential Equations & Integral Transforms
MR/OC 3321 (4-0) Air-Ocean Fluid Dynamics
MR/OC 3522 (4-2) Remote Sensing of the Atmosphere & Ocean
MA 3232 (3-2) Numerical Analysis

Quarter 3

MR 3222 (4-3) Meteorological Analysis/Laboratory
PH 3406 (4-2) Physics of Sound in the Ocean
OC 3240 (4-2) Dynamical Oceanography
MR/OC 3140 (3-2) Probability & Statistics for Air-Ocean Sciences

Quarter 4

OC 4211 (4-0) Linear Wave Dynamics
OC 3150 (3-2) Analysis of Air-Ocean Time Series
OC 4267 (4-3) Ocean Influences & Prediction: Underwater Acoustics
Elective

Quarter 5

OC 4413 (4-0) Air-Sea Interaction
MR 4322 (4-0) Dynamic Meteorology
OC 4213 (3-1) Nearshore & Wave Processes
OC 3445 (2-2) Oceanic & Atmospheric Observational Systems

Quarter 6

MR/OC 3212 (4-0) Polar Meteorology/Oceanography
OC 4331 (3-0) Mesoscale Ocean Variability
OC 4414 (3-0) Advanced Air-Sea Interaction
OC 0810 Thesis Research

Quarter 7

OC 4323 (4-2) Numerical Air & Ocean Modeling
OC 4220 (3-0) Shallow Water Oceanography
OC 4212 (4-0) Tides
OC 0810 Thesis Research

Quarter 8

OC 0810/OC 0999 Thesis Research Presentation
OC 3610 (2-2) Wave and Surf Forecasting
Elective
Elective

HYDROGRAPHIC SCIENCES CURRICULUM 441

This curriculum of study provides students with a sound understanding of oceanography and hydrography. Hydrography (a subdiscipline of Mapping, Charting and Geodesy (MC&G)) is the science of the measurement, description and charting of the sea floor with special reference to navigation and marine operations. This interdisciplinary program integrates the scientific principles of oceanography with the practical engineering procedures of hydrography. Students achieve the technical expertise to provide and utilize hydrographic data in support of all aspects of hydrographic operations.

Entry Date: Hydrographic Sciences is an eight quarter course of study with preferred entry in October. If further information is needed, contact the Academic Associate for this curriculum.

REQUIREMENTS FOR ENTRY

This program is open to officers of the National Oceanic and Atmospheric Administration, Coast Guard, Corps of Engineers, allied officers and civilian employees of the U.S. Federal Government. There is no Navy Subspecialty in Hydrographic Sciences.

A baccalaureate degree with above average grades in mathematics and the physical sciences. Differential and integral calculus and one year of calculus based college physics are required.

An APC of 324 is required for direct entry into the program. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

Academic Associate:

Joseph J. Von Schwind, Assoc. Prof.,
Code 68Vs, Hydrographic Sciences
Building 224, Room 106,
(408) 646-3271, AV 3271.

Degree: Master of Science in Hydrographic Sciences.

TYPICAL COURSE OF STUDY

Quarter 1

MA 2121 (4-0)	Differential Equations
MA 2047 (4-0)	Linear Algebra & Vector Analysis
OC 3230 (3-0)	Ocean Thermodynamics
CS 2450 (3-1)	Computer Programming with Fortran

Quarter 2

MA 3132 (4-0)	Partial Differential Equations & Integral Transforms
MR 2220 (4-1)	Marine Meteorology
OC 3130 (4-2)	Mechanics of Fluids
GH 3901 (4-2)	Mapping, Charting & Geodesy

Quarter 3

OC 3120 (4-3)	Biochemical Processes in the Ocean
MR/OC 3140 (3-2)	Probability & Statistics for Air-Ocean Sciences
OC 4213 (3-1)	Nearshore & Wave Processes
GH 3902 (4-2)	Hydrographic and Geodetic Surveying

Quarter 4

CS 3010 (4-0)	Computing Devices and Systems
GH 3906 (2-2)	Hydrographic Survey Planning
GH 3914 (2-2)	Adjustment Computations
GH 4908 (3-2)	Photogrammetry and Remote Sensing

Quarter 5

GH 3903 (4-0)	Electronic Surveying and Navigation
GH 3910 (2-1)	Hydrographic Survey Field Experience
GH 3911 (1-5)	Geodetic Survey Field Experience
GH 4906 (4-0)	Geometric & Astronomic Geodesy

Quarter 6

OC 3260 (3-0)	Sound in the Ocean
OC 3325 (3-0)	Marine Geophysics
OC 0810	Thesis Research Track Option

Quarter 7

OC 0810	Thesis Research
OC 4212 (4-0)	Tides
GH 4907 (4-0)	Gravimetric and Satellite Geodesy
	Track Option

Quarter 8

OC 0810/OC 0999	Thesis Research Presentation
NS 3962 (4-0)	Ocean, Maritime and Tort Law for the Hydrographic Community
	Track Option
	Track Option

ANTISUBMARINE AND ELECTRONIC WARFARE PROGRAMS

Curricular Officer

David P. Kimball, CDR, USN,
Code 3A, Spanagel Hall, Room 304,
(408) 646-2135/6, AV 878-2135/6.

ANTISUBMARINE WARFARE CURRICULUM 525

The ASW Curriculum educates officers in the engineering fundamentals, physical principals and analytical concepts that govern operational employment of ASW sensors and weapon systems, and includes extensive breadth in the appropriate scientific and technical disciplines. This interdisciplinary program integrates mathematics, physics, acoustics, electrical engineering, oceanography, operations analysis, human factors, computer science and meteorology. The academic content divides naturally into four major areas: Electrical Engineering with emphasis on signal processing, Underwater Acoustics with emphasis on signal propagation and detection, Operations Analysis with emphasis on tactical application and decision analysis, and Air-Ocean Sciences with emphasis on the environmental factors affecting sound in the sea.

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. An additional qualification for entry is that a selectee must have demonstrated strong professional performance in at least one ASW mission unit. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of Engineering Science (Curriculum 460).

ANTISUBMARINE WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Antisubmarine Warfare Subspecialist with a subspecialty code of XX44P. The Curriculum Sponsor is OP-951, Antisubmarine Warfare Division.

Typical Jobs in this Subspecialty:

- Naval Ocean Systems Center
- Naval Underwater Systems Center
- Naval Surface Warfare Development Group
- Destroyer Squadron Staffs
- Operational Test and Evaluation Force
- Submarine Development Squadron Twelve
- Patrol Wing Staffs
- Naval Air Systems Command
- Air Test and Evaluation Squadron One
- OPNAV

Entry Dates: The ASW Curriculum is an eight quarter course of study with entry dates in April and Otober. If further information is needed, contact the Academic Associate or Curricular Officer for this Curriculum.

Academic Associate:

James V. Sanders, Assoc. Professor, Code 33A, Spanagel Hall, Room 328, (408) 646-2116, AV 878-2116.

Degree: Requirements for the degree Master of Science in System Technology (Antisubmarine Warfare) are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA 1112 (2-2)	Selected Calculus Topics Review
MA 2129 (2-1)	Ordinary Differential Equations and Laplace Transforms
MA 2181 (2-1)	Vector Calculus
OC 2120 (4-0)	Survey of Oceanography
OS 2210 (4-1)	Introduction to Computer Programming

Quarter 2

EO 2720 (4-2)	Electronic Systems
OS 2103 (4-1)	Applied Probability for Systems Technology
PH 2119 (4-1)	Oscillation and Waves
MA 3139 (4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3

PH 2401 (3-0)	Introduction to the Sonar Equations
EO 3720 (4-1)	Introduction to Signals & Noise
OS 3303 (4-1)	Computer Simulation
OS 3604 (4-0)	Decision & Data Analysis

Quarter 4

EO 4720 (4-1)	Signal Processing Systems
OC 4267 (4-3)	Ocean Influences & Predictions: Underwater Acoustics
PH 3402 (4-2)	Underwater Acoustics
OS 3601 (4-0)	Search Detection & Localization

Quarter 5

(first six weeks)

MR 2413 (3-1)	Meteorology for Antisubmarine Warfare
OS 3402 (3-1)	Human Vigilance Performance

(last six weeks)

EXPERIENCE TOUR OFF CAMPUS

Quarter 6

EC 4450 (4-1)	Sonar Systems Engineering
PH 3479 (3-0)	Physics of Underwater Weapons
PH 4403 (4-1)	Advanced Topics in Underwater Acoustics

Quarter 7

OS 3602 (4-1)	Introduction to Combat Models & Weapons Effectiveness
OS 4601 (4-0)	Test & Evaluation
PH 3306 (4-0)	Electromagnetic Wave Propagation
ST 0810	Thesis

Quarter 8

PH 3001 (4-0)	Non-Acoustic Sensor Systems
ST 0810	Thesis
ST 4999 (3-0)	Antisubmarine Warfare Developments

ELECTRONIC WARFARE CURRICULUM 595

This curriculum provides the services with officers thoroughly knowledgable in the technical and operational aspects of the role of electronic warfare as a vital, integral part of modern warfare. It is designed to provide an understanding of the principles underlying the broad field of electronic warfare, and because of the electronic nature of modern sensor, weapon and command, control and communications systems, it seeks to develop in the officer a grasp of electronic, electrial and electromagnetic fundamentals, theory and techniques.

REQUIREMENTS FOR ENTRY

To undertake studies in this curriculum requires a baccalaureate degree with above average grades and

completion of mathematics courses through differential and integral calculus. Students lacking the background may matriculate via the Engineering Science Program (Curriculum 460). An APC of 325 is required for direct entry.

ELECTRONIC WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Electronic Warefare Subspecialist with a code of XX46. The Curriculum Sponsor is OP-956, Electronic Warfare Division.

Typical Jobs in this Subspecialty:

Staff Electronic Warfare
COM3RDFLT OPS CP
CDR
OPNAV OP-954H1
Staff Electronic Warfare
CINCPACFLT
LCDR
FLTCORGRU 2
Air Anti-Submarine
COMCARGRU 8
Staff Electronic Warfare
COM7THFLT
Electronic Warfare Assistant
VAQ 33
Executive Officer
NSGA, Naples/ECCM

Entry Date: The Electronic Warfare Curriculum is an eight quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:
Alfred Cooper, Professor,
Code 61Cr, Spanagel Hall, Rm. 212,
(408) 646-2452, AV 878-2452.

Degree: Requirements for the degree Master of Science in Systems Engineering are met as a milestone en route to satisfying the skill requirements of this curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS	2450 (3-1)	Computer Programming with Fortran
MA	1112 (2-2)	Selected Calculus Topics Review
MA	2129 (2-1)	Ordinary Differential Equations and Laplace Transforms
MA	2181 (2-1)	Vector Calculus
PH	2203 (4-0)	Topics in Basic Physics: Waves and Optics

Quarter 2

EO	2720 (4-2)	Introduction to Electronic Systems
OS	2103 (4-1)	Applied Probability for Systems Technology
MA	3139 (4-0)	Fourier Analysis and Partial Differential Equations
PH	2304 (2-0)	Topics in Basic Physics: Electromagnetism

Quarter 3

EO	3720 (4-1)	Intro to Signals & Noise
OS	3604 (4-0)	Decision & Data Analysis
EO	2760 (4-1)	Electromagnetic Theory
EC	2810 (3-2)	Digital Machines
EO	2730 (2-1)	Control Systems

Quarter 4

EO	4720 (4-1)	Signal Processing Systems
OS	3003 (4-0)	Operations Research for EW
PH	2207 (4-0)	Fundamentals of Electro-Optics
EO	3760 (4-2)	EM Radiation Scattering and Propagation

Quarter 5

EO	4760 (4-1)	Microwave Devices and Radar (First six weeks)
PH	3208 (4-1)	Electro-Optic Principles and Devices (Last six weeks) Experience tour off campus

Quarter 6

OS	3603 (3-1)	Simulation and Wargaming
EO	4730 (3-1)	EO Systems and CM
EO	4780 (3-2)	Electronic Warfare Systems
EW	0810	Thesis

Quarter 7

EO	3780 (3-2)	Electronic Warfare Computer Applications
OS	4601 (4-0)	Test and Evaluation
EW	0810	Thesis

Quarter 8

EO	4750 (2-0)	Signal Intelligence
EO	4790 (2-0)	C3 Counter Measures
NS	3152 (4-0)	Naval Warfare and the Threat Environment
EW	0810	Thesis

ELECTRONIC WARFARE (INTERNATIONAL) CURRICULUM 596

The curriculum is modeled after Curriculum 595 and for the first four quarters exactly parallels the basic curriculum. In the second year, international students are channeled in courses similar in content to courses taught to U.S. students but without the classification level.

REQUIREMENTS FOR ENTRY

International students must meet the APC requirements and receive approval by the Director of Admissions at the Naval Postgraduate School. Actual quota assignment and invitational travel orders are approved and issued by the Office of the Chief of Naval Operations through Foreign Military Assistance Division.

COMPUTER TECHNOLOGY PROGRAMS

Curricular Officer
James L. Branson, CDR, USN,
Code 37, Spanagel Hall, Room 401,
(408) 646-2174/5, AV 878-2174/5.

COMPUTER SYSTEMS MANAGEMENT CURRICULUM 367

This is an interdisciplinary graduate level master's program integrating mathematics, accounting, economics, statistics, computer science information systems, behavioral science, and management disciplines.

This program prepares the officer for the planning, procurement, and management decision-making skills necessary to evaluate changing technology, to translate operational requirements and economic trade offs into system specifications, and to implement and properly utilize complex tactical and non-tactical military computer centers, networks, and systems. This curriculum is designed to meet the Navy's need for a technically qualified officer with managerial skills essential to the successful implementation and effective utilization of computer systems in military settings.

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 335 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program providing their undergraduate records and/or other indicators of success, such as GRE (Graduate Record Examination), GMAT (Graduate Management Admission Test) formerly ATGSB (Admission Test for Graduate Schools of Business), indicate a capability for graduate level work. While previous computer or automatic data processing (ADP) experience is certainly helpful, it is not essential.

COMPUTER SYSTEMS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Computer Systems Management Subpecialist with a subspecialty code of XX59. The Curriculum Sponsor is OP-945, Director, Information Systems Division.

Typical Jobs in this Subspecialty:

Weapons Control Project Subsurface Service Engineer
Naval Underwater Systems Center, Newport, RI
Operation Test Evaluation
NAVELEX PDE-106 NAVSPACE PROGRAM, Washington, DC
Air Systems
NAVOCEANSYSCEN San Diego, CA
Computer Systems
NSA/CSS, Ft. Meade, MD
Data Base Management
Naval War College, Newport, RI
Computer Systems Analyst/Development
COMNAVMEDCOM Washington, DC
Computer Systems Analyst
COMNAVDAC, Washington, DC

Entry Dates: Computer Systems Management is a six quarter course of study with entry dates in April and October. On a case-by-case basis, students may commence preparatory programs in January and July. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

Daniel R. Dolk, Assistant Professor, Code 54Dk, Ingersoll Hall, Rm. 316, (408) 646-2260, AV 878-2260.

Degree: Requirements for the degree Master of Science in Information Systems are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS	2970 (5-0)	Struc Prog with PASCAL
IS	3170 (4-0)	Econ Eval of Info Sys I
MN	2155 (4-0)	Accounting of Mgmt
MN	3105 (4-0)	Organization and Mgmt

Quarter 2

CS	3010 (4-0)	Comp Devices & Sys
CS	3020 (4-0)	Software Design
MN	3307 (4-0)	ADP Acquisition
IS	2100 (0-2)	Info Systems Lab
OS	3101 (5-0)	Stat Anal for Mgmt

Quarter 3

CS	3030 (4-0)	Op Sys Structures
IS	4200 (4-0)	Sys Anal & Design
IS	4183 (4-0)	Applic of Database Mgmt Sys
OS	3004 (5-0)	Ops Research for CSM

Quarter 4

IS	3502 (4-0)	Computer Networks: Wide Area/Local Area
IS	4185 (4-0)	Decision Support Sys
IS	0810	Thesis (Option Elective)

Quarter 5

MN	4145 (4-0)	Financial Mgmt in The Armed Forces
IS	0810	Thesis (Option Elective)

Quarter 6

IS	4300 (4-0)	Software Eng & Mgmt
IS	4182 (4-0)	Info Systems Mgmt
IS	0810	Thesis (Option Elective)

COMPUTER SCIENCE CURRICULUM 368

This program is an interdisciplinary tecnical graduate level master's program integrating mathematics, statistics, computer science, electrical engineering, information systems, and operations research. The Computer Science curriculum is designed to provide an 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 officers in the analysis and design methodologies appropriate for hardware, software, and firmware, and to provide the officer with practical experience in applying modern computer laboratory equipment and research techniques to military problems.

COMPUTER SCIENCE SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Computer Science Subspecialist with a subspecialty code of XX91. The Curriculum Sponsor is OP-945, Director, Information Systems Division.

Typical Jobs in this Subspecialty:

Navigation Systems Integration Projects Office
STRATSTSORIG, Washington, DC

Assistant Information Management/TRIMIS ADDU FM
COMNAVMEDCOM, Washington, DC

ADP Programs/WWMCCS, Project
DPSCPAC, Pearl Harbor, HI
ADP Plans Director
FLEMATSUPPO, Mechanicsburg, PA
ADP Plans-Customer Liaison
NARDAC, Pensacola, FL
ASST CIC - NTDS
USS CARL VINSON (CVN-70)

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 majors in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program providing their undergraduate records and/or other indicators of success, such as GRE (Graduate Record Examination), indicate a capability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance an applicant's potential for admission, such experience is not a prerequisite.

Entry Dates: Computer Science is a seven quarter course of study with entry dates in April and October. On a case-by-case basis, students may commence preparatory programs in January and July through prior preparation. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

Uno R. Kodres, Professor,
Code 52 Kr, Spanagel Hall, Rm 534A,
(408) 646-2197, AV 878-2197.

Degree: Requirements for the degree Master of Science in Computer Science are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS	2970 (5-0)	Structured Programming with PASCAL
CS	2000 (3-1)	Introduction to the Science of Computing
EE	2810 (3-2)	Digital Machines
MA	2025 (4-1)	Logic, Sets & Functions

Quarter 2

CS	3200 (3-2)	Introduction to Computer Organization
CS	3111 (4-0)	Principles of Programming Languages
CS	3300 (3-1)	Data Structures
MA	3026 (5-0)	Discrete Math and Automatic Theory

Quarter 3

CS	3601 (4-0)	Automata, Formal Languages, and Computability
CS	3460 (3-2)	Software Methodology
CS	3450 (3-1)	Software System Design

Quarter 4

CS	3310 (4-0)	Artificial Intelligence
OS	3001 (4-0)	Ops Research for Computer Scientists
CS	4113 (4-0)	Advanced Lang. Topics
CS	4300 (4-0)	Data Base Sys

Quarter 5

CS	3502 (4-0)	Computer Communications and Networks
CS	4310 (4-0)	Advanced Artificial Intelligence
CS	4500 (4-1)	Software Engineering
CS	0810	Thesis

Quarter 6

		Option Elective
		Option Elective
CS	0810	Thesis

Quarter 7

		Option Elective
		Option Elective
CS	0810	Thesis
CS	0810	Thesis

ELECTRONICS AND COMMUNICATIONS PROGRAMS

Curricular Officer

John T. Donnelly, CDR, USN,
Code 32, Spanagel Hall, Room 404,
(408) 646-2056, AV 878-2056

ELECTRONIC SYSTEMS ENGINEERING CURRICULUM 590

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, information processing applicability. It will enhance individual performance in all duties throughout a naval career, including operational billets, technical management assignments and policy making positions, thereby preparing the officer for progressively increased responsibility including command, both ashore and afloat.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in engineering or the physical sciences is required. Differential and integral calculus and one year of calculus based college physics 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.

Entry Dates: Electronic Systems Engineering is a nine quarter course of study with entry dates in every quarter. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

ELECTRONICS AND COMMUNICATIONS 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
OP-934f Head
OPNAV
Executive Officer
SPAWARHDQTRS
Operations Test and Evaluation
COMOPTEVFOR
Electronics Maint: Officer
USS NIMITZ CVN 68
Executive Officer
NEEACT PAC, Pearl Harbor, HI
Electronics P & P
CINCLANTFLT
Ship Coordinator
COMNAVAIRLANT
Electronics Maint. Officer
USS BLUE RIDGE LCC 19

Academic Associate:

Paul H. Moose, Assoc. Prof.,
Code 62Me, Spanagel Hall,
Room 206A,
(408) 646-2838, AV 878-2838.

Degree: Requirements for the degree Master of Science in Electrical Engineering are en route to satisfying the skill-requirements of this curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

EC 2100 (3-2)	Circuit Analysis I
EC 2820 (3-2)	Digital Logic Circuits
MA 2047 (4-0)	Linear Algebra & Vector Analysis
CS 2450 (3-1)	Computer Programming with Fortran

Quarter 2

EC 2110 (3-2)	Circuit Analysis
EC 2200 (3-3)	Electronics Engineering
MA 2121 (4-0)	Differential Equations
EC 3830 (3-2)	Digital Design Methodology

Quarter 3

EC 2800 (3-2)	Introduction to Microprocessors
EC 2210 (3-2)	Electronics Engineering II
MA 3232 (3-2)	Numerical Analysis
EC 2410 (3-0)	Fourier Analysis of Signals and Systems

Quarter 4

EC 3800 (3-2)	Microprocessor-Based System Design
EC 2400 (3-0)	Discrete Systems
EC 2420 (3-0)	Linear Systems
EC 2500 (3-2)	Communications Theory

Quarter 5

EC 3400 (3-0)	Introduction to Digital Signal Processing
EC 3820 (3-1)	Computer Systems
EC 2300 (3-2)	Control Systems
EC 2220 (2-4)	Applied Electronics (2-4)

Quarter 6

EC 2600 (4-0)	Introduction to Fields and Waves
EC 3830 (3-2)	Digital Design
EC 3830 (3-2)	Digital Design
OS 2102 (4-1)	Introduction to Applied Probability for Electrical Engineering
CS 3550 (3-2)	Computers in Combat Systems

Quarter 7

EC 2610 (3-2)	Electromagnetic Engineering
EC 3310 (4-0)	Linear Optimal Estimation & Control
EC 3500 (4-0)	Analysis of Random Signals
EC 0810	Thesis

Quarter 8

EC 2600 (4-0)	Introduction to Fields and Waves
EC 4820 (3-1)	Computer Architectures
EC 0810	Thesis

Quarter 9

EC 4460 (3-0)	Principles of Systems Engineering
CS 4500 (4-1)	Software Engineering
EC 0810	Thesis
EC 0810	Thesis

COMMUNICATIONS ENGINEERING CURRICULUM 600

The curriculum will provide officers with a comprehensive scientific and technical knowledge in the field of communications engineering as applied to Navy and Defense command, control and communication systems. It is designed to establish a broad background of basic engineering knowledge, leading to the selected advanced studies in communications. The officer student is provided a sound academic background in mathematics, computer science and technology, physics and electrical engineering. Additionally, the subject areas of digital signal processing, analysis of random signals, radiation, scattering and propagation, and micro-processor-based systems design are included.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, in engineering or the physical

sciences is preferred. 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 part of the program, each officer will have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

COMMUNICATIONS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Communications Engineering Specialist with a code of XX81. The Curriculum Sponsor is OP-941, Naval Communications Division.

Typical Jobs in this Subspecialty:

Communications Engineering
DEFCOMMENGCEN, Washington, DC
TACAMO Project Control
SPAWAR
Command Assistant for Electromagnetic
CINCPACFLT
Decision & Control
NOSC, San Diego, CA
Assistant for FLTSATCOM/UH
OPNAV OP-943C2
Assistant for MILSTAR/EXT
OPNAV OP-943C4
MILAST/ADUSD
Office of Secretary of Defense
SR TELECOMM
NSA/CSS, Ft. Meade, MD
Signal Analyst
NSA/CSS, Ft. Meade, MD
Plans & Projects
COMNAVSECGRU, Washington, DC

Academic Associate:

Paul H. Moose, Assoc. Prof.,
Code 62Me, Spanagel Hall,
Room 206A,
(408) 646-2838, AV 878-2838.

Degree: Requirements for the degree Master of Science in Electrical Engineering are met as a milestone en route to satisfying the skill requirements of this curricular program.

Entry Dates: Communications Engineering is a nine quarter course of study with entry dates in January, April, July and October. If further information is needed contact the Academic Associate for this curriculum.

TYPICAL COURSE OF STUDY

Quarter 1

EC	2100 (3-2)	Circuit Analysis I
EC	2820 (3-2)	Digital Logic Circuits
MA	2047 (4-0)	Linear Algebra & Vector Analysis
CS	2450 (3-1)	Computer Programming with Fortran

Quarter 2

EC	2210 (3-2)	Circuit Analysis II
EC	2200 (2-4)	Electronics Engineering
MA	2121 (4-0)	Differential Equations
EC	3830 (3-2)	Digital Des Method

Quarter 3

EC	2410 (3-0)	Fourier Analysis of Signals and Systems
EC	2210 (3-2)	Electronics Engineering II
MA	3232 (3-2)	Numerical Analysis
EC	2400 (3-0)	Discrete Systems

Quarter 4

EC	2500 (3-2)	Communications Theory
EC	2420 (3-0)	Linear Systems
OS	2102 (4-1)	Intro to App Prob for Elec Eng
EC	2600 (4-0)	Intro to Fields & Waves

Quarter 5

EC	2300 (3-2)	Control Systems
EC	2220 (2-4)	Applied Electronics
EC	3500 (4-0)	Anal of Random Signals
EC	2610 (3-2)	E.M. Engineering

Quarter 6

EC	3400 (3-0)	Introduction to Digital Signal Processing
EC	4590 (3-0)	Comm Sat Sys Eng
EC	3510 (3-0)	Comm Engineering
EC	3600 (3-2)	E.M. Rad. Scat & Prop

Quarter 7

EC 2800 (3-2)	Intro to Microprocessors
EC 4560 (3-2)	Communications ECCM
MN 3301 (4-0)	Sys Acq & Proj Mgmt
EC 0810	Thesis

Quarter 8

EC 3800 (3-2)	Microprocessor-Based System Design
EC 4500 (4-0)	Digital Communications
EC 0810	Thesis
EC 0810	Thesis

Quarter 9

CM 3112 (4-0)	Navy Telecomm Sys
EC 0810	Thesis
	Communications Elective
	Elective

TELECOMMUNICATIONS SYSTEMS MANAGEMENT CURRICULUM 620 and 620CG

This curriculum provides instruction to officers who will perform as communications managers of new communications systems applications or as communication officers in large commands and staffs, afloat and ashore, including the organization of the Joint Chief of Staff and the Defense Communications Agency. The 620 and 620CG curricula are sponsored respectively by the Director of Naval Communications and the U.S. Coast Guard Headquarters. Each curriculum provides comprehensive study in management, with emphasis upon the systems management field. Additionally, the curricula provide study in the technical field appropriate to decision making in advanced systems and program management. These technical courses within the 620 curriculum have been especially prepared for non-engineers whereas those in the 620CG curriculum are engineering courses.

TELECOMMUNICATIONS SYSTEMS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Telecommunications Systems Management Subspecialist with a code of XX82. The Curriculum Sponsor is OP-941, Naval Communications Division.

Typical Jobs in this Subspecialty:

COMM AF
USS JOHN F. KENNEDY CV 67
Commanding Officer
NAVCOMSTA, Thurso, UK
Commanding Officer
NAVCOMSTA, Jacksonville, FL
COMM OPS/FLT COMM
CINCUSNAVEUR
OPS T & E
SPAWAR PDE-120
Staff COMM 84/10
EUCOM US HDQTRS
PACAREA SI COMM
CNPACFLT SECGRP
COMM AF
USS BLUE RIDGE LCC 19

REQUIREMENTS FOR ENTRY

To undertake studies in this curriculum requires a baccalaureate degree with above average grades and completion of mathematics courses through single variable calculus. An APC of 335 is required for direct entry.

Degree: Requirements for the degree Master of Science in Telecommunications Systems Management are met as a milestone en route to satisfying the skill requirements of the curricular program.

Entry Date: Telecommunications Systems Management is a six quarter course of study with a single entry date in October. The 620CG curriculum is eight quarters in length and convenes in July. If further information is needed, contact the Academic Associate for these curricula.

Academic Associate:

Dan C. Boger, Assoc. Professor,
Code 54Bo, Ingersoll Hall, Rm. 241,
(408) 646-2607, AV 878-2607.

TYPICAL COURSE OF STUDY
Standard Option

Refresher Period

MA 0112 (5-5)	Calculus
CM 3111 (3-0)	C3 Mission and Organization

Quarter 1

CS 2970 (5-0)	Pascal
MN 2155 (4-0)	Accounting for Management
MN 3105 (4-0)	Organization and Management
MN 3301 (4-0)	Systems Acquisition
CM 0001 (0-2)	Seminar

Quarter 2

CS 3050 (4-0)	Software Engineering
MA 1248 (4-1)	Applied Mathematics
OS 3104 (4-0)	Statistics
CM 0001 (0-2)	Seminar

Quarter 3

OS 3404 (3-0)	Man/Machine Interaction
EO 2710 (3-2)	Signal and Systems I
CM 3112 (4-0)	Naval Telecommunications Systems
OS 3005 (4-0)	Operations Research for Communications Managers
CM 0001 (0-2)	Seminar
	Two Week Experience Tour

Quarter 4

MN 4125 (4-0)	Managing Planned Change in Complex Organizations
EO 2750 (3-2)	Signals and Systems II
IS 3502 (4-0)	Computer Networks
CM 3001 (4-0)	Economic Evaluation of Telecommunications
CM 0001 (0-2)	Seminar

Quarter 5

CM 0810	Thesis
EO 3750 (4-1)	Communications Systems Analysis
CM 4502 (4-0)	Telecommunications Networks
CM 3002 (4-0)	Economic Evaluation of Telecommunications
CM 0001 (0-2)	Seminar

Quarter 6

CM 0810	Thesis
CM 4925 (4-0)	Telecommunications Systems, Industry
MN/IS/CM/ OS	Elective
CM 0001 (0-2)	Seminar

Coast Guard Option

Quarter 1

EC 2170 (4-2)	Intro to Elec Eng
MA 1116 (5-0)	Multivariable Calculus
CS 2950 (5-0)	Structured Progamming with FORTRAN
MN 3105 (4-0)	Organization and Mgmt.

Quarter 2

EC 2110 (3-2)	Circuit Analysis II
MA 2049 (4-0)	Applied Mathematics for Eng. and Ops. Analysis
OS 3404 (3-0)	Man-Machine Interactions
MN 2155 (4-0)	Accounting for Mgmt.

Quarter 3

EO 2720 (4-2)	Intro to Electronic Sys
CS 3010 (4-0)	Comp Devices & Sys
OS 3101 (5-0)	Stat Anal for Mgmt.
MN 4125 (4-0)	Managing Planned Change in Complex Organizations

Quarter 4

EI 3720 (4-1)	Intro to Signals & Noise
OS 3005 (4-0)	Op Res for Comm Mgrs
CM 3112 (4-0)	Navy Telecomm Sys
CM 3111 (4-0)	C3 Mission & Org

Quarter 5

CS	3020 (3-2)	Software Design
IS	3502 (4-0)	Computer Networks: Wide Area/Local Area
CM	3001 (4-0)	Econ Eval of Telecomm Sys I

Quarter 6

EI*	3750 (3-1)	Comm Sys Anal
CS	3030 (4-0)	Operating Sys Struc
CM	3002 (4-0)	Econ Eval of Telecomm Sys II
CM	0810	Thesis

Quarter 7

CM	4925 (4-0)	Telecomm Sys, Ind, Reg
CM	0810	Thesis

Quarter 8

EC	2250 (4-2)	Accelerated Review of Electronic Engineering
MN	3301 (4-0)	Sys Acq & Proj Mgmt
CM	0810	Thesis

JOINT COMMAND, CONTROL AND COMMUNICATIONS (Joint C3) PROGRAMS

Curricular Officer

Linda K. Crumback, LTCOL, USAF,
Code 39, Spanagel Hall, Room 203,
(408) 646-2772, AV 878-2772.

JOINT COMMAND, CONTROL AND COMMUNICATIONS CURRICULUM 365

The Joint C3 curriculum is designed to provide officers and their civilian DoD equivalents and a comprehensive operational and technical understanding in the field of command, control and communications systems. A primary goal is to enable the student to operate with enhanced capabilities in such diverse fields as military decision making, current and future C3 systems design, and joint military operations. The curriculum is tailored to the requirements of selected officers who have outstanding performance records and anticipate continued careers focused on the conduct of military operations.

The Joint C3 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 in the field of Command, Control and Communications systems as applied to Joint and combined military operations at the national and unified command levels. To develop individuals who have an understanding of the role C3 systems play in the use of military power, and the ability to interpret the impact of C3 on operating philosophy; possess an adequate background knowledge in the basic technology, human capabilities and joint military operations and how these are exploited in current C3 systems; can perform requirement and planning studies of new C3 systems, and contribute to crisis management. These officers should be able to undertake a wide range of assignments in C3 (both joint and intra-service) over the full span of a career.

REQUIREMENTS FOR ENTRY

The Joint C3 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. A Top Secret security clearance is required with Special Intelligence (SI) clearance obtainable. An APC of 325 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 AND COMMUNICATIONS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Joint Command, Control and Communications Subspecialist with a subspecialty code of XX45. The Curriculum Sponsor is OJCS/J6, Directorate for Command, Control and Communications Systems.

Typical Jobs in this Subspecialty:

Staff Command and Control Officer
Commander in Chief, Pacific Fleet
Surface Systems Officer
Naval Ocean Systems Center

ADP Plans Officer
World Wide Military Command & Control System Joint Program Office
Staff Operations Plans Officer
Headquarters, European Command
Staff Operations and Plans Officer
Commander 7th Fleet
Programs Manager
Naval Space and Warfare Systems Command

Entry Dates: Joint Command, Contol and Communications is a six 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.

Academic Associate:
Carl R. Jones, Professor,
Code 54Js, Ingersoll Hall, Room 248,
(408) 646-2726, AV 878-2767.

Degree: Requirements for the degree Master of Science in Systems Technology (Command, Control and Communications) are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS 2970 (5-0)	Struc Prog with PASCAL
OS 3404 (3-0)	Man-Machine Interaction
OS 2103 (4-1)	App Prob for Sys Tech
CM 3111 (4-0)	C3 Missions & Organization Theory

Quarter 2

MA 2050 (4-1)	App Math for Eng & Op Anal (Plus Lab)
EO 2710 (4-2)	Intro to Signals & Systems
CS 3050 (3-2)	Software Project Development
OS 3604 (4-0)	Decision & Data Analysis

Quarter 3

OS 3603 (3-1)	Simulation & Wargaming
	Emphasis Sequence Elective
EO 2750 (4-2)	Communication Systems
OS 3008 (4-0)	Analytical Planning Methodology
	Emphasis Sequence Elective
MN 3301 (4-0)	Systems Acquisition and Project Management

Quarter 4

OS 3636 (4-0)	Architecture of C3 Information System
OS 4602 (3-3)	C3 Systems Evaluation

Quarter 5

EO 3750 (3-1)	Communication Systems Analysis
CC 0810	Thesis Research
	Emphasis Sequence Elective
MR 2419 (2-0)	Atmosphere Factors in C3

Quarter 6

CC 4113 (4-0)	C3 Policies and Problems
CC 0810	Thesis Research

SPACE SYSTEMS OPERATIONS CURRICULUM 366

The Space Systems Operations graduate curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, a 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.

Entry Dates: Space Systems Operations is an eight quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate of the Curricular Officer for this curriculum.

SPACE SYSTEMS OPERATIONS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of XX76. The Curriculum Sponsor is OP-943, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

Commanding Officer
  Naval Space Surveillance Systems
Plans Officer
  North American Aerospace Defense Command
Advanced Concepts Officer
  Naval Space and Warfare Systems Command
Space Defense Director
  North American Aerospace Defense Command

REQUIREMENTS FOR ENTRY

This curriculum is open solely 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 and integral calculus, plus at least one course in calculus-based engineering physics. Students lacking this background may matriculate through the engineering science program (Curriculum 460). A Top Secret security clearance is required with Special Intelligence (SI) clearance obtainable.

Academic Associate:

Carl R. Jones, Professor,
Code 54Js, Ingersoll Hall, Room 248,
(408) 646-2767, AV 878-2767.

Degree: Requirements for the degree Master of Science in Systems Technology (Space Operations) are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

SS	2001 (4-0)	Mil Ops in Space
MA	2050 (4-1)	App Math for Eng & Ops Anal
CS	2970 (5-0)	Struc Prog with PASCAL
OS	2103 (4-1)	App Prob for Sys Tech

Quarter 2

PH	2502 (4-0)	Intro to Space Mech
MA	1118 (5-2)	Multivariable Calculus
EO	2710 (4-2)	Intro to Signals & Sys
OS	3604 (4-0)	Decision & Data Anal

Quarter 3

PH	3514 (4-0)	Intro to Space Environ
CM	3111 (4-0)	C3 Mission and Organ
EO	2740 (4-2)	Communications Sys
OS	3008 (4-0)	Anal Plan Method

Quarter 4

PH	3513 (4-0)	Intermediate Orb Mech
SS	3001 (4-0)	Mil App of Space
OC	3522 (4-2)	Remote Sensing of the Atmosphere and Ocean

Quarter 5

AE	4791 (3-2)	Spacecraft Systems I
NS	3452 (4-0)	Sov Nav & Maritime Strat
EO	3750 (3-1)	Comm Sys Analysis
OS	3603 (3-1)	Sim & Wargaming

Quarter 6

AE	4792 (4-0)	Spacecraft Systems II
OA	3602 (4-0)	Search Theory and Det
MN	3301 (4-0)	Sys Acq & Proj Mgmt

Quarter 7

SS	4001	Decisions and Space Sys
SS	0810	Thesis Research
		Elective

Quarter 8

CS	3020 (3-2)	Software Design
SS	0810	Thesis Research
		Elective

SPACE SYSTEMS ENGINEERING CURRICULUM 591

To provide officers, through graduate education, with a comprehensive scientific and technical knowledge in technological field applicable to 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. Officer graduates will be prepared by their education to design, develop, and manage the acquisition of space communications, navigation, surveillance, EW and environmental sensing systems.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, in engineering or the physical sciences if preferred. 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.

Entry Dates: Space Systems Engineering is a nine quarter course of study with entry dates in January, April, July and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

Rudolf Panholzer, Professor,
Code 62Pz, Bullard Hall, Room 205,
(408) 646-2154, AV 878-2154.

Degree: Requirements for the degree Master of Science in Electrical Engineering are met as a milestone en route to satisfying the skill requirements of this curricular program.

SPACE SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of XX77. The Curriculum sponsor is OP-943, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

Assistant Project Manager Satellite Communications
SPAWAR
Manager Navy Space Project
SPAWAR
Head DMSP & NAVDEP, Joint Program Office
Navy Space Systems Activity, Los Angeles, CA
Assistant forNavigation Systems
CNO OP-943DI
MILSTAR Systems Engineering
Navy Space Systems Activity, Los Angeles, CA
Head Satellite Surveillance
CNO OP-986E
Launch & Control Systems Officer
Naval Space Command
Assistant for TENCAP Systems
OP-943E11
Plans & Project Officer
Naval Space Surveillance Systems
Electronics Engineering Systems Dept. Head
Navy Astronautics Group, Pt. Mugu, CA

TYPICAL COURSE OF STUDY

Quarter 1

EC	2450 (4-2)	Accel Review of Systems
EC	2250 (4-2)	Accel Review of Electronics Engineering
AE	2042 (3-2)	Fundamentals of Thermofluid Dynamics
MA	2121 (4-0)	Differential Equations
SS	2001 (4-0)	Military Ops in Space, I

Quarter 2

EC	2500 (3-2)	Communications Theory
EC	2650 (4-2)	Accel Review of Electromagnetics
AE	2043 (3-2)	Fundamentals of Gas Dynamics
PH	3513 (4-0)	Intermediate Orbital Mechanics

Quarter 3

MA	3232 (3-2)	Numerical Analysis
AE	2015 (3-2)	Engineering Dynamics
PH	3514 (4-0)	Introduction to the Space Environment

Quarter 4

EC	2300 (3-2)	Control Systems
EC	3800 (3-2)	Microprocessor-Based System Design
AE	2021 (4-1)	Introduction to Flight Structures
OS	2102 (4-1)	Introduction to Applied Probability for Electrical Engineering
SS	3001 (4-0)	Military Applications of Space, I

Quarter 5

EC	3310 (4-0)	Linear Optimal Estimation and Control
EC	3500 (4-0)	Analysis of Random Signals
EC	3400 (3-0)	Introduction to Digital Signal Processing
AE	4791 (3-2)	Spacecraft Systems I

Quarter 6

EC	4310 (3-0)	Digital Control Systems
EC	3510 (3-0)	Communications Engineering
EC	3600 (3-2)	Electromagnetic Radiation, Scattering and Propagation
AE	4792 (4-0)	Spacecraft Systems II

Quarter 7

EC	4330 (4-0)	Navigation, Missile and Avionics Systems
MS	3201 (3-2)	Materials Science and Engineering
SS	4001 (4-0)	Decisions and Space Systems
EC	0810	Thesis

Quarter 8

EC	4590 (3-0)	Communications Systems Satellite Engineering
MS	3505 (4-0)	Material Selection for Military Application
OC	3522 (4-2)	Remote Sensing of the Atmosphere & Ocean with Laboratory
EC	0810	Thesis

Quarter 9

EC	4460 (3-0)	Principles of Systems Engineering
MN	3301 (4-0)	Systems Acquisition and Project Management
EC	0810	Thesis
EC	0810	Thesis

NATIONAL SECURITY AND INTELLIGENCE PROGRAMS

Curricular Officer

James W. Mueller, CAPT, USN,
Code 38, Root Hall, Room 216,
(408) 646-2228, AV 878-2228.

Assistant Curricular Officer

Denise P. Newell, LT, USN,
Code 381, Root Hall, Room 211,
(408) 646-2845, AV 878-2845.

MIDDLE EAST, AFRICA, SOUTH ASIA CURRICULUM 681

Area Studies curricula focus on the history, culture, and religion of a specific region or country and provide 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 U.S. military officers or civilian employees of the U.S. Federal Government. Students must have a baccalaureate degree earned with above average academic performance and an APC of 365. College-level preparation in basic descriptive and inferential statistics is required.

Entry Dates: Area studies are six quarter courses of study with entry dates in January and July. If information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

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 XX21. The Curriculum Sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Operations Intelligence
Commander Middle East Force
STF Operations and Plans
Commander Middle East
for Bahrain
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
OP-611
Military Assistance Program
Military Liason Office Tunisia
CTRY Director - Acting Officer
Office of the Secretary of Defense
DIA

Academic Associate:

E. Olson, Associate Professor,
Code 56Os, Root Hall, Room 201J,
(408) 646-3163, AV 878-3163

Degree: Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

FAR EAST, SOUTHEAST, PACIFIC CURRICULUM 682

Area Studies curricula focus on the history, culture, and religion of a specific region or country and provide students with a knowledge of current is-

sues, economic and political structures and institutions, military forces, including strategic capabilities and policy implications, and geopolitical influences.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government. Students must have a baccalaureate degree earned with above average academic performance and an APC of 365. College-level preparation in basic descriptive and inferential statistics is required.

FAR EAST, SOUTHEAST, PACIFIC SUBSPECIALTY

Completion of the 682 curriculum qualifies an officer as a Far East, Southeast, Pacific Subspecialist with a subspecialty code of XX22. The Curriculum Sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Chief of Staff
COMNAVBASE GUAM
Staff Negotiations Representative
USCINPAC REP PHILIPPINES
Staff Operations and Plans
CINCPACFLT
Faculty Member
DIC
OP-635C Assistant for Military Sales
OPNAV-FOREIGN MILITARY
Analyst
OPNAVSUPPACT, Washington, DC

Entry Dates: Area Studies are six quarter courses 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.

Academic Associate:

E. Olson, Associate Professor, Code 56Os, Root Hall, Room 201J, (408) 646-3163, AV 878-3163

Degree: Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

EUROPE AND USSR CURRICULUM 683

Area Studies curricula focus on the history, culture, and religion of a specific region or country and provide students with a knowledge of current issues, economic and political structures and institutions, military forces, including strategic capabilities and policy implications, and geopolitical influences.

EUROPE AND USSR SUBSPECIALTY

Completion of the 683 curriculum qualifies an officer as a Europe/USSR Subspecialist with a subspecialty code of XX24. The Curriculum Sponsor is OP-06, Chief of Naval Operations. (Plans, Policy and Operations).

Entry Dates: Area Studies are six quarter courses 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.

Typical Jobs in this Subspecialty:

Staff Plan
NATO
ACOS for Plans
SACLANT
POL-MIL Planner
Joint Chiefs of Staff
Geopolitical Intelligence Office
CINCUSNAVEUR LONDON

Atlantic Allied Plans
COMINEWARCOM
Naval Coordinator
EUCOM
Staff Infrastructure Policy
SHAPE
Area Officer
DIA
NATO Strategic Concepts
OPNAV
Country Director Spain & Portugal
Office of Secretary of Defense

Degree: Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government. Students must have a baccalaureate degree earned with above average academic performance and an APC of 365. College-level preparation in basic descriptive and inferential statistics is required.

Academic Associate:

E. Olson, Associate Professor, Code 56Os, Root Hall, Room 201J, (408) 646-3163, AV 878-3163.

INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS CURRICULUM 684

This curriculum focuses on the security relationships between the United States and other nation states. Courses address the implications of both govvernmental and non-governmental actions, the organization and structure through which relationships are conducted, and the development of international institutions and policies that provide guidelines for such interaction, including international law, the law of war, and the law of the sea.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government. Students must have a baccalaureate degree earned with above average academic performance and an APC of 365. College-level preparation in basic descriptive and inferential statistics is required.

Entry Dates: International Organizations and Negotiations is a six quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS SUBSPECIALTY

Completion of the 684 curriculum qualifies an officer as an International Organizations and Negotiations Subspecialist with a subspecialty code of XX25. The Curriculum Sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Liaison Officer
PEP Bahamas
Force Requirements/Programs Office
SACLANT
Representative for International Negotations
Joint Chiefs of Staff
Intelligence Affairs Officer
EUCOM US HQ
Military Assistant
U.S. Arms Control and Disarmament
Ship Operations
COMSC MED

Head, Ocean Policy Branch
OPNAV
Chief
DIA

Assistant for Nuclear Negotiations
OPNAV
Strategic Policy Planner
Joint Chiefs of Staff

Academic Associate:
Frank M. Teti, Associate Professor, Code 56TT, Root Hall, Room 201, (408) 646-2528, AV 878-2528.

Degree: Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

NS 3010	Comparative Analysis and Research Methods
NS 3400	Domestic Context of Soviet National Security Policy
NS 3900	International Organizations & Negotiations
NS 3020	International Relations

Quarter 2

NS 3060	American National Security Policy
NS 3040	The Politics of Global Economic Relations
NS 3410	Soviet National Security
NS 3902	Modern Revolution and Political Terrorism

Quarter 3

NS 3960	International Law
NS 3450	Soviet Military Strategy
NS 4500	Seminar in the National Interest
NS 4902	Seminar on Modern Revolution & Terrorism

Quarter 4

NS 4251	American National Security Objectives and Net Assessment
NS 3021	The Role of the Superpowers in the Third World
NS 4900	Seminar in International Negotiations
NS 3452	Soviet Naval and Maritime Strategy

Quarter 5

NS 4250	Problems of Security Assistance and Arms Transfers
NS 4262	Seminar in Strategic Deception
NS 4901	Seminar in Ocean Policy
NS 0810	Thesis Research

Quarter 6

NS 3961	The Law of War
NS 4040	Strategic Resources and U.S. National Security Policy
NS 4950	Seminar in Arms Control and National Security
NS 0810	Thesis Research

WESTERN HEMISPHERE CURRICULUM 685

Area Studies curricula focus on the history, culture, and religion of a specific region or country and provide 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 U.S. military officers or civilian employees of the U.S. Federal Government. Students must have a baccalaureate degree earned with above average academic performance and an APC of 365. College-level preparation in basic descriptive and inferential statistics is required.

WESTERN HEMISPHERE SUBSPECIALTY

Completion of this curriculum qualifies an officers as a Western Hemisphere Subspecialist with a subspecialty code of XX23. The Curriculum Sponsor is OP-06, 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
Air Antisubmarine Warfare/Plans
COMSOLANTFOR
Strategy and Policy Central and South Atlantic
USCINCLANT
Intelligence Analyst
USCINSCO
Area Officer
DIA
OP-613B1 CUBA/CARIBBEAN
OPNAV
Assistant for Military Sale
OPNAV-FOREIGN MILITARY
CTRY Director
Office of Secretary of Defense
OP-613 Assistant Branch Head
South America

Academic Associate:

E. Olson, Associate Professor,
Code 56Os, Root Hall, Room 201J,
(408) 646-3163, AV 878-3163.

Degree: Requirements for the degree of Master in Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

Entry Dates: Area Studies are six quarter courses of study with entry dates in January and July. If further information is needed, contact the academic Associate or Curricular Officer for this curriculum.

STRATEGIC PLANNING CURRICULUM 686

This curriculum is designed to provide the student with an understanding of the generation and use of military power in support of national objectives, the process of U.S. strategic decision-making, and the deployment of military forces, including maritime nuclear strategic and theater forces in peacetime and under conditions of conventional and nuclear war.

REQUIREMENTS FOR ENTRY

Entrance is 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 completed 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 a six quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Curricular Officer of this curriculum.

Academic Associate:

Frank M. Teti, Associate Professor,
Code 56Tt, Root Hall, Room 201,
(408) 646-2528, AV 878-2528.

STRATEGIC PLANNING SUBSPECIALTY

Completion of the 686 curriculum qualifies an officer as a Strategic Plannig Subspecialist with a subspecialty code of XX26. The Curriculum Sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

International Plans
COMCANLANT
War Plans
CINCUSNAVEUR
Staff Plans
SHAPE
NATO Plans Officer
COMSTRIKEFLTLANT
Navy Plans Officer
Special Operations
Nuclear Weapons/Air Warfare Instructor
NUCWEAPTRAGRLANT/PAC
SSBN Current Operations
USCINCLANT
Head Trident Strategic Weapons
OPNAV

Degree: Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1		
NS	3152	Naval Warfare and the Threat Environment
OS	3101	Statistical Analysis for Management
NS	3400	Domestic Context of Soviet National Security Policy
NS	3020	Analysis of International Relations
Quarter 2		
NS	3030	American National Security Policy
NS	3040	The Politics of Global Economic Relations
NS	3150	Intelligence Data Analysis & Research Methods
NS	3410	Soviet National Security
Quarter 3		
NS	4500	Seminar in the National Interest
NS	3230	Strategic Planning and U.S. National Security Policy
NS	3450	Soviet Military Strategy
NS	3250	Defense Resources
Quarter 4		
NS	3280	Nuclear Weapons and Foreign Policy
NS	3452	Soviet Naval and Maritime Strategy
NS	4251	American Nat Sec Obj & Net Assessment
NS	4230	Seminar in Strategic Planning
Quarter 5		
NS	4250	Problems of Security Assistance and Arms Transfers
NS	3902	Modern Revolution and Political Terrorism
NS	4262	Seminar in Strategic Deception
NS	0810	Thesis Research
Quarter 6		
PH	3006	Weapons Systems and Weapons Effects
NS	4040	Strategic Resources and U.S. National Security Policy
NS	4261	Survey of Strategic Studies
NS	0810	Thesis Research

INTELLIGENCE CURRICULUM 825

This curriculum is a technical, interdisciplinary program integrating the study of political science, data analysis, aeronautical engineering, operations research, physics, electrical engineering, information systems, and oceanography into an understanding of intelligence.

Coursework addresses three broad fields: defense technology, analysis and management, and national security affairs. Defense technology courses are designed to address the special problems of technical intelligence,

emphasizing technical literacy. The analysis and management sequence provides a grounding in quantitative techniques and research methods. National security affairs courses address the interface between international politics and national security objectives.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligibil for a Top Secret clearance with access to Sensitive Compartmented Information based on a 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 334.

Entry Dates: Intelligence is a six quarter course of study with starting dates in April and October. In addition, all students will report for a math and physics refresher in mid February or mid August. If further information is needed, contact the Academic Associate or the Curricular Officer of this curriculum.

INTELLIGENCE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Intelligence Specialist with a subspecialty code of XX17. The Curriculum Sponsor is Naval Intelligence Command.

Typical Jobs in this Subspecialty:

Operations Intelligence Analyst
NAVOPINTCEN, Washington, DC
Technical Intelligence
COMNAVFOR JAPAN
Naval Attache
Attache USSR
Commander Shore Activity
NISC, Washington, DC
Staff Operations/Submarine Operations
CINCUSNAVEUR LONDON
Intelligence Officer
COMSUBGRU
Surface Analyst
FOSIF ROTA SPAIN
Tactical Intelligence
Office of the Secretary of Defense
Intelligence Officer
War College, Newport, RI
Intelligence Production Analyst
NORAD/ADCOM JNT SUPP

Degree: Requirements for the degree Master of Science in National Security Affairs are met en route to satisfying the skill requirements of the curricular program.

Academic Associate:

Robert L. Armstead, Assoc. Prof., Code 61Ar, Spanagel Hall, Rm. 112, (408) 646-2125, AV 878-2125.

TYPICAL COURSE OF STUDY

Quarter 1

OC 2001	Ocean Systems
NS 2154	Intelligence and the Military
NS 3150	Intelligence Data Analysis and Research Methods
NS 3030	American National Security Policy

Quarter 2

SE 2002	Electromagnetic Systems
NS 3450	Soviet Military Strategy
NS 3020	International Relations
EO 2790	Communications Systems

Quarter 3

AE 3005	Survey of Aircraft and Missile Technology
NS 3410	Soviet National Security
NS 4251	American National Security Objectives and Net Assessment
NS 3151	Intelligence Systems and Products

Quarter 4

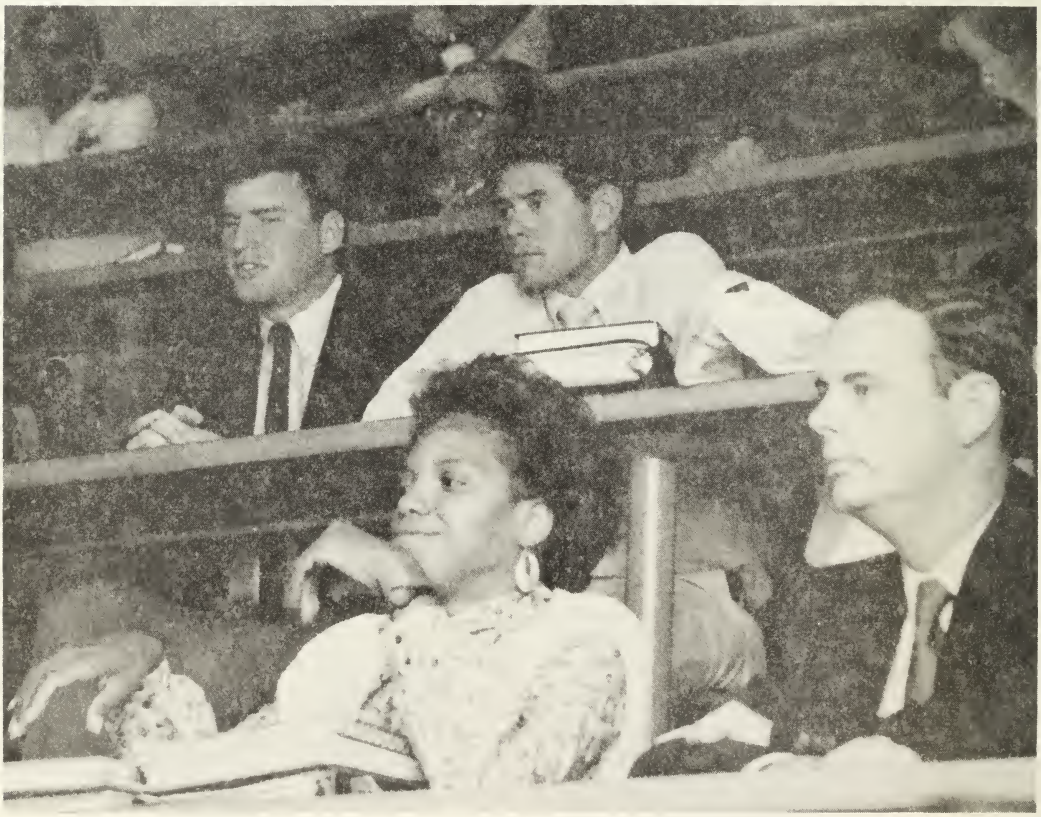
NS 3902	Modern Revolution and Political Terrorism
NS 4500	Seminar in the National Interest
NS 4250	Problems of Security Assistance and Arms Transfers
OS 3404	Man-Machine Interaction

Quarter 5

SE 3004	Weapons Systems Analysis
OS 3002	Operations Research for Intelligence
NS 3452	Soviet Naval and Maritime Strategy
NS 0810	Thesis Research

Quarter 6

SE 4006	Technical Assessment and Intelligence Systems
NS 4152	Problems of Intelligence and Threat Analysis
NS 0810	Thesis Research
IS 3183	Management Information Systems



NAVAL ENGINEERING PROGRAMS

Curricular Officer

Dennis P. Mahoney, CDR, USN,
Code 34, Halligan Hall, Room 220,
(408) 646-2033, AV 878-2033.

NAVAL ENGINEERING PROGRAMS CURRICULUM 570

The objective of this program is to provide graduate education, primarily in the field of Mechanical Engineering. The graduate will have the technical competence to operate and maintain modern warships and naval systems. He will be able to participate in technical aspects of naval systems acquisitions 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 (334 via Engineering Science Curriculum 460) is required. 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. Current enrollment is approximately 115 students.

NAVAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Naval 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 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, SIMA
- Board of Inspection and Survey
- Propulsion Examining Board

Entry Dates: Naval Engineering is an eight quarter course of study with entry dates in April and October. For Engineering Duty Officers, the program is nine quarters long. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Academic Associate:

Robert H. Nunn, Professor,
Code 69Nn, Halligan Hall, Rm. 207,
(408) 646-2365, AV 878-2365.

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

TYPICAL COURSE OF STUDY

Quarter 1

MA 1118 (5-2)	Multivariable Calculus
EC 2170 (4-2)	Intro to Electrical Eng
ME 2101 (4-1)	Thermodynamics
ME 2501 (3-0)	Statics

Quarter 2

MA 2047 (4-0)	Linear Algebra & Vector Analysis
ME 2440 (3-0)	Methods of Eng Computation
ME 2441 (0-2)	Eng Computational Lab
ME 2502 (4-1)	Dynamics
ME 2601 (3-2)	Solid Mechanics I

Quarter 3

MA 2121 (4-0)	Ordinary Differential Equations
ME 2201 (3-2)	Intro to Fluid Mechanics
ME 2801 (3-2)	Intro to Engineering Systems
ME 3611 (4-0)	Solid Mechanics II

Quarter 4

MA 3132 (4-0)	Partial Differential Equations
ME 3150 (4-2)	Heat Transfer
ME 3201 (3-2)	Intermediate Fluid Mechanics
ME 3801 (3-0)	Linear Automatic Controls
ME 3802 (0-2)	Mechanical Engineering Controls Lab

Quarter 5

* ME 2410 (2-3)	Mechanical Engineering Lab
MS 3201 (3-2)	Materials Science
ME 3220 (3-2)	Auxiliary & Turbomachinery
ME 3711 (4-1)	Design of Machine Elements

Quarter 6

MA 3232 (3-2)	Numerical Analysis
MS 3202 (3-2)	Failure Analysis
ME 3521 (3-2)	Vibrations
ME 3240 (3-0)	Reciprocating & Gas Turbine Power Plants
ME 3241 (0-3)	Marine Eng Lab

Quarter 7

*ME 2301 (2-0)	Intro to Naval Architecture
ME 3230 (2-0)	Nuclear Power Systems
ME 4XXX	Elective
ME 4XXX	Elective
*ME 0810/4999	Thesis/Elective

Quarter 8

EC 2370 (3-2)	Electromechanical Energy Conversion
*ME 4XXX	Elective
ME 0810	Thesis
ME 0810	Thesis

Quarter 9

*OS 3104 (4-0)	Statistics for Science & Engineering
*ME 4XXX	Elective
ME 0810	Thesis
ME 0810	Thesis

*Unrestricted Line Officers do not take asterisked courses in their eight quarter program

OPERATIONS ANALYSIS PROGRAMS

Curricular Officer

Thomas E. Halwachs, CDR, USN,
Code 30, Root Hall, Room 232,
(408) 646-2786, AV 878-2786.

OPERATIONS ANALYSIS CURRICULUM 360

This program provides education in the application of quantitative analysis to operational, tactical, and managerial problems. The disciplines of mathematics, probability, statistics, economics, human factors, physical science, and optimization which the officer student learns here, or brings with him, supply the theoretical background for analyzing alternative choices in tactical and strategic warfare and in planning, budgeting and procurement of systems and forces. The course of study generates computational capability and develops skills in identifying relevant information, generating decisions 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 in mathematics is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. A one year course in college physics is highly desired. Students lacking these quantitative prerequisites will be accepted, in certain cases, where their undergraduate records indicate that they are exceptional students and there are other possible indicators of success such as 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 OP-91, Program Resource Appraisal Division.

Typical Jobs in this Subspecialty:

Destroyer Squadron Chief Staff Officer
OPNAV Air Warfare Program Analyst
JCS Analyst
Director OPS Research, SACLANT
Asst Staff OPS/PLANS, COMCARGRU
Staff OPS & PLANS, COMTHIRDFLT

Entry Dates: Operations Analysis is an eight quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Academic Associate:

James D. Esary, Professor,
Code 55Ey, Root Hall, Room 273,
(408) 646-2780, AV 878-2780.

Degree: Requirements for the degree Master of Science in Operations Research are met as a mileston en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

OA 2200 (4-1)	Computational Methods for Operations Research
MA 1118 (5-2)	Multivariable Calculus
MA 2042 (4-0)	Linear Algebra
OA 3101 (4-1)	Probability

Quarter 2

OA 2600 (4-0)	Introduction to Operations Analysis
MA 3110 (4-0)	Topics in Intermediate Analysis
PH 3301 (4-0)	Radiating Systems
OA 3102 (4-1)	Probability and Statistics

Quarter 3

OA 3201 (4-0)	Linear Programming
OA 3401 (4-0)	Human Factors in Systems Design I-II
OA 3301 (4-0)	Stochastic Models I
OA 3103 (4-1)	Statistics

Quarter 4

OA 3602 (4-0)	Search Theory and Detection
AS 3610 (4-0)	Economic Analysis and Operations Research
OA 3302 (4-0)	Systems Simulation
OA 3104 (3-1)	Data Analysis

Quarter 5

(first six weeks)

OA 3601 (4-1)	Combat Model and Games
AS 3611 (4-1)	Planning and Capital Allocation in the Department of Defense

(last six weeks)

EXPERIENCE TOUR OFF CAMPUS

Quarter 6

OA 4604 (4-0)	Wargaming Analysis
OA 4201 (4-0)	Nonlinear and Dynamic Programming
OA 4301 (3-2)	Stochastic Models II
OA XXXX	Elective

Quarter 7

OA 4603 (3-2)	Test and Evaluation
OA 0810 (0-0)	Thesis Research
OA XXXX	Elective
OA XXXX	Elective

Quarter 8

OA 4602 (4-0)	Campaign Analysis
OA 0810 (0-0)	Thesis Research
OA XXXX	Elective
OA XXXX	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 analyzing alternative choices in planning for sustainability of Naval Forces involved in long range deployments.

The course of study generates computational capability and develops skills in 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.

OPERATIONAL LOGISTICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Logistics Subspecialist with a subspecialty of XX43P. The curriculum sponsor is OP-04, Office of Chief of Naval Operations (Logistics).

Typical Jobs in this Subspecialty:

AGOS, SACLANT
LOG, PLANS, CINCUSNAVEUR
LOG, PLANS, CINCPACFLT
OPNAV Fleet Mobilization
JCS Logistics
Warfare Analyst, NSURFWPC
OSD Analyst
USCINPAC Analyst
Head Special Studies, Strategic Systems Project Officer
VX-1 Analyst
War College Professor

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above average grades in mathematics is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. A one year course in college physics is highly desired. Students lacking these quantative prerequisites will be accepted, in certain cases, where their undergraduate records indicate that they are exceptional students and there are other possible indicators of success such as Graduate Record Examination scores, correspondence or extension courses in quantitative subjects, and outstanding motivation for the program.

Entry Date: Operational Logistics is an eight quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

F. Russell Richards, Assoc. Prof., Code 55Rh, Root Hall, Room 271, (408) 646-2543, AV 878-2543.

Degree: Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

OA 2200 (4-1)	Computational Methods for Operations Research
MA 1118 (5-2)	Multivariable Calculus
MA 2042 (4-0)	Linear Algebra
OA 3101 (4-1)	Probability

Quarter 2

OA 2600 (4-0)	Introduction to Operations Analysis
MA 3110 (4-0)	Topics in Intermediate Analysis
MN 3372 (4-0)	Material Logistics
OA 3102 (4-1)	Probability and Statistics

Quarter 3

OA 3201 (4-0)	Linear Programming
OA 3700 (4-0)	Mobilization
OA 3301 (4-0)	Stochastic Models I
OA 3103 (4-1)	Statistics

Quarter 4

OA 4202 (4-0)	Network Flows and Graphs
AS 3610 (4-0)	Economic Analysis and Operations Research
OA 3302 (4-0)	Systems Simulation
OA 3104 (3-1)	Data Analysis

Quarter 5

(first six weeks)

OA 3601 (4-1)	Combat Model and Games
AS 3611 (4-1)	Planning and Capital Allocation in the Department of Defense

(last six weeks)

EXPERIENCE TOUR OFF CAMPUS

Quarter 6

OA 4604 (4-0)	Wargraming Analysis
OA 3602 (4-0)	Search Theory and Detection
MN 4373 (4-0)	Transportation Management
OA XXXX	Elective

Quarter 7

OA 4202 (4-0)	Network Flows and Graphs
MN 4310 (4-0)	Logistics Engineering
OA 0810 (0-0)	Thesis Research
OA XXXX	Elective

Quarter 8

OA 4602 (4-0)	Campaign Analysis
OA 0810 (0-0)	Thesis Research
OA 4302 (4-0)	Reliability
OA XXXX	Elective

WEAPONS ENGINEERING PROGRAMS

Curricular Officer

Milo J. Kilmer, II, CDR, USN,
Code 33, Spanagel Hall, Room 328,
(408) 646-2116/7, AV 878-2116/7.

WEAPONS SYSTEMS ENGINEERING CURRICULUM 530

This program is designed to meet the needs of the military services for an officer having a strong broad-based technical education with particular applications toward weapons systems. The fundamental task of the Weapons Engineering subspecialty community is the design, development, test and evaluation, acquisition, operation and support of naval weapons systems. In support of this career pattern, the objective of these curricula is to provide that advanced technical education on a broad foundation encompassing the basic scientific, analytic and engineering principles underlying the field of naval weaponry. The specific areas of study and the levels of expertise to be attained are formulated to insure a sound basis for technical competence and for subsequent growth as may be required to support the fundamental task of the community.

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 Curriculum discussed elsewhere in this catalog. An APC of 323 is required.

WEAPONS SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Weapons Systems Engineering Subspecialist with a subspecialty code of XX61. The Curriculum Sponsor is Naval Sea Systems Command Headquarters.

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

Entry Dates: Weapons Engineering is a nine quarter course of study with entry dates in March and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

James V. Sanders, Assoc. Prof.,
Code 61Sd, Spanagel Hall, Rm. 146B,
(408) 646-2931, AV 878-2931.

Degree: Requirements for the degree Master of Science in Engineering Science are met as a milestone en route to satisfying the 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 or one of the engineering disciplines.

TYPICAL COURSE OF STUDY

Quarter 1

MA 1118 (5-2)	Multivariable Calculus
MA 2047 (4-0)	Linear Algebra and Vector Analysis
EC 2810 (3-2)	Digital Machines
PH 1121 (3-2)	Basic Physics I: Mechanics

Quarter 2

MA 2121 (4-0)	Differential Equations
CS 2450 (3-1)	Fortran
EC 2170 (4-2)	Electrical Engineering
PH 1322 (4-0)	Physics II: Electricity and Magnetism

Quarter 3

PH 2151 (4-1)	Mechanics I: Particle Mechanics
	Elective
MA 3132 (4-0)	Partial Differential Equations and Integral Transforms
PH 2223 (4-2)	Physics III: Optics

Quarter 4

MS 3201 (3-2)	Material Science
	Elective
PH 2681 (4-2)	Introductory Quantum Physics
PH 2724 (4-0)	Physics IV: Thermodynamics, Fluids and Acoustics

Quarter 5

PH 3360 (4-1)	Electromagnetic Wave Propagation
EC 2140 (3-0)	Analog Signals
CS 3201 (3-2)	Computer Architecture
MS 3202 (3-2)	Failure Analysis

Quarter 6

	Specialization Course
CC 4900 (4-0)	Combat Systems
EC 2500 (4-2)	Communications Systems
CS 3550 (3-2)	Computers in Combat Systems

Quarter 7

	Specialization Course
	Specialization Course
PH 3461 (4-1)	Explosions & Explosives
OS 3104 (4-0)	Statistics for Science and Engineering
XX 0810	Thesis

Quarter 8

EC 3670 (3-2)	Radar Systems
	Specialization Course
PH 3461 (4-1)	Explosions & Explosives
XX 0810	Thesis

Quarter 9

	Specialization Course
PH 3161 (4-1)	Fluid Dynamics
XX 0810	Thesis
XX 0810	Thesis

WEAPONS SYSTEMS SCIENCE CURRICULUM 531

This program is designed to meet the needs of the military services for officers who have a strong broad-based technical education with graduate emphasis in engineering physics and its applications.

In addition to the introductory and core courses previously described, all students in this curriculum take additional courses in electromagnetic phenomena and statistical physics. In-depth option sequences of two or more courses are offered wherein students specialize in a particular area of physics. Students also engage in thesis research in an area related to these advanced studies.

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 curriculum.

Officers may enhance their selectability by taking off-campus courses, including participation in the Postgraduate School Continuing Education program. An APC of 323 is required.

WEAPONS SYSTEMS SCIENCE SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Weapons Systems Science Subspecialist with a subspecialty code of XX63. The Curriculum Sponsor is Naval Sea Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Weapons Department Head
Naval Academy, Annapolis, MD
Research Associate
Lawrence Livermore Laboratory (6)
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 (4)

Entry Dates: Weapons Systems Science is a nine quarter course of study with entry dates in March and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

James V. Sanders, Assoc. Prof., Code 61Sd, Spanagel Hall, Rm. 146B, (408) 646-2931, AV 878-2931.

Degree: Requirements for the degree Master of Science in Physics are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

PH	1121 (4-2)	Basic Mechanics
MA	1118 (5-2)	Multivariable Calculus
MA	2047 (4-0)	Linear Algebra and Vector Analysis
PH	2911 (3-2)	Computational Physics

Quarter 2

PH	1322 (4-2)	Basic E & M
MA	2121 (4-0)	Differential Equations
PH	2012 (2-2)	Physics Lab I
PH	2724 (4-0)	Thermodynamics

Quarter 3

PH	2223 (4-2)	Optics
PH	3990 (4-0)	Theoretical Physics
PH	2013 (2-2)	Physics Lab II
PH	2151 (4-1)	Analytical Mechanics I

Quarter 4

PH	3152 (4-1)	Analytical Mechanics II
PH	2681 (4-2)	Introductory Quantum
PH	2351 (4-1)	E & M I
EC	3670 (3-2)	Radar Systems

Quarter 5

PH	3782 (4-0)	Statistical Physics
PH	3683 (4-2)	Intermediate Quantum
PH	3352 (4-0)	E & M II
SE	3911 (3-1)	Simulation

Quarter 6

		Specialization
MS	3201 (3-2)	Material Science
PH	4984 (4-0)	Advanced Quantum
SE	4911 (3-1)	Combat Systems Simulation

Quarter 7

Specialization
PH 4353 (4-0) Advanced E & M
Elective
Thesis

Quarter 8

Specialization
Elective
PH 4760 (4-0) Solid State Physics
Thesis

Quarter 9

Specializtion
Elective
Thesis
Thesis

NUCLEAR PHYSICS (WEAPONS & EFFECTS) CURRICULUM 532

This program is designed to meet the needs of the naval service for officers who have a broad technical education with a graduate specialization in the physics of nuclear weapons and weapons effects. The graduate specialization sequence consists of a series of courses in the area of nuclear physics, effects of nuclear explosions, hardening technologies and nuclear warfare analysis. Students can also take elective courses in this or related areas and are expected to engage in thesis research in their field of specialization.

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 Curriculum discussed elsewhere in this catalog.

Officers may enhance their selectability by taking off-campus courses, including participation in the Postgraduate School Continuing Education program which has been outlined earlier in the catalog. An APC of 323 is required.

NUCLEAR PHYSICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Nuclear Physics (Weapons & Effects) Subspecialist with a subspecialty code of XX67. The Curriculum Sponsor is OP-981N, Headquarters, Nuclear Branch.

Typical Jobs in this Subspecialty:

Test Manager
Defense Nuclear Agency (DNA)
Research & Development Coordinator
Defense Nuclear Agency (DNA)
Physicist
Defense Nuclear Agency (DNA)
Tactical Nuclear Weapons/Plans
CINCLANT (2)
Test Officer/Programs Officer
DNA, Dirkland AFB (2)
Navy Research Officer
Los Alamos National Laboratory (3)
Navy Research Officer
Lawrence Livermore Laboratory
Nuclear Effects Officer/Nucleonics Officer
SPAWARSYSCOM (2)
Nuclear Physicist
DNA, Los Alamos
Instructor
Nuclear Weapons Training Group Atlantic

Entry Dates: Nuclear Physics is a nine quarter course of study with entry dates in March and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

James V. Sanders, Assoc. Prof., Code 61Sd, Spanagel Hall, Rm. 146B, (408) 646-2931, AV 878-2931.

Degree: Requirements for the degree Master of Science in Physics are met as a milestone en route to satsifying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

PH 1121 (4-2) Basic Mechanics
MA 1118 (5-2) Multivariable Calculus
MA 2047 (4-0) Linear Algebra and Vectors
PH 2911 (3-2) Computational Physics

Quarter 2

PH 1322 (4-2) Basic E & M
MA 2121 (4-0) Differential Equations
PH 2021 (2-2) Physics Lab I
PH 2724 (4-0) Thermodynamics

Quarter 3

PH 2223 (4-2) Optics
PH 3990 (4-0) Theoretical Physics Elective
PH 2151 (4-1) Analytical Mechanics I

Quarter 4

PH 3152 (4-1) Analytical Mechanics II
PH 2681 (4-2) Introductory Quantum
PH 2351 (4-1) E & M I
Elective

Quarter 5

PH 3782 (4-0) Statistical Physics
PH 3683 (4-2) Intermediate Quantum
PH 3352 (4-1) E & M II
PH 2013 (2-2) Physics Lab II

Quarter 6

PH 3855 (4-1) Nuclear Physics
PH 4856 (4-1) Nuclear Explosions
EXPERIENCE TOUR

Quarter 7

PH 4751 (3-1) Semiconductors
PH 4353 (4-0) Advanced E & M
SE 3911 (3-1) Simulation
Thesis

Quarter 8

PH 4857 (4-0) Nuclear Weapons Effect
PH 3461 (4-1) Explosions & Explosives
PH 4984 (4-0) Advanced Quantum
Thesis

Quarter 9

Elective
PH 3161 (4-1) Fluid Dynamics
Thesis
Thesis

UNDERWATER ACOUSTIC SYSTEMS CURRICULUM 535

Underwater Acoustic Systems is an interdisciplinary program. Courses are drawn principally from the fields of physics, electrical engineering, computer science and mathematics. Although boradly based, the emphasis is on underwater acoustics and signal processing applications to undersea warfare. As can be seen in the following list, courses included relate to the generation and propagation of sound in the ocean, military applications of underwater sound and the electrical engineering and computer science aspects of signal processing in sonar systems. Also included are topics concerning the effects of the noise environment on people.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with mathematics through differential and inte-

gral 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 Curriculum discussed elsewhere in this catalog.

Officers may enhance their selectability by taking off-campus courses, including participation in the Postgraduate School Continuing Education program which has been outlined earlier in the catalog. An APC of 323 is required.

UNDERWATER ACOUSTICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Underwater Acoustics Subspecialist with a subspecialty code of XX56. The Curriculum Sponsor is Naval Sea Systems Command/Commander Space and Naval Warfare Systems Command.

Typical Jobs in this Subspecialty:

Physics Instructor
Naval Academy, Annapolis, MD
OP981H
OPNAV
Instructor
Naval Postgraduate School, Monterey, CA
Training Officer
PDW-124 (Undersea Surveillance)
Staff
Commander 7th Fleet
Staff
COMNAVSURFLANT
Test & Evaluation Officer
OPTEVFOR
Strategic Systems Project Officer
Director of SSPO
Staff Antisubmarine Warfare
NAVSEASYSCOM
Research & Development Project Officer
Office of Secretary of Defense

Entry Dates: Underwater Acoustics is a nine quarter course of study with entry dates in March and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

James V. Sanders, Assoc. Prof., Code 61Sd, Spanagel Hall, Rm. 146B, (408) 646-2931, AV 878-2931.

Degree: Requirements for the degree Master of Science in Engineering Acoustics are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

PH	2911 (5-0)	Structured Programming
MA	1118 (5-2)	Multivariable Calculus
MA	2047 (4-0)	Linear Algebra
EC	2810 (3-2)	Digital Machines

Quarter 2

PH	2119 (4-1)	Oscillations & Waves
MA	2121 (4-0)	Differential Equations
PH	2724 (4-0)	Thermodynamics
		Elective

Quarter 3

PH	3451 (4-2)	Fundamental Acoustics
PH	3990 (4-0)	Theoretical Physics
		Elective
EC	2410 (3-0)	Fourier Analysis

Quarter 4

PH	3452 (4-1)	Underwater Acoustics
OS	2102 (4-1)	Probability for EE
EC	2500 (4-2)	Communication Theory
PH	1322 (4-0)	Electricity & Magnitism

Quarter 5

PH	4453 (4-0)	Propagation in the Ocean
EC	3500 (4-0)	Random Signals
EC	2400 (3-0)	Discrete Systems
EC	2810 (3-2)	Digital Machines

Quarter 6

PH	4410 (0-6)	Acoustics Laboratory
PH	3458 (4-0)	Noise, Shock & Vibration
EC	3400 (3-0)	Digital Signal Processing
EC	4550 (4-1)	Sonar Systems Engineering

Quarter 7

PH	3166 (4-0)	Underwater Vehicles
OC	2121 (4-0)	Oceanography
OC	3261 (4-2)	Ocean Factors in Acoustics
		Thesis

Quarter 8

CS	3050 (3-0)	Software Design
		Elective
EC	4570 (4-0)	Decision & Estimation
		Thesis

Quarter 9

PH	4454 (3-2)	Transducers
EC	3550 (3-1)	Fiber Optics
		Thesis
		Thesis

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 physical, engineering, managerial, or tactical problem; formulate it in mathematical terms; solve or approximate the solution to the mathematical problem; interpret the solution in the framework of the original problem, and present the results

REQUIREMENTS FOR ENTRY

Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level which includes linear algebra, abstract algebra, advanced calculus in one and several variables, ordinary differential equations, probability, statistics, and general physics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science curriculum discussed elsewhere in this catalog. An APC of 203 is required.

ADVANCED SCIENCE (APPLIED MATHEMATICS) SUBSPECIALY

Completion of this curriculum qualifies an officer as an Applied Mathematics Subspecialist with a subspecialty code of XX41. The curriculum sponsor is the U.S. Naval Academy of Mathematics. The typical job in this subspecialty is an instructor in mathematics or physics at the U.S. Naval Academy.

Entry Dates: Advanced Science (Applied Mathematics) is an eight quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate for this curriculum.

Academic Associate:

Carroll O. Wilde, Professor,
Code 53, Ingersoll Hall, Room 346,
(408) 646-2664, AV 878-2664.

Degree: Requirements for the degree Master of Science in Mathematics are met as a milestone en route to satisfying the skill requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA 1117 (5-2)	Calculus I
MA 2025 (4-1)	Logic and Set Theory
MA 2047 (4-0)	Linear Algebra
MA 1110 (2-0)	Basic for Microprocessors

Quarter 2

MA 1118 (5-2)	Calculus II
MA 3026 (5-0)	Discrete Mathematics
MA 3046 (3-0)	Advanced Linear
CS 2950 (5-0)	FORTRAN Programming

Quarter 3

MA 2121 (4-0)	Ordinary Differential Equations
MA 3110 (4-0)	Multivariable Calculus
OA 3201 (4-0)	Linear Programming
OA 3101 (4-1)	Probability

Quarter 4

MA 3400 (3-0)	Mathematical Modeling
MA 3565 (3-0)	Modern Algebra I
MA 3605 (3-0)	Real Analysis I
OA 4204 (4-0)	Games of Strategy

Quarter 5

	Elective
MA 4026	Combinatorial Mathematics
OA 4202 (4-0)	Networks and Graphs
OA 3104 (3-1)	Data Analysis

Quarter 6

	Elective
MA 4566	Modern Algebra II
MA 3606 (3-0)	Real Analysis II
OA 4203 (4-0)	Mathematical Programming

Quarter 7

	Elective
MA 4611 (3-0)	Calculus of Variations
MA 3675 (3-0)	Complex Analysis I
	Thesis

Quarter 8

	Thesis
	Thesis
MA 3676 (3-0)	Complex Analysis II
OA 4206 (4-0)	Dynamic Programming

CURRICULA CONDUCTED AT OTHER UNIVERSITIES

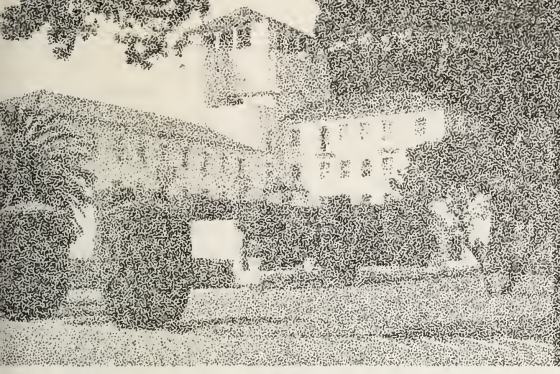
The Navy's fully-funded graduate education program supports 71 subspecialties. This involves 75 curricula, 40 at NPS and 35 at over 45 civilian institutions. Programs available at NPS are not offered at civilian institutions. Approximately 20% of the fiscal year officer graduate education assignments are slated for these universities. Where more than one school is listed for a particular curriculum, subspecialty education placement officers plan quota distribution.

In order to qualify for the Civilian Institutions Program, officers must be PG School selected and must meet all the requirements of an officer entering the Naval Postgraduate School.

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	47X	1-2 yrs.	Various	NAVFACENGCOM
Forensic Science and Law	885	1 yr.	Various	NJAG
International Law	887	1 yr.	Various	NJAG
Joint Intelligence	990	9-12 mos.	Defense Intell. Sch.*	NAVINTCOM
Labor Law	886	1 yr.	Various	NJAG
Advanced Military Justice	881	9-12 mos.	JAG School	NJAG
Logistics Management	700	15 mos.	Air Force Inst. of Technology*	NAVAIRSYSCOM
National Security (Int'l Rel & Dipl)	688	12-24 mos.	Harvard (JFK Sch of Govt)	CNO OP-06
National Security (Int'l Rel & Dipl)	689	12 mos.	Various	CNO OP-06
Naval Const. & Engrg.	510	2-3 yrs.	M.I.T.	NAVSEASYSCOM
Nuclear Engineering (ED)	520	18-24 mos.	M.I.T.	NAVSEASYSCOM
Nuclear Physics (Weapons & Effects)	521	18 mos.	Air Force Inst. of Technology*	CNO-OP98IN
Ocean Engineering	472	1-2 yrs.	Various	NAVFACENGCOM
Ocean Law	883	1 yr.	Various	NJAG
Petroleum Management	811	17 mos.	U. of Kansas	NAVSUPSYSCOM
Petroleum Engineering	630	12-24 mos.	Various	NAVFACENGCOM
Public Affairs	920	1 yr.	Various	CHINFO
Religion	97X	9 mos.	Various	CHCHAP
Retailing	830	1 yr.	Various	NAVSUPSYSCOM
Subsistence Technology	860	15-21 mos.	Michigan St.*	NAVSUPSYSCOM
Supply Acquis/ Distrib Mgmt	810	12-18 mos.	Various	NAVSUPSYSCOM
Tax Law	882	1 yr.	Various	NJAG

*No NROTC Unit at Institution

Inquiries concerning curricula conducted at other universities should be directed to Manager, Civilian Institutions Program, Naval Postgraduate School, Monterey, CA 93943. Telephone (408) 646-2319 or Autovon 878-2319.



ACADEMIC DEPARTMENTS AND COURSE DESCRIPTIONS

DEPARTMENT OF ADMINISTRATIVE SCIENCES

Tarek Abdel-Hamid, Assistant Professor of Management Information Systems (1986); PhD, MIT Sloan School of Management, 1984.

Kent Harry Allison, Commander, U.S. Navy, Assistant Professor of Management (1987); DPA, University of Southern California, 1982.

Dan Calvin Boger, Associate Professor of Economics (1979); PhD, University of California at Berkeley, 1979.

Tung Xuan Bui, Associate Professor of Management Information Systems (1984); PhD, New York University, 1985.

Paul Marshman Carrick, Associate Professor of Economics (1969); PhD, University of California at Berkeley, 1956.

William Howard Church, Professor Emeritus (1956); MSPA, University of Southern California, 1941.

John Wallis Creighton, Professor Emeritus (1967); PhD, University of Michigan, 1954.

Leslie Darbyshire, Professor Emeritus (1961); University of Washington, 1957.

Daniel Roy Dolk, Associate Professor of Management Information Systems (1982); PhD, University of Arizona, 1982.

James Robert Duke, Jr.,Lieutenant Commander, U.S. Navy, Instructor in Financial Management (1985); MS, Naval Postgraduate School, 1985.

Mark Jan Eitelberg, Adjunct Professor of Public Administration (1982); PhD, New York University, 1979.

Carson Kan Eoyang, Associate Professor of Management (1974); PhD, Stanford University, 1976.

Kenneth James Euske, Associate Professor of Accounting (1978); PhD, Arizona State University, 1978.

Roger Dennis Evered, Professor of Administrative Sciences (1979); PhD, University of California at Los Angeles, 1973.

James Morgan Fremgen, Professor of Accounting (1965); DBA, Indiana University, 1961.

Barry Albert Frew, Lieutenant Commander, U.S. Navy, Instructor in Information Systems (1984); MS, Naval Postgraduate School, 1984.

Willis Roswell Greer, Jr., Professor of Accounting (1982); PhD, University of Michigan, 1971.

David Richard Henderson, Associate Professor of Economics (1984); PhD, University of California at Los Angeles, 1976.

Milton H. Hoever, Captain, U.S. Navy, Instructor in Telecommunications Systems (1987), BS, Naval Postgraduate School, 1965.

Fenn Clark Horton, Associate Professor of Economics (1964); PhD, Claremont Graduate School, 1968.

Timothy Patrick Hudson, Major, U.S. Marine Corps, Instructor in Financial Management (1986); MS, Naval Postgraduate School, 1980.

John B. Isett, Major, U.S. Air Force, Assistant Professor of Information Systems (1986); PhD, University of Texas at Austin, 1987.

Carl Russell Jones, Professor of Information and Telecommunications Systems (1965); PhD, Claremont Graduate School, 1965.

Lawrence R. Jones, Adjunct Professor of Public Budgeting (1987); PhD, University of California at Berkeley, 1977.

Melvin Bernard Kline, Professor Emeritus (1970); University of California at Los Angeles, 1966.

David Vincent Lamm, Adjunct Professor of Acquisition and Contract Management (1978); DBA, George Washington University, 1976.

Shu Sheng Liao, Professor of Accounting (1977); PhD, University of Illinois, 1971.

Norman Robert Lyons, Associate Professor of Management Information Systems (1979); PhD, Carnegie-Mellon University, 1972.

Danny Gerald Matthews, Lieutenant Commander, U.S. Navy, Instructor in Accounting (1986); MS, Naval Postgraduate School, 1983.

Jerry Lee McCaffery, Professor of Public Budgeting (1984); PhD, University of Wisconsin, 1972.

John Franklin McClain, III, Commander, U.S. Navy, Instructor in Acquisition and Contract Management (1985); MS, Naval Postgraduate School, 1977.

Richard Allin McGonigal, Associate Professor of Management (1974); PhD, Michigan State University, 1971.

Alan Wayne McMasters, Associate Professor of Operations Research and Administrative Sciences (1965); PhD, University of California at Berkeley, 1966.

Stephen Louis Mehay, Associate Professor of Labor Economics (1985); PhD, University of California at Los Angeles, 1973.

Thomas Preston Moore, Assistant Professor of Management Science (1986); PhD, Virginia Polytechnic Institute and State University, 1985.

Yehia Kamel Mortagy, Adjunct Instructor in Information Systems (1986); MBA, University of California at Los Angeles, 1979.

Orrin Douglas Moses, Assistant Professor of Accounting (1985); PhD, University of California at Los Angeles, 1983.

Clair Alton Peterson, Associate Professor Emeritus (1962); PhD, Massachusetts Institute of Technology, 1961.

Benjamin J. Roberts, Adjunct Professor of Management (1985); PhD, Pennsylvania State University, 1977.

Nancy Charlotte Roberts, Associate Professor of Organization Behavior (1986); PhD, Stanford University, 1983.

Joseph Girard San Miguel, Professor of Accounting (1982); PhD, University of Texas, 1972.

Norman Floyd Schneidewind, Professor of Information Systems (1971); DBA, University of Southern California, 1966.

John David Senger, Professor Emeritus (1957); PhD, University of Illinois, 1965.

Taracad R. Sivasankaran, Assistant Professor of Management Information Systems (1985); PhD, New York University, 1984.

Raymond William Smith, Lieutenant Commander, U.S. Navy, Instructor in Acquisition and Contract Management (1985); MS, Naval Postgraduate School, 1982.

Loren Michael Solnick, Associate Professor of Labor Economics (1985); PhD, Cornell University, 1973.

James Edward Suchan, Associate Professor of Managerial Communication (1986); PhD, University of Illinois, 1980.

George William Thomas, Associate Professor of Economics (1978); PhD, Purdue University, 1971.

Kenneth W. Thomas, Professor of Administrative Sciences (1987); PhD, Purdue University, 1971.

Ronald Alfred Weitzman, Associate Professor of Psychology (1971); PhD, Princeton University, 1959.

David Richard Whipple, Jr., Professor of Economics and Policy Analysis (1971); PhD, University of Kansas, 1971.

Chester Arthur Wright, Assistant Professor Emeritus (1973); MS, University of California at Los Angeles, 1968.

Chairman:

David R. Whipple, Professor,
Code 54, Ingersoll Hall, Room 229,
(408) 646-2161, AV 878-2161.

Associate Chairmen:

Instruction:

James M. Fremgen, Professor,
Code 54Fm, Ingersoll Hall, Room 301,
(408) 646-2644, AV 878-2644.

Research:

Shu S. Liao, Professor,
Code 54Lc, Ingersoll Hall, Room 302,
(408) 646-2505, AV 878-2505.

The Department of Administrative Sciences has primary responsibility for three academic programs, and awards three graduate degrees. The largest program is a group of curricula in Administrative Science. These curricula include Acquisition and Contract Management, Financial Management, Manpower/Personnel Training Analysis, Material Logistics Support, Systems Inventory Management, and Transportation Management. Graduates of these curricula are awarded the degree Master of Science in Management. The Administrative Sciences curricula are accredited by the National Association of Schools of Public Affairs and Administration.

Next largest is the Computer Systems Management Curriculum, whose graduates receive the Master of Science in Information Systems. Finally, the Telecommunications Systems Management Curriculum leads to the degree Master of Science in Telecommunications Sytems Management.

The Department has three microcomputer laboratories for instructional and research purposes.

MASTER OF SCIENCE IN INFORMATION SYSTEMS

A candidate for the degree of Master of Science in Information Systems must successfully complete or validate core courses in each of the following disciplines:

Accounting and financial management
Organization sciences
Information systems
Computer science
Economics
Management theory and practice
Quantitative methods

In addition, each candidate's curriculum must include the successful completion of 48 quarter hours of graduate-level course work and an acceptable thesis or project. At least 12 quarter hours of the course work must be at the 4000 level. Further, this graduate-level course work must include at least 24 quarter hours in Administrative Sciences and at least 16 quarter hours in Computer Science.

The candidate's program must be approved by the Chairman of the Department of Administrative Sciences.

MASTER OF SCIENCE IN MANAGEMENT

The degree Master of Science in Management requires:

a. 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 disciplines:

Accounting and financial management	6
Economics	6
Organization and management	6
Quantitative methods	8

b. In addition to the above, completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.

c. The completion of an approved sequence of courses in the student's area of concentration.

d. The submission of an acceptable thesis on a topic previously approved by the Department of Administrative Sciences.

e. Final approval of a program from the Chairman, Department of Administrative Sciences.

MASTER OF SCIENCE IN TELECOMMUNICATIONS SYSTEMS MANAGEMENT

The degree of Master of Science in Telecommunications Systems Management will be awarded at the completion of an interdisciplinary program that satisfies the following requirements:

a. A minimum of 56 quarter hours of graduate-level work, of which at least 12 quarter hours must represent courses at the 4000 level.

b. The program must consist of a minimum of graduate-level credit as follows:

Administrative sciences and quantitative methods	40
Communications systems and computer science	16

c. In addition to the 56 quarter hours of graduate-level course credit, an acceptable thesis must be completed. Each thesis shall have an advisor and a second reader, at least one of whom must be from the Department of Administrative Sciences.

d. The program must be approved by the Chairman of the Department of Administrative Sciences.

DEPARTMENTAL COURSE OFFERINGS

AS 1501 English Language Skills (4-0). A course in basic English to increase speaking and writing skills and to increase comprehension. A pre and post conversation test is administered to each student. Open only to Allied Officers.

Upper Division or Graduate Courses

AS 3610 Economic Analysis and Operations Research (4-0).
A presentation of basic economic concepts involved in the decision processes of individuals and groups faced with scarcity of resources. Topics covered include consumer theory and demand, individual behavior under uncertainty, producer theory and supply, firm behavior under uncertainty, output and input market structures, partial and general equilibrium analysis, and market imperfections and welfare analysis. PREREQUISITES: MA 2042, MA 2110 (concurrently), and OA 3201 (concurrently).

AS 3611 Planning and Capital Allocation in the Department of Defense (4-1).
Extension of concepts discussed in AS 3610 to allocation of resources over time. Covered are models of consumption and production over time, optimal investment decision rules and investment under uncertainty. Models of welfare economics and cost-benefit analysis are presented. Also covered are planning and decentralization techniques using decomposition algorithms. Cost effectiveness and costing models from current practices in DOD are examined. Institutional procedures and processes such as PPBS, FYDP, and weapons systems acquisition are also discussed. PREREQUISITES: AS 3610 and OA 3103.

Graduate Courses

AS 4601 Decision Making in Command (4-0).
This course will focus on the processes and mechanisms of decision making in military organizations, especially in the context of war. After a review of concepts, theories, and models relevant to decision making in organizations, the course will analyze the nature of and constraints on command and control in military organizations. Also, a comparison will be made of the consequences of different organization structures on decision making and implementation, technology, organization design, and conflict resolution. PREREQUISITES: CM 3111 and OS 3636 (or equivalent).

AS 4613 Theory of Systems Analysis (4-0).
Systems analysis (cost-effectiveness analysis) formulated as commensurable and incommensurable physical capital investment choice models. Emphasis on decision rules and the nature of opportunity costs with respect to scale and timing of investment. Interpretation of methods of risk, modeling, and solution computation. Theory of the second best; theory of the social discount rate. Introduction to models of planning and control emphasizing decentralization of the decision making problem. PREREQUISITES: AS 3611 and OA 4201 (concurrently).

TELECOMMUNICATIONS SYSTEMS MANAGEMENT COURSES

CM 0001 Seminar for Telecommunications Systems Management Students (0-2).
Guest lectures. Thesis and research presentations.

CM 0810 Thesis Research for Telecommunications Systems Management Students (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division or Graduate Courses

CM 3001 Economic Evaluation of Telecommunications Systems I (4-0).
Study of economic evaluation concepts and methods for planning, coordinating, and controlling telecommunications systems. Topics include cost performance (value) analyses, capacity planning, pricing of telecommunications services, and make, lease, or buy decisions. PREREQUISITE: MN 2155.

CM 3002 Economic Evaluation of Telecommunications Systems II (4-0).
Continuation of material in CM 3001. PREREQUISITE: CM 3001.

CM 3111 C3 Mission and Organization (4-0).
A survey of command, control, and communications organizations within OSD, JCS, and the Service Headquarters. Execution of National Strategic Nuclear 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 C3 organizations and systems, with brief historical perspective. PREREQUISITE: SECRET clearance.

CM 3112 Navy Telecommunications Systems (4-0).
Description of the Naval Telecommunications Systems, with emphasis on the organization and management control and operational direction of the facilities. Current subsystems are described in detail. PREREQUISITES: SECRET clearance and CM 3111 or permission of the Instructor.

Graduate Courses

CM 4003 Seminar in Telecommunications Systems Management (1-0 to 4-0).
Study of a variety of topics of current interest in telecommunications systems, to be determined by the Instructor. PREREQUISITES: A background in telecommunications systems and permission of the Instructor.

CM4502 Telecommunications Networks (4-0).
This course covers telecommunications networks design, development, and management topics, including service requirements determination, signaling, interoperability, switching, synchronization protocols, demand, and architecture. A variety of applications will be presented. PREREQUISITE: IS 3502.

CM 4925 Telecommunications Systems, Industry, and Regulation (4-0).
Study of the telecommunications industry (domestic and international) and its regulation by Congress, Executive Branch, Federal Communications Commission, and International Telecommunications Union. Consideration of special issues, including allocation of the spectrum, telecommunication service pricing, and DOD lease decisions. PREREQUISITES: CM 3002 and OS 3005.

INFORMATION SYSTEMS COURSES

IS 0001 Seminar for Computer Systems Management Students (0-2).
Guest lectures. Thesis and research presentations.

IS 0810 Thesis Research for Computer Systems Management Students (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division Courses

IS 2000 Introduction to Computer Management (3-0).
This course will provide an introduction to the field of automatic data processing and the functions and responsibilities of the computer manager. Specific topics include a survey of contemporary computer applications, hardware and software, and introductions to personnel management, financial management, quantitative methods, and computer science in the computer management function.

IS 2100 Information Systems Laboratory (0-2).
The objective is to develop computer literacy early in the Computer Systems Management student's program and to reinforce material in IS 2000. Students will perform elementary laboratory assignments involving use of microcomputer systems and digital logic; hardware architecture; machine, assembly, and high-order language programming, and application packages such as database management and word processing. PREREQUISITE: IS 2000.

IS 2901 Computer Skills Development (0-2).
An introduction to the use and operation of both the NPS mainframe computer and microcomputers, with emphasis on applications in the administrative sciences. Exposure to pertinent software pakcages. Graded on a Pass/Fail basis only.

Upper Division or Graduate Courses

IS 3000 Distributed Computer Systems (4-0).
This course covers the technology, application and management of distributed computer systems. Specific topics include distributed processing, distributed database management, communication facilities and protocols, economic and performance analysis, and managerial and organizational problems. PREREQUISITES: CS 2810, CS 3010 or CS 3400, and IS 3170 (may be taken concurrently).

IS 3100 Survey of Contemporary Computer Systems (3-0).
Study and analysis of contemporary large, mini, and micro computer systems, including hardware, applications of software, operating systems, and price characteristics. Emphasis is on the study and comparison of specific vendor's systems which are available in the market and evaluation of their applicability to various military requirements. Trends in computer technology and pricing structures. PREREQUISITES: CS 2810, CS 3010 or CS 3400, CS 3030 or CS 3112, and IS 3170.

IS 3170 Economic Evaluation of Information Systems (4-0).
The basic principles of microeconomics applied to information systems. Microeconomic topics include demand, cost, production theory, competition, monopoly, interest rates and present values. Information systems topics include capacity planning, capital budgeting, pricing for computer services, and a study of the information industries (computers and software). PREREQUISITE: MN 2155 (may be taken concurrently).

IS 3171 Economic Evaluation of Information Systems II (4-0).
Continuation of material in IS 3170. PREREQUISITE: IS 3170.

IS 3183 Management Information Systems (4-0).
Study of what an information system is, how the computer and other resources fit into the system, and management considerations involved in computer-based and other information systems. Study of computer and MIS concepts. PREREQUISITES: MN 3105 and a basic computer course.

IS 3220 Computer Center Management (3-2).
Theory and practice of the management of computer center operations. Specific topics include facilities planning, production scheduling and control, operational procedures, and computer performance evaluation. PREREQUISITES: CS 3030 and OS 3004.

IS 3502 Computer Networks: Wide Area/Local Area (4-0).
Analysis, evaluation, management and development of wide area and local area computer networks and supporting packet switching computer communication systems. Specific topics include network architectures, protocols, functions, standards, error detection/correction, cost reduction, interconnection, management, and security. Example systems include Defense Data Network, System Network Architecture, DECNET, Ethernet, token ring, broadband, fiber optics, private automatic branch exchanges, and satellite communications systems. PREREQUISITES: CS 2810, CS 3010, and OS 3004.

IS 3503 Microcomputer Networks (3-2).
This course covers the 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 AppleTalk, 3Comm Ethernet, AST, PC Net, and Network Systems Hyperchannel. Student reports on comparative evaluations of contemporary microcomputer networks will be required. The IEEE Local Area Network Standards will be covered. PREREQUISITE: IS 3502 concurrently.

Graduate Courses

IS 4182 Information Systems Management (4-0).
Management of ADP in the Federal Government, especially in the Department of Defense. Specific topics include computer center and computer systems development management, procurement of computer systems, and installation and effective utilization of ADP systems. PREREQUISITE: IS 4200 (concurrently).

IS 4183 Applications of Database Management Systems (4-0).
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 implementation project are considered. Students will be expected to implement an applications systems using a database management package. PREREQUISITES: CS 3010, CS 3020, and IS 2000.

IS Decision Support Systems (4-0).
The application and design of computer-based information systems to support decision making for management planning, control, and operations. Survey of current decision support systems and approaches to DSS technology, including artificial intelligence and expert systems. Students will be expected to implement an application system using available DSS tools. PREREQUISITES: MN 2155, MN 3105, OS 3101, and IS 2000 or equivalent.

IS 4200 Systems Analysis and Design (4-0).
This course covers computer-based systems development, including the following concepts, methodologies, and techniques: information systems requirements analysis, technical and economic feasibility studies, systems costing, functional specifications, computer and data communication hardware and software trade-off evaluations and specifications, conversion, and testing. PREREQUISITES: CS 2810, CS 3010, and CS 3020 or CS 2810, CS 3111, and CS 3400.

IS 4300 Software Engineering and Management (4-0).
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. This will be accomplished by studying the wealth of material available in the literature and applying what has been learned by using the computer to analyze typical software. Written and oral technical and management reports will be made to document the student's findings. PREREQUISITES: CS 3030, IS 3170, and OS 3004.

IS 4925 Seminar in Information Systems (1-0 to 4-0).
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.

MANAGEMENT COURSES

MN 0001 Seminar for Administrative Sciences Students (0-2).
Guest lectures. Thesis and research presentations.

MN 0810 Thesis Research for Administrative Sciences Students (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division Courses

MN 2031 Economic Decision Making (4-0).
The macroeconomic section focuses on methods of national income determination, the consumption function, the multiplier, and the impact of fiscal and monetary policies. The microeconomic section analyzes individual economic decisions and their relation to attainment of market equilibria. PREREQUISITE: MA 2300 (concurrently).

MN 2111 Seminar in Manpower, Personnel, and Training Issues I (0-2).
An introduction to the institutional and issue focus of the military MPT system. Graded on a Pass/Fail basis only.

MN 2112 Seminar in Manpower, Personnel, and Training Issues II (0-2).
Exposure to elementary analysis of problems and issues in the contemporary military MPT system. Graded on a Pass/Fail basis only.

MN 2113 Seminar in Manpower, Personnel and Training Issues III (0-2).
Presentation and discussion of contemporary issues and problems associated with components of the MPT arena. Graded on a Pass/Fail basis only.

MN 2114 Seminar in Manpower, Personnel, and Training Issues IV (0-2).
An in-depth series of analyses of MPT issues and problems selected to integrate the skills covered in courses in the fourth quarter of the MPTA curriculum and to provide suggestions for thesis topics. Graded on a Pass/Fail basis only.

MN 2150 Financial Accounting (4-0).
Study of basic accounting concepts and standards. Specific topics include the accounting cycle, asset valuation, equities and capital structure, earnings measurement, cash flow analysis, and financial statement analysis. (May be taken through Continuing Education.)

MN 2155 Accounting for Management (4-0).
Brief introduction to financial accounting, with emphasis on the content and analysis of financial statements. Specific topics in management accounting include fundamentals of cost accounting, cost-volume-profit analysis, budgeting, relevant costs for decision making, capital budgeting, and financial performance measures. (Closed to students in Administrative Sciences curricula.)

MN 2302 Seminar for Acquisition and Contracting Students (0-3).
Guest lectures. Thesis and research presentations. Certified Professional Contracts Management certificate examinations. Graded on a Pass/Fail basis only.

Upper Division or Graduate Courses

MN 3105 Organization and Management (4-0).
Study of managing organizations in a dynamic environment. Emphasis is on managerial decision making, leadership, planning and control, organizational structure and planned organizational change, and their systemic impacts on organizational effectiveness and adaptation.

MN 3111 Personnel Management Processes (4-0).
A broad coverage of human behavior in the work situation, with special emphasis on the problem of work in the Naval environment. Topical areas covered include selection, placement, training, and evaluation of personnel; motivation, remuneration, morale, supervision, and working conditions in organizations; equipment design and man-machine relationships, and consumer (user) behavior and the impact of technological programs. PREREQUISITES: MN 3105 and OS 3106 (concurrently).

MN 3123 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, and professionalism are considered from the perspective of sociology. PREREQUISITE: MN 3105.

MN 3140 Microeconomic Theory (4-0).
Determination of the allocation of resources and the composition of output. Consumer and producer choice theory. Partial and general equilibrium analysis. Welfare economics. Applications to defense problems are emphasized. PREREQUISITES: MA 2300 and MN 2031.

MN 3161 Managerial Accounting (4-0).
Introduction to cost accounting, including job order systems, overhead costing, variable and absorption costing, and standard costs. Emphasis is on applications of accounting data to planning, control, and decision making. Topics covered include bud-

geting, flexible budgets, variance analysis, performance measures, cost-volume-profit analysis, cost analysis for decision making, and capital budgeting. PREREQUISITE: MN 2150. (May be taken through Continuing Education.)

MN 3172 Public Policy Processes (4-0).
A presentation of means by which resources are allocated to the production of goods in the defense sector. Defense budget preparation. Presidential policy making and management and Congressional budget action are considered and are set within the theory of public goods. PREREQUISITE: MN 3140.

MN 3301 Systems Acquisition and Project Management (4-0).
This course provides the student with an understanding of the underlying philosophies and concepts of the systems acquisition process and the practical application of project management methods within this process. Topics include the evolution and current state of systems acquisition management; the defense systems acquisition cycle; user-producer acquisition management disciplines and activities; and project planning, organization, staffing, directing, and controlling.

MN 3303 Principles of Acquisition and Contracting (4-0).
Introduction to the principles of acquisition and contracting. This course studies the fundamentals of the Federal Acquisition Regulation and the DOD Supplement; the acquisition and contracting processes, including requirements determination, acquisition strategies, basic contract law, ethics, and contracting methods, and acquisition/contract management techniques.

MN 3304 Contract Pricing and Negotiations (4-0).
This course involves the study of pricing theory and strategies, cost methods, cost and price analysis, cost principles, Cost Accounting Standards, and contract negotiations. Students develop and sharpen negotiating skills by participating in practical negotiation exercises. PREREQUISITES: MN 3140, MN 3303, and OS 3105.

MN 3305 Contract Administration (4-0).
This course stresses the management skills and techniques necessary for the successful administration of government prime contracts and subcontracts. Topics include managing contract progress and performance, change control, quality control, cost/financial control, property, terminations, and regulatory and policy concerns. PREREQUISITE: MN 3304.

MN 3307 ADP Acquisition (4-0).
Introduction to the management principles, concepts, and issues involved in Federal Government acquisition of ADP requirements. The course focuses on the concepts of system acquisition and project management, as they pertain to ADP acquisition and specific purchases of computer hardware and software, and on administrative issues through the use of case studies. PREREQUISITE: Enrollment in Computer Systems Management curriculum or permission of the Instructor.

MN 3333 Managerial Communication Skills (4-0).
Study of communicating as an integral function of management. A competency-oriented course designed to enable students to develop proficiency in those aspects of speaking, listening, writing, and reading that are particularly relevant to management. Considers various facets of human communication in 2-person, small group, audience-sized, and organization-wide situations. Topics include subordinate-superior interactions, conducting meetings, making presentations, writing point papers, resolving conflicts, and telecommunicating. PREREQUISITE: Enrollment in an Administrative Sciences curriculum or permission of the Instructor.

MN 3371 Contracts Management and Administration (4-0).
Study of the characteristics and phases of the contracting process. Coverage includes planning, execution, and control of the contracting process; techniques used in purchasing goods and services of varying complexities; and the relationship of contracting to the acquisition process.

MN 3372 Material Logistics (4-0).
An overview of the elements of business logistics, including purchasing, inventory management,warehousing, materials handling, transportation and traffic management, facilities location, and the structure of the logistics function within an organization. PREREQUISITE: OS 3105.

MN 3373 Transportation Management I (4-0).
Analysis of transportation systems from a managerial perspective. Topics include carriers and users of systems; alternative modes; intra and intermodal competitive relationships; regulatory and legal considerations; demand, cost, and pricing analysis; and managerial resource allocation problems. Application of these topics to the U.S. domestic freight transportation network. PREREQUISITE: MN 3140 (may be taken concurrently).

MN 3374 Production/Operations Management (4-0).
Analytical techniques which facilitate production and operations management. Topics include forecasting, facilities planning and location, manufacturing resources planning, shop floor scheduling, work measurement, quality control, project control, robotics, and flexible manufacturing. PREREQUISITE: OS 3006.

MN 3375 Material Handling Systems (4-0).
A study of the principles and systems concepts of materials handling and their application in the design of a materials handling system. An overview of current DOD automated materials handling systems is also provided.

MN 3377 Inventory Management (4-0).
The inventory management process of the Naval Supply Systems Command, with emphasis on the procedures for determining when and how much of a given item to order. Provisioning, wholesale and retail replenishment, and the supply budgetary process. Required for all Supply Corps officers in Administrative Science curricula, except Systems Inventory Management. PREREQUISITE: OS 3105.

MN 3650 Health Economics (4-0).
An overview and analysis of the underlying elements of the continuing problems in the military and civilian health care delivery systems. Elements covered are organizational structure and change in the mode of health care delivery; supply, demand, output, and quality measurement of health services; the impact of health care legislation; and the relationship of the military and civilian sectors. PREREQUISITE: A course in microeconomics.

MN 3760 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, market wage determination, internal labor market, human capital formation, migration and stability, compensating wage differentials, earnings equation, pay and employment discrimination, and unemployment and inflation. PREREQUISITE: MN 3140.

MN 3801 Technology Transfer (4-0).
The study of dissemination and utilization of technology and associated problems, with emphasis on communication, sociology, and organizational factors. PREREQUISITE: MN 3105 or graduate standing in a technical curriculum and permission of the Instructor.

MN 3900 Readings in Administrative Sciences (1-0).
An individualized program of readings and study in some area of the administrative sciences, 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.

MN 3902 MPT Computer Skills Enhancement (0-2).
Extension and application of the basic skills covered in IS 2901, with particular reference to applications in current course work. PREREQUISITE: IS 2901. Graded on Pass/Fail basis only.

MN 3903 MPT Computer Applications (0-2).
Empirical analysis of MPT issues and concepts covered in MN 3760 and MN 2113, taken concurrently. PREREQUISITE: MN 3902. Graded on a Pass/Fail basis only.

Graduate Courses

MN 4105 Management Policy (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. PREREQUISITE: Open only to students in the final quarter of an Administrative Science curriculum, Computer Systems Management, or Telecommunications Systems Management.

MN 4106 Manpower/Personnel Policy Analysis (4-0).
Study and analysis of 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. PREREQUISITE: Open only to students in the final quarter of the Manpower, Personnel and Training Analysis curriculum.

MN 4110-4111 Multivariate Manpower Data Analysis I-II (5-2 and 5-2).
Processes and techniques used to construct and test mathematical representations of relationships in the world of manpower: classical linear regression model, multiple regression when the standard assumptions are not met, qualitative choice models, discriminant analysis, principal component analysis, factor analysis, canonical correlation analysis, and cluster analysis. PREREQUISITE: A course in statistics.

MN 4117 Job Analysis and Personnel Training (4-0).
Study of job analysis and its use in determining training requirements. Consideration of instructional systems development and training pipeline management. Attention to cost-benefit issues involving training in regard to selection, equipment design, changing job requirements, and career development. PREREQUISITE: MN 3111.

MN 4119 Seminar in Manpower Analysis (1-0 to 4-0).
Study of a variety of topics of current interest in manpower analysis, to be determined by the Instructor. PREREQUISITES: A background in manpower analysis and permission of the Instructor.

MN 4121 Organization Theory (4-0).
Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenomena from multiple perspectives, using theories of individual, group, and organizational behavior. Topics include organization design and culture, political analysis of organizations, management of change, open systems theory, and contingency theories. PREREQUISITE: MN 3105.

MN 4122 Planning and Control: Measurement and Evaluation (4-0).
Theory and techniques of the managerial functions of planning and control. Emphasis is placed on the effects of the planning and control structure on the behavior of human components of the system. Topics include the problems associated with the utilization of surrogates for measurement purposes; the analysis of the influence of assumptions, values, and objectives on the planning and control process; budgeting and forecasting, and performance evaluation and the reward structure. PREREQUISITES: MN 3105 and MN 3161.

MN 4125 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 specialist 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. Focuses on problems involved in effective implementation of technologically, structurally, or human resource based planned change efforts. PREREQUISITE: MN 3105.

MN 4127 Seminar in Organization Behavior (1-0 to 4-0).
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.

MN 4145 Policy Analysis (4-0).
The application of economic methods to nonmarket transactions. Analysis of large scale defense resource allocation problems. Weapons Systems definition. Life cycle cost models. Examples of cost-benefit and cost-effectiveness analysis. PREREQUISITES: MN 3140, MN 3161, and OS 3106.

MN 4151 Internal Control and Financial Auditing (4-0).
Study of the objectives and techniques of internal control systems and of audits of financial reports and records. Specific topics include the independent audit function in America, audit evidence, audit procedures, the auditor's decision process, statistical sampling, and special controls and audit problems in computer-based systems. Audits of several transaction cycles are examined. PREREQUISITES: MN 3161, OS 3106, and a basic computer course.

MN 4152 Corporate Financial Management (4-0).
The management of the finance function in industry, with particular attention to defense contractors. Specific topics include cash and working capital management, long-term financing, and determination of optimal capital structure. PREREQUISITE: MN 3161.

MN 4153 Seminar in Financial Management (1-0 to 4-0).
Study of a variety of topics of current interest in financial management, to be determined by the Instructor. PREQUISITES: A background in financial management and permission of the Instructor.

MN 4154 Financial Management in the Armed Forces (4-0).
Review of financial management concepts and practices in DOD and the Armed Forces, with emphasis on the Department of the Navy. Includes study of PPBS, controllership, budget formulation and execution, headquarters and field activity accounting systems, and various types of funds. PREREQUISITES: MN 2155 or MN 3161.

MN 4155 Operational Auditing (4-0).
This course examines auditing as a tool of management control in large, complex organizations. Case studies are used to discuss the scope of the audit, audit procedures, audit findings and recommendations, auditor training and professionalism, and the roles and responsibilities of auditee-managers, users of audit reports, and auditors. The General Accounting Office's audit and internal control standards are also examined, as well as directives of the Office of Management and Budget. Department of Defense, and Department of the Navy. During the last few weeks, students do field research on an operational audit for a local organization. PREREQUISITE: MN 3161. This course should be taken during one of the last three quarters of the student's program.

MN 4159 Financial Reporting and Analysis (4-0).
Advanced study of basic accounting concepts underlying published financial reports. Emphasis is placed on the measurement, communication, and evaluation processes. Topics include setting accounting policies, alternative bases of valuation, alternative concepts of earnings, and discussion of controversial accounting issues. The course takes the perspective of managers and users of financial information. PREREQUISITE: MN 3161.

MN 4161 Financial Management Control Systems (4-0).
Study of the structure and the processes of management control in government organizations. Specific topics include the basic concepts of planning and control, organization of the management control function, measurement of inputs and outputs, pricing government services, programming, budgeting, accounting, and performance evaluation. PREREQUISITES: MN 3105 and MN 2155 or MN 3161.

MN 4162 Cost Accounting (4-0).
Review of basic cost accounting procedures. In-depth study of cost accounting systems, allocation of direct and indirect costs to cost objectives, and special problems of accounting for materials, labor, and overhead costs. Specific attention is given to the objectives and the substance of Cost Accounting Standards for negotiated defense procurement contracts. PREREQUISITE: MN 3161.

MN 4163 Analytical Techniques for Financial Control and Planning (4-0).
Study of quantitative methods most useful for financial planning and control. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are introductions to the relevant quantitative techniques, 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 planning and control environments in the public sector. PREREQUISITES: MN 3161 and OS 3106.

MN 4301 Contracting for Major Systems (4-0).
Study of the major systems contracting process, procedures and practices. This course focuses on the contracting process of the Navy Systems Commands and the Major Weapons Acquisition Process as described in SECNAVINST 5000.1. Major topics include contracting organization for systems acquisition, systems acquisition process, business clearance process, source selection, multi-year procurement, IMIP, and administration of major contracts. Related topics include funding, reliability/maintainability, ILS, foreign military sales, and initial provisioning/spare parts support. PREREQUISITE: MN 3305 or permission of the Instructor.

MN 4302 Public Expenditure Policy and Analysis (4-0).
The process of government decision making, particularly as reflected in the defense budgeting process. Models of budget decision making, including decentralization. Application of social choice concepts. Illustrations from the defense budgeting process. PREREQUISITE: MN 4145.

MN 4310 Logistics Engineering (4-0).
The concept of integrated logistics support and its development. The maintenance concept, functional analysis, life cycle costs, logistics support analysis, human factors in design, provisioning and resupply of repair and spare parts, test and evaluation, and production. PREREQUISITE: OS 3006 (concurrently).

MN 4371 Acquisition and Contracting Policy (4-0).
A seminar using case studies to appraise government and business acquisition/contracting policies. Emphasis is on acquisition/contracting decision making and policy formulation. PREREQUISITES: MN 4301 or MN 3301 and MN 3371 and permission of the Instructor.

MN 4372 Seminar in Acquisition and Contract Management (1-0 to 4-0).
Study of a variety of topics of current interest in acquisition and contracting, to be determined by the Instructor. PREREQUISITES: A background in acquisition and permission of the Instructor.

MN 4373 Transportation Management II (4-0).
A continuation of MN 3373. Concentration on the management of large-scale transportation networks, emphasizing international transportation and the role of the U.S. Merchant Marine. Also covered are the DOD transportation agencies, DOD transportation planning models, and current research in commercial and military transportation. PREREQUISITES: MN 3373 or permission of Instructor and SECRET NOFORN clearance.

MN 4376 Seminar in Material Logistics (4-0).
Study of a variety of topics of current interest in logistics, to be determined by the Instructor. PREREQUISITES: A background in logistics and permission of the Instructor.

MN 4500 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: MN 3105 and MN 3140.

MN 4650 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: MN 3650.

MN 4651 Hospital Economics and Systems Analysis (4-0).
This course deals analytically and empirically with the major organizational and economic structures and problems associated with the operation of a health care delivery facility or group of facilities (hospital or integrated group of clinics). The roles of institutional incentives, methods of reimbursement, provider organization and payment, and exogenous factors such as general inflation and legislative parameters are discussed. The objective is a working knowledge of these major elements in the health care production process and probable systemic change. PREREQUISITE: MN 3650.

MN 4652 Micro Health Systems Analysis (4-0).
The purpose of this course is to analyze in depth, using analyses of extant institutional constructs, the potential for deriving policy recommendations and designing research to motivate more efficient provision of health care by individual facilities. The emphasis is on identifying gaps in incentives and organizational structures which lead to suboptimal facility behavior in the cost containment and quality areas. PREREQUISITES: MN 4650 and MN 4651.

MN 4761 Manpower Economics II (4-0).
A continuation and application of theoretical development in MN 3760. Recent applications of economic analysis to manpower, personnel, and training problems are studied. Typical topics include accession, supply models, turnover and retention models, alternative retirement systems, civilian earnings effects on military employment, alternative compensation systems, career mix, and billet cost estimation. PREREQUISITE: MN 3760.

MN 4900 Readings in Administrative Sciences (1-0 to 4-0).
An individualized program of advanced readings and study in some area of administrative sciences. PREREQUISITES: A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

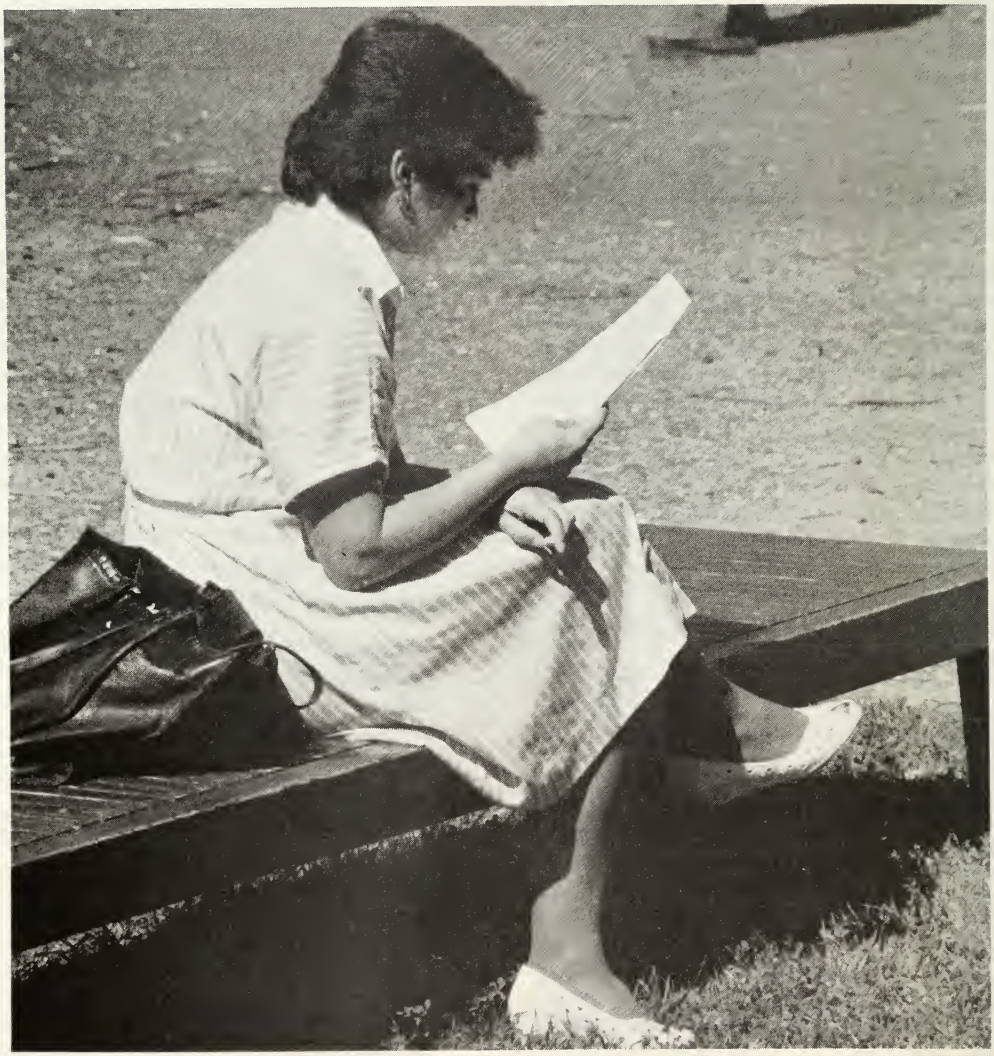
MN 4904 Advanced MPT Computer Applications (0-2).
Applications of computer skills to problems and issues developed in MN 2114, MN 4110, and MN 4761 (taken concurrently). PREREQUISITE: MN 3903. Graded on a Pass/Fail basis only.

MN 4942 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 character-

istics policy, and policies toward rivals and customers), and performance (e.g., efficiency, progress and employment). The government as consumer and regulator. Typical industries studied are aerospace, computers, shipbuilding, and telecommunications. PREREQUISITE: MN 3140 or equivalent.

MN 4945 Seminar in Economics (1-0 to 4-0).
Study of a variety of topics of current interest in economics, to be determined by the Instructor. PREREQUISITES: A background in economics and permission of the Instructor.

MN 4970 Seminar in Administrative Sciences (1-0 to 4-0).
Study of a variety of topics of general interest in the adminstrative sciences, to be determined by the Instructor. PREREQUISITES: A background in administrative sciences and permission of the Instructor.



DEPARTMENT OF AERONAUTICS

Max Franz Platzer, Chairman and Professor of Aeronautics (1970)*; Dr. Tech. Science, Technical University of Vienna, Austria, 1964.

Donald Merrill Layton, Associate Chairman and Professor of Aeronautics (1965); MS Princeton University, 1954.

Robert Edwin Ball, Professor of Aeronautics (1967); PhD, Northwestern University, 1962.

William Richard Bell, Professor of Aeronautics (1951); PhD, California Institute of Technology, 1958.

Oscar Biblarz, Associate Professor of Aeronautics (1968); PhD, Stanford University, 1968.

Satya Bodapati, Associate Director of Navy-NASA Joint Institute of Aeronautics (1986) and Adjunct Professor of Aeronautics; PhD, University of Cambridge, 1975.

Daniel Joseph Collins, Professor of Aeronautics (1967); PhD, California Institute of Technology, 1961.

Theodore Henry Gawain, Professor of Aeronautics (1951); PhD, Massachusetts Institute of Technology, 1944.

James Valentine Healey, Associate Professor of Aeronautics (1983); PhD, University of Southern California, 1969.

Chester Arthur Heard, Instructor of Aeronautics (1984); MS, Naval Postgraduate School, 1977.

Richard Moore Howard, Assistant Professor of Aeronautics (1987); PhD, Texas A&M University, 1986.

Ramesh Kolar, Assistant Professor of Aeronautics (1985); PhD, University of Arizona, 1984.

Gerald Herbert Lindsey, Professor of Aeronautics (1965); PhD, California Institute of Technology, 1963.

James Avery Miller, Associate Professor of Aeronautics (1963); PhD, Illinois Institute of Technology, 1963.

David Willis Netzer, Professor of Aeronautics (1968); PhD, Purdue University, 1968.

Raymond Parmous Shreeve, Professor of Aeronautics (1971); PhD, University of Washington, 1970.

Richard D. Wood, Adjunct Professor of Aeronautics (1985); PhD, Columbia-Pacific University, 1981.

Edward Ming-Chi Wu, Professor of Aeronautics (1984); PhD, University of Illinois, 1965.

Robert Diefendorf Zucker, Associate Professor of Aeronautics (1965); PhD, University of Arizona, 1966.

**The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Max F. Platzer, Professor,
Code 67, Halligan Hall, Room 135,
(408) 646-2311, AV 878-2311.

Associate Chairman:

Donald M. Layton, Professor,
Code 67Ln, Halligan Hall, Room 253,
(408) 646-2997, AV 878-2997.

The Department of Aeronautics provides advanced professional knowledge in the field of Aeronautical Engineering in order to provide Navy technical managers with a broad-base education. Basic and advanced graduate courses are offered in fluid mechanics, structures, guidance and control, flight mechanics and propulsion for rotary and fixed-wing aircraft and missiles.

After a preparatory phase and a graduate core series of courses, students specialize in the advanced graduate phase in either Aeronautical Engineering (Curriculum 610) or Aero-Electronic Engineering (Curriculum 611). The Degree of Master of Science in Aeronautical Engineering is offered in both Curricula. Selected students may be eligible to pursue the degree of Aeronautical Engineer or Doctor of Philosophy.

The Department of Aeronautics received a renewal of its full six (6) year accreditation from the Accreditation Board for Engineering and Technology in 1984.

ENTRANCE REQUIREMENTS FOR STUDY OF AERONAUTICAL ENGINEERING

The entrance requirement for study in the Department of Aeronautics generally is a baccalaureate in engineering earned with above average academic performance. This requirement can sometimes be waived for students who have shown distinctly superior ability in backgrounds other than engineering but who have had adequate coverage in the basic physical and mathematical sciences. All entrants must obtain the approval of the Chairman, Department of Aeronautics.

Students who have not majored in Aeronautics, or who have experienced a significant lapse in continuity with previous academic work, initially will take preparatory courses in aeronautical engineering and mathematics at the upper division level, extending through the first three academic quarters and constituting a portion of the course-work for degrees in Aeronautics. Final approval of programs leading to degrees in Aeronautical Engineering must be obtained from the Chairman, Department of Aeronautics.

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

Upon completing the preparatory courses, students may be selected on the basis of academic performance for the degree program leading to the Master of Science in Aeronautical Engineering. However, students who have recently earned a degree with major in Aeronautics may apply for admission directly to the graduate program.

The Master of Science degree requires a minimum of 36 credit hours of graduate courses, of which at least 12 credit hours shall be at the 4000 level. It also requires that not less than 32 credit hours shall be in the disciplines of engineering, physical science or mathematics, and that this shall include a minimum of 20 hours of courses in the Department of Aeronautics and a minimum of 8 hours in other departments.

An acceptable thesis is required for the degree unless waived by the Chairman, Department of Aeronautics, in which case 10 quarter hours of 4000 level courses in the disciplines of engineering, physical science, or mathematics will be required in addition to those specified above, increasing the total requirements to 46 quarter hours of graduate level credits.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students of the Weapons Systems Engineering Curriculum (530) can elect Aeronautics as 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. Cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman

of the Department of Aeronautics.

The program must contain at least 12 hours at the graduate level in courses other than those presented in the Department of Aeronautics.

The candidate must present an acceptable thesis on a topic given prior approval by the Department of Aeronautics. Final approval of the program leading to the Master of Science in Engineering Science with specialization in Aeronautics shall be obtained from the Chairman of the Department of Aeronautics.

AERONAUTICAL ENGINEER

Upon completing the equivalent of two quarters of a graduate program, students may be selected on the basis of academic performance for the program leading to the degree Aeronautical Engineer. Selection to this degree program shall be limited to those students who, in the opinion of the faculty, have the potential to conduct the required research. The degree Aeronautical Engineer requires a minimum of 72 credit hours of graduate courses, of which at least 40 credit hours shall be at the 4000 level. It also requires that not less than 64 credit hours shall be in the disciplines of engineering, physical science, or mathematics, and that this shall include a minimum of 36 hours of courses in the Department of Aeronautics and a minimum of 12 hours in other departments. An acceptable thesis is required for the degree.

Students admitted to work for the degree Aeronautical Engineer may be satisfying requirements for the Master of Science degree concurrently. The Master of Science in Aeronautical Engineering may be conferred at the time of completion of the requirements for that degree.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Aeronautics 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 who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The Department of Aeronautics 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 shall submit transcripts of their previous academic and professional records and letters of recommendation to the Department Chairman. The Chairman, with the advice of other department members, shall decide whether or not to admit the applicant to the Doctoral Program.

Every applicant who is accepted for the Doctoral Program will initially be enrolled in the AeE 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 find a faculty advisor to supervise his research and help him initially in the formulation of his plans 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.

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 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 finally to satisfy the above requirements for the doctorate for any reason but has in the course of his doctoral studies actually completed all of the requirements for the degree of Aeronautical Engineer, he shall be awarded the latter degree.

AERONAUTICAL 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 and composite materials.

The subsonic aerodynamics laboratory consists of two low-speed wind tunnels and a large continous flow visualization tunnel. Standard wind tunnel techniques are used in the 32 x 45 inch and 42 x 60 inch tunnels and helium bubble filaments are used in the 5 x 5 x 12 foot test section of the three-dimensional flow visualization tunnel.

The gas dynamics laboratory includes a 4 x 4 inch blowdown supersonic wind tunnel, a cold driven, three-inch double-diaphragm shock tube, a 2 x 2 x 18 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 electrohydrodynamic 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 ^{0}R. 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 10 x 60 inch rectilinear and 4 x 8 foot diameter radial cascade wind tunnels and a large 3-stage axial research compressor for low speed studies. 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 spinpit for structural testing of rotors to 50,000 RPM and 1800^{0}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 100 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 IBM 307-3033 computers are available for data analysis or flow computation.

The Computer Aided Design — Computer Aided Engineering (CAD/CAE) laboratory is a joint Department of Mechanical Engineering — Department of Aeronautics project. This laboratory, which is now under develop-

ment, will have twelve 32-bit networked CAD/CAE workstations, twenty-four microcomputer systems and two computer-controlled data acquisition systems.

The flight mechanics laboratory, also under development, will consist of a fixed-base, six-degree-of-freedom flight simulator for ground based studies. A remotely controlled helicopter model is used in rotary-wing studies.

The structural test laboratory contains testing machines for static and dynamic tests of materials and structures and an 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. The dynamics section of this laboratory contains shaker tables, analog computers and associated instrumentation. An adjacent strain gage and photo-elastic 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.

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. S. Bodapati.

SPACE SYSTEMS LABORATORIES

Laboratories which support the Space Systems Programs are located in several departments including Physics, Oceanography, and Electrical and Computer Engineering. Refer to the appropriate part of the catalog for descriptions. Aeronautics has developed a Solar Simulator laboratory which features a 2500W source. Experiments are computer controlled using IBM/PC with ISAAC 2000 controller. Solar cells can be tested for radiation damage using the LINAC or Pulserod sources which are located in Physics. The Laser Damage Facility is a Joint Physics/Aeronautics laboratory developed to support instruction and research related to such topics as satellite vulnerability. The Laser Damage Facility features a pulsed CO electrical laser with sufficient irradiance to generate laser supported detonation waves. An optics laboratory is also available which utilizes lasers for such space functions as remote sensing in addition to precision optical measurements.

DEPARTMENTAL COURSE OFFERINGS

AERONAUTICS

AE 0020 Aeronautical Engineering Program Planning (0-1).
Oral presentations by the Aeronautics Academic Associate and faculty members involved in research with Aeronautical students on program planning, thesis requirements and research specialty areas.

AE 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division Courses

Some preparatory courses in Aeronautics are available through the Continuing Education Division. These one-credit hour mini-courses have been prepared in a self-instructional mode (PSI) and complete descriptions for each mini-course may be found in the Continuing Education catalog. The mini-courses are equivalent to, and may be substituted for, the on-campus courses as follows:

Campus	Equivalent mini-course sequence
AE 2021	AE 2101 through 2106
AE 2042	AE 2401 through 2404

AE 2015 Engineering Dynamics (3-2).
Fundamental physical concepts; dynamics of particles and of systems of particles; concepts of work-energy and impulse-momentum; rigid-body dynamics in two dimensions. PREREQUISITE: MA 2121.

AE 2021 Introduction to Flight Structures (4-1).
Introduction to concepts of stress and strain, and mechanical behavior of materials. Bending and torsional stress and deflection analysis of representative aero-structural components, including statically indeterminate cases. Introduction to stability analysis, and energy methods. (May be taken through Continuing Education as mini-courses AE 2101-06.)

AE 2035 Basic Aerodynamics (3-2).
Continuity/Momentum equations; dimensional analysis; elements of two dimensional ideal flow; thin-airfoil, finite wing theory. PREREQUISITE: AE 2042.

AE 2036 Performance and Stability (3-2).
Model atmosphere; defined airspeeds; aircraft performance including climb, range, endurance and energy management; principles of longitudinal, lateral and directional static stability and control of aircraft. PREREQUISITE: AE 2035.

AE 2042 Fundamentals of Thermo-Fluid Dynamics (3-2).
Properties of fluids. Principles of continuity, momentum, and energy for incompressible and compressible fluids; control volume formulations. Second law of thermodynamics, entropy and irreversibilities; equations of state, properties of pure substances; power cycles. Viscous flows, boundary layer concepts. (May be taken through Continuing Education as mini-courses AE 2401-2404.)

AE 2043 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. PREREQUISITE: AE 2042.

AE 2801 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, report writing. Selected experiments in all aeronautical laboratories. PREREQUISITES: AE 2021, 2035, 2043, and 2015 (concurrent) or equivalent.

Upper Division or Graduate Courses

AE 3001 Space Systems Laboratory (0-2).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 3005 Survey of Aircraft & Missile Technology (4-0).
(For Non-Aeronautical Engineering Students.) A survey of aeronautical engineering concepts as applied to airplanes and missiles, starting with explanations of the basic principles of aerodynamics, performance, propulsion, etc., and extending to examples of these principles in present-day hardware.

AE 3101 Flight Vehicle Structural Analysis (3-2).
Graduate core course in structures covering basic definitions and field equations for solid bodies, two-dimensional stress analysis, thin skin and thick skin wing bending analysis, fracture and fatigue theory. PREREQUISITE: AE 2021 or equivalent.

AE 3201 System Safety Management and Engineering (3-2).
An introduction to System Safety, with emphasis on the requirements imposed by MILSTD-882A. Fundamental mathematical concepts (probabilities, distribution theory, Boolean algebra); safety analysis techniques (hazard analysis, fault-tree analysis, sneak circuit analysis); safety criteria, tasks, data, and documentation; lifecycle considerations.

AE 3251 Aircraft Combat Survivability (4-1).
This course brings together all of the essential ingredients in a study of the survivability of fixed wing, rotary wing and missile aircraft in a hostile (non-nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of survival in a AAA/SAM/Laser environment are presented in some detail. Topics to be covered include: current and future threat descriptions; the mission/threat analysis; combat data analysis of SEA and Mid-East losses; vulnerability reduction techniques and technology for the major aircraft systems; susceptibility reduction concepts and equipment for reducing the probability of detection and avoidance of the threat; and 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. PREREQUISITE: U.S. Citizenship and SECRET clearance.

AE 3304 Rotary Wing Aircraft Technology (3-2).
(For Non-Aeronautical Engineering Students.) A course designed to familiarize the student with the major aerodynamic, propulsion, structural, and stability and control aspects of rotary wing aircraft, past and current helicopter developments, technology status and problems. PREREQUISITE: Consent of Instructor.

AE 3305 V/STOL Aircraft Technology (4-0).
(For Non-Aeronautical Engineering students.) Basic aerodynamic and propulsion principles and phenomena, past and current vertical take-off and landing aircraft developments, current technology status and problems. U.S. Navy V/STOL aircraft requirements and acquisition programs. Russian V/STOL aircraft and assessment of USSR-V/STOL aircraft technology and trends, impact of V/STOL aircraft technology on naval systems acquisition and operations. PREREQUISITE: Consent of Instructor.

AE 3340 Linear Vibration and Dynamic Stability (3-2).
Single and multiple degree of freedom systems; damped/undamped; free/forced response. Continuous systems. Stability derivatives; aircraft equations of motion; uncoupled and cross-coupled modal solutions. PREREQUISITES: AE 2015 and 2036.

AE 3341 Control of Aerospace Vehicles (3-2).
Elements of classical control analysis as applied to aircraft and missiles; Bode, Nyquist, Root Locus methods; compensators, autopilot design, stability augmentation systems. Introduction to state-variable methods. PREREQUISITE: AE 3340.

AE 3451 Aircraft and Missile Propulsion (3-2).
Description, design criteria, analysis and performance of ramjets, turboprops, turbojets, and turbofans. Analysis of components: inlets, compressors, combustors, turbines and nozzles. Current state-of-the-art and impact of trends in propulsion technology. PREREQUISITE: AE 2043.

AE 3501 Current Aerodynamic Analysis (3-2).
Introduction to current aerodynamic analysis methods for subsonic and supersonic flight vehicles. Developments proceed from the three-dimensional Navier-Stokes equations to various approximation methods, such as linearized, inviscid, subsonic and supersonic panel methods for wing-body combinations; discussion of sweep-back effect and area rule; laminar and turbulent boundary layer analysis; use of state-of-the-art computer programs. PREREQUISITES: AE 2043 and AE 2035.

AE 3701 Missile Aerodynamics (4-1).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 3705 Air Defense Lethality (4-1).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 3711 Missile Flight Analysis (4-0).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 3802 Advanced Aeronautical Measurement Techniques and Test Facilities (3-3).
This course is intended to introduce the student to aeronautical measuring techniques and test facilities used by NASA and the aerospace industry during the research, development, and testing phase (RDT&E) of aircraft and missile systems. Applications of laser-doppler velocimetry, hot wire instrumentation, flow visualization methods and modern data acquisition systems will be demonstrated. Field trips to NASA Ames Research Center will be arranged to show how the advanced techniques and facilities are applied to solve real-world problems in aeronautics.

AE 3900 Special Topics in Aeronautics (Variable credit up to five hours.)
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman.

Graduate Courses

AE 4000 Graduate Aeronautical Engineering Seminar (1-0).
Oral presentations of material not covered in formal courses. Topics cover a wide spectrum of subjects ranging from reports of current research to survey treatments of fields of scientific and engineering interest.

AE 4102 Advanced Aircraft/Missile Structural Analysis (3-2).
The finite element method of structural analysis will be studied and applied to aircraft and missile structures. Capabilities of the current finite element computer programs will be discussed. An introduction to the theory of structural dynamics and stability will also be presented. PREREQUISITE: AE 3101.

AE 4103 Advanced Aircraft Construction (3-2).
A course covering the manufacturing techniques and analysis of composite materials and sandwich construction. Theories of failure, damage and repair. Advanced design concepts. PREREQUISITE: AE 3101.

AE 4202 Reliability in Structures and Materials (4-0).
A course providing the background and specifics associated with the design, certification and maintenance of structures in critical applications. The background includes an introduction to probability, reliability in design, and statistical modeling. The specifics include reliability, testing and statistical modeling of structures with applications to materials development, life durability characterization, proof-test, and maintenance of advanced composite materials. PREREQUISITE: Graduate standing in an Engineering/Science Curriculum.

AE 4273 Aircraft Design (3-2).
A course in conceptual design methodology which centers around an individual student design project. It draws upon all of the aeronautics disciplines and provides the student with experience in their application to design. PREREQUISITE: Completion of the Aero Graduate Core.

AE 4304 Helicopter Performance (3-2).
The performance characteristics of rotary wing aircraft. Blade motion, momentum theory, blade element theory, tip loss factor, ground effect, hover, vertical flight, forward flight, climbing flight, autorotation, tail rotors, range and endurance, and multiple rotors. Numerical problems in helicopter performance. PREREQUISITE: Aero Preparatory Phase or equivalent.

AE 4305 V/STOL Aircraft Technology (3-2).
Types of V/STOL aircraft, fundamental principles, main performance characteristics, and propulsion requirements; STOL technology: mechanical highlift devices, powered-lift devices, jet flaps, augmentor wings; VTOL technology: flow vectoring devices, lift engine and lift fan technology, augmentor wings, airframe/propulsion system interactions, ground interference effects; V/STOL stability and control considerations, handling qualities; review of current NAVY V/STOL requirements and programs. PREREQUISITE: Aero Graduate Core or permission of Instructor.

AE 4306 Helicopter Design (3-2).
Engineering problems that are to be found in rotary-wing design are presented for solution to develop a basic understanding of the conceptual design process for both single and multi-rotor helicopters. Interfaces of sub-systems and the required design tradeoffs, including economic and operational factors, are emphasized. A preliminary design of a single rotor helicopter is conducted to meet specified requirements and the performance of the resulting vehicle is evaluated. PREREQUISITE: AE 4304.

AE 4307 Advanced Helicopter Design (3-2).
An extension of the conceptual design concept to a more detailed design. Elements of static and dynamic stability, control, weight and balance, detailed sizings, and effects of parameter variation are considered. The detailed design will usually be limited to a single area. PREREQUISITE: AE 4306.

AE 4317 Advanced Flight Vehicle Structural Dynamics (4-0).
Response of single and multiple degree-of-freedom systems; vibrations of continuous systems - rods, beams and plates. Finite element formulation for structural dynamics problems in fixed-wing and rotary-wing aircraft, flexible spacecraft and large space structures. Computational methods for dynamic response. Aspects of vibration testing. Response to random and acoustic excitation. PREREQUISITES: Ordinary differential equations, matrix algebra and consent of Instructor.

AE 4318 Aeroelasticity (4-0).
Response of discrete and continuous elastic structures to transient loads and to steady oscillatory loads. Static aeroelasticity, nonstationary airfoil and wing theory. Unsteady missile aerodynamics. Application to the flutter problem. Transient loads, gusts, buffet, and stall flutter. PREREQUISITE: AE 3340.

AE 4323 Flight Evaluation Techniques (3-2).
Quantitative and qualitative techniques for the evaluation of aircraft performance and handling qualities of flight; aircraft data acquisition systems; normalizing and standardizing of flight test data; pilot rating scales; effects of design parameters; application of specifications to flight evaluations. In-flight laboratory is provided. PREREQUISITE: AE 3340.

AE 4342 Advanced Control for Aerospace Systems (3-2).
State variable analysis including state variable feedback and state variable estimators (observers). Optimal control; digital fly-by-wire systems. Topics from non-linear systems and/or stochastic control. PREREQUISITE: AE 3341.

AE 4343 Guided Weapons Control Systems (3-2).
Detailed analysis of tactical missiles, performance of target trackers, basic aerodynamics of missiles, missile autopilot design, missile servos and instruments, line of sight guidance loops, terminal guidance, proportional navigation. PREREQUISITE: AE 3341 or equivalent.

AE 4431 Aerothermodynamics & Design of Turbomachines (3-3).
Flow and energy exchange in compressors and turbines, and current engineering methods for their aerodynamic design, test, and measurement. PREREQUISITE: Aero Preparatory Phase or equivalent.

AE 4451 Aircraft Engine Design (3-2).
The design process, aircraft-engine constraints, mission constraints, review of on-design and off-design cycle analysis, engine sizing for installed performance, component designs (fans, compressors, turbines, burners, inlets, exhaust nozzles). PREREQUISITE: AE 3451.

AE 4452 Rocket and Missile Propulsion (4-0).
Applications and analysis of solid-propellant rockets, ramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, technology requirements. PREREQUISITE: AE 3451.

AE 4502 High-Speed Aerodynamics (4-0).
Nonlinear and linearized analysis of inviscid subsonic and supersonic flow over wings and bodies. Steady and unsteady phenomena. Method of characteristics. Method of distributed singularities. Computer solution of typical problems. If class progress warrants, instructor may elect to present additional topics on transonic flow. PREREQUISITE: AE 3501.

AE 4503 Missile Aerodynamics (4-0).
The aerodynamics of missiles and guided projectiles for various speed regimes and motions. Topics include slender body and linearized theory as well as nonlinear aerodynamic effects, coupling effects, Magnus effects, etc. The impact of these effects on missile flight dynamics, guidance and control is included. PREREQUISITE: AE 3501.

AE 4504 Convective Heat and Mass Transfer (4-0).
Convective heat and mass transfer on internal and external flow systems common to aerospace vehicles; laminar and turbulent flows. Analytic techniques, integral and numerical methods, experimental correlations. Effects of variations in thermophysical properties. PREREQUISITE: AE 3501.

AE 4505 Laser/Particle Beam Technology (3-2).
Survey of different types of particle beams, including electrical, gasdynamic and chemical lasers, electron beams; resonator cavities for lasers and external propagation mechanisms; high energy lasers and charged particle beams, military applications. PREREQUISITE: Consent of Instructor.

AE 4506 Rarefied Gas Dynamics (4-0).
Topics include kinetic theory, distribution functions, Boltzmann equation, transport phenomena from a kinetic theory viewpoint, free molecular flow, transitional flow between continuum and free molecular flow, dynamic coefficient and numerical solutions. PREREQUISITE: Consent of Instructor.

AE 4632 Computer Methods in Aeronautics (3-2).
Use of the digital computer in numerical methods. Classification of Aeronautical Engineering problems as equilibrium, eigenvalue or propagation problems. Computer solution procedures developed for the ordinary and partial differential equations of gas dynamics, heat transfer, flight mechanics and structures. PREREQUISITE: Aero Preparatory Phase or equivalent.

AE 4641 Aeronautical Data Systems (3-2).
A design-project-oriented course utilizing microprocessor technology with emphasis upon aeronautical engineering applications. Both software and hardware aspects of system integration will be considered for engineering tradeoffs during problem definition and solution. PREREQUISITE: EE 2811 or equivalent.

AE 4702 Missile Propulsion (4-0).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4703 Missile Stability and Performance (4-1).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4704 Missile Configuration and Design (3-2).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4706 High Energy Laser System Design (4-0).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4712 Missile Systems Design and Integration (3-2).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4791 Spacecraft Systems I (3-2).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4792 Spacecraft Systems II (4-0).
(See Weapons Engineering and Space Science Course listing at the end of this listing.)

AE 4900 Advanced Study in Aeronautics (Variable credit up to five hours.)
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman.

WEAPONS ENGINEERING and SPACE SCIENCE COURSES

Courses marked with an asterisk (*) are intended for non-Aeronautical Engineering students.

Upper Division or Graduate Courses

AE 3001 Space Systems Laboratory (0-2).
The laboratory will be used to support the Naval Postgraduate School (NPS) experiments to be flown on board Space Shuttle or on other Spacecraft. The laboratory does not consist of canned experiments; the specific activity depends on the nature of the experiment currently being prepared for flight. Course may be repeated for additional credit to continue work on the project. PREREQUISITE: Consent of the Instructor.

AE 3701 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: AE 2043.

AE 3705 Air Defense Lethality (4-1).
This course examines the design and effectiveness of antiaircraft 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 fuses on small arms, antiaircraft artillery, and guided missiles are presented. The 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 the air defense lethality are also described.

AE 3711 Missile Aerodynamics (3-2)*
A first course in aerodynamic principles applied to subsonic/supersonic missiles. PREREQUISITE: Completion of Engineering/Science Core or equivalent.

Graduate Courses

AE 4702 Missile Propulsion (4-0).*
Applications and analysis of solid propellant rockets, ramjets and ducted rockets. Propellant selection criteria and chracteristics, combustion models and behavior, performance analysis, technology requirements. PREREQUISITE: AE 3701.

AE 4703 Missile Flight Analysis (4-1).*
Stability and control. Configuration determinants. Transient (dynamic) modes. 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: AE 3701.

AE 4704 Missile Systems Integration (3-2).
A project oriented course developing microcomputer simulants of flight trajectories and target intercepts, focusing on tradeoffs among propulsion requirements, air loads, sensors, guidance laws, controls and structural components. PREREQUISITES: AE 4702 and 4703 or equivalent.

AE 4706 High Energy Laser System Design (4-0).
Types of lasers including excimer lasers. Laser performance. Adoptive optics. Propagation of laser beams. Pointing and tracking. Acquisition and handoff, fire control. Damage mechanisms. Advantages and limitations of both CW and Pulsed. Applications include ASMD, SAM-suppression, anti-tank optics, and space warfare. High energy laser systems are contrasted with other directed energy concepts. Students design a complete laser system. PREREQUISITE: Completion of an Engineering/Science Core or equivalent.

AE 4712 Survey of Tactical Missile Systems (3-2).*
Overview of missile technology: air loads, propulsion, guidance and control, sensors. Simple trajectory analysis. Performance tradeoffs. PREREQUISITE: Completion of an Engineering/Science Core or equivalent.

AE 4791 Spacecraft Systems I (3-2).
Examination of the factors affecting space systems selection and design, impact of orbital and sensor characteristics, ground facilities requirements, manufacturing, testing and verification techniques and requirements. Payload design considerations including impact of antennas, RF environment and EMI. Mechanical and electrical design of space systems. Temperature control. Attitude control. Special techniques associated with large space structures. PREREQUISITES: PH 3111; completion of Space Curricula Core or equivalent. SECRET clearance.

AE 4792 Spacecraft Systems II (4-0).
Survivability of space systems in wartime is discussed along with design features to improve protection. Case studies are selected to emphasize and illustrate material presented previously in AE 4791 as well as material in AE 4792. The students design a space system to meet mission requirements. PREREQUISITE: AE 4792. SECRET clearance.

ANTISUBMARINE WARFARE ACADEMIC GROUP

Chairman:

R. Neagle Forrest, Professor,
Code 71, Root Hall, Room 267,
(408) 646-2653, AV 878-2653.

The Antisubmarine Warfare Academic Group is an interdisciplinary association of faculty, consisten of ten members representing seven separate academic disciplines. An academic group is a less formal organization than an academic department, and each professor in the group has an appointment in an academic department. The Antisubmarine Warfare Academic Group has administrative responsibility for the academic content of the Antisubmarine Warfare Program of Study. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Administrative Sciences, Electrical and Computer Engineering, Mathematics, National Security Affairs, Oceanography, Operations Research, and Physics. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree of Master of Science in Systems Technology (Antisubmarine Warfare) will be awarded at the completion of an interdisciplinary program carried out in accordance with the following degree requirements:

The Master of Science in Systems Technology requires 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 disciplines must be included and in three disciplines, a course at the 4000 level must be included.

An approved sequence of at least three courses constituting advanced specialization in option area must be included.

In addition to the 45 hours of course credit, an acceptable group project or thesis must be completed.

The entire program must be approved by the Chairman of the ASW Group.

COURSE OFFERINGS

ST 0001 Seminar (0-1).
Special lectures, and discussion of matters related to the ASW Program. PREREQUISITE: Enrollment in the ASW Curriculum and SECRET clearance.

ST 0810 Thesis Research/Group Project (0-0).
Students in the ASW Curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

Upper Division or Graduate Course

ST 3000 Study Project on ASW 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 ASW system under a variety of operating conditions. PREREQUISITE: Enrollment in the ASW Curriculum or consent of the Group Chairman and SECRET clearance. Graded on a Pass/Fail basis only.

Graduate Course

ST 4999 Special Studies in ASW (1-0 to 4-0).
A course designed to meet the needs of students for special work in advanced topics related to ASW. PREREQUISITE: Enrollment in the ASW Curriculum and consent of the Group Chairman.

AVIATION SAFETY PROGRAMS

Vincent James Huth, Captain, U.S. Navy; Director (1987)*; MS, University of Southern California, 1984.

Milton Harold Bank, II, Associate Professor of Aeronautical Engineering and Safety (1971); PhD, Georgia Institute of Technology, 1971.

Russell Branson Bomberger, Professor of Law and Psychology (1958); PhD, University of Iowa, 1962.

Lynn Carter, II, Lieutenant Commander, U.S. Navy, Instructor in Fixed-Wing Aerodynamics (1986); MSAE, Naval Postgraduate School, 1976.

Virgil B. Cook, Commander, U.S. Navy, Instructor in Aviation Safety Programs (1987); MS, Naval Postgraduate School, 1979.

Lawrence J. Coppotelli, Commander, U.S. Navy, Instructor in Aviation Safety Programs (1985); MBA, National University, San Diego, 1983.

E. Michael DerManuel, Commander, U.S. Navy, Instructor in Aviation Safety Programs (1985); BS, University of Kansas, 1966.

Robert Wayne Hensley, Lieutenant Colonel, U.S. Marine Corps, Instructor in Aviation Mishap Investigation (1985); BS, Central State University, Oklahoma, 1968.

Robert Edward Joslin, Captain, U.S. Marine Corps, Instructor in Rotary-Wing Aerodynamics (1987); MSAE, Naval Postgraduate School, 1987.

Edward John Kennedy, Adjunct Professor of Aviation Physiology (1972); MD, University of Iowa College of Medicine, 1962.

John A. LeMoine, Major, U.S. Marine Corps, Instructor in Rotary-Wing Aerodynamics (1985); MSAE, Naval Postgraduate School, 1984.

Charles D. Pickett, Captain (Medical Corps), U.S. Navy, Assistant Professor of Aeromedical Aspects of Safety (1987); DO, College of Osteopathic Medicine, University of Health Sciences, Kansas City, Missouri, 1962.

Paul Edward Yoos, Lieutenant Commander, U.S. Navy, Instructor in Mishap Reporting (1984); BA, Rutgers University, 1972.

**The year of joining the 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 commanding officer in conducting an aggressive mishap prevention program. When the ASO completes the course he will be able to orgnize and administer a mishap prevention program at the squadron level as defined in OPNAVINST 3750.6.

The five week course consists of approximately 146 classroom and laboratory hours, plus a two-day field trip. Subjects addressed in the classroom and laboratory include safety programs, mishap prevention techniques, operational aerodynamics and aerostructures, mishap investigation and

reporting, psychology, safety law, and aeromedical support. During the field trip a Safety Survey of an operating squadron is made by the students.

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 Type Commanders, or CMC, as appropriate. 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: AO 2020, AO 2030, AO 3000, AO 3050, and AO 3060. Substitutions of equivalent courses taken in other departments for some of these courses may be made upon approval of the Director of Aviation Safety Programs. For example, AO 2020 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 nine times each year on a temporary additional duty basis to commanding officers, executive officers, OinCs of aviation detachments, and officers screened for command. One of the annual offerings of this course is designated "RASC"; attendance at this course offering is restricted to reserve officers. 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 34 classroom and laboratory hours addressing subjects including safety programs, safety psychology, aviation law, aircraft systems, mishap investigation, mishap and incident reports and endorsements, and aerospace medicine.

No academic credit is given for this course.

SURVEY OF AVIATION SAFETY

A Survey of Aviation Safety course offered annually on an active duty for training/temporary additional duty basis to reserve naval aviators and naval flight officers. This course is designed to increase the safety awareness of naval reservists, and to provide them with an understanding of the fundamentals of safety programs so that they can contribute effectively to the preservation of assets and maintenance of readiness.

This two week course includes approximately 57 classroom and laboratory hours. In addition, there is a two-day field trip during which a Safety Survey of an operating reserve squadron is made.

No academic credit is given for this course.

DEPARTMENTAL COURSE OFFERINGS

Upper Division Courses

AO 2020 Aerodynamics for Aircraft Accident Prevention and Investigation (3-0).
Survey of aerodynamics, performance, stability and control of fixed wing/rotary wing aircraft. Effects of varying conditions, configurations, designs and crew techniques on critical areas of operation.

AO 2030 Aircraft Structural Analysis (1-0).
Strength of materials, design criteria, failure mechanisms. Recognition of failures, fatigue, brittle fractures, contribution of manufacturing and maintenance, analysis of evidence, corrosion control technology, and quality control concepts.

Upper Division or Graduate Courses

AO 3000 Problems in Accident Prevention and Investigation (0-4).
Management Theories, practices and techniques, developing applications for the organization and control of a squadron mishap prevention program. Problem-solving exercises in the application of system safety concepts in the squadron accident prevention and investigation effort. Through case-study methods, the course emphasizes mission accomplishment, conservation of resources, cost-effectiveness, and systems management in accident prevention, investigation, and reporting.

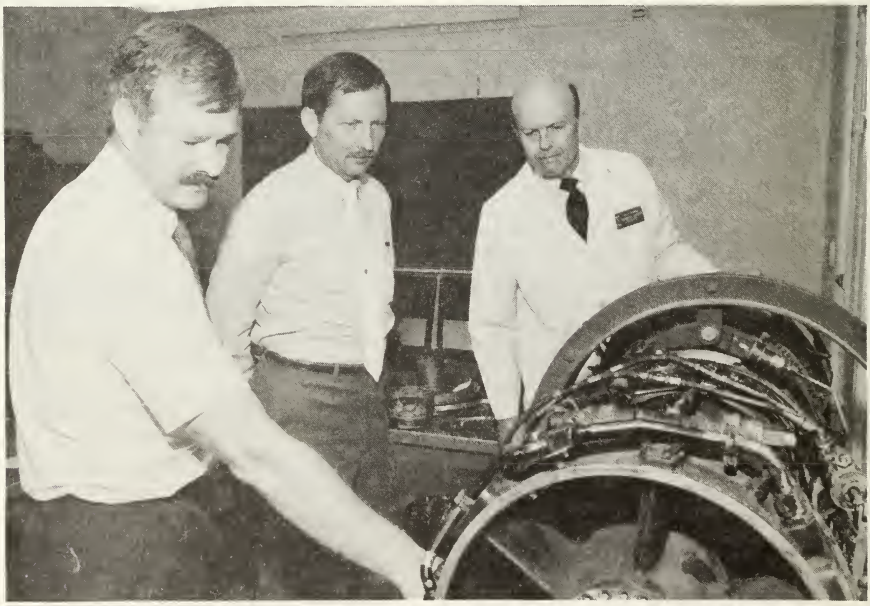
AO 3040 Safety Psychology (1-0).
Study of human reliability in survival-value environments; personality elements is safety motivation; identification and reduction of problems in human reliability.

AO 3050 Safety Law (1-0).
Study of leading cases and statutes concerning rights and duties in the safety disciplines. Emergency claims; quasicontractural duties. Criminal prosecution of safety violations. Legal duties of care. Special rules of evidence used by the courts in safety-related disputes.

AO 3060 Problems in Aviation Medicine (1-0).
Life-science considerations in accident prevention and investigation. Medical prediction. Effects of hypoxia, dysbarism, G-forces, spatial disorientation, diet, drugs, and exercise upon flight capabilities. Recognition of emotional difficulties; emotional considerations in accident prevention. Interpretation of autopsy reports.

AO 3100 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.

AO 3120 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.



COMMAND, CONTROL & COMMUNICATIONS (C3) ACADEMIC GROUP

Chairman:

Carl R. Jones, Professor,
Code 74, Spanagel Hall, Room 203,
(408) 646-2618, AV 878-2618.

The Command, Control and Communications (C3) Academic Group is an interdisciplinary association of faculty, consisting of fifteen members representing six separate academic disciplines. An academic group is a less formal organization than an academic department, and each professor in the group has an appointment in an academic department. The C3 Academic Group has administrative responsibility for the academic content of the Joint Command, Control and Communications Program of Study. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Administrative Sciences, Computer Science, Electrical and Computer Engineering, Mathematics, Meteorology, and Operations Research. Thesis topics for students in this area of study are approved by the Group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree of Master of Science in Systems Technology (Command, Control & Communications) will be awarded at the completion of an interdisciplinary program carried out in accordance with the following degree requirements:

The Master of Science in Systems Technology (Command, Control & Communications) 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.

GROUP COURSE OFFERINGS

CC 0001 Seminar (0-1).
Special lectures and discussion of matters related to the C3 Program.

CC 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

CC 3505 C3I Architecture (4-0).
This course supports the C3, Space Operations, and Intelligence Curricula by providing an overview of the principles, concepts, and trade-offs underlying all C3I architectures. Students address alternative models of C3I architecture, and then examine the attributes of a variety of current and proposed C3I architectures. In a class project, students assess the probability that a current or proposed C3I architecture can satisfy a measure of effectiveness of their choice. PREREQUISITES: A 3000-level Operations Research survey course of permission of the Instructor. TOP SECRET clearance with access to SPECIAL INTELLIGENCE information.

Graduate Courses

CC 4113 Policies and Problems in C3 (5-0).

CC 4113 Policies and Problems in C3 (5-0).
An in-depth study of the fundamental role C3 systems fulfill in operational military situations, including crisis warning and crisis management. An analysis of the changing role of intermediate level headquarters and its impact on C3 systems requirements and design. Additionally, the course considers the complexities imposed on C3 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 C3 curriculum. PREREQUISITE: CM 3111.

CC 4200 Combat Systems Engineering (4-0).
This course examines the generation of combat systems 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.

CC 4900 Special Topics in Command Control and Communications (2-0 to 5-0).
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.

DEPARTMENT OF COMPUTER SCIENCE

Vincent Y. Lum, Chairman and Professor (1985)*; PhD, University of Illinois at Urbana, 1966.

Richard A. Adams, Major, U.S. Air Force, Assistant Professor (1986); PhD, University of Illinois at Urbana, 1986.

Hassanein H. Amer, Assistant Professor (1987); PhD, Stanford University, 1987.

Gary S. Baker, Commander, U.S. Navy, Instructor (1985); MS, Naval Postgraduate School, 1981.

Valdis Berzins, Associate Professor (1986); PhD, Massachusetts Institute of Technology, 1979.

Gordon H. Bradley, Professor (1973); PhD, Northwestern University, 1967.

Daniel L. Davis, Associate Professor (1983); PhD, California Institute of Technology, 1969.

Richard W. Hamming, Adjunct Professor (1976); PhD, University of Illinois, 1942.

David K. Hsiao, Professor (1982); PhD, University of Pennsylvania, 1968.

Gary Hughes, Commander, U.S. Navy, Instructor (1986); MS, Naval Postgraduate School, 1983.

Uno R. Kodres, Professor (1963); PhD, Iowa State University, 1958.

Yuh-jeng Lee, Assistant Professor (1987); PhD, University of Illinois at Urbana, 1987.

LuQi, Assistant Professor (1986); PhD, University of Minnesota, 1986.

Bruce J. Maclennan, Associate Professor (1979); PhD, Purdue University, 1975.

Lewis G. Mason, Commander, U.S. Navy, Instructor (1986); MS Naval Postgraduate School, 1986.

Robert B. McGhee, Professor (1986); PhD, University of Southern California, 1963.

George A. Rahe, Professor Emeritus (1965); PhD, University of California at Los Angeles, 1965.

Neil C. Rowe, Associate Professor (1983); PhD, Stanford University, 1983.

Louis D. Stevens, Adjunct Professor (1987); MS, University of California at Berkeley, 1949.

Suchai Thanawastien, Associate Professor (1987); PhD, Auburn University, 1982.

C. Thomas Wu, Associate Professor (1985); PhD, University of California, San Diego, 1983.

Michael J. Zyda, Associate Professor (1984); DSc, Washington University, 1984.

* *The year of joining the Postgraduate School Faculty in indicated in parentheses.*

Chairman:

Vincent Y. Lum, Professor,
Code 52, Spanagel Hall, Room 513,
(408) 646-2449, AV 878-2449.

Associate Chairmen:

Uno R. Kodres, Professor,
Code 52Kr, Spanagel Hall, Rm. 534,
(408) 646-2197, AV 878-2197.

Michael J. Zyda, Assoc. Professor,
Code 52Zk, Spanagel Hall, Rm. 530B,
(408) 646-2305, AV 878-2305.

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.

However, to bring our officer-students up to a speed, a preparatory phase of some specially-tailored courses is provided for the new students. These basic and advanced courses lead to either a degree in Master of Science or Doctor of Philosophy. The requirements to complete either program are rigorous and are comparable to those set up in other major universities.

MASTER OF SCIENCE IN COMPUTER SCIENCE

The degree of Master of Science in Computer Science will be 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. The Program shall include at least:

28 quarter hours in Computer Science
12 quarter hours in other disciplines

c. Completion of an approved sequence of courses constituting specialization in an area of Computer Science.

d. Completion of an acceptable thesis in addition to the 40 quarter hours of course work.

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE

The Department of Computer Science has a program leading to the degree of Doctor of Philososphy. Areas of special strength in the department are Data-base Systems, Artificial Intelligence, Software Engineering, and Systems Architecture. Minors in areas of other departments are possible. A noteworthy feature of these areas of research 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.

COMPUTING FACILITIES

The facilities of the W. R. Church Computer Center provides school-wide timesharing and batch processing for Computer Science classroom instruction and research. The Center has an IBM 3033 Attached Processor with 16 megabytes of memory. The system has an IBM 3850 Mass Store that can hold 38 billion bytes of information. The system supports a wide variety of languages, and applications programs. Timesharing service provides 8 terminal/printer locations across the campus.

In addition to the campus computing center which provides mainframe computing services to the whole school, the Computer Science Department's computing facilities provide students and faculty with access to minis and micros for teaching, thesis work and research. These facilities are composed of a general-purpose laboratory and several individual laboratories for mainstream computer science areas. Further, these laboratories have their computers interconnected via local-area networks. Currently the six individual laboratories are Database Systems, Graphics Video, Software Engineering, Artificial Intelligence, Systems Architecture, and Microcomputers.

The variety of hardware and software existing in the Department is rather large. Currently the computers in the Department include a VAX 11/785, and a VAX 11/780, one VAX 11/750, two PDP 11/44s, and nearly a hundred microcomputers of different kinds. We have a large number of terminals, disks, image processors, and other devices. The Department also possesses a number of very advanced graphic (IRIS) workstations, symbolic machines, AI workstations, and many intelligent (ISI) workstations. Further, a substantial number of additional hardware and computers have been ordered.

Via the local-area networks, all other laboratories are connected to the General Laboratory which in turn provides gateways to the MILNET, ARPANET and CSNET. This interconnection allows us to communicate easily within the Department and outside the School.

On the software side, the major operating systems in the Department are Berkeley UNIX and DEC VMS. The languages supported in the systems include C, Usp, Prolog, as well as the normal ones like Ada, Pascal and Fortran-77. Commercial version of Ingres database systems has been installed.

Naturally, support for the Department's teaching and research is not complete with only hardware and software. We must have high-quality professional support as well. Currently the Department has 9 qualified hardware/software, full-time professionals who oversee the operation of these various equipments. They work closely with the faculty and students in support of teaching and research.

RESEARCH LABORATORIES

The computing equipments of the research laboratories are purchased by various funds. They are dedicated to the NPS students and faculty for the thesis development and faculty research. There are six research laboratories in the Computer Science Department. The laboratories and the computer equipment are listed as follows:

Laboratory for Database Systems Research
(DEC PDP 11/44s, DEC's parallel communications link to VAX 11/785, printers and terminals: ISI workstations, Ethernet links to VAX 11/750; MicroVAX-IIs, DECnet connection to VAX 11/780.)

Laboratory for Computer Graphics
(IRIS-2400 graphics workstations with bit-map display memory, high-resolution color monitor, digitizer tablet and mouse, Ethernet link to VAX 11/785.)

Laboratory for Software Engineering Research
(Apple MacIntoshes with extended memory, microfloppy and fixed disks, Apple Imagewriter and Laserwriter, 300/1200 baud modems for remote access; IVY DT20 (IBM-PC/AT compatible) with Intel 80287 math co-processors, color monitors, Okidata Microline 193 text and graphic printers.)

Laboratory for Articial Intelligence
(AI workstations with Prolog, Common Lisp, and smalltalk languages, symbolics Lisp machines with color graphics.)

Laboratory for Computer Engineering and Combat Systems
(Intel iSBC 86/12 single-broad computers, RAM, bubble memories, disk drives, Intel's MULTIBUS and Ethernet; GEMINI multi-level trusted system; INMOS multitransputer systems.)

Laboratory for Microcomputer Systems
(Z100 microcomputers with Intel-8085 and Intel-8088 processors, color monitors, Daisy wheel and high-speed printers; Intel 86/12A single-board computer with serial interface and Ethernet controller.)

DEPARTMENTAL COURSE OFFERINGS

CS 0001 Seminar (0-1).
Special or guest lecturers.

CS 0002 Seminar (0-1).
This seminar is open to new students only. It is lectured by the Chairman of the Department and offered every Fall and Spring.

CS 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division Courses

CS 2000 An Introduction to Computer Systems (3-1).
Primarily designed for computer science majors, this course provides a comprehensive introduction to computer systems in terms of their major building blocks and their interactions for the purpose of tying all the other concurrent and subsequent computer science courses together. The emphases of the course are on fundamentals, technical issues, conceptual entities and their relationships in a computer systems environment. There are no programming assignments. NO PREREQUISITE.

CS 2010 Introduction to Computer Systems (for Non-Majors) (2-0).
An introduction to the general characteristics of contemporary computers and to the fuctions they serve in a diversity of organizations is provided. The capabilities and limitations of computing as well as the economics of data processing in general are emphasized. There are no prerequisite or corequisite courses. Prior computing experience is not assumed and programming is not taught.

CS 2106 Introduction to Programming in FORTRAN (1-2).
The course is an introduction to programming using FORTRAN. The course is intended for management students with no previous programming experience who are already familiar with computer fundamentals. PREREQUISITE: CS 2010 or consent of Instructor. Graded on Pass/Fail basis only.

CS 2450 Computer Programming with FORTRAN (3-1).
This course provides an overview of the computer systems: hardware, software, and the operating systems. Algorithms and programs are developed using a structured approach to stepwise refinement of the algorithms and programs. The design and testing of computer programs in FORTRAN are studied, and practiced by the student in the laboratory. Computer projects of increasing difficulty are assigned. Graded on Pass/Fail basis only.

CS 2950 Structured Programming with FORTRAN (5-0).
An introduction to computer algorithms, programs and hardware. Algorithms and programs are developed using a structured approach to stepwise refinement of the algorithms and programs. The design and testing of computer programs in FORTRAN are studied, and practiced by the student in the laboratory. Computer projects of increasing difficulty are assigned. Computer systems including data representation, computer organizations, and systems software are introduced.

CS 2970 Structured Programming with PASCAL (4-1).
An introduction to computer algorithms programs and hardware. Algorithms and programs are developed using a structured approach to stepwise refinement of the algorithms and programs. The design and testing of computer programs in PASCAL are studied, and practiced by the student in the laboratory. Computer projects of increasing difficulty are assigned. Computer systems topics including data representation, computer organization, and systems software are introduced.

Upper Division or Graduate Courses

CS 3010 Computing Devices and Systems (4-0).
Designed primarily for non-computer science majors, this course examines functional components and their organization as a computer system. Although emphasis is upon computer hardware, the importance of both hardware and software in constituting a computer system is discussed. Important instances of software-hardware trade-offs in the implementation of various components are discussed. In this course, computer systems are examined through a hierarchy of four levels. The electronic circuit level, the logic or digital device level, the programming level, and the systems level. Major emphasis is upon the higher levels (programming and systems). PREREQUISITE: CS 2450 or CS 2960 or CS 2970 or consent of Instructor.

CS 3020 Software Design (3-2).
This course will provide the student with a broad background in the concept, design implementation and testing of computer programs. The topics will include identification of program requirements, language selection, design methodology, program efficiency, test and debug practices, and documentation. NO PREREQUISITE.

CS 3030 Operating Systems Structures (4-0).
Designed primarily for non-computer science majors, this course will provide a broad overview of operating systems including memory management techniques, job scheduling, processor scheduling, device management and data (information) management techniques. Case studies will be included to illustrate the issues in manager-operating systems selection, data control and security, and operating system utility support. In addition, future trends in computers will be identified, including maxi, mini, and microcomputers. PREREQUI—SITES: CS 3010 or equivalent background and consent of Instructor.

CS 3050 Software Project Development (4.0).
This course will provide the student with an overview of software development methodology, emphasizing the planning and design activities in the software life-cycle. A project walk-through approach will be used to familiarize the student with the methods, practices, techniques and concepts used to convey the scope and status of a project at various periods in its development. PREREQUISITE: A structured programming course.

CS 3111 Principles of Programming Languages (4-0).
This course is an introduction to the design, evaluation and implementation of programming languages. The four themes of name, data, control, and syntactic structuring are traced through the five major programming language generations. Principles for the evaluation of languages are developed and investigated. Key implementation concepts are covered, including interpreters and runtime organization. PREREQUISITES: CS 2450 or CS 2960 or CS 2970 or consent of Instructor.

CS 3113 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: CS 3111 and CS 3300 or consent of Instructor.

CS 3200 Introduction to Computer Architecture (3-2).
This course examines the organization of computers, processor architectures, machine and assembly language programming. Microcomputer systems are used in the laboratory to give students hands-on experience. Included are hardware components: the processor, memories, serial I/O, parallel I/O, real time clock, interrupt control, DMA; processor instructions: information transfer, arithmetic, control, process switching; machine language and assembly language programming: aritchmetic functions, input/output, interrupt handling, multicomputer control. PREREQUISITES: CS 2970 and either EC 2810 or equivalent.

CS 3201 Introduction to Computer Organization for Non-majors (3-2).
Designed primarily for weapons and electronic warfare majors, this course examines the organization of computers, processor architecture, machine and assembly language programming, Microprocessor systems are used in the laboratory to give students hands-on experience. Included are hardware components: the processor, memories, serial I/O, parallel I/O, real time clock, interrupt control, DMA; processor instructions: information transfer, arithmetic, control, machine language and assembly language programming: arithmetic functions, input/output, interrup handling. PREREQUISITES: CS 2450 or CS 2960 and EC 2810 or equivalent.

CS 3300 Data Structures (3-1).
The course deals with the specification, implementation and analysis of data structures. Common data objects such as strings, arrays, records, linear lists and trees, together with the operations used to manipulate these objects are studied. Particular emphasis is placed on linked structures. Implementation of symbol tables by hash tables and other means is presented. Applications to memory management, compiler design and sorting/searching algorithms are given. Computer projects in a high-level language are required. PREREQUISITE: CS 2970 or consent of Instructor.

CS 3310 Artificial Intelligence (4-0).
Survey of topics and methods of Artificial Intelligence. Topics include expert systems, visual scene analysis and descriptions, understanding of natural language, computer game playing, knowledge engineering systems. Methods include heuristic search and exploitation of natural constraints, means-ends analysis, production systems, semantic networks, and frames. Emphasis is placed on solving problems which seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. PREREQUISITE: MA 0125 or MA 2025 or consent of Instructor.

CS 3450 Software Systems Design (3-1).
The course covers the design and implementation of software systems elements, including assemblers, loaders, input/output control sub-systems, and interpreters. PREREQUISITES: CS 3200, CS 3300 and CS 3111 or consent of Instructor.

CS 3460 Software Methodology (3-1).
Methods for the design, implementation and testing of computer software. Stepwise refinement, decomposition, information hiding, program style, debugging, testing and informal verfication. Several program designs will be investigated by means of code reading, program modification and writing software. PREREQUISITES: CS 3111 and CS 3300.

CS 3502 Computer Communications and Networks (4-0).
An introduction to the structure and architecture of computer networks. Topics covered include network topology, single and multipe server queueing models, link establishment and link operation protocols, local area networks, packet radio networks, and point-to-point networks. The ISO model and the ARPA, ALOHA and ETHERNET systems are studied. Term papers and/or projects will be an important aspect of the course. PREREQUISITES: CS 3200 or CS 3010 (or equivalent) and MA 2300 (or equivalent).

CS 3550 Computers in Combat Systems (3-2).
This course describes the functions and algorithms of combat systems, the human interaction, and the systems organization in terms of processes. The laboratory experience includes work with navigational, tracking and ballistics functions, display control and the use of wakeup and block primitives in process control. Real-time performance analysis and prediction using simulations is included. PREREQUISITE: CS 3200 or CS 3201 or equivalent.

CS 3601 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 relate to language and compiler design. In addition, the major results involving the concept of undecidability are covered. PREREQUISITES: MA 2025 and MA 3026 or equivalent.

CS 3650 Theory 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: CS 3300 and CS 3601.

CS 3800 Directed Study in Computer Sciences (0-2 to 0-8).
Individual research and study by the student under the supervision of a member of the faculty 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.

CS 3900 Selected Topics in Computer Science (3-0).
Presentation of a wide selection of topics from current literature. Lectures on subjects of current interest and exploration may be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School. Tours of other facilities of interest may also be conducted. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

Graduate Courses

CS 4112 Operating Systems (4-0).
An in-depth theoretical treatment of operating systems concepts. Major course topics include process synchronization using semaphores, critical regions, and rendezvous, virtural memory including demand paging and segmentation, dynamic linking and loading, file structures and information security. The producer-consumer problem, readers and writers problem and the dining philosophers problem are examined. Architectural and language implications of evolving operating systems are considered. PREREQUISITES: CS 3450 and either CS 3112 or CS 3030.

CS 4113 Advanced Language Topics (4-0).
This course covers advanced topics and recent developments in programming languages and compilers. Typical topics are functional programming, object-oriented programming and logic programming. Both the theory and practice of functional programming are covered. Theoretical topics include the Church-Rosser theorem, the significance of various evaluation orders, and the use of recursive simultaneous equations to define data types. Functional, object-oriented and logic programming are viewed from the unified perspective of tree transformation. PREREQUISITES: CS 3111 and CS 3450 or consent of Instructor.

CS 4150 Programming Tools and Environments (4-0).
This course covers the design and implementation of tools to aid software development, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, type checkers, and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented programming environment. PREREQUISITES: CS 3450 and CS 4113 or consent of Instructor.

CS 4202 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 and image-processing facilities. The course is intended for students proficient in the development of software systems. PREREQUISITES: CS 2970, CS 3200, CS 3300 or consent of the Instructor.

CS 4203 Interactive Computation Systems (3-2).
A study of the human-computer interface and methods for interactive computer assisted problem solving. Topics include applicable human psychology, physiology and cognitive science. The main focus of the course is a design project involving computer graphics. PREREQUISITE: CS 4202 or consent of the Instructor.

CS 4300 Database Systems (3-1).
This course presents an up-to-date introduction to database systems including database system architectures, physical storage organization, data models, data languages, design of databases, query optimization, database integrity, security, concurrency control and recovery. PREREQUISITES: CS 3450 and CS 3300, or consent of Instructor.

CS 4310 Advanced Artifical Intelligence (4-0).
Artificial Intelligence has seen a rapid growth in applications in recent years. This course will survey a wide variety of current research, using a seminar format. Application areas surveyed include planning, language understanding, vision, robotics, human tutoring, database design, and statistics. PREREQUISITES: CS 3310 or consent of Instructor.

CS 4311 Expert Systems (3-1).
This course covers the design and implementation of expert systems. Topics include acquiring, representing, and organizing knowledge, multiple levels of problem structure and domain knowledge, metaknowledge and multilevel control structures. These topics will be studied in the context of several problem-solving, signal understanding, and machine learning tasks. PREREQUISITE: CS 3310 or consent of the Instructor.

CS 4312 Advanced Database Systems (3-1).
This course is a sequel to CS 4300, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, logic and databases, and other advanced topics. Many topics will be illustrated using both commercial and prototype database systems. PREREQUISITE: CS 4300 or consent of Instructor.

CS 4313 Advanced Robotic Systems (4-0).
This course is concerned with the kinematics, dynamics, and control of robotic systems. These systems will be studied primarily by means of computer simulations using graphics workstations. In addition to basic principles, the course will consider specific examples including instances of mobile robots as well as fixed-base (industrial) robots. Robot intelligence and task planning will be emphasized rather than lower-level implementation details. PREREQUISITE: CS 3310 or consent of Instructor. In addition, a basic understanding of calculus and matrix algebra is essential to this course.

CS 4320 Database Systems Design (4-0).
Primarily designed for non-computer science majors, this course explores the design and technology of database software. Implementation techniques, viable alternatives, database philosophy, data manipulation in complex information environments, and systems requirements are explored. Examples of systems will be drawn from active DOD database systems and current application/research in the private as well as public sectors. PREREQUISITE: CS 3020 or knowledge of a higher-level language and consent of Instructor.

CS 4322 Advanced Database Systems Seminar (3-1).
This course covers the advanced topics and recent research efforts in advanced database systems. Topics such as multilingual, multibackend, multimedia, and real-time database systems are the possible topics to be discussed in the course. In addition to theoretical and design studies, the experimentation of some advanced prototype database systems may be included. PREREQUISITES: CS 3450 and CS 3300, CS 4312, or consent of Instructor.

CS 4450 Advanced Computer Architecture (4-0).
This course examines advanced concepts of computer architectural design not covered in CS 3200. The core topics of the course are computer interconnection structures, internal and external memory, the central processing unit, microprogramming and parallel computer organizations. Additional topics from the recent literature are covered as time is available. PREREQUISITES: CS 3200 or equivalent.

CS 4451 Design and Analysis of Multiple-Processor, Real-Time Computers (3-1).
This course covers computer architectures ranging from pure multiprocessor to massively parallel systems used for real-time applications. Processing capacities are analyzed and performance estimates are made based on various real-time applications. Reliability and fault-tolerance issues are considered for the multiple-processor

systems. Application-program complexities are considered from the programmer's point of view. Laboratory experiments with multiple processor systems will be conducted in the microcomputer laboratory. PREREQUISITES: CS 3200 and CS 3450 or consent of Instructor.

CS 4452 Design and Analysis of Special-Purpose Computers (4-0).
This course deals with the organization of computer systems designed to achieve high efficiency with respect to a particular application or language. The course will be conducted in a seminar format, with the specific systems studied in any given quarter being determined by student and faculty interests. Examples of the types of computers to be considered include: Lisp machines, Prolog machines, image processors, vision and graphics computers, database computers, avionics computers, etc. PREREQUISITES: CS 3200 or equivalent and consent of Instructor.

CS 4470 Advanced Computer Graphics Topics (3-2).
This course covers advanced topics in computer image generation. The topics discussed include quality and realism in computer images, advanced real-time interactive systems, and special architectures for the real-time generation and display of computer images. PREREQUISITES: CS 4202 and consent of Instructor.

CS 4500 Software Engineering (4-1).
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: CS 3460 or CS 3020 or consent of Instructor.

CS 4510 Cognitive Sciences and Computer Programming (3-0).
This is a seminar on the application of results in the cognitive sciences to the study of computer programming. There will be extensive readings covering topics in cognitive psychology, software psychology, selected areas of artificial intelligence and programming methodology. Topics covered include definition of the programming task, complexity of programs, understanding of software, and tentative models of the programming task. PREREQUISITES: CS 4500 and the consent of the Instructor.

CS 4550 Distributed Computing (4-0).
The course covers all aspects of computer systems that have multiple computers connected by communications links. Distributed systems architectures, local area networks, geographically distributed network, multiprocessor systems, performance and reliability, distributed operating systems are studied. The course also covers distributed computing related topics in the areas of programming languages, computer science theory and software engineering. PREREQUISITES: CS 3450.

CS 4600 Topics in Formal Semantics (3-0).
This course covers advanced topics in the theory of formal semantics, as used in formal specifications for programming languages, and other areas of computer science. The topics discussed include specific semantic theories such as denotational semantics, axiomatic semantics, operational semantics, and current uses of formal semantics in the specification of abstract data types and other computing resources. PREREQUISITES: CS 3111 and CS 3601 or consent of the Instructor.

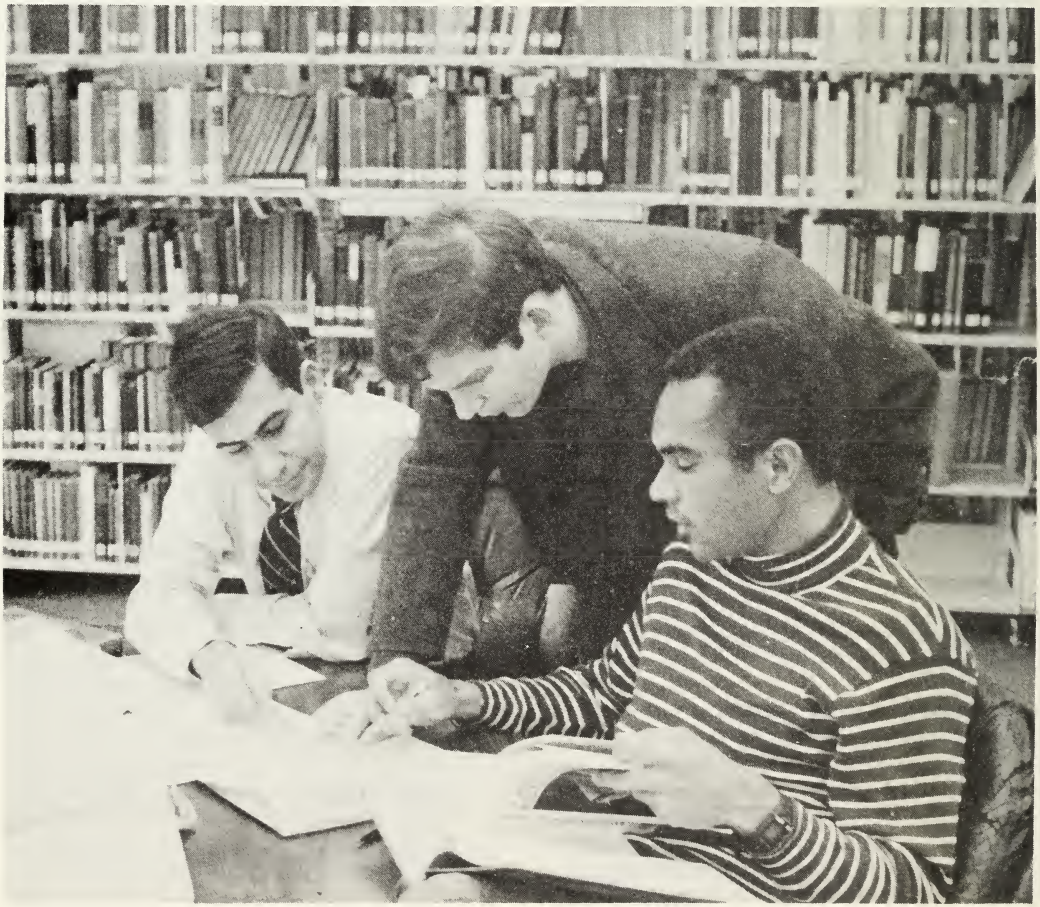
CS 4700 Epistemology for Computer Scientists (3-0).
This is a seminar on the applications of epistemology, the theory of knowledge, to computer science problems. There will be a particular ephasis on Artificial Intelligence applications, especially knowledge acquisition and representation, natural language understanding, perception, skill representation and cognitive simulation. The course covers the major epistemological theories emphasizing those with a relevance to computer science. Other topics discussed include logic (deductive and inductive), philosophy of science, foundations of mathematics and the use of empirical techniques in computer science. PREREQUISITES: CS 3310 and consent of Instructor; CS 4310 or CS 4311 is also recommended.

CS 4800 Directed Study in Advanced Computer Science (0-2 to 0-8).
Directed advanced study in computer science on a subject of mutual interest to student and staff 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.

CS 4900 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 fourth quarter of study in the selection of an area/topic of thesis research. PREREQUISITE: Computer Science students in fourth quarter or consent of department Chairman. Graded on Pass/Fail basis only.

CS 4910 Advanced Readings in Computer Science (0-2 to 0-8).
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.



DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

John Patrick Powers, Chairman and Professor (1970)*; PhD, University of California at Santa Barbara, 1970.

Richard W. Adler, Adjunct Professor (1970); PhD, Pennsylvania State University.

Harry A. Atwater, Adjunct Professor (1986); PhD, Harvard University, 1956.

Daniel Bukofzer, Assistant Professor (1980); PhD, University of California, 1979.

Thomas Jay Brown, Major, U.S. Air Force, Instructor (1984); MS. Air Force Institute of Technology, 1973.

Mitchell Lavette Cotton, Associate Professor, EE, University of California at Berkeley, 1954.

Roberto Cristi, Assistant Professor (1985); PhD, University of Massachusetts, 1983.

John Henry Duffin, Professor (1962); PhD, University of California at Berkeley, 1959.

Janine Vettesem England, Lieutenant, U.S. Navy, Instructor (1987); MS, Naval Postgraduate School, 1987.

Gerald Dean Ewing, Associate Professor (1963); PhD, Oregon State University, 1964.

Alex Gerba, Jr., Associate Professor (1959); MS, University of Illinois, 1957.

Ralph Hippenstiel, Assistant Professor (1986); PhD, New Mexico State University, 1985.

Stephen Jauregui, Jr., Adjunct Professor (1971); MSEE, Naval Postgraduate School, 1962.

Donald Evan Kirk, Professor (1965); PhD, University of Illinois, 1965.

Jeffrey Knorr, Professor (1970); PhD, Cornell University, 1970.

Allen Kraus, Professor (1976); PhD, University of South Florida, 1976.

Chin-Hwa Lee, Associate Professor (1982); PhD, University of California at Santa Barbara, 1975.

Hung-Mou Lee, Associate Professor (1982); PhD, Harvard University, 1981.

Herschell Loomis, Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Sherif Michael, Assistant Professor (1983); PhD, University of West Virginia, 1983.

Paul Henry Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Michael Allen Morgan, Associate Professor (1979); PhD, University of California at Berkeley, 1967,

Glen Allen Myers, Associate Professor (1965); PhD, Stanford University, 1965.

Rudolph Panholzer, Professor (1964); DSc, Technische Hochschule in Graz, Austria, 1961.

Robert Partelow, Adjunct Professor (1985); MSEE, Stanford University, 1975.

Robert Denney Strum, Professor (1958); MS, University of Santa Clara, 1964.

Frederick Terman, Adjunct Professor (1983); MSEE, Stanford University, 1964.

George Julius Thaler, Professor (1951); DEng, Johns Hopkins University, 1947.

Charles William Therrien, Associate Professor (1984); PhD, Massachusetts Institute of Technology, 1969.

Harold Arthur Titus, Professor (1962); PhD, Stanford University 1962.

Murali Tummala, Adjunct Research Professor (1987); PhD, India Institute of Technology, 1984.

John Robert Ward, Professor (1962); PhD, University of Sydney, 1958.

Lawrence James Ziomek, Associate Professor (1982); PhD, Pennsylvania State University, 1981.

**The year of joining the Postgraduate School is indicated in parentheses.*

Chairman:

John P. Powers, Professor,
Code 62, Spanagel Hall, Room 437,
(408) 646-2081, AV 878-2081.

Associate Chairmen:

Academic Affairs:

Robert D. Strum, Professor,
Code 62St, Spanagel Hall, Rm. 221A,
(408) 646-2652, AV 878-2652.

Computer Engineering:

Herschel H. Loomis, Jr., Professor,
Code 62Lm, Spanagel Hall, Rm. 446,
(408) 646-3214, AV 878-3214.

Electrophysics:

Jeffrey B. Knorr, Professor,
Code 62Ko, Spanagel Hall, Rm. 428,
(408) 646-2815, AV 878-2815.

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering Curriculum, the Communications Engineering Curriculum, and the Space Systems Engineering Curriculum. Additionally, the Department offers courses in support of other curricula such as Electronic Warfare Systems Technology; Telecommunications Systems Management; Command, Control and Communications, Space Systems Operations; Weapons 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 (PhD). The School typically graduates 80-90 MSEE degree candidates, 5 Electrical Engineer degree recipients, and 1 PhD per year.

A typical MSEE student will 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 course work spanning the breadth of Electrical and Computer Engineering. Students are required to take at least one graduate

level course in each of the following areas: Signal Processing; Communications; Electromagnetics, and Computers. In addition to the core requirements students concentrate in one major area of Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

Communications Systems
Computer Systems
Guidance, Navigation and Control Systems
Radar, Electro-optics and Electronic Warfare Systems
Signal Processing 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 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 36 credits in the course sequence 3000 - 4999 of which at least 27 credits must be in Electrical and Computer Engineering. Specific courses may be required by the Department and at least four courses, that total a minimum of 15 credits, must be in the course sequence 4000 - 4999.

An acceptable thesis must be presented 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 is to include at least 36 credit hours in the course sequence 3000 - 4999 in the disciplines of engineering, science, and mathematics. At least 12 of these 36 hours must be at the 4000 level, and at least 20 hours are to be in electrical engineering courses. A minimum of 8 quarter hours in 4000-level electrical engineering courses and at least 12 credit hours in courses outside of the Electrical and Computer Engineering Department are required. All students must submit an acceptable thesis. 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 Electrical Engineer.

A minimum of 72 graduate course credits is required for the award of the Engineer's Degree of which at least 54 credits must be in Electrical and Computer Engineering.

Of these at least 36 hours are to be in courses in the sequence 4000 - 4999. An acceptable thesis must be completed. Approval of all programs must be obtained from the Chairman of the Department of Electrical and Computer Engineering.

DOCTOR OF PHILOSOPHY

The Department of Electrical and Computer Engineering has an active program leading to the degree of 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 area of specialty.

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 Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including a 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 VAX 11/758 and a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system will provide resource-sharing and will integrate these systems with office and laboratory microcomputers.

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 purpose of the Space Systems Laboratory is to provide the instrumentation, computer software and systems necessary to support instructional activities and research related to spacecraft and space systems.

This is a relatively new laboratory which currently has a DOMSAT earth terminal and a TRANSIT navigation satellite receive installed.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems to support instructional activities and research in the frequency range from 100 MHz to 300 GHz.

The Transient Electromagnetic Laboratory supports research related to radar target classification based on broadband high-resolution coherent backscattering.

Other support facilities within the department include the Production Laboratory for the prototyping, layout and production of printed circuit boards, the Calibration and Instrument Repair Laboratory, as well as the Supply and Issue Facility for the ordering of instrumentation and electronic components.

DEPARTMENTAL COURSE OFFERINGS

COURSES FOR ENGINEERING AND SCIENCE CURRICULA

EC 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

EC 0950 Seminar (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.

Upper Division Courses

EC 2100 Circuit Analysis I (3-2).
An introductory course for students with no electrical engineering background. The fundamental concepts of voltage, current, power, signals, and sources are developed and applied to the analysis of resistive circuits, including simple transistor amplifiers and the operational amplifier. The principle of superposition, the one-port equivalents due to Thevenin and Norton, and the source transformation theorem are introduced. PREREQUISITE: Linear algebra and calculus (may be concurrent).

EC 2110 Circuit Analysis II (3-2).
A continuation of 2100. Following the introduction of the energy-storage elements, dynamic circuits are analyzed with the aid of the Laplace transform. Network functions and other s-domain concepts are developed. Then the special case of the sinusoidal steady-state is examined, using phasor methods of analysis. Frequency response, filtering, and ac power are discussed. PREREQUISITE: EC 2100.

EC 2150 Review of Circuit Analysis (4-2).
A review of circuit analysis for students with a moderate background in electrical engineering. Starting from a review of the basic concepts of current, voltage, power, signals, and sources, the methods of dynamic circuit analysis are developed through the real and complex frequency domains. Network functions, frequency response, and ac power are included, as are the more common circuit theorems. PREREQUISITE: Some background in circuit analysis.

EC 2170 Introduction to Electrical Engineering (4-2).
An introductory course intended for students not majoring in electrical engineering. Circuit elements, signals and waveforms; power and energy; Kirchhoff's laws and resistive circuits; diode circuit applications; application of Laplace transform to the step and sinusoidal response of dynamic networks. PREREQUISITES: Linear algebra and calculus (may be concurrent).

EC 2200 Electronics Engineering I (3-3).
An introduction to electronic devices and circuits. Electronic properties and charge-flow mechanisms of crystalline semiconductor material; properties of p-n junctions in diodes and bipolar junctions transistors; static and dynamic models for these devices; applications of diodes in wave shaping and power supplies; application of transistors in amplifiers and digital systems; characteristics and fabrication of integrated circuits. PREREQUISITE: A first course in electrical engineering.

EC 2210 Electronics Engineering II (3-2).
Characteristics of discrete device amplifiers (op-amps). Analysis and design of amplifiers including frequency response and biasing considerations. Applications of feedback amplifiers and op-amps. PREREQUISITE: EC 2200.

EC 2220 Applied Electronics (2-4).
A project course covering the application of linear and communications integrated circuits (ICs). Includes an introductory overview of important linear and communications ICs and practical experimental applications of these devices. PREREQUISITES: EC 2210 and EC 2500.

EC 2250 Accelerated Review of Electronics Engineering (4-2).
An advanced review of semiconductor devices and circuits intended for students who have previously studied the subject matter of EC 2200 and EC 2210. PREREQUISITE: Sufficient background in electronic circuits. Graded on Pass/Fail basis only.

EC 2300 Control Systems (3-2).
The application of feedback principles to the design of linear control systems using frequency domain (Bode-Nichols), s-domain (root locus) and state variable methods. Performance criteria including steady-state accuracy, transient response specification, bandwidth and integral performance indices are presented. Laboratory work includes testing and evaluation of physical systems and simulation studies. PREREQUISITE: EC 2420.

EC 2370 Electromechanical Energy Conversion (3-2).
Concepts of force and torque developed as results of the interaction of magnetic fields are presented as the common basis for all electromechanical machinery. Fundamental characteristics of DC motors and generators, synchronous machines and induction motors are developed and applied. Transformers and control and distribution circuits are also introducted. PREREQUISITE: A course in circuits.

EC 2400 Discrete Systems (3-0).
Principles of discrete systems, including modeling, analysis, and design. Topics include difference equations, z-transforms, stability, frequency response, and system diagrams. PREREQUISITE: FORTRAN or other high level language.

EC 2410 Fourier Analysis of Signals and Systems (3-0).
Analysis of analog signals in the time and frequency domains; properties and applications of Fourier series and transforms; convolution, correlation and spectral density; applications to amplitude modulation and demodulation systems. PREREQUISITES: Differential equations and a course in circuits.

EC 2420 Linear Systems (3-0).
Formulation of system models including state equations, transfer functions, and system diagrams; computer and analytical solution of system equations; stability. PREREQUISITES: Laplace transform, differential equations and FORTRAN or other high level language.

EC 2450 Accelerated Review of Systems (4-2).
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 EC 2400, EC 2410 and EC 2420. Some parts of the course will be in the self-study mode. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only (Parts of this course may be taken through Continuing Education as mini courses (EE-2151-55).

EC 2500 Communications Theory (3-2).
In this first course on the transmission of electrical signals, the following concepts are formulated mathematically and then considered in terms of devices and systems: sampling, analog modulation and demodulation, frequency multiplexing, digital signal representation, digital modulation and demodulation, time multiplexing; applications to broadcast systems. PREREQUISITE: EC 2410.

EC 2600 Introduction to Fields and Waves (4-0).
Static field theory is developed and applied to boundary value problems. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include skin effect, reflection of waves and radiation. PREREQUISITE: Vector calculus.

EC 2610 Electromagnetic Engineering (3-2).
A continuation of EC 2600. Topics include transmission lines, waveguides, cavity resonators, and high frequency components. Applications are presented in the laboratory. PREREQUISITE: EC 2600.

EC 2650 Accelerated Review of Electromagnetics (4-2).
A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC 2600 and EC 2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC 2800 Introduction to Microprocessors (3-2).
A basic understanding of a typical high performance microprocessor and its associated system is developed. A methodology for solving engineering problems through systematic software development and hardware design is introduced. The laboratory sessions provide familiarization with state-of-the-art development tools and emphasize assembly language programming and hardware interfacing using commercially available microprocessor support chips. PREREQUISITES: A high level language and EC 2820 (may be concurrent).

EC 2810 Digital Machines (3-2).
An introductory course in the analysis of digital systems and computers. No previous background in electrical engineering or digital techniques is assumed. Topics include: Number systems, logic gates and logic design; arithmetic circuits; flip-flops, counters, registers, and memories; basic digital computer architecture and the internal operation of computers, and elementary machine-language programming. The laboratories are devoted to the study of logic elements, arithmetic circuits, flip-flops, registers, and counters.

EC 2820 Digital Logic Circuits (3-2).
An introductory course in the analysis of digital systems leading up to computers. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, gates, truth tables and Kornaugh maps, integrated circuit families, decoders, multiplexers, PLAs; sequential logic including latches, flip-flops, memories, registers and counters, and sequential machines including state diagrams and synchronous systems.

Upper Division or Graduate Courses

EC 3210 Introduction to Electro-Optical Engineering (3-1).
An overview of the elements that comprise current electro-optical and infrared (EO/IR) systems. Topics include radiation sources (both laser and thermal), detector devices, modulators, optical elements, and propagation characteristics. Examples of various simple EO/IR systems are discussed. PREREQUISITE: EC 2210 (may be concurrent).

EC 3270 Power Electronics (4-0).
An introduction to the theory and application of low-power analog and digital devices used in the control of electric power systems found in Shipboard Systems. Applications of power electronics with emphasis on regulators, inverters and rectifiers. PREREQUISITES: EC 2370 and differential equations.

EC 3310 Linear Optimal Estimation and Control (4-0).
Techniques of optimal control and estimation theory and their application to military systems. Topics include performance measures; dynamic programming, the linear regulator problems; state estimation using observers and Kalman filters; Monte Carlo simulation; combined estimation and control and case studies. PREREQUISITES: EC 2300 and EC 3500 (may be concurrent).

EC 3400 Introduction to Digital Signal Processing (3-0).
The foundations of digital filtering and signal processing are developed. Topics include Discrete Fourier Transforms (DFTs) and the Fast Fourier Transform (FFT) algorithm, circular convolution and correlation, the use of DFTs and FFTs to evaluate convolution and correlation, spectrum analysis, design methods for nonrecursive and recursive digital filters, and signal flow graph and matrix representations. Computer-aided design techniques are emphasized. PREREQUISITES: EC 2400 and EC 2410.

EC 3410 Introduction to Discrete-Time Random Processes (4-0).
Fundamentals of discrete-time random processes are developed for digital signal processing, control, and communications. Topics covered are multivariate analysis and description of discrete-time random signals, sampling of continuous-time random signals, statistical averages and second moment analysis, linear transformations, optimal estimation, and spectral analysis. Subject matter includes an introductory treatment of linear prediction and autoregressive time series models, Kalman filtering, and maximum likelihood and maximum entropy spectral estimation. PREREQUISITES: EC 3400 and OS 2102.

EC 3440 Image Processing and Recognition (3-2).
Subjects introduced in this course include image representation, enhancement, restoration, transformation, and encloding. Pattern recognition using statistical decision theory will be discussed briefly. Some analysis involving region segmentation and block world understanding will be introduced. Some effort is directed to robotic vision where contemporary techniques used to recognize objects and extract depth information are dealt with briefly. There will be a series of experiments using special peripherals and computers. PREREQUISITE: EC 3400 (may be concurrent).

EC 3450 Acoustic Field Theory (4-0).
The objectives of this course are to expose the student to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, Legendre polynomials, etc.), orthogonality relationships, etc., which will enable him to solve fundamental problems concerning the radiation, scattering and propagation of sound in fluids. Topics to be covered include: general solutions of the three-dimensional Helmholtz wave equation in rectangular, cylindrical, and spherical coordinates with Dirichlet, Neumann, and Robin boundary conditions; radiation and scattering from sylinder and spheres; sound propagation in the ocean — the WKB approximation, ray acoustics, and the parabolic equation approximation, and other topics as time permits. PREREQUISITES: EC 2610 or EC 2650 or consent of Instructor.

EC 3500 Analysis of Random Signals (4-0).
Fundamental concepts necessary for handling non-deterministic signals and noise in communication, control, and signal processing systems are developed. Topics include properties of random time functions, statistical averages, autocorrelation and the power spectral density, transform relations, stationarity and ergodicity, noise models. PREREQUISITES: EC 2500 and OS 2102.

EC 3510 Communications Engineering (3-0).
The influence of noise and interference on the design and selection of hardware in practical radio communication transmitters and receivers. Specific topics include link and signal-to-noise ratio calculations, bandwidth trade-offs, carrier and data synchronization methods and hardware paramenters. PREREQUISITES: EC 2220 and EC 3500.

EC 3550 Fiber Optic Systems Fundamentals (3-1).
An introduction to the components and to the concepts of designing fiber optic communication systems. Includes fiber properties and parameters, fiber fabrication and testing, LED and injection laser sources, pin photodiodes and avalance photodiode detectors, receiver design considerations, connector and splice techniques, and system design incorporating analysis and tradeoffs. Data distribution techniques are also studied. PREREQUISITES: EC 2220 and EC 2600.

EC 3600 Electromagnetic Radiation, Scattering, and Propagation (3-2).
The principles of electromagnetic radiation as applied to antenna engineering and scattering. The characteristics of various practical antenna types are considered. System parameters such as gain, pattern and cross-section are introduced and array theory is covered. Applications include sidelobe suppression, radar target scattering and satellite communications. PREREQUISITE: EC 2610.

EC 3610 Microwave Engineering (3-2).
A continuation of EC 2610, this course covers elements of microwave systems. The course begins with a discussion of circuit media, network characterization with s-parameters and passive circuits such as filters, couplers and impedance transformers. Solid state devices and integrated circuits are then discussed and electron tubes are treated. The course concludes with a study of microwave and millimeter wave propagation. Several laboratory exercises allow the student to pursue selected topics in greater depth in a practical setting. PREREQUISITE: EC 2610.

EC 3670 Principles of Radar Systems (4-2).
For students in the Avionics and Weapons curricula. Topics include microwave devices, microwave propagation, antenna fundamentals, electronically steerable arrays, plus radar basics, detection of signals in noise, the radar equation, CW, pulse doppler, moving-target indicators, pulse compression, the ambiguity function, tracking radars, conical scan, track-while-scan, scan with compensation and monopulse. PREREQUISITES: Consent of Instructor, U.S. Citizenship and SECRET clearance.

EC 3800 Microprocessor-Based System Design (3-2).
Advanced microprocessor systems concepts are studied. Multimaster and multiprocessor systems issues. Memory management issues. Coprocessors and other advanced VLSI peripheral devices. HLL for solving engineering applications and linkage to OS and assembly language programs. The laboratory sessions will emphasize a design project involving advanced microprocessor systems concepts. PREREQUISITES: EC 2800 and EC 2820.

EC 3820 Computer Systems (3-1).
The course presents a unified approach design of computer systems stressing the interacting processes implemented in hardware, software and firmware. General features of operating systems are studied as well as specific features of an existing system. The elements of multiprogramming systems are introduced. PREREQUISITE: EC 2800.

EC 3830 Digital Computer Design Methodology (3-2).
A design and project oriented course. Basic principles, theories and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential elements of classical switching theory with a thorough understanding of the versatility of modern integrated circuits. Laboratory introduces modern design aids. PREREQUISITE: EC 2820.

EC 3910 Topics in Electrical Engineering (3-0 or 4-0).
This course examines topics of current interest in the field of electrical engineering. PREREQUISITE: Consent of Instructor.

Graduate Courses

EC 4100 Advanced Network Theory (4-0).
Modern active circuit design topologies; analog and sampled data networks. Analysis of transfer function properties, stabilities, sensitivities and causalities. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched capacitor filtering and nonfiltering applications. Introduction to analog VLSI techniques using stray insensitive switched capacitor networks. PREREQUISITES: EC 2210 and EC 2400.

EC 4210 Electro-Optic Systems Engineering (3-0).
Advanced topics and applications of electro-optics. Military applications of infrared technology. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current interest. PREREQUISITE: EC 3210.

EC 4300 Advanced Topics in Modern Control Theory (3-0).
Advanced topics and current developments in control theory and applications including such subjects as: the calculus of variations and Pontryagin's minimum principle applied to optimal control problems; numerical solution of two-point boundary-value problems; nonlinear estimation techniques; robust design techniques; large-scale systems; system identification; case studies of fire control and ship control systems. PREREQUISITE: Consent of Instructor.

EC 4310 Digital Control Systems (3-0).
Discrete systems are described and analyzed using time-domain and z-transform methods. Analytical design techniques are studied, as well as the engineering chracteristics of computer control systems. PREREQUISITES: EC 2400 and EC 3310.

EC 4320 Design of Linear Control Systems (4-0).
Advanced concepts in the design of linear feedback systems. Frequency response and root locus methods are applied to the design of cascade and feedback compensators for improvement of stability, accuracy and dynamic response. Parameter plane methods are used to place dominant poles while considering both sensitivity and optimization. SISO and MIMO systems are optimized using function minimization subroutines. PREREQUISITE: EC 2300.

EC 4330 Navigation, Missile, and Avioncis Systems (4-0).
The principles of operation of navigation, missile and avionics systems are presented. Topics are selected from the following areas to address the specific interests of the class: IR, EO, radar, laser, and acoustic sensors; inertial platforms; gyros and accelerometers; Loran, Omega, GPS, guidance, fir control, and tracking systems. PREREQUISITES: EC 3310, U.S. Citizenship and SECRET clearance.

EC 4340 Navigation, Missile and Avionics Systems (4-0).
This course covers essentially the same material as EC 4330, but with deletion of detailed analysis of specific systems. This course is intended for officers who do not have U.S. Citizenship. PREREQUISITE: EC 3310.

EC 4350 Nonlinear Systems (3-2).
Analysis and design of nonlinear systems with phase plane and describing function methods. Accuracy, limit cycles, jump resonances, relay servos and discontinuous systems are considered. PREREQUISITE: EC 2300.

EC 4370 Mathematical Models and Simulation for Control Systems (4-0).
Modeling concepts and techniques for linear and nonlinear systems. Philosophy of model studies. Verification of the model and its parameters. Design studies using computer models. PREREQUISITE: EC 2300.

EC 4430 Advanced Signal Processing and Spectral Estimation (3-0).
Design and implementation of digital signal processing algorithms. Least square estimation filter including discrete Weiner filtering (stochastic deconvolution), linear prediction, autoregressive moving average processing, Levinson's algorithm and lattice structures, and self-adaptive filters. Spectral estimation techniques including Burg's method, maximum likelihood method and others. PREREQUISITE: EC 3410.

EC 4440 Multidimensional Digital Signal Processing. (3-1).
Fundamentals of digital signal processing for signals that are a function of two or more independent variables. Analysis in both the time/space and frequency domains. Areas where the theory of one-dimensional signal processing does not extend in any straight forward way to two or more dimensions are highlighted. Topics include convolution, difference equations, recursively computable systems, sampling, regions of support, multidimensional periodicity, Fourier analysis including discrete Fourier transforms, z-transforms, stability, multidimensional causality, and an introduction to filter design, PREREQUISITE: EC 3400.

EC 4450 Sonar Systems Engineering (4-1).
Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems. Topics from complex aperture theory, array theory, and signal processing are covered. PREREQUISITES: EC 3450 or PH 3452 or PH 3402 and EC 3410 or EC 3500 or EO 4720.

EC 4460 Principles of Systems Engineering (3-0).
An introduction to the concepts, principles, methodology, and techniques of the design of large scale systems. Lecture topics include the systems approach; the systems life cycle and systems design process; determining systems requirements from operational requirements; systems effectiveness, reliability, maintainability, safety, and logistic support considerations; test and evaluation;

and cost as a design parameter. Applications to Navy electronics systems are used to illustrate the subjects covered. A detailed case study analysis of a specific Navy system is performed by the students. PREREQUISITE: Consent of Instructor.

EC 4480 Signals Intelligence (SIGINT) Systems Engineering (2-2).
Airborne, shipboard, and ground based interept and direction finding systems techniques used against simple and sophisticated electromagnetic radiation systems. Among the topics covered are current state of the art for wideband and directional antennas, wideband RF preamplifiers, scanning and chirping receivers, displays, recorders, pattern recognizers, and signal analysis devices. The laboratory periods are largely devoted to the specification and block diagram of systems to handle specified SIGINT tasks. PREREQUISITES: Consent of Instructor; U.S. Citizenship and SECRET clearance.

EC 4550 Digital Communications (4-0).
This course discusses some of the advantages and limitations of digital communications systems, to include: common modulation formats, matched-filter receivers, probability of error calculations, non-coherent receivers, carrier synchronization, frame and bit synchronization, telephone line modems, inter-symbol interference and adaptive equalizers,wideband modems, exchange of bandwidth and signal-to-noise ratio, diversity combining, maximum-likelihood and maximum aposterior probability receivers, and channel capacity and finite rate communication with arbitrarily few errors. PREREQUISITE: EC 3510.

EC 4560 Communications ECCM (3-2).
Methods of reducing the effects of jamming on radio communications systems are considered. Matched filter and correlator theory and application to spread spectrum techniques of digital data transmission are treated. Synchronization problems and techniques are presented. Codes for error correction are briefly considered. Frequency hopping, time hopping, and hybrid systems are studied in addition to direct sequence spreading. Use of steerable null antennas is described. PREREQUISITE: EC 3510.

EC 4570 Decision and Estimation Theory (4-0).
Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include Maximum-Likelihood, Bayes Risk, Neyman Pearson and Min-Max criteria and calculations of their associated error probabilities (ROC curves) for signals in Gaussian noise. Principles of Maximum-Likelihood, Bayes Cost, MMSE and Maximum-Aposterior estimators are introduced. Asymptotic properties of estimators and the Cramer-Rao bound are developed. The estimator-correlator stucture is derived for detection of signals with unknown parameters. This structure is illustrated by development of the radar (sonar) ambiguity function and matched filter processing systems. State estimation and the Kalman filter are derived and related to MMSE estimators. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations, PREREQUISITE: EC 3410 or EC 3500.

EC 4580 Information Theory (4-0).
Concepts of information measure for discrete and continuous signals. Fundamental theorems relating to coding and channel capacity. Effects of noise on information transmission. Coding methods for error control in digital communications systems. Selected applications of the theory to systems. PREREQUISITE: EC 3410 or EC 3500.

EC 4590 Communication Satellite Systems Engineering (3-0).
Communication satellite systems including the satellite and user terminals. Subjects include orbits, power sources, antennas, stabilization, link calculations, multiple access techniques, modulation and demodulation schemes, phase-locked loops, coding, transponder intermodulation and hardlimiting, receiver design, spread spectrum in SATCOM for multiple access, anti-jam and covert communications. PREREQUISITE: EC 3510 (may be concurrent).

EC 4600 Advanced Electromagnetic Theory (3-0).
An introduction is provided to advanced mathematical and numerical techniques of importance in the solution of electromagnetic problems. Applications of interest in the areas of antennas and microwave theory are covered. These include radiation and scattering from wires and surfaces and wave propagation on structures used in microwave integrated circuitry. PREREQUISITE: EC 3600 or EC 3610.

EC 4610 Radar Systems (3-2).
The radar range equation is developed in a form including signal integration, the effects of target cross-section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency-modulated radar, MTI, pulse doppler systems, monopulse tracking systems, multiple-unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurements of radar cross section of targets. PREREQUISITES: EC 3410 or EC 3500, EC 3600 and EC 3610 (may be concurrent), or equivalent; U.S. Citizenship and SECRET clearance.

EC 4620 Radar Systems (3-2).
This course covers essentially the same material as EC 4610, but with deletions of detailed analysis of specific items. PREREQUISITES: EC 3410 or EC 3500, EC 3600 and EC 3610 (may be concurrent), or equivalent. This course is intended for students who do not have U.S. Citizenship.

EC 4660 High Frequency Techniques (4-0).
The high frequency path from transmitter multicoupler to receiver multicouplers. Topics include HF propagation, propagation prediction, sounders, nuclear effects, ionospheric noice and interference, dynamic range problems, antenna and site effects, and target location techniques. PREREQUISITES: EC 3600 or consent of Instructor; U.S. Citizenship and SECRET clearance.

EC 4670 Electronic Warfare (4-1).
This course is intended for students who are not in the Electronics of Communications Engineering curricula. Three lecture hours are shared with EC 4680. In addition to the topics listed under EC 4680, background material on communication theory and digital signal processing is presented. PREREQUISITES: EC 3670, U.S. Citizenship and SECRET clearance.

EC 4680 Electronic Warfare Techniques and Systems (3-3).
Active and passive countermeasure techniques are considered, including signal representation, signal analysis, and signal interception. Important parameters of radar and communications systems are defined. Denial and deceptive jamming techniques are considered along with countermeasure and counter-countermeasure techniques. Signal intercept systems are treated. Acoustic, radio-frequency, infrared, and optical countermeasures are discussed. PREREQUISITES: EC 4610, U.S. Citizenship and SECRET clearance.

EC 4690 Principles of Electronic Warfare (unclassified) **(3-2).**
For students who do not have U.S. Citizenship. The objectives are to define EW signals and systems parameters, and establish interrelationships of these parameters for active and passive EW systems. Topics included are signal waveforms and spectra, receivers, signal processing and display, jamming techniques, direction finding, deception and confusion techniques. Laboratory exercises apply the basic principles of jamming and CCM to radar systems. PREREQUISITE: EC 4620.

EC 4820 Computer Architectures (3-1).
A study of advances in computer architecture. Computer descriptive languages. Memory system issues. Mini-computers and bit-slice microcomputers. High performance computers: pipeline supercomputers, array processors, multiprocessors. Data flow architectures. Fault tolerant and military architectures; PREREQUISITES: EC 3800 and EC 3820 or EC 3830.

EC 4830 Digital Computer Design (3-1).
A study of the architecture of and the design process for digital computer systems. Topics covered will include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, design of systems using standard and custom VLSI devices. Modern computer aided-design tools are emphasized. Laboratory projects is the design of a digital computer. PREREQUISITES: EC 3820 and EC 3830.

EC 4850 Computer Communication Methods (3-0).
The course objective is to develop an understanding of computer communications network design. Coverage includes the essential topics of network topology, connectivity, queueing delay, message throughput and cost analysis. The International Standard Office (ISO) model is divided into physical link, data link, network, transport, session and application layers. The protocol of these layers, data framing, error control, flow control, packet assembly/disassembly, routing, congestion, virtual circuit connection are discussed. New lower networking technologies such as Ethernet, ring, satellite link, X.25 public packet switching are introduced. PREREQUISITES: EC 2500 and EC 3820.

EC 4870 VLSI Systems Design (3-2).
An introduction to the technology and design of very-large-scale-integrated systems. Emphasizing NMOS devices and circuits, a structured approach to systems design is developed. The approach is based upon the use of repetitive cell structures and highly regular topologies. A complete VLSI system example is presented in detail. Project work is oriented to system and layout planning of a small system. PREREQUISITE: EC 3830.

EC 4900 Special Topics in Electrical Engineering (2-0 to 5-0).
Supervised study in selected areas of electrical engineering to meet the needs of the individual student. A written report is required at the end of the quarter. PREREQUISITE: Consent of the Department Chairman. Graded on Pass/Fail basis only.

EC 4910 Advanced Topics in Electrical Engineering (3-0 to 4-0).
This course examines advanced topics of current interest in the field of electrical engineering. PREREQUISITE: Consent of Instructor.

COURSES FOR INTERDISCIPLINARY CURRICULA

Upper Division Courses

EO 2710 Introduction to Signals and Systems (4-2).
A first course in communications systems for the C3, Space Systems Operations, and Telecommunications Management curricula. Coverage begins with the representation of signals in the time and frequency domains and progresses through linear system analysis using Fourier transform theory. Analog modulation techniques are presented emphasizing communications systems level analysis and spectral representation. Topics include Fourier series, Fourier transforms, linear systems, filters, signal bandwidth, communications channels and amplitude, frequency, and phase modulation. PREREQUISITE: MA 2050.

EO 2720 Introduction to Electronic Systems (4-2).
A first course in electronic systems for the ASW and EW systems curricula. Emphasis is on the functional aspects of basic circuits and signals. Topics include electrical quantities, resistive circuits, inductance and capacitance, operational amplifiers, time and frequency response, rectifiers and logic elements. PREREQUISITE: Calculus.

EO 2730 Control Systems (2-1).
This course develops the basic tools of the control systems engineer. The applications to electronic warfare are emphasized in the examples and laboratory experiments. The dynamics for a radar control system, a missile seeker head tracking system and missiles are investigated. Basic topics are introduced such as signal flow graphs and system step and frequency response characteristics, and digital systems theory as used in radar tracking and command guided and semiactive homing missiles. PREREQUISITES: Differential equations, Laplace transform and FORTRAN.

EO 2750 Communications Systems (4-2).
A second course in communications systems for the C3, Space Operations, and Telecommunications Management curricula. Coverage begins with the sampling theorem and various forms of digital modulation emphasizing the spectral representation of digital and pulse signals. Noise is introduced with emphasis on its effects on a communication system. Specific topics include sampling, pulse-amplitude modulation, time-division multiplexing, pulsecode modulation, baseband encoding, phaseshift keying, noise temperature, noise figure, and signal-to-noise ratio. PREREQUISITE: EO 2710.

EO 2760 Electromagnetic Theory (4-1).
The experimental laws of electromagnetic theory and the development of Maxwell's equations are presented. Maxwell's equations are then utilized in the study of plane waves, transmission lines, wave guides, cavity resonators, and elementary radiation. Laboratory experiments dealing with high frequency components and measurements reinforce and extend the concepts presented in the lectures. PREREQUISITES: EO 2720 and MA 2181.

EO 2790 Survey of Communications Systems (4-0).
This course supports the Intelligence curriculum by providing an overview of the principles, concepts, and trade-offs underlying communications systems. Topics include: signals and their representation as functions of time and frequency, effects of bandwidth limitations upon signals. analog and digital modems, signal-to-noise considerations in communications systems, reliable communications path concepts, major communications systems design tradeoffs, and examples of modern communications systems.

Upper Division or Graduate Courses

EO 3720 Introduction to Signals and Noise (4-1).
A course in the analysis of signals and noise for the ASW and EW curricula. Topics include Fourier analysis of periodic and pulse signals, linear filter response, correlation and spectral density of random signals and sampling. PREREQUISITES: EO 2720 and a first course in probability.

EO 3750 Communications Systems Analysis (3-1).
The final course in communications systems for the C3, Space Systems Operations, and Telecommunications Management curricula. The objective is to study communications from a system perspective concentrating on the relative performance of several important communication systems and the analysis of trade-offs available in the design of communications systems. Specific topics introduced include relative performance of modulation types in noise, bit error rates, error detection and correction, signal-to-noise ratio, antenna characteristics, propagation, and path calculations. Special subjects will be introduced and existing knowledge reinforced through the study of existing military communications systems. PREREQUISITE: EO 2750.

EO 3760 Electromagnetic Radiation, Scattering, and Propagation (4-2).
The fundamentals of antennas used in the VLF through the microwave portion of the electromagnetic spectrum and presented. Scattering and propagation in this part of the spectrum are also discussed, as are those elements of electromagnetic compatibility which relate to radiation. Laboratory exercises relating to pattern and impedance measurement, and use of computer programs further enhance the student's understanding of the lecture concepts. PREREQUISITE: EO 2760.

EO 3780 Electronic Warfare Computer Applications (3-2).
Application of digital and analog techniques to the recording, processing, display, and interpretation of electronic warfare signals and data. The computer is applied to the solution of electronic warfare problems such as signal identification. PREREQUISITES: EC 2810, CS 3510, or CS 3230; EO 4780.

Graduate Courses

EO 4720 Signal Processing Systems (4-1).
A study of digital, analog, and hyband signal processing systems for communica-

tions, echo ranging, and electronic surveillance. Examples from current and proposed military systems will be analyzed. The course is designed for the ASW and EW curricula. PREREQUISITE: EO 3720.

EO 4730 Electro-Optic Systems and Countermeasures (3-1).
A study of military applications of electro-optic systems, IR and EO missile seekers, laser designators, optical surveillance, high energy laser systems, laser communications, and laser radar. Emphasis is on systems applications, countermeasures and counter-countermeasures. Students report on electro-optic systems. PREREQUISITES: EC 4410 or PH 3271; U.S. Citizenship and SECRET clearance.

EO 4750 Signals Intelligence (2-0).
This course focuses on U.S. signals intelligence capabilities for countering current threats and the processes for designing or upgrading U.S. capabilities. It is designed to enhance the student's knowledge and understanding of current and planned U.S. SIGINT systems and capabilities and the design, development and employment of SIGINT and ESM systems. PREREQUISITES: Registration in EW curriculum (595) or consent of Instructor; U.S. Citizenship and SI clearance.

EO 4760 Microwave Devices and Radar (4-2).
Those microwave devices most important in radar and in electronic warfare systems are studied, including magnetrons, traveling-wave tubes, and solid-state diodes. The radar range equation is developed. In addition to basic pulse radar, modern techniques are discussed including doppler systems, tracking radar, pulse compression, and electron ically steerable array radars. Electromagnetic compatability problems involving radar systems are considered. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross-section of targets. PREREQUISITES: EO 4720, EO 3760 (may be taken concurrently) or consent of Instructor; U.S. Citizenship and SECRET clearance.

EO 4780 Electronic Warfare Systems (3-2).
This course covers electronic warfare in that portion of the electromagnetic spectrum through the millimeter wavelength region. The infrared through electro-optic region is covered in a companion course, EO 4730. Electronic denial and deceptive countermeasures against fuses, communications, and various radar detection and tracking systems are discussed. Equations for required jammer gain and power output are developed. The characteristics of passive countermeasures are discussed. Other topics include anti-radiation missiles, counter-countermeasure circuits, target masking and modification, signal intercept, signal sorting, signal identification, and direction finding. Techniques are discussed in relation to U.S., allied, and communist bloc systems. Laboratory work reinforces the classroom discussions. PREREQUISITES: EO 4760, U.S. Citizenship and SECRET clearance.

EO 4790 C3 Countermeasures (2-0 to 5-0).
Supervised study in selected areas of electronic warfare to meet the needs of individual students. A written report is required at the end of the quarter. PREREQUISITE: Consent of C3 Group Chairman. Graded on a Pass/Fail basis only.

ELECTRONIC WARFARE ACADEMIC GROUP

Chairman:

Joseph Sternberg, Professor,
Code 73, Spanagel Hall, Room 200,
(408) 646-3496, AV 878-3496.

The Electronic Warfare Academic Group is an interdisciplinary association of faculty, consisting of eight members representing five separate academic disciplines. An academic group is a less formal organization than an academic department, and each professor in the group has an appointment in an academic department. The Electronic Warfare Academic Group has administrative responsibility for the academic content of the Electronic Warfare Program of study. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Meteorology, Operations Research, and Physics. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The degree of Master in Science in Systems Engineering (Electronic Warfare) will be awarded at the completion of a multidisciplinary program, Curriculum 595, satisfying the following degree requirements:

The Master of Science in Systems Engineering requires a minimum of 45 quarter hours of graduate level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included, and in two disciplines, a course at the 4000 level must be included.

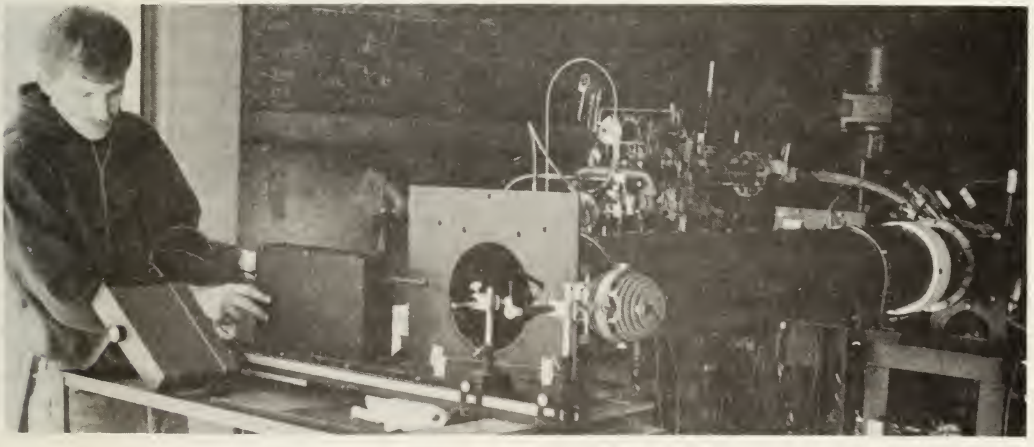
An approved sequence of at least three courses constituting advanced specialization in one area must be included.

In addition to the 45 hours of course credit, an acceptable thesis must be completed.

COURSE OFFERINGS

EW 0002 Seminar (0-1).
Special lectures and discussion of matters related to the EW program. PREREQUISITE: SECRET clearance.

EW 0810 Thesis Research/Group Project (0-0).
Students in the Systems Engineering curricula will enroll in this course which consists of an individual thesis or a group project involving several students and faculty.



ENGINEERING ACOUSTICS ACADEMIC COMMITTEE

Chairman:

Steven L. Garrett, Assoc. Professor,
Code 61Gx, Spanagel Hall, Rm. 101I,
(408) 646-2540, AV 878-2540.

The academic character of the programs in the Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics, signal processing, and computers related to underwater sound propagation, electroacoustic transduction, and the detection, tracking, and quieting of underwater targets. These programs are designed specifically for students in the Underwater Acoustics Curriculum and government employees in acoustics-related laboratories and systems commands.

The academic aspects of the program are the responsibility of an academic committee composed of representatives from the Department of Physics and of Electrical and Computer Engineering.

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

The degree, Master of Science in Engineering Acoustics, will be awarded as an interdisciplinary program to be carried out in accordance with the following degree requirements:

a. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have competed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.

b. The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter hours of course work; at least 20 graduate quarter hours must be taken in acoustics and its applications. One 4000 level course from each of three of the following areas must be included: wave propagation, transducer theory and design sonar systems, and signal processing.

c. An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid point of the degree program.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Departments of Electrical Engineering and Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the degree Doctor of Philosophy or Doctor of Engineering. Areas of special strength in the departments are physical acoustics, ocean acoustics, and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other Federal Government installation. The degree requirements and examinations are as outlined under the general school requirements for the Doctor's degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

DEPARTMENT OF MATHEMATICS

Harold M. Fredricksen, Chairman and Professor (1980)*; PhD, University of Southern California, 1968.

Donald Alfred Danielson, Associate Professor (1985); PhD, Harvard University, 1968.

Carl L. Devito, Associate Professor (1985); PhD, Northwestern University, 1967.

Richard Homer Franke, Professor (1970); PhD, University of Utah, 1970.

Toke Jayachandaran, Professor (1967); PhD, Case Institute of Technology, 1967.

William T. Kelley, Associate Professor (1985); MS, University of Illinois, 1972.

Gordon Eric Latta, Professor (1979); PhD, California Institute of Technology, 1951.

William T. Little, Adjunct Professor (1984); PhD, Georgia Institute of Technology, 1970.

Kenneth Robert Lucas, Associate Professor (1958); PhD, University of Kansas, 1957.

George William Morris, Professor (1968); PhD, University of California at Los Angeles, 1957.

Beny Neta, Associate Professor (1985); PhD, Carnegie-Mellon University, 1977.

Guillermo Owen, Professor (1983); PhD, Princeton University, 1962.

Ira Bert Russak, Associate Professor (1972); PhD, University of California at Los Angeles, 1967.

Arthur Loring Schoenstadt, Professor (1970); PhD, Rensselaer Polytechnic Institute, 1968.

Donald Herbert Trahan, Associate Professor (1966); PhD, University of Pittsburgh, 1961.

Maurice Dean Weir, Professor (1969); DA, Carnegie-Mellon University, 1970.

Carroll Orville Wilde, Professor (1968); PhD, University of Illinois, 1964.

** The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Harold M. Fredricksen, Professor,
Code 53Fs, Ingersoll Hall, Room 344,
(408) 646-2206, AV 878-2206.

Associate Chairmen:

Research:

Guillermo Owen, Professor,
Code 53On, Ingersoll Hall, Room 341,
(408) 646-2720, AV 878-2720.

Advanced Programs:

Carroll Wilde, Professor,
Code 53Wm, Ingersoll Hall, Room 346,
(408) 646-2664, AV 878-2664.

Laboratory:

Gordon Latta, Professor,
Code 53Lz, Ingersoll Hall, Room 339,
(408) 646-2684, AV 878-2684.

As well as the master of science degrees, the Mathematics Department offers individually tailored minor programs for many of the School's doctoral students. The majority of the departmental effort is devoted to the service courses offered, including the refreshers, and 1000-2000 level courses. The department maintains a microprocessor lab, available at all times to all students and staff.

MASTER OF SCIENCE IN APPLIED MATHEMATICS

In order to enter a program leading to the degree Master of Science in Applied Mathematics, a student must have a background which would qualify him for a Bachelor of Science degree with major in mathematics or, with a strong mathematical orientation, in a physical science or engineering.

A program that leads to the degree Master of Science in Applied Mathematics for a student who has met the entrance criteria must contain a minimum of 45 quarter hours of graduate level courses with a minimum QPR of 3.0, subject to the following conditions:

a. The program must be approved by the Chairman of the Department of Mathematics.
b. The program must include at least fifteen hours at the 4000 level, with at least twelve hours in 4000 level mathematics courses.
c. The program must contain at least nine hours in an approved sequence of application courses from outside the Mathematics Department, and at least nine hours in an approved sequence of courses from within the Mathematics Department.
d. An acceptable thesis is normally required and is credited as the equivalent of nine hours of 3000 level mathematics courses. (A student may petition the Chairman of the Mathematics Department to substitute nine hours of courses for the thesis.)
e. Courses in the following areas are specifically required in any program; some of these courses may be used to satisfy part (or all) of the mathematics sequence requirement in item c. above:

(1) Real/complex analysis (a two-course sequence), or applied algebra (a two-course sequence)
(2) Ordinary and/or Partial Differential Equations and Integral Transforms
(3) Numerical Analysis
(4) Probability and Statistics

MASTER OF SCIENCE DEGREE WITH MAJOR IN MATHEMATICS

In order to pursue a program leading to the Master of Science degree with a major in mathematics, a student must have a background which would qualify him for a Bachelor of Science degree with major in mathematics.

A curriculum which satisfies the Master of Science degree requirements consists of a minimum of 45 quarter hours of approved courses in mathematics and related subjects. An acceptable thesis may be counted as equivalent to nine quarter hours. A student must have a QPR of 3.0 or greater in any major program.

At the discretion of the Chairman of the Department of Mathematics, a student pursuing a program leading to the Master of Science degree with major in mathematics may (or may not) be required to write a thesis in mathematics.

The following topics are specifically included in any major program:

a. 6 hours of Algebra
b. 6 hours of Analysis

The main areas of thesis topics are:

a. Optimization
b. Differential Equations
c. Fourier Analysis
d. Functional Analysis
e. Numerical Methods
f. Optimal Control
g. Calculus of Variations
h. Tensor Analysis and Applications.

COURSE SEQUENCES FOR SPECIAL CURRICULA

The Mathematics Department offers several sequences of courses for various curricula. Students of these curricula typically enter these sequences at their appropriate level and exit when completing their particular requirement.

Computer Science

MA 2025
MA 3026

Management

MA 2300

Operational Curricula

MA 1112
MA 2129
MA 2181
MA 3139

Engineering Science

MA 1117
MA 1118
MA 2047
MA 2121
MA 3132
MA 3232

Operations Research

MA 1118
MA 2042
MA 3110

PREREQUISITES

Prerequisites are as described in the course descriptions. If a student has not taken the prescribed prerequisites at NPS, then a validation examination by the Mathematics Department may be substituted.

Generally speaking, credit for courses given in sequences will not be available to every student. Credit will be given for only one of a pair of equivalent courses.

DEPARTMENTAL COURSE OFFERINGS

MA 0110 Refresher for Basic Programming on Desk-Top Microcomputers (2-0) (Meets last 6 weeks of quarter)
Numerical calculations and BASIC programming on desk-top microcomputers. Numerical calculations will include powers and roots, logs and exponentials and trigonometric functions. BASIC programming includes input/output, loops, branching, subroutines and use of library functions.

MA 0112 Refresher Mathematics (3-3) (Meets last 6 weeks of quarter)
Calculus Review.

MA 0125 Logic and Set Theory (3-0) (Meets last 6 weeks of quarter)
An introduction to the elements of set theory and mathematical reasoning. Sets, Venn diagrams, truth tables, quantifiers, logical reasoning. Functions, relations, partitions and equivalence relations. 1-1 correspondence. (Paradoxes of set theory, axiom of choice.)

MA 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

MA 1110 Introduction to BASIC Programming on Desk-top Microcomputers (2-0).
Numerical calculations and BASIC programming on desk-top microcomputers. Numerical calculations will include powers and roots, logs and exponentials and trigonometric functions. BASIC programming includes input/output, loops, branching, subroutines and use of library functions.

MA 1112 Selected Calculus Topics Review (2-2).
Functions, limits, continuity, differentiation of functions of one and several variables, implicit functions, parametric equations, optimization; sequences and series, series representation of functions; Euler's formula; review of complex numbers. PREREQUISITE: A previous course in calculus.

MA 1117 Single Variable Calculus (5-2).
Review of analytic geometry and trigonometry, functions of one variable, limits, derivatives, continuity and differentiability; differentiation of algebraic, trigonometric, logarithmic and exponential functions with applications to maxima and minima, rates, differentials; product rule, quotient rule, chain rule; antiderivatives, integrals and the fundamental theorem of calculus; definite integrals, areas, lengths of curves and physical applications; special methods of integration, including a 2-hour problem solving laboratory. PREREQUISITE: Precalculus mathematics (may be taken through Continuing Education as minicourses MA 1131-36).

MA 1118 Multivariable Calculus (5-2).
Review of calculus of one variable; vector algebra and calculus, directional derivative, gradient and integral theorems; maxima and minima of functions of two independent variables, total differential; double and triple integrals, cylindrical and spherical coordinate systems; infinite series; convergence tests, uniform convergence and Taylor series, including a 2-hour problem solving laboratory. PREREQUISITE: Previous course in calculus (may be taken through Continuing Education as minicourses MA 1127-40 and 1150).

MA 1248 Selected Topics in Applied Mathematics for C3, Space Operations and Communications Management (4-1).
A survey of selected calculus and post calculus topics - infinite sequences and series; Fourier series and Fourier integral transforms, and matrix algebra and determinants. (This course may not be taken for credit by students in an engineering or science degree program.) PREREQUISITE: MA 1117.

Upper Division Courses

MA 2025 Logic, Sets and Functions (4-1).
Propositional logic, elements of set theory, relations, functions and partitions. An introduction to theorem proving techniques, including mathematical induction, in the context of basic mathematical systems.

MA 2042 Linear Algebra (4-0).
Sytems of linear equations, matrices, and determinants. Finite dimensional vector spaces, linear dependence, bases, dimension, inner products, orthogonalization. Linear transformations, rank and nullity, change of basis, linear functionals, orthogonal transformations, quadratic forms, symmetric matrices, diagonalization, eigenvalues and eigenvectors. PREREQUISITE: MA 1117 or MA 1118 taken concurrently.

MA 2047 Linear Algebra and Vector Analysis (4-1).
Solution of linear systems of equations, algebra of matrices, determinants. Linear vector spaces, linear dependence and independence, subspaces, bases and dimension. Inner products, ortho-normal bases and Gram-Schmidt process. Eigenvectors and eigenvalues. The algebra and calculus of vectors in R2 and R3. Del operator, directional derivative, gradient, divergence and curl with applications. Line, surface and volume integrals, Green's, Stoke's and divergence theorems. PREREQUISITE: MA 1118 (may be taken concurrently).

MA 2121 Differential Equations (4-0).
Ordinary differential equations: linear and nonlinear equations, homogeneous and nonhomogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms applications. PREREQUISITES: MA 1118 or equivalent, MA 2047 or equivalent concurrently.

MA 2129 Ordinary Differential Equations and Laplace Transforms (2-1).
First order ordinary differential equations, second order equations with constant coefficients, application, Laplace transforms. PREREQUISITES: MA 1112, MA 1117 or equivalent.

MA 2181 Vector Calculus (2-1).
Differentiation and integration of vector functions. The Del operator and related concepts. Green's theorem, Stoke's theorem, divergence theorem. Interpretations and applications. PREREQUISITE: Calculus and vector algebra.

MA 2300 Mathematics for Management (5-0).
This course is designed to provide a mathematical basis for modern managerial tools and techniques. It includes elements of differential and integral calculus, sequences and series and an introduction to matrix algebra. PREREQUISITE: College algebra.

MA 3001 Incremented Directed Study (1-0).
This course provides the opportunity for a student who is enrolled in a three thousand level course to pursue the course material in greater depth by directed study to the extent of one additional hour beyond the normal course credit.

MA 3002 Incremented Directed Study (2-0).
This course provides the opportunity for a student who is enrolled in a three thousand level course to pursue the course material in greater depth by directed study to the extent of two additional hours beyond the normal course credit.

MA 3026 Discrete Mathematics (5-0).
Graph theory and introduction to algebraic systems. Applied combinatorics and analysis of algorithms. Applications to computer science. PREREQUISITE: MA 2025.

MA 3035 Mathematical Introduction to Microprocessors (2-1).
An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, connecting and controlling peripherals (terminal, disc drive...), operating systems.

MA 3046-3047 Linear Algebra I-II (3-0).
Special types of matrices; orthogonal reduction of a real symmetric matrix to diagonal form; quadratic forms and reductions to expressions involving only squares of the variables; applications to maxima and minima; Lambda matrices and related topics; Cayley-Hamilton theorem. Reduced characteristic function; canonical forms, idempotent and nilpotent matrices; solutions to matrix polynomial equations; functions of a square matrix; applications such as to differential equations, stability criteria. PREREQUISITE: MA 2042.

MA 3110 Topics in Intermediate Analysis (4-0).
Integrated with linear algebra. Functions of several variables, continuous transformations, jacobians, chain rule, implicit function theorem, inverse function theorem, extrema, Lagrange multiplier technique, curvilinear coordinates, convexity, difference equations and generating functions. PREREQUISITES: MA 1118 or equivalent, MA 2042 or equivalent concurrently.

MA 3132 Partial Differential Equations and Integral Transforms (4-0).
Solution of boundary valve problems by separation of variables; Sturm-Liouville problems; Fourier, Bessel and Legendre series solutions, Laplace and Fourier transforms; classification of second order equations; applications. PREREQUISITE: MA 2121 or equivalent.

MA 3139 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. For ASW and EW students. PREREQUISITE: MA 2129.

MA 3185 Tensor Analysis (3-0).
Definition of tensor as linear fuction of vectors, invariant under change of coordinates. Dyadic representation of tensor in arbitrary coordinate systems with covariant or contravariant base vectors. Tensor calculus. Cartesian tensor notation. Tensors used in various applications: stress, rotation, inertia, momentum-flux, metric, Riemann-Christoffel, electromagnetic field, etc. PREREQUISITE: MA 2047 or equivalent concurrently.

MA 3232 Numerical Analysis (4-1)
Solution of nonlinear equations, zeros of polynomials. Interpolation and approximation. Numerical differentiation and quadrature. Matrix manipulations; linear simultaneous, algebraic equations; eigenvalues. Numerical solutions of ordinary differential equations. Analysis for computational errors. PREREQUISITE: MA 2121 or equivalent (may be taken concurrently) and FORTRAN programming.

MA 3243 Numerical Methods for Partial Differential Equations (4-1).
Finite difference approximations for derivatives. Truncation and discretization errors. Parabolic and hyperbolic equations. Explicit and implicit methods. The Crank-Nicolson method. Approximations at irregular boundaries. Elliptic equations, the Liebmann method. Systems of partial differential equations. Students are expected to write FORTRAN programs for the above methods. PREREQUISITES: MA 3132 and FORTRAN programming.

MA 3400 Mathematical Modeling Processes (3-0).
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. PREREQUISITE: MA 1118 or MA 2300 or consent of Instructor.

MA 3560 Modern Applied Algebra (3-0).
An introductory course in the techniques and tools of abstract algebra with special emphasis on applications to coding theory, radar and communications systems and computer science. Elements of set theory, equivalence relations and partitions. Semigroups, groups, subgroups and homomorphisms. Rings, ideals and fields. Directed graphs and lattices. Applications may vary. PREREQUISITE: Consent of Instructor.

MA 3565 Modern Algebra (3-0).
An advanced course in the subject of abstract algebra. Semigroups, groups, subgroups, normal subgroups. Groups acting on sets, operator groups. The Jordan-Holder Theorem, solvable groups. The Krull-Schmidt Theorem. PREREQUISITE: MA 3560 or consent of Instructor.

MA 3605-3606 Fundamentals of Analysis I-II (3-0).
Elements of set theory, the real number system, and the usual topology of En; properties of continuous functions; differential of vector-valued functions, Jacobians, and applications (implicit function, inverse function theorem, extremum problems). Functions of bounded variation and theory of Reimann-Stieltjes integration, multiple and iterated integrals, convergence theorems for sequences and series of functions. PREREQUISITE: Consent of Instructor.

MA 3610 Introduction to General Topology (3-0).
Topologies, bases and subbases, compactness and connectivity. Moore-Smith convergence theorems. Metrization and embedding theorems, uniform structures. Tychonoff product theorem, Alexandroff and Stone Cech compactification. PREREQUISITE: MA 3605 or consent of Instructor.

MA 3675-3676 Theory of Functions of a Complex Variable I-II (3-0).
Selected topics from the thoery of functions of a real variable; complex functions, power series, Laurent series. Singularities of complex functions; residues and contour integration; zeros of analytic functions; factors of an infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. PREREQUISITE: Consent of Instructor.

MA 3730 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 solution of ordinary differential equations. PREREQUISITE: Consent of Instructor.

Graduate Courses

MA 4237 Advanced Topics in Numerical Analysis (Variable credit, usually (4-0)).
The subject matter will vary according to the abilities and interest of those enrolled. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

MA 4362 Orbital Mechanics (3-0).
A review of the two body problem; non-central geopotentials; long-term periodic effects; perturbations. PREREQUISITE: Consent of Instructor.

MA 4391-4392 Numerical Methods for Fluid Dynamics I-II (4-0).
Analytical methods used to study potential, inviscid and viscous flows will be considered in the first quarter. Numerical methods for the solution of the same problems will be exclusively used during the second quarter. PREREQUISITES: MA 2129, MA 3132 or MA 3139.

MA 4393 Topics in Applied Mathematics (3-0).
A selection of topics in applied mathematics. The course content varies. Credit may be granted for taking this course more than granted for taking this course more than once. PREREQUISITE: Consent of Instructor.

MA 4566 Modern Algebra II (3-0).
A continuation of MA 3565. Rings and homomorphism, intregral domains and euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, field extension and Galois theory. PREREQUISITE: MA 3565.

MA 4593 Topics in Algebra (3-0).
A selection of topics in algebra. Content of the course varies. Students will be allowed credit for taking the course more than once. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

MA 4611 Calculus of Variations (3-0).
Euler equation. Weierstrass maximum principle. Legendre condition, numerical procedures for determining solutions, gradient methods, Newton's method, transversality condition. Rayleigh-Ritz method, conjugate points, and applications. PREREQUISITE: MA 2121 (programming experience desirable).

MA 4620 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. PREREQUISITE: Consent of Instructor.

MA 4622-4623 Principles and Techniques of Applied Mathematics I-II (3-0).
Linear operators, generalized functions and Hilbert spaces; solutions of partial differential equations by Green's functions and eigenfunctions; variational techniques and their applications to eigenfunctions; Fredholm and Volterra integral equations; asymptotic methods and perturbations. PREREQUISITE: MA 3132 or equivalent.

MA 4635-4636 Functions of Real Variables I-II (3-0).
Semi-continuous functions, absolutely continuous functions, functions of bounded variation, classical Lebesque measure and integration theory, convergence theorems and Lp spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesque decomposition and product measure; Daniell integrals and integral representation of linear functionals. PREREQUISITE: MA 3606.

MA 4672 Integral Transforms (3-0).
The Laplace, Fourier and Hankel transforms and their inversions; asymptotic behavior. Applications to problems in engineering and physics. PREREQUISITE: Consent of Instructor.

MA 4693 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.

MA 4872 Topics in Calculus of Variations (3-0).
Recent development of the numerical solution of problems in the calculus of variations. Foundations of numerical methods, applications to control problems. Differentials, perturbations, variational equations, adjoint system, condition for optimum. Euler equations, maximum principle of Weierstrass and Pontryagin, the Legendre condition. Methods of solution: special variations, variation of extremals, dynamic programming. Applications in ship routing and missile control. PREREQUISITES: MA 2121 and computer programming or consent of Instructor.

DEPARTMENT OF MECHANICAL ENGINEERING

Anthony Healey, Chairman and Professor (1986)*; PhD, Sheffield University, United Kingdom, 1966.

Giles Cantin, Professor (1960); PhD, University of California, Berkeley, 1968.

Kenneth David Challenger, Associate Professor (1979); PhD, University of Cincinnati, 1973.

Liang-Wey Chang, Assistant Professor (1985); PhD, Purdue University, 1984.

Isaac Elishakoff, Professor (1987); DSc, Moscow Energetics Institute, USSR, 1971.

Stephen J. Hales, Adjunct Research Professor (1985); PhD, University of Illinois, Urbana, 1985.

Yogendra Joshi, Assistant Professor (1986); PhD, University of Pennsylvania, 1984.

Matthew Dennis Kelleher, Professor (1967); PhD, University of Notre Dame, 1966.

Kil-Soo Kim, Adjunct Research Professor (1985); PhD, Standord University, 1984.

Shankar Lal, Adjunct Professor (1985); PhD, California Institute of Technology, Pasadena, 1955.

Chu-Hwa Lee, Adjunct Teaching Professor (1988); PhD, Stanford University, 1987.

Phillip Meredith Ligrani, Associate Professor (1984); PhD, Stanford University, 1980.

Jose Mauro Barros Losz, Adjunct Research Professor (1987); PhD, University of Leeds, United Kingdom, 1983.

Paul James Marto, Distinguished Professor (1965); ScD, Massachusetts Institute of Technology, 1965.

Terry Robert McNelley, Professor (1976); PhD, Stanford University, 1973.

Uri Navon, Adjunct Teaching Professor (1988); PhD, Princeton University, 1967.

Robert Harry Nunn, Professor (1968); PhD, University of California, Davis, 1967.

Arthur Jeffrey Perkins, Professor (1972); PhD, Case Western Reserve University, 1969.

Paul Francis Pucci, Professor (1956); PhD, Stanford University, 1955.

Saeed Saboury, Adjunct Teaching Professor (1988); PhD, Emperial College, London, 1983.

David Salinas, Associate Professor (1970); PhD, University of California, Los Angeles, 1968.

Turgut Sarpkaya, Distinguished Professor (1967); PhD, University of Iowa, 1954.

Young Sik Shin, Associate Professor (1981); PhD, Case Western Reserve University, 1971.

Bart A. Singer, Adjunct Research Professor (1988); PhD, Stanford University, 1987.

David Lee Smith, Associate Professor (1983); PhD, Oklahoma State University, 1979.

Amarawansa Wanniarachchi, Adjunct Professor (1983); PhD, Pennsylvania State University, 1981.

Tadayoshi Yamashita, Adjunct Research Professor (1988); PhD, Hiroshima University, Japan, 1955.

** The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Anthony J. Healey, Professor,
Code 69Hy, Halligan Hall, Room M-4,
(408)646-2586/3462, AV 878-2586/3462.

Associate Chairmen:

Paul F. Pucci, Professor,
Code 69Pc, Halligan Hall, Room 205,
(408) 646-2363, AV 878-2363.

Kenneth D. Challenger, Assoc. Prof.,
Code 69Ch, Spanagel Hall, Room 245,
(408) 646-3036, AV 878-3036.

The Department of Mechanical Engineering provides a strong academic program which spans across the discipline areas of structural mechanics, dynamics and control, materials science and the thermal-fluid sciences. These disciplines are blended together with an 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 minor deficiencies, or who would like to review their undergraduate material, may utilize the NPS Continuing Education Program which offers a variety of courses in the self-study mode. 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. At minimum, the approved curriculum must satisfy the requirements below.

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 10 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.

An acceptable thesis is required for 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 topic must be obtained from the Chairman of the Department of Mechanical Engineering. An advisor will be appointed by the Chairman of the Department of Mechanical Engineering for consultation in the development of a program of research.

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 these 36 hours, at least 20 hours (8 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.

MECHANICAL ENGINEER

A graduate student with a superior academic record may enter a program leading to the degree Mechanical Engineer. A candidate is normally selected after completion of his first year of residence.

The 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 paragraphs below.

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 program must be obtained from the Chairman of the Department of Mechanical Engineering. An advisor will be appointed by the Chairman of the Department of Mechanical Engineering for consultation in the development of a program of research.

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 special strength in the department are hydrodynamics, viscous flows, heat transfer, materials science, dynamics and control, vibrations and finite element analysis.

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 machinery for the investigation of dynamic and static problems in engineering mechanics; a completely equipped materials science laboratory, including a scanning electron microscope, a transmission electron microscope, and an X-ray diffractometer; 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 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.

DEPARTMENTAL COURSE OFFERINGS
MECHANICAL ENGINEERING

ME/MS 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

ME 0951 Seminars (0-1).
Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government and industrial activities.

Lower Division Course

ME 1000 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.

Upper Division Courses

ME 2001 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. Engineering communications, including graphics. This course is intended for students with a non-engineering background. PREREQUISITE: MA 1115 (may be taken concurrently).

ME 2101 Engineering Thermodynamics (4-1).
A comprehensive coverage of the fundamental concepts of classical thermodynamcs, 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 and dissociation. PREREQUISITE: MA 1116. (May be taken through Continuing Education as minicourses ME 2111-15.)

ME 2201 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. Emphasis on naval engineering applications and problem solving. PREREQUISITE: ME 2502.

ME 2301 Introduction to Naval Architecture (2-0).
Introduction to the hydrostatics and hydrodynamics of a monohull vessel. Hull structural strength using simple approximations and common ship building materials. Intact initial transverse and longitudinal stability. Stability at large angles of heel and under special circumstances such as docking and after damage to the hull. Resistance and powering of the hull; determination of effective horsepower. PREREQUISITES: ME 2201 and ME 2601.

ME 2410 Mechanical Engineering Lab (2-3).
Fundamentals of mechanical measurement systems, structure laboratory experments using resistance strain gages, pressure transducers, temperature, flow and velocity measurement devices. PREREQUISITES: ME 2101, ME 2201, and ME 2601, any of which may be taken concurrently.

ME 2440 Modern Methods of Engineering Computation (3-0).
Formulation and solution of engineering problems using modern computers. Introduction to high-level programming languages including FORTRAN and BASIC. Development of computer programs including flowcharting, data transfer, subroutine organization, input and output. Application of programming techniques to the solution of selected problems in Mechanical Engineering. PREREQUISITES: MA 1116, ME 2101, ME 2501 (all may be taken concurrently). ME 2441 must be taken concurrently.

ME 2441 Engineering Computational Laboratory (0-2).
Introduction to the computing facilities at the Naval Postgraduate School with particular emphasis on those unique to the Department of Mechanical Engineering. Familiarization with software available at the Naval Postgraduate School for solution of engineering problems. Various programming exercises. (ME 2440 must be taken concurrently.) Graded on a Pass/Fail basis only.

ME 2501 Statics (3-0).
Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. PREREQUISITE: MA 1116 (may be concurrent); may be taken through Continuing Education as mini-courses ME 2511-13.

ME 2502 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: ME 2501.

ME 2601 Mechanics of Solids (3-2).
Stress, strain, Hooke's law. Elementary stress and deformation analysis for shafts, beams and columns. Supporting laboratory work. PREREQUISITES: ME 2501 and MA 1116.

ME 2801 Introduction to Engineering Dynamics (3-2).
Generalized system modeling principles and reduction to mathematical forms. Analogies between electrical, mechanical, fluid, and thermal systems. Laplace Transform solutions for response of first and second system characteristics, transient and frequency response. Computer simulation for complex system response. Introduction to feedback control concepts. PREREQUISITES: ME 2502 and MA 2121.

Upper Division or Graduate Courses

ME 3150 Heat Transfer (4-2).
Elementary treatment of the principles of Heat Transfer application to problems in Mechanical Engineering. Steady and unsteady conduction. Principles of forced and natural convection. Thermal radiation. Boiling. Condensation. Heat exchanger analysis. Use of the thermal circuit analog numerical and graphical techniques. Selected laboratory experiments. PREREQUISITES: ME 2101, ME 2201, MA 3132 (may be taken concurrently).

ME 3201 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 viscous laminar flow problems. Boundary-layer concepts. PREREQUISITES: ME 2101, ME 2201, MA 3132 (may be taken concurrently).

ME 3220 Steam Power, Refrigeration, and Turbomachinery (3-2).
The conventional Rankine cycle steam plants, 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. Application to pumps, fans, compressors, and turbines. PREREQUISITES: ME 2101 and ME 2201.

ME 3230 Nuclear Power Systems (2-0).
Introduction to atomic and nuclear physics. Fundamentals of nuclear reactor analysis, including nuclear and thermal aspects in core design. Reactor system design and operation. Comparison of principle reactor types emphasizing significant features of marine reactors. Basic health physics considerations and reactor shielding. Basic insight into waste management and reactor safety. PREREQUISITE: MA 3132.

ME 3240 Reciprocating and Gas Turbine Power Plants (3-0).
Thermodynamic analyses and performance characteristics of 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. PREREQUSITIES: ME 2101, ME 2201 (ME 3241 must be taken concurrently).

ME 3241 Power Plants Laboratory (0-3).
Selected experiments demonstrating power plant performance, e.g., diesel engine, and gas turbine engine. (ME 3240 must be taken concurrently.) Graded on Pass/Fail basis only.

ME 3430 Mechanical Engineering Lab II (1-3).
A project-oriented continuation of mechanical measurements systems. Application of measurement techniques using group projects in thermodynamics, mechanics of solids, heat transfer, fluid flow, vibrations and nuclear radiation detection. PREREQUISITES: ME 2410, ME 3150, ME 3521, and ME 3611. Graded on Pass/Fail basis only.

ME 3440 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: ME 2201, ME 2440, ME 2502, and ME 2601.

ME 3521 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: ME 2502, ME 2601, and MA 2401 or equivalent (may be taken concurrently).

ME 3611 Mechanics of Solids (4-0).
Fundamentals of elasticity. Failure theories. Energy methods. Indeterminate structures. Stability of simple structures. Torsion of members with non-circular cross section. Plate behavior. PREREQUISITES: ME 2601 and MA 2401 or equivalent (may be taken concurrently).

ME 3711 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. PREREQUISITES: ME 2410 and ME 2601.

ME 3801 Linear Automatic Control (3-0).
Classical control design for linear systems with single input, single output design requirements. PID control. Transient responce analysis. Root locus and frequency response methods. Control design and compensation techniques. PREREQUISITE: ME 2801.

ME 3802 Controls Laboratory (0-2).
Adjunct laboratory for ME 3801. Must be taken concurrently with ME 3801.

Graduate Courses

ME 4160 Applications of Heat Transfer (4-0).
Application of heat transfer principles to engineering systems. Topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. PREREQUISITE: ME 3150.

ME 4161 Conduction Heat Transfer (4-0).
Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Variational methods. Mechanical Engineering applications. PREREQUISITE: ME 3150.

ME 4162 Convection Heat Transfer (4-0).
Fundamental principles of forced and free convection. Dimensionless correlations. Heat transfer during phase changes. Combined conduction, convection and radiation heat transfer systems. Heat exchanger analysis with Mechanical Engineering applications. PREREQUISITES: ME 3150, ME 4220.

ME 4163 Radiation Heat Transfer (3-0).
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. Combined convection and radiation. Spectral aspects of gases. PREREQUISITE: ME 3150.

ME 4202 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: ME 3201 or equivalent compressible flow coverage.

ME 4211 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: ME 3201.

ME 4214 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. Hydrodynamic aspects of hull, propulsor, and appurtenances. Design tools for estimating hydrodynamic derivatives and their effects on vehicle performance. Selected topics. PREREQUISITE: ME 3201.

ME 4220 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, compressibility effects. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications. PREREQUISITE: ME 3201.

ME 4240 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-steamline analysis of jets, wakes, and cavities. PREREQUISITES: ME 4220 and ME 4211.

ME 4321 Reactor Engineering Principles and Design (4-2).
Reactor heat generation and removal. Thermal hydraulic analysis of light water reactors. Principles of reactor shielding, Materials and safety considerations in reactor design. Group design project. PREREQUISITE: ME 3230 or equivalent.

ME 4420 Marine Gas Turbines (4-0).
Thermodynamic analyses of gas turbine cycles, including airbreathing and closed cycle enginers. 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: ME 3240.

ME 4512 Advanced Dynamics (3-2).
Introduction to the variational principle. Kinematics and kinetics of three-dimensional motion for complex systems utilizing Newton-Euler's method, Lagrange's method, and Kane's method. Computer software implementation and simulation. Applications in robotics emphasizing the dynamic problems of design and control. PREREQUISITE: ME 3521.

ME 4522 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: ME 3521.

ME 4525 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: ME 3521 or equivalent.

ME 4550 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: ME 3521 or equivalent.

ME 4612 Advanced Mechanics of Solids (4-0).
Selected topics from advanced strength of materials, elasticity, and the theory of plates and shells. Applications of finite element codes to the solution of difficult problems. PREREQUISITE: ME 3611.

ME 4613 Finite Element Methods (4-0).
Systematic construction of line, surface, and volume elements for continuous systems. Computer programming, and applications to structural mechanics, heat transfer and fluid flow. PREREQUISITE: ME 3611.

ME 4620 Theory of Continuous Media (4-0).
Tensor analysis. Stress and strain tensors. Motion of a continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. PREREQUISITES: ME 3201 and ME 3611.

ME 4721 Marine Vehicle Design (2-4).
Various categories of marine vehicles are described; this includes single hull, multiple hull, submarine, surface effect, wing-in-ground effect and hydrofoil vehicles. A category of marine vehicle is selected to fulfill a

stated mission. A vehicle configuration and specification of major components which satisfies mission requirements is sought. Consideration is given to all major facets of marine vehicle synthesis including structures, hull forces, propulsion, electronics, armament, crew, etc. PREREQUSITIE: Consent of Instructor.

ME 4722 Marine Engineering Design (2-4).
A major component of a marine vehicle is designed so as to meet stated specifications. Impact of the design features of the major component upon the overall vehicle performance is considered; emphasis is on design tradeoffs. Examples of major components to be designed include complete electrical power generation and distribution systems, steering, superconducting electrical motors for main propulsion, bulbous bow for sonar, armor protection of CIC, etc. PREREQUISITE: Consent of Instructor.

ME 4731 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: ME 3150, ME 3201, ME 3611, ME 2440 and MA 2400, or equivalent.

ME 4801 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 electrohydraulic position and velocity control servomechanisms for high performance with stability. Supporting laboratory experiments. PREREQUISITE: ME 3801.

ME 4802 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: ME 3801, ME 3240 (may be taken concurrently), and MA 3132.

ME 4803 Modern Control Systems (3-2).
Multivariable analysis and control concepts for MIMO systems. State Observers. Linear Optimal Control. Introduction to non-linear systems analysis. Limit cycle behavior. PREREQUISITE: ME 3801.

ME 4902 Advanced Study in Mechanical Engineering (1-0 to 6-0).
Directed advanced study in mechanical engineering on a subject of mutual interest to student and staff member. May be repeated for credit with a different topic. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

MATERIALS SCIENCE

Upper Division Course

MS 2201 Engineering Materials (3-2).
The basic principles of materials science are covered with emphasis on the factors involved in control of the strength and ductility of metallic materials of Naval interest. Atomic and crystal structure are discussed and emphasis is given to microstructural control and microstructure-property relationships. Additional topics include crystalline defects, deformation processes, strengthening mechanisms and heat treatment. The course aims to provide the student with the working vocabulary and conceptual understanding necessary to more advanced study and for communication with materials experts. PREREQUISITE: Undergraduate courses in physics and chemistry and consent of Instructor.

Upper Division or Graduate Courses

MS 3201 Materials Science and Engineering (3-2).
Fundamental principles of materials science are presented with particular emphasis on and advanced coverage of the relationship between microstructure and mechanical properties of engineering materials. The effects of atomic structure, crystal structure and microstructure on properties are presented. Crystalline defects, deformation processes, strengthening mechanisms, fracture, phase equilibria, phase transformations and methods of microstructural control are discussed and practical examples are included. The course aims at providing the engineering student with the vocabulary and conceptual understanding necessary for further study and for communicating on materials engineering topics. PREREQUISITE: Undergraduate course in chemistry and physics.

MS 3202 Failure Analysis and Prevention (3-2).
Properties, problems and failures of structural materials are studied in the context of actual case studies. Topics of interest to Naval, Aero and Weapons engineers are included. For a given case study cause(s) of failure are discussed, and the relevant fundamental knowledge to fully understand the observed phenomena is developed. Failure prevention, materials developments and modern methods of materials analysis are among the many aspects that are of interest. PREREQUISITE: MS 3201 or equivalent or consent of Instructor.

MS 3304 Corrosion and Marine Environmental Degradation (3-2).
Presents the basic chemical, electrochemical mechanical, and metallurgical factors which influence the corrosion, oxidation, and deterioration of materials. Discusses standard methods of corrosion control, such as cathodic protection coatings, cladding, alloy selection, and inhibitors; special problems encountered in unfamiliar environment. PREREQUISITE: MS 2201 or equivalent.

MS 3401 Microscopy (3-2).
Electron microscopy and other sophisticated techniques are emphasized in a coverage of modern methods of microscopic observation. Techniques covered include scanning electron microscopy, transmission electron microscopy, conventional microprobe analysis, field ion microscopy, and polorized light, stereo, interference, phase contrast, and holographic light optical methods. Course and lab will simultaneously cover both theory and practice, including specimen preparation, instrument design and operation and applications. PREREQUISITE: Consent of Instructor.

MS 3505 Materials Selection for Military Applications (4-0).
This course deals in depth with one of the most common and important problems in materials engineering, that of selecting 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 many other situations. 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: MS 2201 or equivalent.

MS 3606 Introduction to Welding and Joining Metallurgy (3-2).
Metallurgical aspects of welding and joining processes; nature of and applications of welding and joining processes; welding and joining of steels, aluminum alloys, stainless steels, heat-resistant alloys and copper-base alloys; inspection and quality assurance of weldments. PREREQUISITE: MS 2201/3201.

Graduate Courses

MS 4215 Phase Transformations (3-2). Structural changes which commonly occur in materials by various mechanisms are considered. Solidification, precipitation, recrystallization, and martensitic transformations are emphasized, both in principle and in regard to t heir technological importance. Principles of nucleation and growth, diffusion and kinetics are presented and their relevance to practical heat treating and fabrication processes are considered. PREREQUISITE: MS 2201 or equivalent.

MS 4302 Special Topics in Materials Science (1-0 to 6-0). Directed advanced study in materials science on a subject of mutual interest to student and staff member. May be repeated for credit with a different topic. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

MS 4312 Advanced Materials (4-0). The course is structured to provide a vehicle for the study of materials pertinent to a specific area of environment utilization or design. Example categories are marine materials, elevated-temperature materials, aircraft alloys materials for energy conversion. Topics discussed may include material failures, materials selection testing, and new concepts in materials engineering. Course scope is decided by mutual agreement of students and Instructor. PREREQUISITES: MS 2201, MS 3202 or equivalent.

MS 4811 Mechanical Behavior of Engineering Materials (4-0). The response of structural materials to mechanical stress is discussed with emphasis on plastic deformation in metals. Topics include mechanisms of high-temperature deformation, fatigue and fracture. New concepts allowing development of materials to circumvent these failure mechanisms are treated. PREREQUISITE: MS 3202 or permission of Instructor.

DEPARTMENT OF METEOROLOGY

Robert J. Renard, Chairman and Professor (1952)*; PhD, Florida State University, 1970.

Chih-Pei Chang, Professor (1972); PhD, University of Washington, 1972.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Philip A. Durkee, Assistant Professor (1984); PhD, University of Minnesota, 1984.

William D. Duthie, Distinguished Professor Emeritus (1945); PhD, Princeton University, 1940.

Kristine C. Harper, Lieutenant Commander, U.S. Navy, Instructor (1986); MS, Naval Postgraduate School, 1985.

Russell L. Elsberry, Professor (1968); PhD, Colorado State University, 1968.

George J. Haltiner, Distinguished Professor Emeritus (1946); PhD, University of Wisconsin, 1948.

Robert L. Haney, Professor (1970); PhD, University of California at Los Angeles, 1971.

Frank L. Martin, Professor Emeritus (1947); PhD, University of Chicago, 1941.

Wendell A. Nuss, Adjunct Professor (1986); PhD, University of Washington, 1986.

William J. Shaw, Assistant Professor (1983); PhD, University of Washington, 1982.

Willem van der Bijl, Associate Professor (1961); PhD, State University, Utrecht, 1952.

Carlyle H. Wash, Associate Professor (1980); PhD, University of Wisconsin, 1978.

Forrest R. Williams, Adjunct Professor (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 Postgraduate School Faculty/Staff is indicated in parentheses.*

Chairman:

Robert J. Renard, Professor,
Code 63Rd, Root Hall, Room 252,
(408) 646-2516, AV 878-2516.

Associate Chairmen:

Research:

Carlyle H. Wash, Assoc. Prof.,
Code Wx, Root Hall, Room 249,
(408) 646-2295, AV 878-2295.

Curricular Matters:

Robert L. Haney, Professor,
Code 53Hy, Root Hall, Room 245,
(408) 646-2308, AV 878-2308.

The Department of Meteorology is one of six Departments in the Science and Engineering Division, and its 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 its supports separate Master of Science Degree programs in Meteorology, Meteorology and Oceanography, and Oceanography and also provides courses for the Space, Antisubmarine Warfare, Electronic Warfare and C3 Curricula.

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 meterology, including analysis and prediction in tropical, middle latitude and polar regions in both hemispheres. Forty courses are offered in Meteorology, primarily at the graduate level. The Department has fourteen teaching faculty, and four adjunct research faculty who are active researchers, 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 numerical weather prediction, tropical meteorology, including monsoon circulations and tropical cyclone forecasting, 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., model output statistics, regional studies, maritime cyclogensis, short range forecasting, numerical-model output verification).

Both Visiting Scientist and Navy-sponsored Research Chair programs are an integral part of the Department's operation. The Ph.D. program in the Department is active with Navy and Air Force officers. DoD civilians and internationals 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 of Master of Science in Meteorology requires completion of:

a. Mathematics courses in vector analysis, partial differential equations, and application of numerical methods and computers to the solution of differential equations.

b. A basic course in applied probability and statistics.

c. The basic sequence of graduate courses in the fields of dynamical, physical and synoptic meteorology which must include eighteen quarter hours in the 4000 series.

d. An acceptable thesis.

Master of Science in Meteorology and Oceanography

Direct entrance to a program leading to the degree Master of Science in Meteorology and Oceanography requires a baccalaureate degree, preferably in physical sciences, mathematics or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, chemistry, 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 Oceanography requires:

a. Completion of forty-eight quarter hours in meteorology and oceanography, to include at least twenty hours in the 4000 series, with a minimum of one 4000-level course in other than directed study.

b. The basic sequence of graduate courses in the fields of dynamical, physical and synoptic meteorology/oceanography must be included in the forty-eight hours.

c. Completion of an acceptable thesis on a topic approved by either department.

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 a minor field. The minor field is usually in oceanography, mathematics or physics.

The required examinations are described in this catalog in the section Requirements for the Doctor's Degree. 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

In addition to the standard synoptic laboratories, NPS meteorological facilities include the Joint Meteorology/ Oceanography Interactive Digital Environmental Analysis Laboratory, which provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology programs. The laboratory consists of 12 image analysis and graphics workstations hosted by three VAX computers with two tape drives and greater than one gegabyte of disc storage. The Department has a variety of instruments for observing the atmosphere, and equipment for receiving weather analyses and forecasts emanating from the National Weather Service, including the DIFAX facsimile network system, the COMEDS link to the Automated Weather Network and a RADAC Weather Radar Receiver, a real-time link to the nationwide weather radar network. Additional information is received from Fleet Numerical Oceanography Center via the Naval Environmental Display System (NEDS). Weather satellite data are received on a UNIFAX recorder via GOESTAP and displayed in animated form by the Digital Weather Image Processing System. Rawinsonde equipment, acoustic sounders and micrometeorologically instrumented masts, and an NSF-owned Research Vessel operated by the Moss Landing Marine Laboratory, are utilized by faculty and students in the meteorology and oceanography programs. A Doppler-radar wind profiler and an instrument calibration facility are to be installed in 1988. Supplementing the School's extensive computer facilities, discussed in the General Information section of this Catalog, the Department also maintains its own Computer Facility to support faculty and staff research, and student thesis/ dissertation projects. Equipment includes a number of networked microcomputers, data and graphics terminals, plotters and printers.

DEPARTMENTAL COURSE OFFERINGS

MR 0110-11-12-13 Applications Seminars (1-0).
Presentation of DoD related research activities, applications to weapons and warfare systems, utilization of oceanography and meteorology in specific billets, presentations by faculty, staff, selected students and visiting authorities. MR 0110 is for orientation; MR 0111 is for intermediate students; MR 0112/0113 is for thesis orientation/ topic selection. PREREQUISITE: Enrollment in an Air-Ocean Science curriculum.

MR 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

MR 0999 Seminar in Meteorology (2-0).
Students present results of thesis or other approved research investigation. PREREQUISITE: Concurrent preparation of thesis or other acceptable research paper.

Upper Division Courses

MR 2020 Computer Computations in Air-Ocean Sciences (1-2).
Introduction to FORTRAN and the NPS mainframe computer as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

MR 2200 Introduction to Meteorology (4-0).
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, severe storms, solar and terrestrial radiation, general circulation and weather forecasting. PREREQUISITE: Department approval (may be taken through Continuing Education as minicourses MR 2201-02).

MR 2210 Introduction to Meteorology/ Laboratory (4-2).
Same course as MR 2200 plus laboratory periods illustrating lecture material, including weather map analysis over oceanic areas using satellite imagery. PREREQUISITE: Departmental approval.

MR 2220 Marine Meteorology (4-1).
An introductory course covering forces and related small- and large-scale atmospheric motions and their interaction with the ocean, severe rotating storms, fronts, general circulation and radiation, atmospheric stability, observation techniques, synoptic charts over marine regions, basics of remote sensing and satellite imagery interpretation, forecasting, climates over the ocean, and sea ice and icebergs. Laboratory exercises illustrate lecture material. PREREQUISITE: Departmental approval.

MR 2262 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: MR 3222, MR 3230 or consent of Instructor.

MR 2300 Observations, Instruments and Climatology (3-2).
Surface and upper-air observations, including rawinsondes. Instruments used in synoptic observations. Climate classifications, changes and controls; basic statistical quantities used in climatology; applications to world climates. PREREQUISITE: Introductory Meterology course (may be taken concurrently).

MR 2413 Meteorology for Antisubmarine Warfare (3-1).
Atmospheric factors affecting the fluxes of momentum, heat and moisture across the air-sea interface; local and synoptic-scale atmospheric features relevant to electromagnetic and electro-optical wave propagations; hands-on experience with existing environmental effects assessment models. PREREQUISITE: Differential and integral calculus (may be taken concurrently).

MR 2416 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. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. PREREQUISITES: Calculus, Computer Programming, Electromagnetic Theory (may be taken concurrently).

MR 2419 Atmospheric Factors in C3 (2-0).
A survey of atmospheric properties and processes affecting propagation of electromagnetic (EM) and electro-optical (EO) waves. Tropospheric phenomena associated with standard anomalous EM wave propagation at wavelengths greater than 10 meters. Ionospheric phenomena associated with longer wavelength (Hf) propagation. PREREQUISITE: Enrollment in C3 curriculum.

MR 2520 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.

Upper Division or Graduate Courses

MR 3140 Probability and Statistics for Air-Ocean Sciences(3-2).
Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussion distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variable. 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.

MR 3150 Analysis of Air-Ocean Time Series (3-2).
Analysis methods for atmospheric and oceanic time series. Correlation, spectrum and empirical orthogonal function analysis. Statistical objective analysis. Optimal design of air-ocean data networks. PREREQUISITES: MA 2121 and a probability and statistics course.

MR 3212 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. Aspects of geology and geophysics. PREREQUISITES: OC 3240, MR 3222 or consent of Instructor.

MR 3220 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 surface and vertical cross-section analysis. Introduction to analysis in the high troposphere and low stratosphere. PREREQUISITES: MR 3420, MR/OC 3321.

MR 3222 Meteorological Analysis/ Laboratory (4-3).
Same as MR 3220 plus laboratory sessions on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposhere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analyses. PREREQUISITES: MR 3420, MR/OC 3321.

MR 3230 Tropospheric and Stratospheric Meteorology (4-0).
An analytic and synoptic interpretation of tropospheric and stratospheric systems with emphasis on the middle and high altitude aspects of extra-tropical cyclones, jet streams and fronts, and related dynamical properties. PREREQUISITE: MR 3222 (may be concurrent).

MR 3234 Tropospheric and Stratospheric Meteorology/Laboratory (4-3).
Same as MR 3230, plus laboratory sessions emphasizing 4-dimensional interrelationships in the troposphere and lower stratosphere. PREREQUISITES: Enrollment in Operational Oceanography Curriculum or consent of Chairman; MR 3222.

MR 3235 Tropospheric and Stratospheric Meteorology Laboratory (0-7).
Practice in 4-dimensional synoptic-scale analysis of variables considered in MR 3230. Emphasis is on a physical understanding of dynamical relationships, including vorticity, divergence and vertical velocity. PREREQUISITES: MR 3222, MR 3230 (may be concurrent).

MR 3240 Radar Meteorology (3-0).
Principles of radar meteorology. Topics covered include radar systems, meteorological radar equations, doppler radar basics, propagation, attenuation precipitation and velocity estimation, and characteristic echoes. PREREQUISITES: MR 3222 and MR 3522.

MR 3250 Tropical Meteorology (3-0).
Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, and the intertropical convergence zone; structure, development and motion of tropical cyclones

and monsoon circulations, with emphasis on analysis and energetics. PREREQUISITES: MR 4322; MR3230; MR 3234 or MR 3235 (may be concurrent).

MR 3252 Tropical Meteorology/Laboratory (3-4).
Same as MR 3250 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 are 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: MR 4322; MR 3230; MR 3234 or MR 3235 (may be concurrent).

MR 3254 Tropical Meteorology/Laboratory (3-2).
Same as MR 3250, plus laboratory sessions stressing tropical general circulation, satellite interpretation and tropical cyclone structure. Tropical summary briefs and track forecasting exercises provide an understanding of the tropical cyclone warning system and the uses of various dynamical, climatological and statistical forecast models. PREREQUISITES: Enrollment in Operational Oceanography Curriculum or consent of Chairman; MR 4322, either MR 3230 and MR 3235 (may be concurrent) or MR 3234 (may be concurrent).

MR 3260 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: MR 3230, MR/OC 4323 or consent of Instructor.

MR 3262 Operational Atmospheric Prediction/Laboratory (3-3).
Same as MR 3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations and National Meteorological Center and Fleet Numerical Oceanography Center products. PREREQUISITES: MR 3230, MR/OC 4323 or consent of Instructor.

MR/OC 3270 Weather, Wave and Surf Forecasting (4-0).
Theory and prediction of weather patterns and elements, and wind-generated ocean waves. Preparation, interpretation and use of subjective and objective meteorological forecast products, and application to real-time weather situations. Spectral transformation of ocean waves from deep to shallow water. Prediction of surf and wave influences on operations. PREREQUISITES: MR/OC 3150, OC 4211, MR 3230, MR/OC 4323 or consent of Instructor.

MR/OC 3272 Weather, Wave and Surf Forecasting Laboratory (4-4).
Same as MR/OC 3270 plus laboratory sessions on the application of lecture material. Also, practice in air/ocean briefing, to include diagnosis and forecasting of current weather and wave/surf situations using atmosphere/ocean satellite observations, and National Meteorological Center and Fleet Numerical Oceanography Center products. PREREQUISITES: MR/OC 3150; OC 4211; MR 3230; MR/OC 4323 or consent of Instructor.

MR 3321 Air-Ocean Fluid Dynamics (4-0).
The hydrodynamical equations for a rotating stratified fluid, forces, kinematics, boundary conditions, scale analysis. Simple balanced flows; baroclinicity, thermal wind; vorticity and divergence: rotational and divergent part of the wind; circulation theorem. Vorticity and potential vorticity. PREREQUISITE: MA 2047.

MR 3420 Atmospheric Thermodynamics (3-0).
The physical variables; properties of gases, water and moist air; equations of state and the laws of thermodynamics applied to the atmosphere; adiabat-

ic processes and potential temperature; meteorological thermodynamic diagrams; geopotential and hydrostatic equilibrium, vertical motion in the atmosphere, stability criteria and condensation levels. PREREQUISITE: MA 1116 or equivalent (may be taken through Continuing Education as mini-course, MR 3418-19).

MR 3421 Cloud Physics (3-0).
Basic principles of cloud and precipitation physics and application to weather modification. Selected topics in atmospheric pollution. PREREQUISITE: MR 3420.

MR 3445 Oceanic and Atmospheric Observational Systems (2-2).
Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC 3230, MR 3420, MR/OC 3150 or consent of Instructor.

MR 3520 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, ordinarly differential equations or consent of Instructor.

MR 3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (4-2).
Same as MR 3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as MR 3520.

MR 3540 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: MR 3420, MR 3520 or MR 3522.

MR 3570 Operational Oceanography and Meteorology (2-4).
Experience at sea in conducting oceanographic, meteorological, acoustical and other observations and analysis. Integration with in situ data and on-scene-prediction. Includes pre-cruise planning, real-time operational product interpretation and post-cruise analysis. PREREQUISITES: MR 3222, MR/OC 3522; MR 4416, OC 4267 and OC 4331 (may be concurrent).

Graduate Courses

MR 4241 Mesoscale Meteorology (3-0).
Descriptive and physical understanding of subsynoptic-scale weather systems 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: MR 3230; MR/OC 4323, or MR 4322 with consent of Instructor.

MR 4242 Advanced Tropical Meteorology (3-0).
Theories and observations of equatorial waves and oscillations; energy sources and instabilities; boundary layer and cumulus convection parameterization; monsoon circulations and their interactions with other systems. Tropical cyclone models and forecasting; selected topics in diagnostic and theoretical studies of tropical flows. PREREQUISITE: MR 3250 and consent of Instructor.

MR 4250 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: MR 4322 and consent of Instructor.

MR 4322 Dynamic Meteorology (4-0).
Pressure coordinates, scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. PREREQUISITES: MR 3420, MR/OC 3321, MA 2047, MA 2121 or equivalent.

MR 4323 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: MR 4322, OC 4211, MA 3132; MA 3232 desirable.

MR 4324 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. PREREQUISITE: MR/OC 4323 or consent of Instructor.

MR 4331 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.

MR 4332 Advanced Geophysical Fluid Dynamics II (3-0).
Energetics of unstable disturbances; frontogenesis; boundary layer analysis with application to the Ekman layer and to the frictional and the nonlinear ocean boundary currents; finite amplitude baroclinic waves. PREREQUISITE: consent of Instructor.

MR 4413 Air/Sea Interaction (4-0).
Fundamental concepts in turbulence. The atmospheric planetary bounday layer, including surface layer and bulk formulae for estimating air-sea fluxes. The oceanic planetory boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. PREREQUISITE: OC 3240 or MR 4322 (may be concurrent), or consent of Instructor.

MR 4414 Advanced Air/Sea Interaction (3-0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC 4413 or consent of Instructor.

MR 4415 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 a turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra; Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. PREREQUISITES: MR/OC 3321; MR/OC 3150 or consent of Instructor.

MR 4416 Atmospheric Factors in Electromagnetic and Optical Propagation (4-0).
Principles of microwave and optical wave propagation in the atmosphere. Effects of atmosphere on propagation; refraction, scattering, attenuation, ducting, etc. PREREQUISITE: MR/OC 4413 (may be concurrent).

MR 4520 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/OC 3522.

MR 4800 Advanced Topics in Meteorology (1-0 to 4-0).
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.

MR 4900 Special Topics in Meteorology (1-0 to 4-0).
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

James John Tritten, Commander, U.S. Navy, Chairman and Assistant Professor (1986)*; PhD, University of Southern California, 1984.

Donald Abenheim, Assistant Professor (1985); PhD, Stanford University, 1985.

John William Amos, II, Associate Professor (1970); PhD, University of California at Berkeley, 1972.

Loftur L. Bjarnason, Professor Emeritus (1958); PhD, Stanford University, 1951.

Sherman Wesley Blandin, Jr., Professor Emeritus (1968); PhD, University of Santa Clara, 1977.

Thomas C. Bruneau, Professor (1987); PhD, University of California at Berkeley, 1970.

David P. Burke, Adjunct Professor (1976); PhD, Harvard University, 1975.

Claude A. Buss, Adjunct Professor (1976); PhD, University of Pennsylvania, 1927.

Ralph Norman Channell, Adjunct Professor (1987); MA, Boston University, 1964.

Brian Dailey, Adjunct Professor (1985); PhD, University of Southern California, 1987.

Richard L. Forney, Lieutenant Colonel, U.S. Air Force, Instructor (1984); MBA, Florida State University, 1972.

Stephen Garrett, Adjunct Professor (1980); PhD, University of Virginia, 1968.

Thomas B. Grassey, Adjunct Professor (1987); PhD, University of Chicago, 1983.

Boyd Francis Huff, Professor Emertus (1958); PhD, University of California, Berkeley, 1955.

Harlan Jencks, Adjunct Professor (1982); PhD, University of Washington, 1978.

Kerry M. Kartchner, Assistant Professor (1984); PhD, University of Southern California, 1987.

Edward John Laurance, Associate Professor (1972); PhD, University of Pennsylvania, 1973.

Robert Edward Looney, Professor (1979); PhD, University of California at Davis, 1969.

Ralph Harry Magnus, Associate Chairman and Associate Professor (1976); PhD, University of California at Berkeley, 1971.

James L. Malone, Adjunct Professor (1987); JD, Stanford Law School, 1959.

Edward Allan Olsen, Associate Chairman and Associate Professor (1980); PhD, The American University, 1974.

Patrick Johnston Parker, Professor (1974); MBA, University of Chicago, 1955.

Kamil T. Said, Adjunct Professor (1975); MA, San Jose State College, 1967.

Joseph Sternberg, Professor (1985); PhD, Johns Hopkins University, 1955.

Russel Henry Stolfi, Professor (1966); PhD, Stanford University, 1966.

Frank Michael Teti, Associate Professor (1966); PhD, Syracuse University, 1966.

Mikhail Tsypkin, Assistant Professor (1987); PhD, Harvard University, 1985.

David Winterford, Adjunct Professor (1983); PhD, University of British Columbia, 1979.

David Scott Yost, Associate Professor (1979); PhD, University of Southern California, 1976.

* *The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

James John Tritten, CDR, USN,
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Associate Chairmen:

Administration:
Ralph H. Magnus, Assoc. Prof.,
Code 56Mk, Root Hall, Room 201C,
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Edward A. Olsen, Assoc. Prof.,
Code 56Os, Root Hall, Room 201J,
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The Department of National Security Affairs offers programs of study in three major fields, supporting eight different curricula. The three major fields encompass Geographic Area Studies, Strategic Planning and Intelligence. The area studies are subdivided into five groups as follows:

Middle East, Africa and South Asia
Far East, Southeast Asia and the Pacific
Europe and USSR
Western Hemisphere
International Organizations and Negotiations

Individual programs in the Area Studies focus on one of the subregions listed or contain a blend of all subregions in the area. The Area Studies program may include a program of study in a language of the area at the Defense Language Institute, located in Monterey.

The field of Strategic Planning includes both general and nuclear strategic planning. Individual programs focus on the evolutionary history of the planning process, strategies for national security, naval and maritime strategy, and management and planning systems.

The Intelligence Curriculum 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. Approximately half of the coursework in this technical (non-engineering) curriculum is undertaken in Naval Postgraduate School academic departments under the Dean of Science and Engineering; the remaining courses are in the information and policy sciences.

Coursework addresses three broad fields: defense technology, analysis and management, and national security affairs. The defense technology courses are designed to address the special problems of technical intelligence, 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 problems.

The analysis and management coursework 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 reliability, and communicate the significance of the results obtained.

Graduate courses in National Security Affairs outline the interface between 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: Completion of graduate courses in the geographic area of specialization, including a 4000 level course.

b. Functional Specialization: Completion of graduate courses in either Strategic Planning or International Organizations and Negotiations, including a 4000 level course.

3. Successful completion of departmental comprehensive examination or completion of an acceptable thesis.

4. Language proficiency, when applicable, for geographic area specialization.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF SCIENCE IN NATIONAL SECURITY AFFAIRS

The degree Master of Science in National Security Affairs will be awarded upon the completion of an interdisciplinary program carried out in accordance with the following degree requirements:

a. A minimum of 45 quarter hours of graduate level work of which at least 12 hours must represent courses at the 4000 level. Graduate courses in at least three different academic disciplines must be included, and in two disciplines a course at the 4000 level must be included.

b. In addition to the 45 hours of course credit, an acceptable thesis must be completed.

c. The program must be approved by the Chairman of the Department of National Security Affairs.

DEPARTMENTAL COURSE OFFERINGS

NS 0010 Seminar for Intelligence Students (0-0).
Guest lectures, presentation of student theses/research, meetings with Academic Associate, Curricular Officer, Chairman.

NS 0012 Introduction to the NPS Computer System for Intelligence (1-1).
A six week course designed to introduce incoming intelligence officers in selected basic concepts of computers in general and the system available at NPS in particular. Twelve class/laboratory periods are presented during the refresher course prior to Spring and Fall quarters. Use of the NPS computer system with special emphasis on intelligence curriculum-related functions is presented and practiced by entering students. Practical exercises using the IBM 3278 terminal are executed to explore the capabilities of the available computer resources.

NS 0020 Seminar for Strategic Planning/IO&N Students (0-0).
Guest Lectures, presentation of student theses/research, meeting with Academic Associate, Curricular Officer, Chairman.

NS 0030 Seminar for Area Studies Students (0-0).
Guest lectures, presentation of student theses/research, meetings with Academic Associate, Curricular Officer, Chairman.

NS 0040 Seminar for NSA Students (0-0).
Guest lectures, presentation of student theses/research, meetings with faculty and Chairman.

NS 0042 Introduction to Student Micro Computer Utilization (2-2).
A special 3-week course for entering students who have access to Zenith micro computers. Twenty-four hours of instruction and twenty-four hours of laboratories are given prior to the summer session. Use of the NPS mainframe computer system is presented with special emphasis on NSA-related functions. The use of the micro computer and its interface to the NPS mainframe computer is taught and practiced in the laboratory periods. Micro software packages included in the course are: operating systems, word processors, data base management, and spreadsheets.

NS 0810 Thesis Research (0-0).
Students conducting thesis research will enroll in this course.

NS 0811 Preparation for Comprehensive Examination (0-0).
Students preparing for comprehensive examinations will enroll in this course.

Lower Division Courses

NS 1500 American Life and Institutions (3-0).
American political institutions and the political, social, economic, and cultural aspects of American Life. OPEN TO ALLIED OFFICERS. Graded on Pass/Fail basis only.

NS 2000 Military History: War in the Modern World (3-0).
Study of the history of war primarily since 1815. Course emphasizes the connection among battles, strategic doctrine, and political objectives. Students have the opportunity to extract the lessons of modern war fighting and the political situations associated with war. Course prepares students to recognize and use historical analogy and to gain more effective understanding of contemporary military and maritime strategy by being able to apply the lessons of history to it.

NS 2154 Intelligence and the Military (4-0).
An overview of the intelligence structure and a survey of the intelligence process focusing on the application of intelligence to the military mission. The organization and functions of the various elements of the intelligence community are presented. Primary emphasis is placed on the use of intelligence by military decision-makers. Included are overviews of systems supporting the collection, production and dissemination of intelligence. The course is intended for the non-intelligence specialist and is available to any student wishing to learn about the intelligence community and its ability to provide support to the military.

Upper Division or Graduate Courses

NS 3000 Military History: War in the Modern World (4-0).
Study of the history of war since 1815. Course emphasizes the connection between the events of war, strategy and policy in the international systems of states. The class compares the military experience of the leading world powers, seeking to demonstrate how war has become total in the modern age. The different national experiences with policy, strategy, operations and tactics form the central focus of the course. Students are expected to prepare an individual project on a selected problem of the history of war for presentation to the class.

NS 3010 Comparative Analysis and Research Methods (4-0).
An analytical and comparative study of the form and functioning of the major types of contemporary governments, with emphasis on the policy-making process and research methods. Graded on Pass/Fail basis only.

NS 3020 Analysis of International Relations (4-0).
A theoretical systematic analysis of international relations and a study of factors, organizational strategies, and techniques of international politics to include a segment on cross-national security assistance and arms transfers.

NS 3021 The Role of the Superpowers in the Third World (4-0).
An analysis of evolving bi-polar influences on the role of the United States, Soviet Union, Great Britain, Japan, and emerging nations politico-military and economic systems in the Third World. PREREQUISITE: NS 3040.

NS 3030 American National Security Policy/Defense Organization (4-0).
An institutional and functional analysis of the national and international factors which shape the U.S. defense policy. Attention in the course 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; 2) the problems of strategic choice, including security assistance, threat analysis, net assessment, deterrence theory, and limited war.

NS 3040 The Politics of Global Economic Relations (4-0).
An integrated analysis on the economic and political factors that together determine national and international economic arrangements. The student first addresses the general principles of public finance as a rereq-uisite for the analysis of budgets and policy priorities in specific ountries and areas. The remainder of the course is concerned with the changing world economic order including issues such as trade, aid, cross-national security assistance, multi-national corporations technology and strategic resources.

NS 3050 Maritime Strategy (4-0).
A policy-oriented analysis of the maritime and naval components of our national military strategy. Introduces to the student the relationship of war at sea and other uses of the sea to what happens ashore. Introduces the student to the use of maritime assets for political gain and the impact of technology on maritime roles, missions, and capabilities. Students are expected to prepare an individual project for presentation to the class. PREREQUISITE: NS 3000 or permission of Instructor.

NS 3150 Intelligence Data Analysis and Research Methods (4-2).
A survey of methods and techniques for synthesis, analysis, interpretation, and reporting of data. Topics include sampling methods, content analysis, data handling and processing, scaling techniques, and parametric and non-parametric tests, with emphasis on application to intelligence. PREREQUISITES: OS 3101, MA 2311 or equivalent. TOP SECRET Clearance with eligibility for SPECIAL INTELLIGENCE information.

NS 3151 Intelligence Systems and Products (4.0).
This course is intended for students in the command and control program. It provides an introduction to intelligence systems and products which support command decision-making, an overview of Soviet command and control concepts and practices required for an appreciation of the significance of intelligence reporting, an insight into intelligence procedures to provide perspective for operational security planning, and material on Soviet intelligence organizations and capabilities. PREREQUISITES: TOP SECRET clearance with eligibility for SI/SAO, U.S. Citizenship, SPECIAL INTELLIGENCE information.

NS 3152 Naval Warfare and the Threat Environment (4-0).
This course supports NPS warfare curricula. It concentrates on the threat posed by Soviet naval warfare forces to successful accomplishment of the U.S. Navy's missions. Issues include: U.S. missions in conflict situations; U.S. intelligence and analysis of the Soviet threat; the politico-military and strategic contexts underlying the use of Soviet naval and other forces for maritime warfare; current status and trends in Soviet naval warfare capabilities; continuities and changes in the missions and operations of Soviet naval and related forces; trends in the superpower naval warfare balance. Secret Clearance is required.

NS 3230 Strategic Planning and U.S. National Security Policy (4-0).
The focus of this course will be on long term strategic planning and will include such topics as: Strategic Goal Analysis, national and transnational power assessment, analysis of the decision-making and administrative processes at the national level, indigenous constraints on the policy process, forecasting and future research techniques and the application of the concepts of strategic planning to the national defense effort. PREREQUISITE: NS 3030.

NS 3250 Defense Resources Allocation (4-1).
A presentation of the concepts, principles and methods of defense resources allocation as they pertain to planning, programming, budgeting and related activities. Emphasis is placed on the analytical aspects of decision-making drawn from the disciplines of management theory, economics and quantitative analysis. The laboratory sessions include problems and case studies in which the concepts and methods are applied to illustrative situations. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

NS 3251 The History of Maritime Strategy (4-0).
The concentration of this course is on historical cases of maritime versus continental pwers and the conflict between the U.S. and the USSR with respect to maritime forces, geography and political interests. It complements the operational ideas of navies presented in NS 2050 or 3050.

NS 3263 Strategic Planning for Southwest Asia (4-0).
Examination of the political and military factors necessary for consideration in the development of a successful Western Strategy for the defense of Asia.

NS 3279 Directed Studies in National Security Affairs (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS 3280 Nuclear Weapons and Foreign Policy (4-0).
An interdisciplinary course which covers both the technology and political influences of nuclear weapons systems with the foreign policies of the major powers and the political blocs from 1945 to present.

NS 3300 Foundation of Middle Eastern Politics: People, Societies, Cultures and Religions (4-0).
An intensive course in Middle Eastern history from the viewpoint of geographical and military factors which have shaped the course of events in the area. The geographic (including oceanographic) environment cal (including oceanographic) environment within which military campaigns have been conducted, which continues to present military problems, is examined. Indigenous and foreign techniques and tactics for dealing with this environment, as well as the historical development of Middle Eastern military organizations are studied.

NS 3310 Problems of Government and Security in the Middle East (4-0).
An introductory course in Middle Eastern society and politics designed to provide the maximum background area knowledge to be utilized in follow-on courses in Middle Eastern politics.

NS 3330 United States Interests and Policies in the Middle East (4-0).
This course offers an analysis of the historical backgrounds and the current status of United States cultural, economic, political and strategic interests in the Middle East. It traces the changing definitions of these interests over time and the alternative policies which have been adopted in order to secure them. The relationship of these policies to broader aspects of United States foreign policy is discussed along with the impact of the policy-making process upon the substance of policies.

NS 3341 Seminar on Middle East Oil (4-0).
An examination of the oil resources of the Middle East for their impact upon the internal, regional and international oil companies, consuming states, and organiza-

tions of exporting countries is studied. Difference in oil resources and revenues are examined and related to different developmental and international policies. The post and future use of oil as a political weapon is discussed and evaluated. The use of revenues from oil is examined for its impact on levels of development and the regional military balance.

NS 3350 The Middle East: The Military Dimension (4-0).
An examination of the political, sociological, cultural and strategic roles of the military in Middle Eastern history and politics. Among the topics considered are: traditional military patterns, military recruitment, organization doctrine, and learning experiences.

NS 3360 North Africa: Problems of Government and Security in the Maghreb (4-0).
This course is designed to extend the student's knowledge of selected North African and Red Sea littoral countries, and to provide some insight into the security problems presented by their domestic politics. In addition, some coverage of central African countries will be included.

NS 3361 Problems of Government and Security in Israel (4-0).
Israeli cultural, social, and political patterns: Hebraic traditions, Zionism and the creation of Israel, institutional and sociological frameworks for Israeli politics, elite recruitment, perceptions and strategic orientations, security issues in Israeli domestic and foreign policy. PREREQUISITES: NS 3310 or NS 3301, or their equivalent.

NS 3362 Problems of Government and Security in the Northern Tier: Turkey, Iran, Afghanistan, Pakistan (4-0).
An examination of internal and external political, economic, and social forces in the major non-Arab Middle Eastern states as reflected in their internal development and international polocies. Cooperation and conflict in the behavior of these nations toward each other will be explored in the context of their recent efforts at regional cooperation and regional organization (the Sadabad Pact, Cento, and ACD). Examination of their relationships to the major outside powers interested in the area, i.e., the U.S. and the Soviet Union. Their relationships both as individual states and as subregion with the Arab states of the Middle East. PREREQUISITES: NS 3310 and NS 3320.

NS 3379 Directed Studies: Middle East (Credit Open).
Format and content vary by student and professor agreement. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS 3400 Domestics Context of Soviet National Security Policy (4-0).
An examination of the role of domestic factors shaping Soviet international conduct, including historical influences, ideology, political and economic systems, nationalities and political culture.

NS 3410 Soviet National Security (4-0).
A follow up course to NS 3400. Examination of the evolution of Soviet national security policy. Introductory part of the course deals with pre-World War II roots of Soviet national security policy and evolution of Soviet national security decision-making. The main part of the course deals with Soviet national security policy from the end of World War II to the present, with special emphasis on US-Soviet relations, relations between the USSR and China, and Soviet use of force in Eastern Europe and the Third World (Middle East, Angola, Ethiopia, Afghanistan). PREREQUISITE: NS 3400 or consent of Instructor.

NS 3450 Soviet Military Strategy (4-0).
Examination of international and external factors conditioning Soviet military doctrine and strategy and their development through Stalin, Khruschev and Brezhnev eras and beyond. Emphasis is on contemporary Soviet strategic concepts and strategy: surprise and deception, war-fighting capabilities, external role of the Soviet armed forces, strategy for nuclear war, Warsaw Treaty Organization strategy, and Soviet naval strategy in the Third World.

NS 3452 The Navy in Soviet Strategy (4-0).
Examination of the roles played by the Soviet Navy, Merchant Marine, fishing fleet, and Oceanological establishment in securing the objectives of the Soviet Government. Topics include: geographic factors affecting Soviet ocean strategies; non-naval strategy trends; international and domestic factors affecting post-1953 naval strategy, development of Soviet naval warfare capabilities; doctrinal and functional analysis of post-1953 trends in naval strategy; command structure; personnel training; law of the sea positions; U.S.-Soviet naval interaction. PREREQUISITES: NS 3450 or permission of Instructor and SECRET clearance.

NS 3460 Problems of Government and Security in Eastern Europe (4-0).
This course analyzes the political economic, national security and international affairs of the communist-ruled states of Europe other than the Soviet Union.

NS 3479 Directed Studies: Soviet Union (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the professor, papers and/or examinations.

NS 3500 Perspectives on American Civilization (4-0).
This course, especially designed for the foreign area studies (attache) program, is an interdisciplinary study of American culture, involving the political economic, social, philosophical and literary development of the Nation from 1789 to the present.

NS 3501 History and Culture of Latin America (4-0).
Identifies those aspects of the heritage most relevant to understanding contemporary conditions in 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 which reoriented the region toward Northwestern Europe and the United States.

NS 3510 Problems of Government and Security in Latin America (4-0).
Considers the nature of political legitimacy in Latin America. Comparative studies indicate the relative role of revolutionary movements, constitutionalism and economic output as sources of social cohesion. Major political factors such as technocrats, organized labor, the church, political parties and the military are studied in reference to how they respond to demand for radical change. Critical analysis of government capacity to meet challenges indicates the degree to which countries in the region face a significant likelihood of instability stemming from internal and/or external sources. Specific countries are given attention based on the future assignments of the students.

NS 3520 International Relations and Security Problems of Latin America (4-0).
Surveys the attempts by countries from various parts of the world—including the Soviet bloc—to penetrate Latin America. The influences of cultural and economic ties, military sales and political subversion have created links between Latin America and Europe with an undercurrent of African relations. The activities coming from outside the region are evaluated in comparison with the efforts of Latin American states to gain diplomatic influence in global organizations and to establish economic links to serve development goals.

NS 3530 United States Interests in Latin America (4-0).
A critical look at Latin America, and at the case made by analysts who argue that U.S. policy has neglected the region as compared with that of the critics of U.S. influence. Traditional views of neighbors sharing a common heritage and geo-political interest are evaluated. The importance of cultural, economic, and military ties are considered in the context of American global economic and security concerns.

NS 3540 Political Economy of Latin American Development Strategies (4-0).
Examination of the forces affecting the interface of economic and political interests in development strategies, especially since the end of World War II. The objectives sought, obstacles encountered, and means utilized are evaluated. External and internal factors are compared in reference both to measurable contributions and to the perceptions of Latin American leaders.

NS 3550 The Role of the Military in Latin America (4-0).
A broad view of the variety of functions served by the military in Latin American societies. Many Latin American military organizations have had training and advisory links with several countries from outside the region. A number of countries have also developed comprehensive doctrines of both military and other activities as part of research and training at advanced staff schools. Some have overseas combat experience, while many have been involved in internal security operations. These factors are considered by this course along with interservice and civil-military relations.

The 357X sequence consists of a series of directed studies of particular sub-areas of Latin America. Each individual course description corresponds to that given below for NS 3570.

NS 3570 Directed Studies: Latin America (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examination.

NS 3571 Directed Studies: Canada (Credit Open).

NS 3572 Directed Studies: Brazil (Credit Open).

NS 3573 Directed Studies: Southern Cone Countries (Credit Open).

NS 3574 Directed Studies: Andean Region (Credit Open).

NS 3575 Directed Studies: Cuba (Credit Open).

NS 3576 Directed Studies: Mexico (Credit Open).

NS 3577 Directed Studies: Central America and the Caribbean (Credit Open).

NS 3579 Directed Studies: Western Hemisphere (Credit Open).

NS 3600 Geography, History and Cultures of Asia (4-0).
An introduction to Asia. This basic course addresses the peoples of Asia and their cultures, civilizations, social organization, economic, political and military development before the coming of Europeans. This course is a prerequisite for the advanced courses on Asia.

NS 3620 International Conflicts of Asia to World War II (4-0).
An analysis of the impact of the West on the peoples of Asia, showing the historical roots of many contemporary conflicts of policy.

NS 3630 Foundations of U.S. Policy in Asia (4-0).
A study of 19th and early 20th century U.S. interests and policy toward Asia. Focuses on the emergence of Asian affairs as an issue for American policy-makers and the public from the U.S. revolution through World War II. Emphasis is placed on tracing Asian-American political, economic, strategic, and cultural interaction as it influenced U.S. policy and the policies of key Asian states.

NS 3631 U.S. Security Interests and Policies in Asia since World War II (4-0).
A study of the national interests of the United States in East Asia, South Asia and adjacent oceans from World War II to the present. The development of hostilities in Korea and Vietnam and their aftermath. Evaluation of relations with the new Japan, the PRC and Taiwan, and the independent nations of Asia, produced by the breakup of traditional empires.

NS 3661 Problems of Government and Security in China (4-0).
The rise of the Chinese Communist Party and the establishment of the Communist state; its domestic achievements and problems; the special problem Taiwan; changing foreign policies and the current role of the Peoples Republic of China in world affairs.

NS 3662 Problems of Government and Security of Contemporary Japan (4-0).
The place of Japan in the modern world; an examination of Japan's political dynamics, economic evolution, social transformation, the National Self Defense Forces and alternatives for providing for national security.

NS 3663 Problems of Government and Security of Contemporary Korea (4-0).
Division of the Korean national 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; the relations of Pyongyang and Seoul, with their key allies.

NS 3664 Problems of Government and Security in Southeast Asia (4-0).
Consideration given to such internal problems as the growth of nationalism, the role of overseas Chinese, and numerous other social changes, economic modernization, insurgencies, conflicting ideologies and the various types of government. External problems include the role of each nation state and regional groups in international affairs and the interests and policies of outside powers in dealing with the area.

NS 3665 Problems of Government and Security in Australia, New Zealand and Melanesia (4-0).
The politics, economics, and foreign relations of Australia, New Zealand, and Melanesian states. The emergence of new states, and the importance of the area's relations with the United States, the Commonwealth, Western Europe and ASEAN, ANZUS, the U.S.

NS 3666 Problems of Government and Security in South Asia and the Indian Ocean Area (4-0).
Internal problems and foreign relations among the states in the regions of South Asia and the Indian Ocean; the strategic interests of the major powers; the importance of the Indian Ocean to the United States, the Soviet Union and their respective allies.

The NS 367X sequence consists of a series of directed studies of particular sub-areas of the Far East, Southeast Asia and Pacific. Each individual course description corresponds to that given below for NS 3671.

NS 3671 Directed Studies: China (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS 3672 Directed Studies: Japan (Credit Open).

NS 3673 Directed Studies: Korea (Credit Open).

NS 3674 Directed Studies: Southeast Asia (Credit Open).

NS 3675 Directed Studies: Australia and New Zealand (Credit Open).

NS 3676 Directed Studies: South Asia (Credit Open).

NS 3679 Directed Studies: General Asia (Credit Open).

NS 3700 History of Europe and Russia, Pre-1917 (4-0).
Review and analysis of the political and military re-history of Europe, including Russia, from the congress of Vienna to the outbreak of World War I.

NS 3701 History of Europe and USSR, Post-1917 (4-0).
This course continues the narrative and analysis begun in NS 3700, brining the student from World War I and the Bolshevik Revolution to the conclusion of World War II.

NS 3710 Problems of Government and Security in Contemporary Western Europe (4-0).
Review and analysis of the history of Western Europe since 1945, including an introduction to the institutions of the European Economic Community and the North Atlantic Treaty Organization. Emphasis is on the political systems and security policies of Britain, France, Italy, and the Federal Republic of Germany.

NS 3720 International Relations and Security Problems of the North Atlantic Alliance (4-0).
The origins and evolution of NATO in relation to the provided threat from the East and the postwar recovery of Europe. Problems of strategy, force posture, alliance cohesion, nuclear policy and the differing interests of NATO states. Current issues facing the alliance and their relation to U.S. foreign and defense policy.

NS 3760 Problems of Government and Security in the Mediterranean Region (4-0).
This course provides an introduction to security problems in the Mediterranean region, with special emphasis on U.S. and Soviet policy as well as on the governments of the northern littoral of the Mediterranean.

NS 3761 Problems of Government and Security in the Scandinavian-Baltic Region (4-0).
This course analyzes the political, economic, social and security problems faced by the Scandinavian-Baltic countries. The role they play on the norther flank of NATO will be examined as well as their position vis-a-vis the growing threat of Soviet military and naval power in the Baltic and Norwegian seas.

NS 3762 Problems of Government and Security in the Federal Republic of Germany (4-0).
The origins of the Federal Republic of Germany; political system, economy, and decision-making; central foreign policy problems, including relations with the U.S. and the USSR, and the German Democratic Republic; the Bundeswehr and current security issues.

NS 3763 Problems of Government and Security in France (4-0).
The fourth and fifth Republics in the context of French political history; political system economy, and decision-making; central foreign policy problems, including relations with the U.S., the USSR, the Federal Republic of Germany, and Africa; the French armed forces and current security issues.

The NS 377X sequence consists of a series of directed studies of particular sub-areas of Europe. Each individual course description corresponds to that given below for NS 3770.

NS 3770 Directed Studies: Mediterranean (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS 3771 Directed Studies: Scandanavia-via-Baltic (Credit Open).

NS 3772 Directed Studies: Federal Republic of Germany (Credit Open).

NS 3773 Directed Studies: France (Credit Open).

NS 3774 Directed Studies: United Kingdom (Credit Open).

NS 3775 Directed Studies: Italy (Credit Open).

NS 3776 Directed Studies: Iberia (Credit Open).

NS 3777 Directed Studies: Eastern Europe (Credit Open).

NS 3779 Directed Studies: General West Europe (Credit Open).

NS 3800 History and Culture of Sub-Saharan Africa (4-0).
An examination of the major historical trends that have shaped African societies. Emphasis will be placed on the interaction between geography, culture, economics and politics. The pre-colonial, and colonial periods in African history will be discussed in detail. This course is intended as a general introduction for the student just beginning the study of Africa.

NS 3810 Problems of Government and Security in Sub-Saharan Africa (4-0).
Emergence of independent African states from a shared colonial heritage, and their common problems in developing viable modern nation-states. Patterns of international cooperation and conflict among African states, including discussions of African socialism, negritude, pan-Africanism, neutralism, and the continuing problem of South Africa's future. Rival policies of outside powers, including the U.S., the Soviet Union, China and the former colonial powers.

NS 3811 Conflict and Change in Africa (4-0).
An examination of the underlying cultural economic and political sources of conflict and change in Africa. Topics to be covered will include: irredentism, civil wars and boundary disputes, ethnic cleavages and political competition, modernization and political stability. These topics will be analyzed by examining a series of case studies: the Congo crisis, the Nigerian civil war, the Eritrea conflict, the Shaba crisis and the Sudanese civil war.

NS 3830 American Interests in Africa (4-0).
This course examines the evolution of American relations with Africa from 1960 to the present. It focuses on the ways in which changing geopolitical and economic conditions have altered official perceptions of American interests in Africa - including the Mahgreb. U.S. involvement in conflicts in the Belgian Congo, Nigeria, Angola, Rhodesia and the Horn of Africa will be studied.

NS 3840 African Political Development Strategies (4-0).
An examination of the political modernization strategies adopted by post-independence governments in Africa. Issues to be discussed will include: the role of political parties in Africa, socialism in Africa, and the like. Special emphasis will be placed on Africa's early post-independence problems and their effect on current African strategies.

NS 3879 Directed Studies: African Area Studies (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS 3900 International Organizations and Negotiations (4-0).
The first part of the course traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various other current forms of multinational and transnational organizations. The emphasis is on policy-making in these organizations. The second part of the course is an analysis of international negotiations, with emphasis on applying theories of negotation to such issues as Law of the Sea and Arms Control.

NS 3902 Modern Revolution and Political Terrorism (4-0).
Study of the general historical framework of modern revolution to include systematical analysis of the development of modern revolutionary situations. Examination of the more important revolutions of modern times, including study of the historical events, testing of the methods of systematic analysis, with emphasis on revolutionary tactics, e.g., political terrorism.

NS 3960 International Law (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.

NS 3961 The Law of War (4-0).
The course presents and analyzes the law of war as it is to be observed and enforced by the Armed Forces of the United States. Special attention is paid to the 1949 Geneva Conventions, the Navy's Law of Naval Warfare and the Army's Law of Land Warfare.

NS 3962 Ocean, Maritime and Tort Law for the Hydrographic Community (4-0).
This course is designed to provide a detailed introduction to the personal and institutional liabilities and immunities of the hydrographic community. As such, it will consist of a general introduction to governmental tort law, including the applicable sections of the Federal Tort Claims Act and pertinent cases; relevant areas of Admiralty law and international law, both public and private, as it applies to the rights and duties pertaining to access to, and use of both international and sovereign waters. In addition, special emphasis will be given to the historical and legal developments of the law of the sea; and to present day trends in international conventions leading up to the proposed law of the Sea Treaty.

Graduate Courses

NS 4010 Seminar in Comparative Regional Security (4-0).
A seminar designed for geographical security area students to address global security issues on a comparative basis. PREREQUISITES: NS 3310, 3410, 3630, 3710 or 3810.

NS 4020 Seminar in Comparative Foreign Policy (4-0).
The objective of this Seminar is to develop the student's ability to analyze and predict the international behavior of states. Emphasis will be placed on comparing the impact of different factors, such as international structure, domenstic politics, bureaucratic institutions, economic resources and ideology, on the foreign policies of different countries. Students will be expected to write a seminar paper using the theoretical material covered in the course to compare the foreign policies of two or more countries. PREREQUISITE: NS 3020 or permission of the Instructor.

NS 4030 Special Topics in National Security Policy (4-0).
Advanced study and research in special topics and issues related to national security policy. Topics may include policy outputs such as foreign trade, public diplomacy, deterrence, low-intensity conflict, etc., or aspects of the policy-making process such as the role of Congress, public opinion and the press, bureaucratic politics, etc. The seminar is used to examine topics not covered in depth in other seminars. PREREQUISITE: Permission of the Instructor. Graded on a Pass/Fail basis only.

NS 4040 Strategic Resources and U.S. National Security Policy (4-0).
Analysis of the problems of access to global resources and their utilization: agricultural production access to critical raw materials; problems and policies of oil; national and international implications of various strategies of self-sufficiency and interdependency. Emphasis is placed on the security problems arising from the geographic distribution of international resources. PREREQUISITES: NS 3030, NS 3020.

NS 4041 Economics of Third World Military Expenditures (4-0).
A comparative analysis of problems of politic-economic growth and development, focusing on selected developing nations. Alternate systems are compared with respect to development goals, theories of economic organizations, institutions and development processes. Emphasis is placed on forecasts of likely changes in economic and politcal conditions and their effect on the political-military situation in each country. PREREQUISITE: NS 3040 or consent of the Instructor.

NS 4042 National Security and Technology Transfer (4-0).
Examines patterns of East-West Trade, U.S. policies regarding technology transfer to the Eastern bloc. PREREQUISITE: NS 3040 or consent of the Instructor.

NS 4079 Advanced Directed Studies in National Security Affairs (Credit Open).
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.

NS 4152 Problems of Intelligence and Threat Analysis (4-0).
This advanced course focuses on problems in analyzing the intentions and capabilities of a military competitor, especially the Soviet Union. This course is specifically intended to draw on the knowledge and experience of practioners and analysts in the Naval Intelligence community. Students will be given the opportunity to undertake analyses where they apply methods and concepts acquired in earlier courses. PREREQUISITES: NS 3150 or NS 3154 or permission of the Instructor. Graded on a Pass/Fail basis only. TOP SECRET clearance with eligibility for SPECIAL INTELLIGENCE information.

NS 4179 Advanced Directed Studies: Intelligence (Credit Open).
Format and content vary. Normally involves extensive individual research under the direction of a substantial paper of graduate seminar quality and scope.

NS 4220 Threat Analysis and the Contemporary International Environment (4-0).
An appreciation for other threats to U.S. interests and those of its allies including: Muslim fundamentalism, the Arab/Israeli conflict, the Persian Gulf and Southwest Asia, threats to the Pacific Rim including Philippine insurgency, North Korea, Vietnam, Central and South American instability, and Africa. Functional threats will also be examined; technological breakthroughs, chemical and biological warfare, as well as the military use of space. Graded on a Pass/Fail basis only.

NS 4230 Seminar in Strategic Planning (4-0).
Advanced study in the concepts and methods of long-range defense and business planning and analysis, particularly with respect to iterative aggregation and synthesis in the Military Departments, the Joint Chiefs of Staff, the office of the Security of Defense and the National Security Council. Students are expected to identify and address some evolving strategic issues which have significant long-term implications for the security of the U.S. PREREQUISITE: NS 3230 or permission of Instructor. Graded on a Pass/Fail basis only.

NS 4231 Science, Technology and Public Policy (4-0).
Advanced study and research in the role of science and technology in the formulation and conduct of U.S. national policy, to include interactions among scientific communities, government and the military services. A research focus will be determined for each course. PREREQUISITE: Consent of the Instructor. Graded on a Pass/Fail basis only.

NS 4250 Problems of 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 role of the military attache; the design, execution and evaluation of security assistance programs. PREREQUISITE: NS 3030 or NS 3020.

NS 4251 American National Security Objectives and Net Assessment (4-0).
Comparative analysis of trends in U.S. and Soviet security policies, military forces, manpower, and capabilities. Special attention is paid to familiarizing students with original source material and major elements in current controversial national security issues. Topics covered include nuclear capabilities and doctrine, BMD and air defense, civil defense, combined arms employment, NATO Warsaw Pact military balance, naval forces, and trends in the U.S. and Soviet economies, especially as they may affect the allocation of resources to defense. PREREQUISITE: TOP SECRET clearance with eligibility for SPECIAL INTELLIGENCE information. Graded on a Pass/Fail basis only.

NS 4252 Maritime Powers and Foreign Policy (4-0).
A comparison of the political uses and operational ideas of the navies of the United States, Great Britain, France, Germany, Soviet Union and Japan. The principal goal of the seminar is to examine how the great maritime powers of the world create the political basis for their naval power and the effect these fleets have upon the nature of foreign policy and strategy. PREREQUISITE: NS 3050 or consent of the Instructor.

NS 4261 Survey of Strategic Studies (4-0).
An extensive survey of the classical and contemporary literature on strategic thinking: national objectives and strategic alternatives; deterrence, counterforce, arms control, counter insurgency, compellence; components and rules of the international strategic system; arms competitions, nuclear proliferation, terrorism. Student projects on current strategic problems are a major component of the course PREREQUISITE: NS 3020.

NS 4262 Seminar in Strategic Deception (4-0).
This course explores the utility of strategic deception in advancing military/political objectives from a variety of social scientific perspective; both historical case studies and contemporary issues will be considered. PREREQUISITE: NS 3230 or concent of the Instructor.

NS 4279 Advanced Directed Studies: Strategic Planning (Credit Open).
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.

NS 4280 Advanced Topics in Nuclear Strategy and Deterrence (4-0).
A follow-up course to NS 3280 that examines advanced issues in nuclear strategy, strategic and crisis stability, and deterrence. In addition to advanced 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. Some of this analysis will be done using both static measurement models and dynamic computer nuclear exchange modeling. PREREQUISITE: NS 3280 or permission of the Instructor; SECRET clearance.

NS 4290 Seminar on the Origins of Soviet American Relations (4-0).
This course examines the origins of contemporary U.S. and Soviet military and political relationships and focuses on the 1945 to 1963 time period. Topics covered include theories of the Cold War (including orthodox), Allied war-time diplomacy and contrasting post-war objectives, Cold War alliance strategies, formulation of American post-war foreign policy, Soviet perspectives on the origins of U.S.-Soviet antagonisms, as well as de-colonization and the Cold War in Asia and the Near and Middle East. PREREQUISITE: NS 3030 or consent of the Instuctor.

NS 4300 Seminar in Middle Eastern Civilization (4-0).
Description and analysis of the four major cultural traditions of the Middle East: Arabic, Persian, Judiac, and Turkish. Students read translations of selected classical and contemporary writings from each of these traditions, and secondary materials concerning social and cultural institutions. PREREQUISITES: NS 3310 or NS 3300, or consent of Instructor.

NS 4310 Seminar in Security Problems of the Middle East (4-0).
Advanced Middle Eastern politics and the security problems they present to the U.S. decision-makers. The central theme of the course is U.S. interests in the Middle East, how these interests are threatened, and what policy alternatives have been proposed to secure them. PREREQUISITE: NS 3310 or NS 3320.

NS 4379 Advanced Directed Studies: Middle East (Credit Open).
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.

NS 4410 Soviet Security Problems (4-0).
An advanced seminar that gives students an opportunity to engage in discussion and research of Soviet national security problems. The focus is on the impact of Soviet political culture on their international conduct, on Soviet policy towards the U.S. and China, on Soviet relations with their allies, and on the impact of Soviet domestic factors (decision-making patterns, civilian-mili-

tary relations, social conditions, sources of political instability) on Soviet national security policies. PREREQUISITE: NS 3410 or consent of Instructor.

NS 4420 Security Problems and International Relations of the Warsaw Treaty Organization (WTO) (4-0).
An advanced study of structures and policy-making in the WTO countries and other communist countries not having WTO membership, above all, China, Yugoslavia, Cuba and Vietnam. Focus on the origin and evolution of the WTO alliance, problems of joint strategy, alliance cohesion and reliability, differing interests of various WTO members, conflict management within the alliance and WTO members relations with other important Communists, NATO and Third World countries. Current issues such as the Soviet-Cuban joint intervention in Africa and involvement in the Caribbean basin, the Soviet alliance with Vietnam in Southeast Asia, Soviet-East German military-security operations in the Third World, and the dynamics of Sino-Soviet relations are viewed with an eye to their implications for the United States. PREREQUISITES: NS 3400, 3410, and 3450, or consent of the Instructor.

NS 4430 Economic Developments in the Eastern Bloc countries (4-0).
This course surveys the current economic conditions prevailing in the USSR and other Eastern Bloc countries. Special topics include the nature of communist economic planning, Marxian economic theory, socialist integration, economic reforms, economic constraints on defense expenditures, trade with the West and the Third World, and prospects for the future. PREREQUISITE: NS 3400.

NS 4450 Soviet Military Operations and Tactics (4-0).
Taking Soviet exercises on the combined arms and tactical levels as cases, students in this advanced seminar will analyze actual Soviet military planning for global and limited wars involving conventional and nuclear arms. Attention may be given also to Soviet concepts of wars of national liberation, guerrilla wars and the use of forces for political-military intimidation. The students will present the results of their independent research into Soviet military theory and practice in class. PREREQUISITE: SI clearance required. NS 3450, Soviet Military Strategy or permission of the Instructor.

NS 4451 Advanced Topics in Soviet Naval Affairs (4-0).
Advanced study and research in Soviet naval and maritime affairs. Topics include: decision-making processes, scenarios, warfare capabilities and support systems, missions methodology, gaming, and U.S.-Soviet naval interactions. PREREQUISITE: NS 3452; TOP SECRET clearance with eligibility for SPECIAL INTELLIGENCE information, or permission of the Instructor.

NS 4460 Seminar in Eastern European Affairs (4-0).
Advanced study and research in government, politics, international relations and national security affairs in the communist-ruled states of Europe other than the Soviet Union.

NS 4479 Advanced Directed Studies: Soviet Union (Credit Open).
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.

NS 4500 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 the American national interest in the international context. Students are required to write a major seminar paper on American national interests in a specific country or region.

NS 4510 Seminar in Government and Politics in Latin America (4-0).
This seminar will consist of intensive readings of advanced topics in Latin American politics and government, including the interplay between economic, political, mili-

tary, and social factors in the process of political change at play in the region. Students will be required to prepare classroom lectures on selected subjects and present an article length paper on a separate topic. Reading assignments will be extensive, which presupposes a significant level of knowledge and preparation prior to the course. PREREQUISITES: NS 3510, 3520, 3540 and 3550.

NS 4540 The Political Economy of Latin America (4-0).
Course examines the economic controversies surrounding Latin America's economic development, current problems facing the major Latin American countries and the economic determinants of Latin American economic expenditures.

NS 4560 Seminar in International Security Problems of Latin America (4-0).
Reviews the history of Latin America as part of an inter-American system, and the case of joint foreign policy action on economic, political, and military fronts. Case studies draw attention to the role of the United States in the region, both within the formal regional institutions and in bilateral relations including military advisor activities. The relations are put in the context of the attitudes of Latin American leaders toward hemispheric solidarity.
The 457X sequence consists of a series of directed studies of particular sub-areas of Latin America. Each individual course description corresponds to that given below for NS 4570.

NS 4570 Advanced Directed Studies: Latin America (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the Instructor, papers and/or examination.

NS 4571 Advanced Directed Studies: Canada (Credit Open).

NS 4572 Advanced Directed Studies: Brazil (Credit Open).

NS 4573 Advanced Directed Studies: Southern Cone Countries (Credit Open).

NS 4574 Advanced Directed Studies: Andean Region (Credit Open).

NS 4575 Advanced Directed Studies: Cuba (Credit Open).

NS 4576 Advanced Directed Studies: Mexico (Credit Open).

NS 4577 Advanced Directed Studies: Central America and the Caribbean (Credit Open).

NS 4579 Advanced Directed Studies: Western Hemisphere (Credit Open).

NS 4660 Asia and Soviet Union (4-0).
An advanced study of the interests and policies of the Soviet Union in Asia and the adjacent oceans, with special reference to the impact of Soviet expansiveness on the policies of the United States, China, Japan and other Asian states. This course is open both to Soviet and Asian area specialists.

The NS 467X sequence consists of a series of directed studies of particular subareas of the Far East, Southeast Asia and Pacific. Each individual course description corresponds to that given below for NS 4671.

NS 4671 Advanced Directed Studies: China (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the Instructor, papers and/or examinations.

NS 4672 Advanced Directed Studies: Japan (Credit Open).

NS 4673 Advanced Directed Studies: Korea (Credit Open).

NS 4674 Advanced Directed Studies: Southeast Asia (Credit Open).

NS 4675 Advanced Directed Studies: Australia and New Zealand (Credit Open).

NS 4676 Advanced Directed Studies: South Asia (Credit Open).

NS 4679 Advanced Directed Studies in General Asia (Credit Open).
Normally involves extensive individual research under direction of the Instructor and submission of substantial paper of graduate seminar quality and scope. Designed for advanced study in one of the following areas: Japan, Korea, China, South or Southeast Asia.

NS 4690 International Security Problems of Asia and the Adjacent Oceans (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 Consent of the Instructor.

NS 4710 Seminar in Political and Security Problems of Europe (4-0).
A research seminar on political and security issues in contemporary Europe. Students conduct and present original research on a selected issue, or related issues, in specific European countries or sub-regions. The issue around which the seminar is structured varies from term to term. It is chosen to meet the research interests of each group of students enrolled in the course.

NS 4720 Seminar in Soviet-European Relations (4-0).
A seminar intended to deepen the student's knowledge of current issues in Soviet and European affairs.

The NS 477X sequence consists of a series of directed studies of particular sub-areas of Europe. Each individual course description corresponds to that given below for NS 4770.

NS 4770 Advanced Directed Studies: Mediterranean (Credit Open).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the Instructor, papers and/or examinations.

NS 4771 Advanced Directed Studies: Scandinavia-Baltic (Credit Open).

NS 4772 Advanced Directed Studies: Federal Republic of Germany (Credit Open).

NS 4773 Advanced Directed Studies: France (Credit Open).

NS 4774 Advanced Directed Studies: United Kingdom (Credit Open).

NS 4775 Advanced Directed Studies: Italy (Credit Open).

NS 4776 Advanced Directed Studies: Iberia (Credit Open).

NS 4777 Advanced Directed Studies: Eastern Europe (Credit Open).

NS 4779 Advanced Directed Studies: General West Europe (Credit Open).

NS 4810 Current Problems in Africa (4-0).
This course will examine the major problems and crises that have confronted African leaders since 1970. Particular attention will be paid to conflicts in Southern Africa. The OAU's role in conflict management will also be discussed.

NS 4820 Advanced Seminar in African Studies (4-0).
Advanced study and research in government, politics, international relations and national security affairs in Sub-Saharan Africa. A continuing theme is the role of the military in African national and international affairs and the implications of contemporary crises for military-security concerns of the continent. PREREQUISITE: NS 3830 or NS 3840.

NS 4830 American Policy Towards Africa (4-0).
The central theme of the course is U.S. interests in Africa, how these interests are threatened, and what policy alternatives have been proposed to secure them. Advanced African politics and the security problems they present to U.S. decision-makers, PREREQUISITES: NS 3340, NS 3840 or NS 3820.

NS 4879 Advanced Directed Studies: African Area Studies (Credit Open).
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.

NS 4900 Seminar in International Negotiations (4-0).
Advanced study and research in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security.

NS 4901 Seminar in Ocean Policy (4-0).
An advanced consideration of ocean policy issues and problems. Emphasis is on legal, political, military, and oceanographic matters in the context of the Law of the Sea and the new U.S. National Oceans Policy.

NS 4902 Seminar on Modern Revolution and Terrorism (4-0).
A research seminar on modern revolution and terrorism. Students will be introduced to the general sources of information and accomplish the research necessary to complete a seminar paper in a related area of their choice. PREREQUISITE: NS 3902.

NS 4950 Seminar on Arms Control and National Security (4-0).
An analysis of international negotiation processes as related to the control of armaments, including a review of the history of modern arms control efforts, examination of the domestic political context of arms limitation, the implications of international law relevant to treaty negotiations, ratification and enforcement, the intellectual contributions of scientists to the development of arms control theory, and a review of selected substantive issues with respect to security concerns, verification capabilities and compliance measures. PREREQUISITES: NS 3450 and 3900 or consent of the Instructor and SECRET clearance.

DEPARTMENT OF OCEANOGRAPHY

Curtis Allan Collins, Chairman and Professor (1987)*; PhD, Oregon State University, 1967.

Mary Louise Batteen, Assistant Professor (1985); PhD, Oregon State University, 1984.

Robert Hathaway Bourke, Professor (1971); PhD, Oregon State University, 1972.

Pecheng Chu, Adjunct Research Professor (1986); PhD, University of Chicago, 1985.

Calvin Ray Dunlap, Adjunct Research Professor (1983); MA, Stanford University, 1972.

Roland William Garwood, Associate Professor (1976); PhD, University of Washington, 1976.

Eugene Clinton Haderlie, Adjunct Distinguished Professor (1965); PhD, University of California at Berkeley, 1950.

Dale Fredrick Leipper, Adjunct Professor (1968); PhD, Scripps Institution of Oceanography, 1950.

Jeffrey Aaron Nystuen, Assistant Professor (1986); PhD, Scripps Institution of Oceanography, 1985.

Robert George Paquette, Adjunct Professor (1971); PhD, University of Washington, 1941.

Steven Richard Ramp, Assistant Professor (1986); PhD, University of Rhode Island, 1986.

Narendra Kumar Saxena, Adjunct Research Professor (1984); PhD, Technical University, Graz, 1972.

Kurt John Schnebele, Commander, NOAA, Instructor (1987); MS, Naval Postgraduate School, 1979.

Albert Julius Semtner, Professor (1986); PhD, Princeton University, 1973.

David Clement Smith, IV, Assistant Professor (1985); PhD, Texas A & M University, 1980.

Timothy Peter Stanton, Adjunct Research Professor (1978); MS, University of Auckland, 1977.

Edward Bennett Thornton, Professor (1969); PhD, University of Florida, 1970.

Stevens Parrington Tucker, Assistant Professor (1968); PhD, Oregon State University, 1972.

Joseph John Von Schwind, Associate Professor (1967); PhD, Texas A & M University, 1968.

Chung-Shang Wu, Adjunct Research Professor (1983); PhD, Cornell University, 1983.

**The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Curtis A. Collins, Professor,
Code 68Co, Spanagel Hall, Rm. 350,
(408) 646-2673, AV 878-2673.

Associate Chairmen:

Research:

Edward B. Thornton, Professor,
Code 68Tm, Spanagel Hall, Rm. 327,
(408) 646-2847, AV 878-2847.

Instruction:

Joseph J. von Schwind, Assoc. Prof.,
Code 68Vs, Bldg. 224, Room 106,
(408) 646-3271, AV 878-3271.

The Oceanography Department primarily supports curricula sponsored by the Oceanographer of the Navy; viz, #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanog-

raphy, #441 Mapping, Charting, and Geodesy.

The department focuses on Physical Oceanography and Mapping, Charting and Geodesy (MC&G) in accordance with naval priorities.

In the Physical Oceanography arena, 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, ocean optics and acoustics, and environmental acoustics. The MC&G arena includes hydrographic surveying, electronic navigation, marine geodesy, photogrammetry, marine geophysics (bathymetry, gravity, magnetics), naval astronomy and precise time, and digital cartography. The department also provides core courses for Naval Intelligence, ASW and the space curricula.

The Mapping, Charting and Geodesy Curriculum has International Hydrographic Organization-International Federation of Surveyor Category A Certification.

MASTER OF SCIENCE IN OCEANOGRAPHY

Entrance to a program leading to the degree Master of Science in Oceanography requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus, one year of college physics, and one year of college chemistry. Previous experience at sea is considered advantageous.

The degree of Master of Science in Oceanography requires:

a. Completion of thirty-five quarter hours of graduate courses, of which fifteen hours must be in the 4000 oceanography 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.

b. Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

MASTER OF SCIENCE IN HYDROGRAPHIC SCIENCES

Entrance to a program leading to the degree Master of Science in Hydrographic Sciences requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus, one year of college physics, and one year of college chemistry. Previous experience at sea is considered advantageous.

The degree of Master of Science in Hydrographic Sciences requires:

a. Completion of forty quarter hours of graduate courses in the MC&G series of which twelve hours must be at the 4000 level. The entire sequence of courses must be approved by the Department of Oceanography. Significant educational experience at sea on a research vessel is required for the degree.

b. Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

MASTER OF SCIENCE IN METEOROLOGY AND OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and 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, chemistry, 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 Post-

graduate School; however, in that event the program may be lengthened by one or more quarters.

The degree of Master of Science in Meteorology and Oceanography requires:

a. Completion of forty-eight quarter hours in meteorology and oceanography, to include at least twenty hours in the 4000 series, with a minimum of one 4000 level course in other than directed study.

b. The basic sequence of graduate courses in the fields of dynamical, physical and synoptic meteorology/ oceanography must be included in the forty-eight hours.

c. A significant and educational experience at sea on a research vessel.

d. Completion of an acceptable thesis on a topic approved by either department.

DOCTOR OF PHILOSOPHY

Department of Oceanography admission requirements for the degree of Doctor of Philosophy include:

a. A Master's degree (or the equivalent) in one of the physical sciences, mathematics, or engineering or

b. A Bachelor's degree with a high QPR or

c. A highly successful first graduate year in a Master's program, with clear evidence of research ability.

The PhD Program is in Physical Oceanography, including areas of study in ocean circulation theory, ocean prediction, and ocean acoustics, among others.

To undertake doctoral work in oceanography, a student must apply to the Chairman, Department of Oceanography. A copy of the Oceanography PhD Program Guidelines is available from the Department of Oceanography, which should be followed.

OCEANOGRAPHIC LABORATORIES

NPS is an Associate Member of UNOLS (University National Oceanography Laboratory System) and a full member 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, with NPS a major user.

A Physical Ocean Observation Laboratory (POOL) 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 velocity structure in a variety of oceanic regimes are analyzed, applying theoretical and mathematical techniques learned in the classroom to actual Naval Oceanography problems.

NPS is also a member of UCAR (University Corporation for Atmospheric 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 14-terminal color graphics instructional laboratory for simulation and analysis of oceanographic data.

DEPARTMENT COURSE OFFERINGS

OCEANOGRAPHIC SCIENCES

OC 0110, 0111, 0112, 0113 Application Seminars (1-0).
Presentation of DOD related research activities, applications to weapons and warfare systems, utilization of oceanography and meteorology in specific billets, presentations by faculty, staff, selected students, visting authorities. OC 0110 is for orientation; OC 0111 is for intermediate students;

OC 0112/0113 is for thesis orientation/ topic selection. PREREQUISITE: Enrollment in an Air-Ocean Sciences curriculum.

OC 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

OC 0999 Seminar in Oceanography (2-0).
Students in the various oceanography curricula present their theses for discussion. PREREQUISITE: Preparation of a thesis.

Upper Division Courses

OC 2001 Ocean Systems (4-0).
This course is designed to support the Naval Intelligence Curriculum by providing an overview of significant oceanographic factors, data networks and their products, sound propagation in the ocean, active and passive sonar, and ocean vehicle design practices.

OC 2020 Computer Computations in Air-Ocean Sciences (1-2).
Introduction to FORTRAN, and the NPS mainframe computer, as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

OC 2120 Survey of Oceanography (4-0).
An integrated view of the whole field of oceanography including physical, biological, geological and chemical aspects. PREREQUISITE: None.

OC 2520 Survey of Air-Ocean Remote Sensing (3-0).
Overview of systems of remote sensing of the atmosphere and oceans from space, and operational applications. PREREQUISITES: Undergraduate physics and calculus, or consent of Instructor.

Upper Division of Graduate Courses

OC 3120 Biogeochemical Processes in the Ocean (4-3).
Basic biological, geological, and chemical processes in the ocean. Biocoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean.

OC 3130 Mechanics of Fluids (4-2).
Fundamentals of the mechanics of fluids as a basis for geophysical fluid dynamics; introduction to field concepts, conservation principles, forces and effects, stress and rate of strain, momentum, energy, irrational flow; introduction to turbulence and boundry-layer flow. Emphasis on problem solving. PREREQUISITE: MA 2121 equivalent (may be concurrent).

OC 3140 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.

OC 3150 Analysis of Air-Ocean Time Series (3-2).
Analysis methods for atmospheric and oceanic time series. Correlation, spectrum, and empirical orthogonal function analyses. Statistical objective analysis. Optimal design of air-ocean data networks. PREREQUISITES: MA 2121 and a probability and statistics course.

OC 3212 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. Aspects of geology and geophysics. PREREQUISITES: MR 3222, OC 3240, or consent of Instructor.

OC 3230 Descriptive Physical Oceanography (3-0).
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. PREREQUISITES: Calculus (may be concurrent) and college physics.

OC 3240 Dynamical Oceanography (4-2).
Classical dynamical concepts of ocean circulation: Currents without friction; application of geostrophy, thermal wind. Wind-driven and frictional currents: Reynolds equations, Ekman solution; Sverdrup transport; potential vorticity; westward intensification; thermocline theories. Computational and computer graphics analysis laboratory. PREREQUISITES: OC 3230, OC 3321.

OC 3260 Sound in the Ocean (3-0).
Designed for students in the Mapping, Charting, and Geodesy curriculum. A brief introduction to the physics of underwater acoustics followed by a detailed discussion of oceanographic factors affecting sound transmission in the ocean including absorption, reflection, refraction, scattering, and ambient noise. Emphasis placed on acoustic depth sounding, seafloor mapping, etc., for the hydrographic scientist. PREREQUISITE: OC 3230.

OC 3261 Oceanic Factors in Underwater Sound (4-2).
Examines the oceanic factors which influence sound propagation in the ocean and the effects in acoustic forecasting. Factors considered include temporal and spatial variations in sound speed profiles, ambient noise, biological effects, reflection characteristics of ocean surface and bottom, signal fluctuations, and forecasting ocean thermal structure, transmission loss, and ambient noise. This course is designed for the Engineering Acoustics Curriculum. PREREQUISITE: PH 3452.

OC 3321 Air-Ocean Fluid Dynamics (4-0).
The hydrodynamical equations for a rotating stratified fluid. Forces, kinematics, boundary conditions, scale analysis. Simple balanced flows, baroclinicity, thermal wind, vorticity and divergence; rotational and divergent part of the wind; circulation theorem. Vorticity and potential vorticity. PREREQUISITE: MA 2047.

OC 3270 Weather, Wave and Surf Forecasting (4-0).
Theory and prediction of weather patterns and elements, and wind-generated ocean waves. Preparation, interpretation and use of subjective and objective meteorological forecast products, and applications to real-time weather situations. Spectral transformation of ocean waves from deep to shallow water. Prediction of surf and wave influences on operations. PREREQUISITES: MR/OC 3150, OC 4211, MR 3230, MR/OC 4323 or consent of Instructor.

OC 3272 Weather, Wave and Surf Forecasting/Laboratory (4-4).
Same as MR 3270 plus laboratory sessions on the application of lecture material. Also, practice in air/ocean briefing, to include diagnosis and forecasting of current weather and wave/surf situations using atmosphere/ocean satellite observations, and National Meteorological Center and Fleet Numerical Oceanography Center products. PREREQUISITES: MR/OC 3150, OC 4211, MR 3230, MR/OC 4323 or consent of Instructor.

OC 3325 Marine Geophysics (3-0).
Theory and methods of marine geophysics surveys, with emphasis on gravity, magnetism, seismic and acoustic wave propagation, heat flow; geophysical anomalies associated with major seafloor features; marine geodesy. PREREQUISITE: MA 2121 (may be concurrent).

OC 3440 Small-Scale Oceanic Processes (2-2).
Introduction to concepts and information about turbulence in the ocean. A survey of measurement techniques and available data used to study small-scale mixing processes and their relationship to internal waves, double diffusion, turbulence generation, and energy dissipitation. The role of turbulence in the dynamics and energetics of the ocean. PREREQUISITE: OC 3230.

OC 3445 Oceanic and Atmospheric Observational Systems (2-2).
Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC 3230, MR 3420, MR/OC 3150 or consent of Instructor.

OC 3520 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. PREREQUISITE: Undergraduate physics and differential/integral calculus; ordinary differential equations or consent of Instructor.

OC 3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (4-2).
Same as OC 3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITE: Same as OC 3520.

OC 3570 Operational Oceanography and Meteorology (2-4).
Experience at sea in conducting oceanographic, meteorological, acoustical, and other observations and analyses. Integration of satellite remote sensing information with in situ data and on scene prediction. Includes pre-cruise planning, real-time operational product interpretation, and post-cruise analysis. PREREQUISITES: MR 3222, MR/OC 3522; MR 4416, OC 4267, OC 4331 (may be concurrent).

Graduate Courses

OC 4211 Linear Wave Dynamics (4-0).
Linear theory of surface, internal, inertial-internal and Rossby waves. Coastal and equatorial trapped waves. Barotropic and baroclinic instabilities in the ocean. PREREQUISITES: MA 3132, OC 3240.

OC 4212 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. PREREQUISITES: OC 3130 or OC 4211.

OC 4213 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: OC 4211 or consent of Instructor.

OC 4220 Coastal Oceanography (3-0).
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. PREREQUISITE: OC 3240.

OC 4250 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 nonlinear theories of the wind-driven ocean circulation, nonlinear thermocline theories, mesoscale eddies, mixed-layer theories), coupled ocean-atmosphere general circulation models. PREREQUISITE: Consent of Instructor.

OĆ 4267 Ocean Influences and Prediction: Underwater Acoustics (4-3).
Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection 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 ASW Curricula. PREREQUISITES: OC 2120, PH 2471, concurrent enrollment in PH 3472 or OC 3240 and PH 3431. SECRET clearance.

OC 4323 Numerical Air and Ocean Modeling (4-2).
Numerical models of atmosphere and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic 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: MR 4322, OC 4211, MA 3132; MA 3232 desirable.

OC 4324 Advanced Numerical Ocean Modeling (3-0).
Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer quasi-geotrophic models, multilevel primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. PREREQUISITES: MR/OC 4323.

OC 4331 Mesoscale Ocean Variability (4-0).
Contemporary knowledge of nonlinear eddy phenomena: Kinematics, dynamics and energetics determined from observations, theories and models. Ocean eddies, ocean fronts, meandering currents, and geostrophic turbulence. PREREQUISITE: OC 4211.

OC 4335 Elements of Ocean Prediction (3-2).
Analyze, forecast, and interpret synoptic information on mesoscale, synoptic scale, and large scale processes on a regional basis. Use is made of dynamical and statistical principles and methods and of diagnostic and prognostic models. PREREQUISITES: OC 4330, and OC/MR 4323 (may be concurrent).

OC 4413 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. PREREQUISITE: OC 3240 or MR 4322 (may be concurrent) or consent of Instructor.

OC 4414 Advanced Air/Sea Interaction (3-0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: OC/MR 4413 or consent of Instructor.

OC 4330 Operational Oceanography of US/USSR Acoustical Surveillance Systems (3-1).
Advanced topics in the application of oceanographic and acoustic principles to specific operational US/USSR surveillance systems. Ocean acoustic limits on figure of merit, signal to noise ratio, performance index, median detection range, reliable acoustic path range, probability of detection, convergence zone and ducting are established in different oceanic regimes and operational scenarios. Advanced ocean acoustic modeling (FACT, PE, ASTRAL, and DANES models) is introduced to compare the ocean acoustic effects on systems and to illustrate model limitations in establishing predicted operational performance. Emphasis on classified student projects and use of visiting undersea surveillance authorities. PREREQUISITES: USN officers only, consent of Instructor.

OC 4520 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: OC/MR 3522.

OC 4610 Soviet Oceanography (1-2).
Soviet civilian and naval oceanography and meteorology. The oceanography of Soviet waters. Includes lectures, library research, and a term paper. SECRET clearance required. PREREQUISITES: OC 3240 and MR 3220 or equivalent.

OC 4800 Advanced Topics in Oceanography (1-0 to 4-0).
Advanced topics in various aspects of oceanography. 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.

OC 4900 Special Topics in Oceanography (1-0 to 4-0).
Independent study of advanced topics in oceanography not regularly offered. PREREQUISITE: Consent of the Department Chairman and Instructor.

MAPPING, CHARTING, AND GEODESY

Lower Division Course

GH 1101 Nautical Science for Hydrographers (2-0).
Basic principles of nautical science for hydrographers with little or no pervious sea experience. Topics include piloting and navigation, rules of the road, use of radar, radar plotting, small boat handling, ship capabilities, seamanship, emergency procedures, safety at sea, marine communications and magnetic and gyro compasses.

Upper Division of Graduate Courses

GH 3901 Mapping, Charting, and Geodesy (4-2).
Principles and fundamentals of geodesy, photogrammetry and cartography. The application of these disciplines to mapping and charting with emphasis on the propagation of random errors inherent in each phase: data acquisition, data reduction, generalization, and portrayal.

GH 3902 Hydrographic and Geodetic Surveying (4-2).
Principles and applications of hydrographic and geodetic surveying. Introduction to surveying procedures, both at sea and on land, including use of surveying instruments. PREREQUISITE: GH 3901.

GH 3903 Electronic Surveying and Navigation (4-0).
Introduction to the theory and practice of electronic surveying and navigation including principles of electronics, electronic surveying systems and basic components, geometry of electronic surveying, ray path curvature, propagation velocity, and velocity applications to surveying. PREREQUISITE: GH 3902.

GH 3906 Hydrographic Survey Planning (2-2).
Planning and management of a hydrographic survey project. Gathering of sufficient background data (geodetic control, historic tide station locations, etc.) and its implementation in planning a complete basic hydrographic survey of Monterey Bay. PREREQUISITE: GH 3902.

GH 3910 Hydrographic Surveying Field Experience (2-9).
Conduct a basic hydrographic survey of a portion of Monterey Bay. Field work consists of locating horizontal control stations through photogrammetric methods, installing and monitoring a tide gage, and running sounding lines using various types of positioning control. Data acquisition, reduction, and presentation will be emphasized. PREREQUISITES: GH 3906 and concurrent registration in GH 3911.

GH 3911 Geodetic Surveying Field Experience (1-5).
Conduct a geodetic survey project in the Monterey Bay area to support GH 3910. Methods include triangulation, trilateration, traverse, resection, and intersection. Azimuth determination by observation on Polaris. PREREQUISITES: GH 3906 and concurrent registration in GH 3910.

GH 3914 Adjustment Computations (2-2).
Solution and analysis of geodetic networks and photogrammetric problems using least squares with matrices. Variance and covariance. Weights. Condition and observation equations and combinations. Statistical tests. PREREQUISITE: MA 2047.

GH 3950 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.

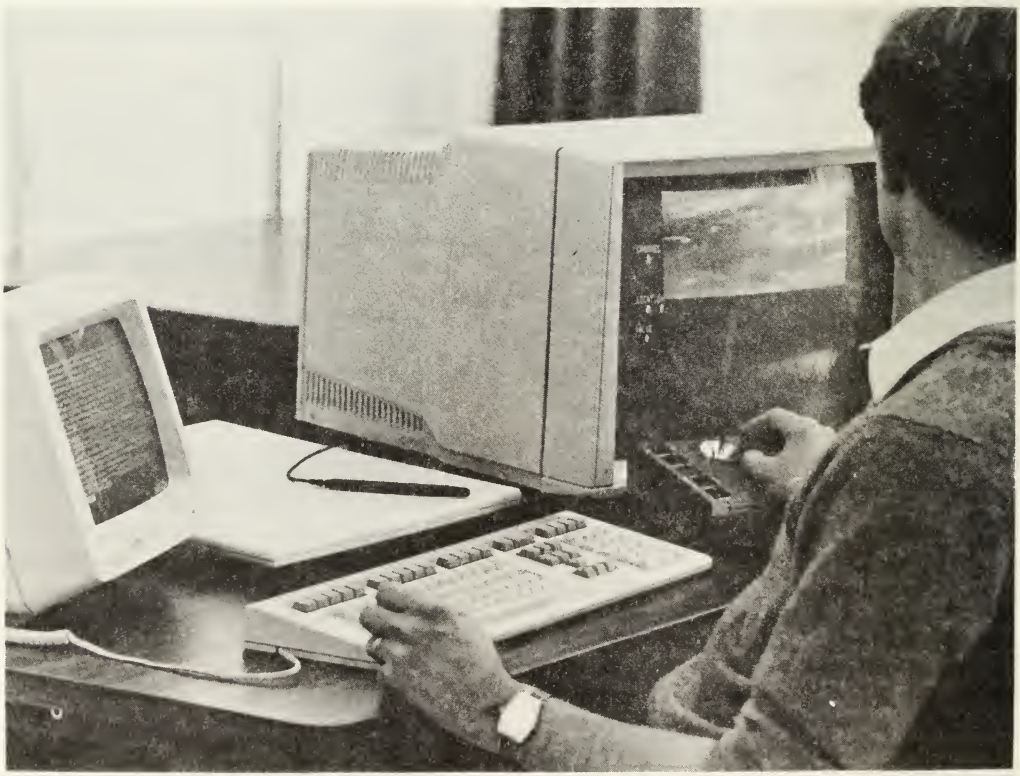
Graduate Courses

GH 4800 Advanced Topics in Geodetic Science (1-0) and (4-0).
Advanced topics in various aspects of the geodetic science. Topics not covered in regularly offered course. The course may be repeated for credit as topics change. PREREQUISITE: Consent of the Department Chairman and Instructor.

GH 4906 Geometric and Astronomic Geodesy (4-0).
Properties of the ellipsoid, geometric aspects of geodesy including triangulation, trilateration, traverse, and leveling techniques and instrumentation, adjustment by least squares, astronomic determination of latitude, longitude, and azimuth; time and astronomic instrumentation. PREREQUISITES: OC 3325 and GH 3902.

GH 4907 Gravimetric and Satellite Geodesy (4-0).
Potential theory as applied to the gravity field of the earth; application of Stoke's Formula, integral, and function; deflection of the vertical; gravimetric reduction; geometric and dynamic applications of satellites, orbital geometry and satellite orbit dynamics. PREREQUISITE: GH 4906.

GH 4908 Photogrammetry and Remote Sensing (3-2).
Application of photogrammetric instruments and techniques to planimetric, topographic, and hydrographic data compilation. Use of analog, semi-analytical, and analytical photogrammetry in geodetic control extension. Planning and execution of aerial photography. Principles and fundamentals of remote sensing. Application of remote sensing imagery to mapping and charting. PREREQUISITE: GH 3902.



DEPARTMENT OF OPERATIONS RESEARCH

Peter Purdue, Chairman and Professor (1986)*; PhD, Purdue University, 1972.

Alvin Francis Andrus, Associate Professor (1963); MA, University of Florida at Gainsville, 1958.

Donald Roy Barr, Professor (1966); PhD, Colorado State University, 1965.

Dan Calvin Boger, Associate Professor (1979); PhD, University of California at Berkeley, 1979.

Gerald Gerard Brown, Professor (1973); PhD, University of California at Los Angeles, 1974.

James Norfleet Eagle, II, Associate Professor (1982); PhD, Stanford University, 1975.

James Daniel Esary, Professor (1970); PhD, University of California at Berkeley, 1957.

Robert Neagle Forrest, Professor (1964); PhD, University of Oregon, 1959.

Donald Paul Gaver, Jr., Distinguished Professor (1956); PhD, University, 1956.

Thomas H. Hoivik, Captain, U.S. Navy, Instructor (1987); MS, Naval Postgraduate School, 1973.

Wayne Philo Hughes, Jr., Adjunct Professor (1964); MS, Naval Postgraduate School, 1964.

Patricia Anne Jacobs, Associate Professor (1978); PhD, Northwestern University, 1973.

Man Won Jee, Adjunct Professor (1987); PhD, Naval Postgraduate School, 1980.

Laura Derelle Johnson, Adjunct Professor (1987); PhD, University of California at Berkeley, 1983.

Harold Joseph Larson, Professor (1962); PhD, Iowa State University, 1960.

Siriphong Lawphongpanich, Assistant Professor (1987); PhD, University of Florida, 1983.

Peter Adrian Walter Lewis, Professor (1971); PhD, University of London, 1964.

Glenn Frank Lindsay, Associate Professor (1965); PhD, Ohio State University, 1966.

Alan Wayne McMasters, Associate Professor (1965); PhD, University of California at Berkeley, 1966.

Paul Robert Milch, Professor (1966); PhD, Stanford University, 1966.

Mark Mitchell, Commander, U.S. Navy, Instructor (1985); MS, Naval Postgraduate School, 1983.

Thomas Mitchell, Lieutenant Commander, U.S. Navy, Instructor (1986); PhD, University of Georgia, 1979.

Gordon Ross Nakagawa, Captain, U.S. Navy, Instructor (1985); MS, Naval Postgraduate School, 1985.

Douglas Elmer Neil, Assistant Professor (1972); PhD, North Carolina State University, 1971.

Samuel Howard Parry, Associate Professor (1972); PhD, Ohio State University, 1971.

Gerald Lee Pauler, Lieutenant Colonel, U.S. Army, Instructor (1987); PhD, Oklahoma State University, 1974.

Gary Kent Poock, Professor (1967); PhD, University of California at Berkeley, 1967.

Robert Richard Read, Professor (1961); PhD, University of California at Berkeley, 1957.

Edward B. Rockower, Associate Professor (1986); PhD, Brandeis University, 1971.

Richard Edwin Rosenthal, Associate Professor (1985); PhD, Georgia Institute of Technology, 1975.

Bruno Otto Shubert, Associate Professor (1968); PhD, Stanford University, 1968.

Rex Hawkins Shudde, Associate Professor (1962); PhD, University of California at Berkeley, 1956.

Michael Graham Sovereign, Professor (1970); PhD, Purdue University, 1965.

Joseph Stanley Stewart, II, Commander, U.S. Navy, Instructor (1984); MS, Naval Postgraduate School, 1973.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

William John Walsh, Lieutenant, U.S. Navy, Instructor (1987); MS, Naval Postgraduate School, 1985.

Alan Robert Washburn, Professor (1970); PhD, Carnegie Institute of Technology, 1965.

Roger Kevin Wood, Associate Professor (1982); PhD, University of California at Berkeley, 1982.

Walter Max Woods, Professor (1962); PhD, Stanford University, 1961.

**The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Peter Purdue, Professor,
Code 55, Root Hall, Room 272,
(408) 646-2381, AV 878-2381.

Associate Chairmen:

Operations:

Alvin F. Andrus, Assoc. Professor,
Code 55As, Root Hall, Room 265,
(408) 646-2413, AV 878-2413.

Research:

Donard R. Barr, Professor,
Code 55Bn, Root Hall, Room 263,
(408) 646-2663, AV 878-2663.

Instruction:

James E. Esary, Professor,
Code 55Ey, Root Hall, Room 273,
(408) 646-2780, AV 878-2780.

The Operations Research Department was founded in 1961, primarily to service students in the rapidly expanding OA (360) Curriculum. Graduates of that Curriculum receive the Master of Science in Operations Research degree, as will graduates of the recently inaugurated Operational Logistics (361) Curriculum. The Department consists of approximately forty faculty located in Root Hall. The Department operates three laboratories: the Man/Machine Systems Design Lab on the first floor of Root Hall, the Wargaming Lab in Ingersoll Hall and the Microcomputer Lab in Ro-262.

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, simulation, combat models, logistic systems and the study of Soviet military operations research.

MASTER OF SCIENCE IN APPLIED SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the 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 of Master of Science in Operations Research requires that:

1. A candidate shall previously have satisfied the requirements for the degree of 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 operations research/ systems analysis courses.
   b. An elective sequence approved by the Department of Operations Research.
   c. At least two but not more than three quarter courses devoted to a thesis. This credit shall not count toward the requirement as stated in (a) above.
3. Submission of an acceptable thesis on a subject previously approved by the Department of Operations Research.

DOCTOR OF PHILOSOPHY

The Department offers the Ph.D. degree in Operations Research. The program begins with advanced coursework 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.

Students wishing to enter directly into the doctoral program should write to the Department Chairman. Applicants should include transcripts, Graduate Record Examination (or equivalent) scores, and a brief statement of purpose. 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 2-3 years beyond completion of a Master's Degree.

DEPARTMENTAL COURSE OFFERINGS

OA 0001 Seminar for Operations Analysis Students (0-2).
Guest lecturers. Review of experience tours. Thesis and research presentations.

OA 0810 Thesis Research for Operations Analysis Students (0-0).
Every student conducting thesis research will enroll in this course.

OA 1200 Introduction to Computational Methods for Operations Research (2-2).
Introduction to proper computer use methods with the NPS mainframe computer. Emphasis of the lectures is on fundamentals and conceptual entities of the computer system, including major building blocks and system limitations. Operating systems will be introduced, with emphasis on the IBM mainframe's VM/CMS system. Laboratories will stress proper use of the mainframe, including programming in REXX, document processing with GML, and batch processing with the MVS system. PREREQUISITE: None.

Upper Division Courses

OA 2200 Computational Methods for Operations Research (3-2).
Introduction to computer usage with emphasis on computational methods particularly appropriate for operations research. Planning and structuring computer programs. Programming in FORTRAN. Use of text editor, disk files, subroutine libraries, and debugging aids in timesharing mode on mainframe computers. Extensive project work coordinates growing student FORTRAN knowledge with topics in OR computing. Project topics may include numerical error analysis, probability distributions, random sampling, matrix computations, search methods and OR modeling. PREREQUISITE: None.

OR 2600 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.

OA 2910 Selected Topics in Operations Analysis (2-0 to 5-0).
Presentation of a wide selection of topics from the current literature. This course may repeated for credit if course content changes. PREREQUISITE: A background in operations research.

Upper Division or Graduate Courses

OA 3101 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: MA 1117 or equivalent.

OA 3102 Probability and Statistics (4-1).
Jointly distributed random variables, independence and contitional distributions, covariance and correlation. Functions of several random variables, sampling distributions, limiting distributions, the central limit theorem, approximations. Order statisitics, the t and f distributions, the bivariate normal distribution. Point estimation, properties of estimators. PREREQUISITES: OA 3101 and MA 1118 or equivalent; MA 3110 taken concurrently.

OA 3103 Statistics (4-1).
Confidence intervals, hypothesis testing, regression, analysis of variance, nonparametric inference. Applications to reliability, test and evaluation and operations research problems. PREREQUISITE: OA 3102 or equivalent.

OA 3104 Data Analysis (3-1).
Techniques of analyzing, summarizing, and comparing sets of real data. The exploratory nature of data analysis is featured through a variety of plotting methods and interactive work on computer terminals. Includes model building, and the discovery and overcoming of shortcomings in data collected in actual situations. PREREQUISITE: OA 3103.

OA 3105 Nonparametic Statistics (4-0).
Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one sample test, 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.

OA 3201 Linear Programming (4-0).
Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, dual simplex algorithm, sensitivity analyses, parametric linear programming, transportation algorithm and matrix payoff games. Applications to resource allocation, manpower planning, transportation and communications network models, ship scheduling and elementary strategic games. Introduction to machine computing and MPS. PREREQUISITES: MA 2042, MA 3110, and FORTRAN or equivalent.

OA 3301 Stochastic Models I (4-0).
The homogeneous and inhomogeneous Poisson process, filtered and compound Poisson process. Stationary Markov chains and their applications in modeling random phenomena. PREREQUISITE: A calculus based probability course.

OA 3302 OA System Simulation (4-0).
Discrete event digital simulation methodology, Monte Carlo techniques, use of FORTRAN and other available simulation languages. Variance reduction techniques, design of simulation experiments and analysis of results. PREREQUISITES: OA 2200 or equivalent; OA 3103 or equivalent; OA 3301.

OA 3401-3402 Human Factors in Systems Design I-II (4-0 and 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.

OA 3501 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 sytems. PREREQUISITE: A calculus based probability course.

OA 3601 Combat Models and Games (4-1).
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: MA 3110, or OA 3102.

OA 3602 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. PREREQUISITES: OA 3301, SE 3321.

OA 3900 Workshop in Operations Research/Systems Analysis (2-0 to 5-0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OA 3910 Selected Topics in Operations Research/Systems Analysis (2-0 to 5-0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research. Consent of Instructor.

Graduate Courses

OA 4101 Design of Experiments (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 package for analysis of experimentation data. PREREQUISITE: OA 3103 or equivalent.

OA 4102 Regression Analysis (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: OA 3102, OA 3103, OA 3104.

OA 4103 Advanced Probability (3-0).
Probability spaces, random variables as measurable functions, expectation using the Lebesque Stieltjes integral and abstract integration. Models of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. PREREQUISITE: MA 3605 or departmental approval.

OA 4104 Advanced Statistics (3-0).
Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher's and Kullback information, asymptotic methods. Sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. PREREQUISITE: OA 3103 and consent of Instructor.

OA 4201 Nonlinear Programming (4-0).
Introduction to modern optimization techniques, 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: OA 3201, MA 3110.

OA 4202 Network Flows and Graphs (4-0).
Introduction to formulation and solution of problems involving networks. Elements of graph theory, data structures, search algorithms, max-flow mincut theorem, shortest route problems, minimum cost flows, and PERT/CPM. Applications to production and inventory, routing, scheduling, network interdiction, and personnel management. PREREQUISITE: OA 3201.

OA 4203 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, weapons systems allocation and others. PREREQUISITE: OA 3201.

OA 4204 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: Knowledge of Linear Programming and a course in Probability.

OA 4205 Advanced Nonlinear Programming (4-0).
Continuation of OA 4201. Advanced topics in nonlinear programming including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods and examination of recent literature in nonlinear programming. PREREQUISITE: OA 4201.

OA 4206 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: OA 3201.

OA 4301 Stochastic Models II (3-2).
Course objectives are to teach methods of stochastic modeling beyond those taught in OA 3301 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 assumption and attainment of practical results. Topics include renewal processes and Kalman Filtering as illustrated by several military and industrial applications. PREREQUISITES: OA 3301; OA 3302; OA 3104.

OA 4302 Reliability and Weapons Systems Effectiveness Measurement (4-0).
Component and system reliability functions and other reliability descriptors of sys-

tems effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. Illustrations of current methods of reliability assessment from appropriate MILSTDs and manuals. PREREQUISITE: OA 3301.

OA 4303 Sample Inspection and Quality Assurance (4-0).
Attribute and variables sampling plans. MILSTD sampling plans with modifications. Multilevel continous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. PREREQUISITE: OA 3101 or consent of Instructor.

OA 4304 Decision Theory (3-0).
Basic concepts, Bayes, admissible, mimimax, and regret strategies. Principles of choice. Relation of statistical decision functions to the theory of games. Applications in the planning of operational evaluation trials. PREREQUISITE: OA 3103.

OA 4305 Stochastic Models III (4-0).
Lecture topics include: non-stationary behavior of Markov processes, point process models, regenerative processes. Markovian queueing 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: OA 3104, OA 3301, OA 4301.

OA 4306-4307 Stochastic Processes I-II (4-0).
The Kolmogorov theorem, analytic properties of sample functions; continuity and differentiability in quadratic mean; stochastic integrals, stationary processes. Stationary and non-stationary problems; Martingale limit theorems and the invariance principle. PREREQUISITE: OA 4103.

OA 4308 Time Series Analysis (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: OA 3301, OA 3104.

OA 4321 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 artifical 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: A course in Computer Programming and a course in Probability.

OA 4333 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: OA 3302.

OA 4401 Human Performance Evaluation (4-0).
Experimental considerations, strategy, and techniques in evaluation of human performance characteristics and capabilities. Detailed examination of special methods to include multivariate designs, psychophysiological methods. Review of important variables affecting human performance and criteria, measures of effectiveness, and figures of merit as indicants of performance quality. PREREQUISITE: OA 3401.

OA 4402 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 and development and prediction of skilled operator performance in the operational setting. PREREQUISITE: OA 3401.

OA 4404 Operations Research in Man-Machine Systems (4-0).
Application of operations research techniques to man-machine design and evaluation problems. Quantitative methods for performance will be treated using such concepts as reliability, information theory, and signal detection theory. A portion of the course is devoted to summarizing approaches to real world problems incorporating current methods from the literature. PREREQUISITES: OA 3401, OA 3201, OA 3301 and OA 4301 (may be taken concurrently.

OA 4501 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: OA 3501.

OA 4502 Inventory II (4-0).
A study of stochastic inventory models. Single period models with time dependent costs, constrained multiple item single period models, deterministic and stochastic dynamic inventory models, the period review model, the Q-I continous review model. PREREQUISITES: OA 3301, OA 3501.

OA 4602 Campaign Analysis (4-0).
The development, use and state-of-the-art of maritime campaign analysis. Emphasis is on formulating the analysis, measures of effectiveness, handling assumptions, and parametric evaluations. Communicating results in speech and writing is an important part of the course. Students conduct a project as study team members. They research and report on major portions of major U.S. Navy analysis. PREREQUISITES: OA 3103, OA 3302, OA 3601, OA 3602, OA 4604, and SECRET NOFORN clearance.

OA 4603 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: OA 3104.

OA 4604 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. NWISS and NAVTAG gaming facilities will be used. PREREQUISITES: OA 3302 and SECRET NOFRON clearance.

OA 4605 Operations Research Problems in Naval Warfare (3-0).
Analyses 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 ASW. Current radar, sonar, communications and ECM problems. PREREQUISITES: OA 3601, OA 4604.

OA 4606 Applications of Search, Detection and Localization Models to ASW (3-0).
Applications of search, detection and localization models to search planning, target localization and tracking procedures, and ASW sensor evaluation. Both acoustic and nonacoustic ASW sensors are considered. PREREQUISITES: OS 3601 or OA 4604. SECRET NOFORN clearance.

OA 4607 Tactical Design and Analysis (4-0).
Use of hand-held programmable calculators (HPCs) and their application to tactical problems in the operational environment. Characteristics of currently available HPCs will be discussed and compared with special emphasis on the use of their more sophisticated features. Methods of implementing environmental, search, localization and tracking algorithms on the HPC. Individual and/or group projects allow the student to apply the concepts presented in class to problems in this area of expertise. PREREQUISITES: OA 3602 or OS 3601 or consent of Instructor; SECRET NOFORN clearance.

OA 4608 Soviet Military Operations Research (4-0).
This course provides an introduction to Soviet military operations research, with an emphasis on asymmetries in Soviet and American use of military OR. It will focus on how OR influences Soviet military the-

ory and practice. It will begin by examining the Soviet military mind as influenced by the Russian/Soviet historical experience, Marxist-Leninist ideology, and Soviet social and military instructions. It will then trace the historical development of military OR in the Soviet Union and discuss its nature today. Students will receive English translations of major Soviet works on military OR. PREREQUISITES: A course on combat modeling (e.g., OA 3601 or OA 4654) or consent of Instructor; SECRET NORFORN clearance.

OA 4610 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.

OA 4654 Airland Combat Models I (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 throughout the course. PREREQUISITE: OA 3301.

OA 4655 Airland Combat Models II (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 allocations, logistics, C3 I process models, artificial intelligence applications. Models currently in use for DOD analysis are used as examples throughout the course. PREREQUISITE: OA 3301 or consent of the Instructor.

OA 4701 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: OA 3103.

OA 4702 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: AS 3611 or equivalent.

OA 4703 Defense Expenditure and Policy Analysis (4-0).
A presentation of the major components of defense budgeting and policy information 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: AS 3611.

OA 4704 OR 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: OA 3201, OA 3301, OA 3103.

OA 4910 Selected Topics in Operations Analysis (2-0 to 5-0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research and departmental approval.

OA 4930 Readings in Operations Analysis (2-0 to 5-0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

Service Course

OS 0810 Thesis Research for C3 Students (0-0).
Every student conducting thesis research will enroll in this course.

Upper Division Courses

OS 2101 Analysis of Experimental Data (4-0).
Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representations. 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.

OS 2102 Introduction to Applied Probability for Electrical Engineering (4-1).
First course in probability. Structure of a probability model, density, distribution functions, expectation and variance. Some basic models, binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. PREREQUISITE: MA 1118 or equivalent.

OS 2103 Applied Probability for Systems Technology (4-1).
First course in probability for students in operational curricula. Topics include classical probability calculations, discrete and continuous random variables, basic probability distributions, introduction to modeling, expectation, variance, covariance and rudiments of discrete-time processes. Emphasis is on developing familiarity with basic concepts and computational skills rather than mathematical rigor. Problem session is used in part to refresh and reinforce necessary calculus topics. PREREQUSITE: MA 1118.

OS 2210 Introduction to Computer Programming (4-1).

An introduction to the operation and programming of the mainframe computer and portable programmable computers used in the ASW Curriculum. The FORTRAN and BASIC languages are emphasized.

Upper Division or Graduate Courses

OS 3001 OR for Computer Scientists (4-0).
An introduction to some methodology and techniques of operations research that are relevant to computer system performance modeling and specification. Topics include Poisson processes, reliability theory and queueing theory.

OS 3002 OR 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 (particularly Soviet use of OR. 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.

OS 3003 OR for Electronic Warfare (4-0).
This course deals with applications of quan-

titative 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 OS 2103.

OS 3004 OR for Computer Systems Managers (5-0).
A one-quarter survey of Operations Research techniques of particular interest to students in computer systems management. Model formulation, decision theory, linear programming, project management techniques, inventory models, queueing and simulation, reliability and maintainability. Examples will illustrate the application of these techniques to the management of computer systems. PREREQUISITES: MA 2300, OS 3101.

OS 3005 OR for Communications Managers (4-0).
A one-quarter survey of operations research techniques of particular interest to students in communications management. Model formulation, decision theory, games, linear programming, network flows, CPM and PERT, reliability and maintainability, queueing theory, and systems simulation. PREREQUISITES: MA 2300, OS 3101 or OS 3105.

OS 3006 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, queueing and simulation. PREREQUISITES: MA 2300, OS 3101 or OS 3105.

OS 3007 Operations Research Methodology (4-0).
Survey of Operations Research techniques not covered in OS 3006. Topics may include simulation, search theory, extensions of combat models, network flows, and Markov chains. PREREQUISITES: OS 3106 and OS 3006 concurrently.

OS 3008 Analytical Planning Methodology (4-0).
A one-quarter survey of operations research techniques of particular interest to students in the C3 curriculum, with emphasis on model information. Topics include linear and nonlinear programming, integer programming, networks, flow shop and project scheduling, decision analysis, queueing and simulation. PREREQUISITE: MA 2300.

OS 3101 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.

OS 3104 Statistics for Science and Engineering (4-0).
Acquaints 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 treated. Additional techniques of data analysis using nonparametric procedures are developed. Quality control charts are discussed as applications along with sampling inspection by attributes and by variables. PREREQUISITE: Calculus.

OS 3105 Statistical Analysis for Management I (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: MA 2300.

OS 3106 Statistical Analysis for Management II (4-1).
The second of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Using the tools and skills developed in OS 3105, the course consists of a general study of linear models. Analysis of variance for one and two way models is followed by simple linear and multiple regression including such topics as curve fitting, residual analysis, and stepwise regression, along with correlation analysis. Again the computer is used as a tool to facilitate computations with emphasis on statistical packages for large data bases, such as SPSS and SAS. The course concludes with a sampling of nonparametric procedures. PREREQUISITE: OS 3105.

OS 3301 Systems Effectiveness Concepts and Methods (4-0).
An introduction to system reliability, maintainability, and effectiveness analysis. Failure (repair) rates and mean times to failure (repair). Models for aging and completion. Block diagrams and fault trees. Life testing. Availability, interval reliability, and the synthesis of reliability, maintainability, and effectiveness analysis. PREREQUISITES: OS 3105, OS 3106.

OS 3303 Computer Simulation (4-1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to ASW 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: OS 2103, OS 3604 or equivalent, and a working knowledge of FORTRAN programming.

OS 3401 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.

OS 3402 Human Vigilance Performance (3-1).
Course involves an examination of man's attentiveness and capability in the detection of changes in stimulus events over prolonged periods of observation. Topics to be covered include theories of vigilance; task, signal, subject and environment influences on performance, physiological and psychological responses and vigilance performance measurement. This course is designed for the ASW curriculum. PREREQUISITE: None.

OS 3403 Human Factors in Electronic 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, workload, 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: OS 3604.

OS 3404 Man-Machine Interaction (3-0).
An introduction to the man-machine interface problems in C3. Information, display and human communication requirements for effective C3. Applied orientation with student receiving his own computerized mailbox on the ARPANET enabling him to experience message handling systems, query languages, computer to computer communications between the U.S. and Europe, command and control applications programs, file transfer between host computers, etc. PREREQUISITE: Enrollment in C3.

OS 3601 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 ASW curriculum. PREREQUISITES: OS 2103 and SECRET clearance.

OS 3602 Introduction to Combat Models and Weapons Effectiveness (4-1).
This course deals with the application of quantitative models to military problems. Topics include Lanchester's theory, game theory, reliability theory, systems effectiveness, and war gaming. This course is designed for the ASW curriculum. PREREQUISITES: OS 2103 and MA 2129.

OS 3603 Simulation and War Gaming (3-1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to C3 and EW 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: OS 2103, OS 3604 or equivalent, and a working knowledge of FORTRAN programming, and SECRET clearance.

OS 3604 Decision and Data Analysis (4-0).
This course provides an introduction to the techniques of decision analysis, statistics and data analysis. It is primarily for students in the ASW, EW and C3 curricula. Emphasis is placed on the analysis of data and decision making in the ASW, EW and C3 environments. PREREQUISITES: OS 2103 or equivalent.

OS 3636 Architecture of C3I Systems (4-0).
This course is primarily intended for students in the command and control program. It provides an introduction to the evaluation and modeling of command-control-communications-and intelligence (C3I) systems, with an emphasis on the comparative anatomy of Blue and Red systems and operational intelligence. The student is introduced to concepts pertaining to the design, functioning, and evaluation of such large-scale systems and their architecture. PREREQUISITES: U.S. citizenship and TOP SECRET clearance with eligibility for SBI.

OS 3637 Soviet Operations and Systems (4-0).
This course is intended for students in any of the operational curricula (but primarily the C3 program). It provides an introduction to Soviet thinking, conceptualization of military affairs, systems, and operations. Soviet control concepts, including troop control, control of combat means, and the role of automation, are emphasized. The

systems approach to integrating different types of intelligence data to support U.S. defense (including command) decision making is considered. The course stresses the understanding of Soviet key words and concepts in military affairs. PREREQUISITES: U.S. citizenship and TOP SECRET clearance with eligibility for SI/SAO.

OS 3702 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 SHORE STAMPS are included. PREREQUISITES: OS 3006 or OA 3201 and OA 3301.

Graduate Courses

OS 4601 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.

OS 4602 C3 Systems Evaluation (2-4).
This course is designed for Systems Technology students in the Command, Control and Communications Curriculum. The course deals with techniques for the design, implementation and analysis of experiments or exercises aimed at the test and evaluation of systems, tactics, or operational concepts. Course topics include modeling, experimentation methodology, design of experiments, multi-criteria decision analysis, reliability, and man-machine interaction. Case studies and real data will be examined and students will actively participate in evaluations through laboratory experiments. PREREQUISITES: OS 3008, OS 3603, OS 3604, SECRET NOFORN clearance.

OS 4701 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. Applications in the form of current military models are included. PREREQUISITES: OS 3006 and OS 3106.

DEPARTMENT OF PHYSICS

Karlheinz Edgar Woehler, Chairman and Professor (1962)*; PhD, University of Munich, 1962.

Robert Louis Armstead, Associate Professor (1964); PhD, University of California at Berkeley, 1964.

Anthony A. Atchley, Associate Professor (1985); PhD, University of Mississippi, 1985.

Steven Richard Baker, Assistant Professor (1985); PhD, University of California at Los Angeles, 1985.

Fred Ramon Buskirk, Professor, (1960); PhD, Case Institute of Technology, 1958.

Alfred William Madison Cooper, Professor (1957); PhD, the Queen's University of Belfast, 1961.

Alan Berchard Coppens, Associate Professor (1964); PhD, Cornell University, 1965.

Harvey Arnold Dahl, Assistant Professor (1964); PhD, Stanford University, 1963.

John Norvell Dyer, Distinguished Professor (1961); PhD, University of California at Berkeley, 1960.

Steven Lurie Garrett, Associate Professor (1982); PhD, University of California at Los Angeles, 1977.

Suntharalingam Gnanalingam, Adjunct Professor (1985); PhD, Cambridge University, 1954.

Don Edward Harrison, Jr., Professor (1961); PhD, Yale University, 1953.

Otto Heinz, Professor (1962); PhD, University of California at Berkeley, 1954.

Lester Ingber, Professor (1986); PhD, University of California at San Diego, 1966.

George Anthony Knott, Instructor (1987); MS, Naval Postgraduate School, 1985.

Xavier K. Maruyama, Professor (1987); PhD, Massachusetts Institute of Technology, 1971.

Edmund Alexander Milne, Associate Professor (1954); PhD, California Institute of Technology, 1954.

John Robert Neighbours, Professor (1959); PhD, Case Institute of Technology, 1953.

Richard Christopher Olsen, Associate Professor (1987); PhD, University of California at San Diego, 1980.

James Vincent Sanders, Associate Professor (1961); PhD, Cornell University, 1961.

Gordon Everett Schacher, Professor (1964); PhD, Rutgers, 1961.

Fred Richard Schwirzke, Professor (1967); PhD, University of Karlsruhe, 1959.

Gerald Lee Swafford, Adjunct Professor (1985); PhD, Texas A & M University, 1978.

Donald Lee Walters, Associate Professor (1983); PhD, Kansas State University, 1971.

Oscar Bryan Wilson, Jr., Professor (1957); PhD, University of California at Los Angeles, 1951.

William Bardwell Zeleny, Associate Professor (1962); PhD, Syracuse University, 1960.

**The year of joining the Postgraduate School Faculty is indicated in parentheses.*

Chairman:

Karlheinz E. Woehler, Professor, Code 61Wh, Spanagel Hall, Rm. 100, (408) 646-2486, AV 878-2486.

Associate Chairmen:

Administration:

William B. Zeleny, Assoc. Prof., Code 61Zl, Spanagel Hall, Rm. 206C, (408) 646-2952, AV 878-2952.

Instruction:

Robert L. Armstead, Assoc. Prof., Code 61Ar, Spanagel Hall, Rm. 112, (408) 646-2125, AV 878-2125.

Research:

Don E. Harrison, Professor, Code 61Hx, Spanagel Hall, Rm. 124, (408) 646-2877, AV 878-2877.

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:

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 Environment.
6. Physics of Solids and Solid State Devices.
7. Stochastic Physics of Large Scale Systems.
8. Classical Field Theory.

All of these specializations, except the last, 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 MS degree in Physics and in Engineering Science. In addition, the Ph.D. is offered by the Department. Upon approval by the Department, courses taken at other institutions may be applied towards 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 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 present an acceptable thesis.

The following specific course requirements must be successfully completed for a student to earn the degree of Master of Science in Physics:

a. Thermodynamics and Statistical Mechanics — the student must take a two-quarter sequence or present equivalent preparation in this area.
b. A course in Advanced Mechanics or Quantum Mechanics.
c. A course in Electromagnetism at the 4000 level.
d. An advanced course in Modern Physics.
e. Specialization, to include at least two advanced courses in an area of specialization.

Programs leading to the Master of Science degree in Physics must be approved by the Chairman of the Department of Physics.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students of the Weapon Systems Engineering Curriculum (530) who elect a Physics area as their specialization option will 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 hours, including work at the 4000 level, must be in the Department of Physics. This will be the major department, and cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Physics.

In addition to the major, the program must contain at least 12 hours at the graduate level in courses representing areas other than the major.

The candidate must present an acceptable thesis on a topic given prior approval by the Department of Physics. Final approval of the program leading to the Master of Science in Engineering Science with major in Physics shall be obtained from the Chairman of the Department of Physics.

DOCTOR OF PHILOSOPHY

The Ph.D. degree is offered in the Department in several areas of specialization which currently include Acoustics, Atomic Physics, Solid State Physics, Theoretical Physics, Nuclear Physics and Plasma Physics.

Requirements for the degree may be grouped into 3 categories: courses, thesis research and examinations in major and minor fields.

The required examinations are outlined under the general school requirements for the Doctor's degree. In addition to the school requirements, the Department requires a preliminary examination to show evidence of acceptability as a doctoral student.

The usual courses to be taken by the candidate include Classical Electrodynamics, Quantum Mechanics and Statistical Physics.(PH 4371, 4971, 4972, 4973, 4771, 4772.) Suitable electives are to be chosen in physics and the minor fields, mainly from the list of graduate level courses.

PHYSICS LABORATORIES

The physics laboratories are equipped to carry on instruction and research work in atomic physics, nuclear physics, solid state physics, electro-optics, plasma physics, spectroscopy, and acoustics.

The 100 MeV electron linear accelerator provides a pulsed electron beam of 1 microampere average current and is used for radiation studies. This machine is being 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 instrumention 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 plasma physics laboratory includes a plasma system, diagnostic equipment for studies of plasma dynamics, and a steady state plasma source with magnetic fields to 10,000 gauss.

The spectroscopy equipment includes a large grating spectrograph, a large prism spectrograph, and an infrared spectrophotometer. The spectroscopic data center contains a comprehensive compilation of the known energy levels and atomic spectral lines in the vacuum ultraviolet range.

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.

DEPARTMENTAL COURSE OFFERINGS

PHYSICS

PH 0110 Refresher Physics (5-3).
NON-CREDIT. A six-week refresher course of selected topics from elementary mechanics for incoming students. Typical topics are kinematics. Newton's Laws, the concepts of work, energy, and linear momentum, and simple harmonic motion. Vector algrebra and some aspects of calculus are developed as needed and their use is emphasized. The two ninety-minute laboratory periods are devoted to guided problem solving. PREREQUISITES: Previous college courses in elementary physics and integral calculus.

PH 0499 Acoustics Colloquium (0-1).
Reports on current research, and study of recent research literature in conjunction with the student thesis. PREREQUISITE: A course in acoustics.

PH 0810 Thesis Research (0-0).
Every student conducting thesis research will enroll in this course.

PH 0999 Physics Colloquium (0-1).
Discussion of topics of current interest by NPS and outside guest speakers.

Lower Division Courses

The sequence of introductory physics courses PH 1101, PH 1702. PH 1303 is intended for students with little or no background in mathematics or physics. Emphasis is therefore placed on the development of problem solving skills. These courses are given on a six week accelerated schedule, and on a pass/fail basis.

The sequence of courses PH 1111 and PH 1312 is intended for students in the Engineering Sciences (460) curriculum, and is designed to present to these students the physics background they will need for entry into various technical curricula.

The sequence of courses PH 1121, PH 1322, PH 2223 and PH 2724 represent a thorough review of the basic principles and concepts of classical physics. The courses will emphasize self study and problem solving skills. These courses are intended primarily for students in the Weapons Engineering programs: WS (531), WN (532), WT (530).

PH 1101 Introductory Physics I: Mechanics (3-2).
Vectors, Kinematics in one and two dimensions. Newton's Laws, force laws, work and energy, conservative forces, conservation of energy, linear momentum. PREREQUISITE: A course in calculus (may be taken concurrently).

PH 1111 Fundamentals of Physics I: Mechanics (4-2).
Vector algebra, kinematics, dynamics, work and energy, linear and angular momentum, conservation laws, rotational kinematics and dynamics, statics, simple harmonic oscillator, gravitation. PREREQUISITE: A course in calculus (may be taken concurrently).

PH 1121 Physics I: Mechanics (4-2).
Vector algebra, particle kinematics in one and two dimensions, Newton's Laws of motion, particle dynamics, work, kinetic and potential energy, conservation of energy, linear momentum and its conservation laws, collisions, rotational kinematics and dynamics, equilibrium of rigid bodies, oscillations and gravitation. PREREQUISITE: A course in calculus (may be taken concurrently).

PH 1303 Introductory Physics III: Electricity and Magnetism (3-2).
Charge and Coulomb's Law, electric field, Gauss' Law, electric potential, current and resistance, electromotive force, magnetic field, Ampere's Law, Faraday's Law. PREREQUISITES: PH 1101 and a course in calculus.

PH 1312 Fundamentals of Physics II: Electricity and Magnetism (4-2).
Electric field and potential, Gauss' Law, capacitors, simple DC circuits, magnetic field, inductance, Maxwell's equations, electromagnetic waves. PREREQUISITE: PH 1111 or equivalent.

PH 1322 Physics II: Electricity and Magnetism (4-1).
Electric charge, Coulomb's Law, electric field and potential, Gauss' Law, capacitors and dielectrics, current and resistance EMF and simple circuits, magnetic field, Ampere's Law, Faraday's Law, inductance, electromagnetic oscillations and waves, Maxwell's equations. PREREQUISITE: PH 1121 or equivalent.

PH 1702 Introductory Physics II: Thermodynamics and Wave Motion (3-2).
Fluids, waves in elastic media, sound waves, heat and the first law of Thermodynamics, kinetic theory of gases, entropy and the Second Law of Thermodynamics. PREREQUISITES: PH 1101 and a course in calculus.

Upper Division Courses

PH 2001 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.

PH 2012 Physics Laboratory I (2-2).
The first course in a two quarter sequence on laboratory measurement and analysis techniques. Graphical techniques, linear regression, distribution functions, statistical analysis of data, computer controlled data acquisition, interfacing, communication protocols, digital sampling. PREREQUISITES: PH 1121, MA 2047.

PH 2013 Physics Laboratory II (2-2).
The second course in a two quarter sequence on laboratory measurements and analysis techniques. Fourier analysis, signals in noise, phase sensitive detection, time windowing and averaging. PREREQUISITE: PH 2012.

PH 2119 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 waves in bars. Transverse waves on rectangular and circular membrances. Vibrations of plates. Laboratory periods include problems sessions and experiments on introduction to experimental techniques and the handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal, and torsional waves on a bar. PREREQUISITE: Course in differential equations and basic physics.

PH 2151 Mechanics I — 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 Weapons Systems Engineering: vibrations and projectile motion. Topics include: damped and driven oscillations, rotating coordinate systems, projectile motion with atmospheric friction, and satellite orbits. PREREQUISITES PH 1121 or equivalent; MA 2121 or equivalent course in ordinary differential equations (may be concurrent).

PH 2203 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 Curriculum, 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, electromagnetic waves, light waves, optics), geometrical and wave optics. PREREQUISITES: MA 1112, MA 2129 and MA 2181 taken concurrently.

PH 2207 Fundamentals of Electro-Optics (4-0).
This course is designed to provide the background knowledge for electro-optics to students in interdisciplinary 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: MA 3139 and PH 2304 (or equivalent).

PH 2223 Physics III: Optics (4-2).
Geometrical optics; reflection and refraction of rays at plane and spherical surfaces; mirrors, plane and spherical; lenses, thick lenses and lens aberration; matrix methods for thick lenses and lens systems. Physical optics, wave equation, phase and group velocity, fourier transforms. interference, diffraction, polarization, birefringence. PREREQUISITES: PH 1322 and a course in differential equations.

PH 2304 Topics in Basic Physics: Electromagnetism (2-0).
This course follows PH 2203. Basic concepts of electric and magnetic fields are intoduced and their interaction with charges and currents discussed. The experimental laws are used to develop Maxwell's Equations, and simple solutions to these equations are considered. PREREQUISITES: PH 2203 or equivalent, and mathematics through vector analysis and ordinary differential equations.

PH 2351 Electromagnetism (4-1).
Electrostatic fields in vacuum and dielectrics, Poisson's and Laplace's equations, electrostatic energy, electric current. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Electromagnetic induction and Faraday's Law. Magnetic energy, PREREQUISITES: PH 1322 or equivalent, MA 2047 or equivalent.

PH 2401 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 Antisubmarine Warfare curriculum and is given in a "structured" PSI mode. PREREQUISITE: Precalculus mathematics. (May be taken through Continuing Education as minicourses PH 2474-76.)

PH 2502 Introduction to Space Mechanics (4-0).
A review of the basic concepts of Newtonian mechanics. Inverse square force law, geometric and energy relations for simple orbits, equations for rocket motion. Definitions and properties of electric and magnetic fields. Motion of charged particles in electric and magnetic fields. PREREQUISITES: Basic physics and calculus.

PH 2511 Introduction to Orbital Mechanics (4-0).
Review of geometric and energy relations of Keplerian orbits. Coordinate systems for orbit determinations. Basic orbital maneuvers. Time of flight. Ballistic missile trajectories. Lunar and planetary orbits. PREREQUISITES: A course in Basic Mechanics (including vectors) and a course in ordinary differential equations.

PH 2681 Introductory Quantum Physics (4-2).
Special relativity plus the fundamental concepts of quantization in modern physics. Topics include the Bohr atom, blackbody radiation, wave—particle duality, the Schroedinger equation and its application to potential barriers and wells, and to the harmonic oscillator and the hydrogen atom. Also the Pauli exclusion principle, spin and angular momentum. PREREQUISITE: PH 2223. A course in theoretical physics (PH 3990) desirable but not mandatory.

PH 2724 Physics IV: Thermodynamics (4-0).
Equations of state; the concepts of temperature, heat and work; the first law of thermo-

dynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. PREREQUISITES: PH 1121 and a course in multivariable calculus.

PH 2810 Survey of Nuclear Physics (4-0).
An introduction to the basic concepts of nuclear physics with emphasis on neutron physics and nuclear reactors. Atomic nature of matter, wave-particle duality, energy levels. Basic nuclear properties, radioactivity, neutron reactions. Elements of fission and fusion reactors. PREREQUISITE: Basic Physics.

PH 2911 Introduction to Computational Physics (3-2).
An introduction to the role of computation in modern physics, with emphasis on the programming of current physics problems. Includes an introduction to mainframe operations in both the time-sharing and batch environments. Algorithmic design and structured programming will be emphasized. Exercises, chosen to emphasize physical objectives, will be assigned in WATFIV and FORTRAN. COREQUISITE: A BASIC physics course.

Upper Division or Graduate Courses

PH 3002 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. FLIR and radar systems for ASW. Exotic detection schemes. PREREQUISITES: PH 3306, EE 3714, SECRET clearance.

PH 3006 Weapons Systems and Weapons Effects (4-0).
This course will cover technical aspects of three areas of modern weapons systems: Nuclear weapons and effects on personnel, equipment and structures; principles of directed energy weapon concepts and their interactions with targets; space based defense system concepts. PREREQUISITE: SE 3301 or equivalent.

PH 3152 Mechanics II — Extended Systems (4-1).
The principles of dynamics are applied to real extended bodies. Topics include: principles of rocket propulsion, rotational motion of axisymmetric bodies and its application to projectile spin and gyroscopic motion. An introduction to generalized methods of description of dynamic systems is given and the general behavior of complex vibrating systems is studied. PREREQUISITE: PH 2151.

PH 3161 Fluid Dynamics (4-1).
This course emphasizes the dynamics of real compressible fluids. The basic properties of fluids are introduced and the concepts of fluid kinematics, stress, and strain are discussed. Both the control-volume and differential equation approaches are applied to the flow of a viscous fluid. The laws of similarity are developed, and the significance of Reynolds, Fraude, and Mach number discussed. Topics covered include laminar and turbulent flow, isentropic subsonic channel flow, supersonic flow in nozzels, and two-dimensional supersonic flow. PREREQUISITE: PH 2151 or equivalent.

PH 3166 Physics of Underwater Vehicles (4-2).
This course emphasizes the dynamics of real incompressible fluids. The basic properties of fluids are introduced and the concepts of fluid kinematics, stress, and strain are discussed. Both the control-volume and the differential equation approaches are applied to the flow of a viscous fluid. The laws of similarity are developed, and the significance of Reynolds, Fraude, and Mach numbers are discussed. Topics covered include laminar flow, turbulent flow, boundary layer theory, and the calculation of lift and drag. One or more special topics may be discussed (surface waves, cavitation, and the fluid-dynamic generation of sound) depending upon the interests of the Instructor and students. PREREQUISITE: PH 2151 or equivalent.

PH 3208 Electro-Optic Principles and Devices (4-1).
This course is designed to provide students in interdisciplinary programs with an understanding of the principles and capabilities of the component devices comprising military electro-optic and infrared systems. Topics treated include: atmospheric extinction, turbulence effects on optical transmission and imaging, thermal blooming and breakdown, adoptive optics, thermal radiation, target signatures, backgrounds, modulators and shutters, beam steerers, reticles, detector characteristics and types, detector noise and cooling, imaging detectors for intensifiers, television and FLIR, CCD and CID devices, and displays. PREREQUISITE: PH 2207 or equivalent.

PH 3252 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; holography; 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, Brillouin zones, junction diodes, photodetection, light emitting diodes and diode lasers. PREREQUISITES: PH 3352, PH 3683, or equivalents.

PH 3306 Electromagnetic Wave Propagation (4-0).
This course is designed for the ASW curriculum. An introduction to Maxwell's equations and the basic properties of electromagnetic wave propagation in various media and the interface between media. These concepts are applied to wave propagation in the sea, the atmosphere and the ionosphere. Basic properties of antennas and wave-guides. PREREQUISITES: A basic course in electricity and magnetism, vectors, and differential equations.

PH 3352 Electromagnetic Waves (4-0).
Maxwell's equations. Plane waves in vacuum and dielectrics, boundary conditions, energy density and Poynting vector. Polarization. Reflection and refraction of dielectric and conducting boundaries for normal and oblique incidence. Electromagnetic propagation in conductors, with emphasis on sea water, metals, and the ionosphere. Waveguides. Radiation from a dipole antenna, qualitative treatment of antenna arrays and antenna patterns.

PH 3360 Electromagnetic Wave Propagation (4-1).
Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, and in dielectrics and conductors. Reflection and refraction at the interface between media. Guided waves, radiation from a dipole, and waves in the ionosphere. PREREQUISITES: MA 2047, MA 3132 (or PH 3990), PH 2151, and a basic course in electricity and magnetism.

PH 3402 Underwater Acoustics (4-1).
The third of a four-course sequence in acoustics for students in the ASW curriculum, this course is an analytical study of those aspects of underwater sound that influence the sonar equations. Topics include: The wave equations in fluids; acoustic properties of fluids, plane, spherical, and cylindrical waves; absorption of sound in sea water; simple sources; transducer properties and sensitivities; surface interference; the three-element array; normal and oblique incidence reflection and transmission of boundaries; image theory and the shallow-water channel; continuous line source and the plane circular piston; radiation impedance; linear arrays with streeing; the Eikonal Equations and ray theory. Laboratory experiments include advanced acoustic instrumentation, longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, and the 3-element array. PREREQUISITE: PH 2119 or equivalent.

PH 3406 Physics of Sound in the Ocean (4-2).
A survey of physical acoustics with emphasis on the generation, propagation, and detection of sound in the ocean. Topics include: complex variables and phasors; the acoustic wave equation and its limitation in fluids; solutions for plane and diverging waves; ray acoustics; radiation of sound; reflection from boundaries; normal mode propagation in the ocean; effects of inhomo-

geneities and sound absorption; term by term analysis of the sonar equations emphasizing transmission loss models and detection threshold models; properties of transducers for underwater sound. Laboratory experiments include surface interference, special analysis of noise, normal modes, waveguides, and acoustical sources. PREREQUISITIES: A course in general physics, and a course in partial differential equations.

PH 3451 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, 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, reciprocity calibration, speed of sound in water, and absorption in gases. PREREQUISITE: PH 2119.

PH 3452 Underwater Acoustics (4-2).
This course is a continuation of PH 3451. Lumped acoustic elements and the resonant bubble. Normal models in rectrangular, cylindrical and spherical enclosures. Steady state response of acoustic waveguides of constant cross section, propagating and evanescent modes, and group and phase speeds. Transmission of sound in the ocean, the Eikonal Equation and necessary 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 cylindrical enclosures, water-filled waveguide, and noise analysis. PREREQUISITE: PH 3451.

PH 3458 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 non-linear 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.

PH 3461 Explosives and Explosions (4-0).
Explosives terminology; manufacturing and testing of high explosives and propellants; flame temperatures; thermochemistry of explosive decomposition; the detonation state; explosives safety. Generation and propagation of explosive shock waves in air; Rankine-Hugoniot equations; scaling laws; normal, oblique, and Mach reflection. Dynamic blast loads and corresponding structure response. PREREQUISITE: PH 2724 or equivalent.

PH 3479 Physics of Underwater Weapons (3.0).
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. An historical summary of U.S. torpedoes and depth charges and a review of current NATO and Soviet torpedoes are also presented. PREREQUISITES: A course in acoustics and a SECRET NOFORN clearance.

PH 3513 Intermediate Orbital Mechanics (4-0).
Review of basic orbital properties. Orbital elements, orbit determination from observations, ground track and earth coverage, basic orbital maneuvers, time of flight, ballistic missile trajectories, lunar and interplanetary trajectories. PREREQUISITES: PH 2502 or PH 2151.

PH 3514 Introduction to the Space Environment (4-0).
Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field, radiation belts, structure and properties of the earth's upper atmosphere, ionosphere, the effects of man in the space environment. PREREQUISITES: PH 2502 or PH 3360 (the latter may be taken concurrently).

PH 3520 Introduction to Space Plasmas (4-0).
Definition of plasma, single particle motions in electric and magnetic fields, invariants of motion, plasma fluid equations, double layers, shocks, plasma waves and oscillation, applications to solar wind, ionosphere and magnetosphere, satellite charging. PREREQUISITE: PH 3360 or equivalent.

PH 3683 Intermediate Quantum Physis (4-1).
Applies the fundamental concepts of quantum physics to the development and application of theoretical methods for dealing with real systems. Time-independent and time-dependent perturbation theory. The helium atom, many electron atoms and spectra, the periodic table, diatomic molecules, lasers, solids, semiconductors and superconductivity. PREREQUISITES: PH 2681, PH 3990, and PH 3782 (the latter may be taken concurrently).

PH 3782 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. Bibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerative systems. Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. PREREQUISITE: PH 2681.

PH 3855 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 t he 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: PH 3152, PH 3360, and PH 3683 or equivalent.

PH 3911 Simulation of Physical Systems (3-1).
Comparisons between simulation, theory and experimentation as techniques of scientific investigation. Computer simultion methodolgy and techniques: Monte Carlo and deterministic simulations, stochastic techniques, design of simulations, variance reduction and analysis of results. Applications from physics and/or weapons performance. There is a one-hour applications laboratory. PREREQUISITES: MA 3400, or OS 3602, or consent of Instructor.

PH 3990 Methods of Theoretical Physics (4-0).
This course is an eclectic selection of mathematical techniques (e.g., differential and integral equations, complex variables, special functions, eigenfunctions, and Green's functions) applied to specific problems drawn from physical systems (e.g., classical waves, scattering, classical electrodynamics, resonant cavities, incompressible flow, dielectric and magnetic media, heat conduction, Fourier optics, and quantum mechanics). PREREQUISITES: MA 2121 and a sequence of courses in basic physics.

PH 3998 Special Topics in Intermediate Physics (1-0 to 4-0).
Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interest 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.

Graduate Courses

PH 4054 Particle Beam and High Energy Laser Weapon Physics (4-0).
This course is an in depth study into the beam weapon concept. 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: PH 3352, PH 2151 or equivalent, courses in electromagnetic and mechanics. SECRET clearance.

PH 4171 Advanced Mechanics (4-0).
Hamilton's Principle. The equations of motion in Lagrangian and Hamiltonian form. Symmetries and constants of the motion. The inertia tensor and rigid bodies. Canonical transformation and Poisson brackets. Small oscillations. PREREQUISITES: PH 3152, PH 3360 or equivalent.

PH 4253 Sensors, Signals, and Systems (4-2).
This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals. Topics included are: optical modulation, nonlinear optics, acousto-optics: specific lasers, Q-switching and mode locking; atmospheric absorption and scattering of radiation; 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, PH 3252. PREREQUISITES: PH 3252 and a course in electromagnetics.

PH 4283 Laser Physics (4-0).
The physics of lasers and laser radiation. Topics will include: spontaneous and stimulated emission, absorption, interaction 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: PH 3252 or equivalent, or consent of Instructor.

PH 4353 Topics in Advanced Electricity and Magnetism (4-0).
Topics selected from: scattering and absorption of waves by single particles: multiple scattering; relativistic formalism and radiation from accelerated charges; propagation in layered conducting media such as the atmosphere, sea water, ocean floor systems. Introduction to free electron lasers. PREREQUISITES: PH 3352 and PH 3990 or equivalent.

PH 4371 Classical Electrodynamics (3-0).
Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. PREREQUISITES: PH 4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

PH 4403 Advanced Topics in Underwater Acoustics (4-1).
The last in a sequence of courses in acoustics for students in the ASW curriculum, this course is a continuation of PH 3402. Topics include: Review of the sonar equations, normal modes in enclosures, steady-state response of isospeed acoustic waveguides, propagating and evanescent modes, group and phase speeds, the wave equation with a source term, the point source in cylindrical coordinates, transmission loss models for isospeed shallow water channel with fluid bottom, the parabolic equation, and the parametric array. Laboratory experiments include analysis of underwater noise, normal modes in a rectangular cavity, and acoustic waveguides. PREREQUISITE: PH 3402 or equivalent.

PH 4410 Advanced Acoustics Laboratory (0-6).
Advanced laboratory projects in acoustics. PREREQUISITE: PH 3452 or equivalent.

PH 4453 Sound Propagation in the Ocean (4-0).
An advanced treatment of propagation in the ocean. Reflection of spherical wave from ocean boundaries. Normal mode propagation of sound; the inhomogeneous wave equation and the point source in cylindrical coordinates, shallow water channel with penetrable bottom, deep sound channel, WKB approximation. Range-dependent channels; adiabatic normal modes, parabolic equation. Scattering of sound from rough surfaces and in a random ocean; frequency amplitude and phase fluctuations, multipath propagation. PREREQUI—SITE: PH 3452 or equivalent.

PH 4454 Transducer Theory and Design (4-2).
A treatment of the fundamental phenomena basic to the design of transducers for underwater sound, specific examples of their application and design exercises. Topics include piezoelectric, magnetostricitive and hydromechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical transducer types, and a design project. PREREQUISITE: PH 3452 (may be taken concurrently).

PH 4456 Seminar in Application of Underwater Sound (3-0).
A study of current literature on application of acoustics to problems of Naval interest. PREREQUISITE: PH 3406 or PH 3452 or PH 4403.

PH 4459 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: PH 3451.

PH 4515 Physics of the Space Environment (4-0).
A graduate level treatment of the structure and properties of the space environment. Topics covered are chosen from: Geomagnetic field and its variations, composition and dynamics of the upper atmosphere, natural and artificial radiation belts, solar emissions and their influence on the near earth space environment. PREREQUISITES: PH 3514 and a 3000 level course in electromagnetism. Some background in plasma physics is desirable.

PH 4531 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: PH 3152 and PH 3352.

PH 4661 Plasma Physics I (4-0).
This course constitutes a broad study of the behavior and properties of gaseous plasma, the fourth — and most abundant — state of matter in the universe. Plasma physics is a vigorously developing branch of contemporary physics. Its many applications are in areas such as astro and space-physics, atomic physics, magneto-hydrodynamic power generation, electron beam excited laser, laser isotope enrichment, ionospheric communication, thermonuclear fusion, and high energy beam weapons. The physical concepts fundamental to various branches of plasma physics are introduced. Topics covered include single particle motions in electromagnetic fields, orbit theory, collision phenomena, breakdown in gases, and diffusion. The magneto-hydrodynamic and the two-fluid plasma models are considered. PREREQUISITES: PH 3360, PH 3782, PH 3683, or the equivalent.

PH 4662 Plasma Physics II (3-0).
A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma. Equilibrium and stability. Classification of plasma instabilities. Kinetic theory, the Boltzmann equation and the macro-

scopic-momentum transport equation. Plasma oscillations and Landau damping. Nonlinear effects, shock waves, radiations from plasma, including bremsstrahlung and cyclotron radiation. Controlled fusion and laser produced plasmas. PREREQUISITES: PH 4353, PH 4661 or equivalent.

PH 4663 Advanced Plasma Physics (3-0).
Selected topics in plasma physics, such as laser-target interaction, dynamics of a laser-produced plasma, self-generated magnetic fields, plasma surface interactions, unipolar arcing, light scattering and absorption in plasma, turbulence and fluctuations, collisionless shock waves. PREREQUISITE: PH 4662 or consent of Instructor.

PH 4750 Radiation Effects in Solids (4-0).
An introduction to solid state physics with emphasis on solid state semiconductor devices is given. Radiation damage mechanisms, TREE and technical aspects relating to hardening of components and systems are discussed in depth. PREREQUISITES: PH 3352 and PH 3683.

PH 4751 Semiconductor Physics (4-0).
Basic physics of semiconductor devices. Band model of solids, carriers (holes and electrons), Fermi function, description of diodes, device fabrication techniques, current and capacitance, various doping distributions, transistors. PREREQUISITES: PH 3683 or PH 2641 or consent of Instructor.

PH 4760 Solid State Physics (4-0).
Fundamental theory and related laboratory experiments dealing with solids: crystals, binding energy, lattice vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semiconductors and insulators, magnetism. PREREQUISITES: PH 3683 and PH 3782 (the latter may be taken concurrently).

PH 4771-4772 Statistical Physics I-II (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. Application to molecules. Bose-Einstein gases, Fermi-Dirac liquids, and irreversible processes. PREREQUISITES: PH 3152, PH 3683, and PH 3782.

PH 4783 Advanced Stochastic Physics (3-0).
Stochastic Physics deals with nonlinear nonequilibrium statistical mechanics, often using and generalizing methods and concepts of equilibrium Statistical Physics. The interplay between deterministic and random forces to generate organization, especially in large-scale systems, will be studied using methods of solution of multivariate rate equations, and some use of their representations as diffusion systems. Specific applications will be stressed; e.g., to physical systems such as lasers. PREREQUISITE: PH 3782 or PH 3990.

PH 4784 Advanced Statistical Physics (3-0).
Methods of modern nonlinear nonequilibrium statistical mechanics are applied to generalize the Lanchester theory of combat, to include nonlinear structures in the presence of noise and uncertainty. This approach to modeling large-scale systems concerns the different representations of Gaussian-Markovian systems; i.e., Langevin rate equations, Fokker-Planck diffusion equations, and Lagrangian path integrals. This course is concerned with direct application of these representations to fit the theoretical Lagrangian to empirical data of real systems; e.g., the human brain and C3 (Command, Control and Communications) systems. This enables the use of computational methods such as "simulated annealing" to develop most likely probability distributions, and "time of first passage" between local maxima of these distributions to study temporal evolution of alternative scenarios. PREREQUISITE: PH 3782 or PH 3990.

PH 4856 Physics of Nuclear Explosions (4-0).
This second course in the nuclear weapon 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: PH 3855 and SECRET clearance.

PH 4857 Radiation Hydrodynamic Transport Theory (4-0).
This course collects in systematic fashion most of the physical ingredients of the large Radiation-Hydrodynamic Computer Codes for nuclear weapon development, nuclear explosion phenomena, particle beam transport, and beam-target interaction. Topics are: Boltzmann transport equation, general theory of transport processes in multi-component gases with reactions and ionization; radiation transport theory; opacity models; shock front structure. PREREQUISITES: PH 2724 and PH 3683.

PH 4881 Advanced Nuclear Physics (3-0).
Topics selected from: relativistic mechanics, scattering of electrons from nuclei, nuclear potentials, relativistic treatment of the electron using the Dirac equation and application to electron scattering to develop the Mott cross-section; treatment of form-factors arising from electron-nucleon and electron-nucleus scattering; application of electron scattering to study the structure of nucleon matter and the study of nucleon models. PREREQUISITE: PH 3855 or equivalent.

PH 4885 Reactor Theory (3-0).
The diffusion and slowing-down of neutrons. Homogeneous thermal reactors, time behavior; reactor control. Multigroup theory. Heterogeneous systems. PREREQUISITE: PH 3855 or equivalent.

PH 4911 Combat Simulation Analysis (1-2).
This is a hands-on course learning to run and analyse a combat simulation. In addition to learning to appreciate the knowledge gained from such simulations, the student also will learn to be a skeptic with regard to weaknesses inherent in simulations which are usually created to emphasize some specific aspect(s) of combat. Analysis of the data will emphasize deduction of physical principles of weapons and C3 (Command, Control and Communications). PREREQUISITE: PH 3911 or equivalent.

PH 4971 Quantum Mechanics I (4-0).
PH 4972 Quantum Mechanics II (3-0).
PH 4973 Quantum Mechanics III (3-0).
Review of Lagrange's and Hamilton's equations of motion. Poisson brackets. General principles of nonrelativistic quantum mechanics; stationary states. Addition of angular momenta; time-independent and time-dependent perturbation theory; scattering theory; identical particles and spin. General principles of relativistic quantum mechanics; properties and solutions of relativistic wave equations. PREREQUISITES: PH 3683, PH 3152.

PH 4984 Advanced Quantum Physics (4-0).
This graduate level course covers "formal" quantum mechanics in the Dirac format. Additional topics include group theory with applications to selection rules and crystal fields, variation principles, self-consistent fields in the many-electron atom, scattering theory, and polyatomic molecules. PREREQUISITE: PH 3683.

Graduate Courses

SE 4006 Technical Assessment of Weapons Systems (4-0).
This course is designed to support the Intelligence curriculum. Current technical trends in weapons systems 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 weapons concepts. PREREQUISITES: SE 3004 or equivalent, and SECRET clearance.

SE 4401 Underwater Sound, Systems, and Countermeasures (3-2).
A study of the principles of underwater sound propagation, and the design and operational characteristics of underwater sound systems. Emphasis is placed on various measures used to interfere with and to deceive active and passive Sonar systems, and the techniques used to counter this interference. Topics studied include: sensor arrays, acoustic quieting, signal processing, and examples of active and passive underwater acoustic systems, including acoustic countermeasures. PREREQUISITES: PH 2203, U.S. Citizenship and SECRET clearance.

SE 4858 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. PREREQUISITES: PH 3461, PH 4856, and SECRET clearance.

PH 4991 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. Dicke's theory, problems of quantum cosmology and superspace. PREREQUISITE: PH 4371.

PH 4998 Special Topics in Advanced Physics (1-0 to 4-0).
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. PREREQUISITE: 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.

SCIENCE AND ENGINEERING

Upper Division Course

SE 2002 Electromagnetic Systems (4-0).
This course is designed to support the Intelligence curriculum by providing an overview of the principles, concepts and tradeoffs underlying systems whose operations require the transmission and/or reception of electromagnetic energy. Topics treated in the course include: the electromagnetic spectrum and its usage, principles of electronic reconnaissance, antennas and their characteristics, factors affecting receiver sensitivity, transmission range, radar principles, the radar equation, optics fundamentals, infrared nomenclature, and principles and elements of photographic science.

Upper Division or Graduate Courses

SE 3004 Weapons Systems Analysis (4-0).
This course is designed to support the Intelligence curriculum. It treats the behavior of weapons systems as influenced by the physical properties of the environment and the physical properties of the devices incorporated into the systems. The course material includes: Electro-optical systems, with some background in semiconductors, Sonar, Non-acoustic ASW (Antisubmarine Warfare), and navigation by means of satellites. PREREQUISITES: SE 2002, EC 2003.

SE 3301 Radiating Systems (4-0).
This course for students of Operations Research and other Weapons Systems 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. PREREQUISITE: MA 1116 or equivalent (may be taken concurrently), or by consent of Instructor.

SPACE SYSTEMS ACADEMIC GROUP

Chairman:

Rudolph Panholzer, Professor,
Code 72, Halligan Hall, Room 275,
(408) 646-2948, AV 878-2984.

The Space Systems Academic Group is an interdisciplinary association of faculty, consisting of twelve members representing eight separate academic disciplines. An academic group is a less formal organization than an academic department, and each professor in the group has an appointment in an academic department. The Space Systems Academic Group has administrative responsibility for the academic content of the Space Systems Operations and the Space Systems Engineering Programs of study. Teaching in these multidisciplinary programs is carried out by faculty members attached to the following academic departments: Administrative Sciences, Aeronautics, Electrical and Computer Engineering, Mathematics, Meteorology, Oceanography, Operations Research and Physics. Thesis topics for students in this area of study are approved by the Group and the final thesis is approved by the Chairman.

GROUP FACILITIES

To provide laboratory experience several facilities have been developed in cooperation with other academic departments.

(1) Solar Simulation Facility
(2) Laser Damage Facility
(3) Linear Accelerator for Sample Irradiation
(4) Navigational Satellite Receiver Laboratory
(5) Small Satellite Test & Development Laboratory
(6) Vibro-Acoustic Test & Measurement Facility
(7) Access to the Secured Computing Facility for classified research & theses work.

DEGREE REQUIREMENTS

The Space Systems Engineering students earn a Master of Science Degree in Electrical and Computer Engineering. Refer to degree requirements as listed by the Department of Electrical and Computer Engineering.

The Space Systems Operations students are awarded the degree of Master of Science in Systems Technology (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. Space Systems Operations curriculum has a series of Space-unique and/or Space-oriented courses. These required courses fulfill the requirements of three courses constituting advanced study in an area of specialization. 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.

GROUP COURSE OFFERINGS

SS 0810 Thesis Research (0-0).
Every Student conducting thesis research enrolls in this course.

SS 2001 Introduction to Military Operations in Space (4-0).
An overview of space systems from the military point of view. Provides introduction to and a perspective on military role in space, the supporting technologies and sciences, and the missions and systems.

Upper Division or Graduate Courses

SS 3001 Military Applications of Space (4-0).
Examination of the military functions which utilize space systems and the capabilities of current systems, impact of space operations on military strategy, doctrine and tactics. National space policy and na-

tional organizations involved in space policy, DoD and service relationships. Tasking and use of space systems and ground support elements and techniques to reduce vulnerability. Impact of current R&D programs. Requires Security Clearance.

SS 3900 Special Topics in Space Systems (Variable Credit up to five hours).
Directed study either experimental or theoretical in nature. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and Instructor.

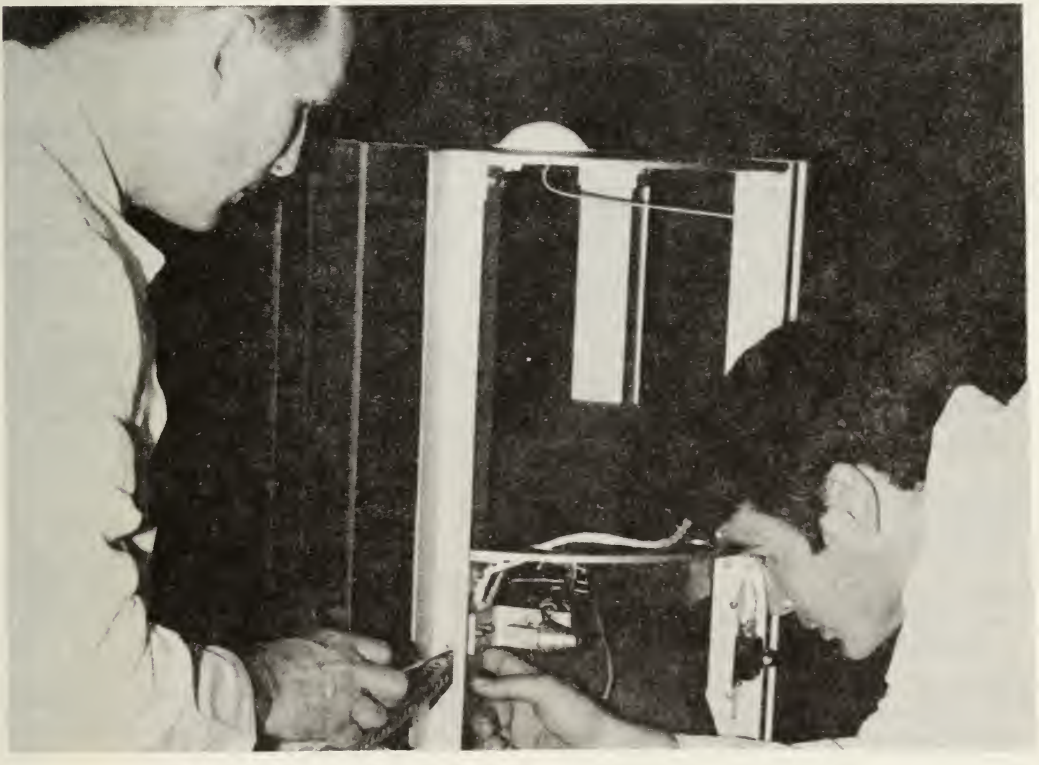
Graduate Courses

SS 4000 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.

SS 4001 Decisions and Space Systems (4-0).
Cost-Performance Analysis including mission analysis, measures of performance, and cost models. Study of the evolution of the interaction of technology, economics, and politics in determining space related activities. Discussion of the militarization of space. PREREQUISITES: SS 3001, OS 3008 or equivalent.

SS 4002 Military Operations in Space (4-0).
Operation of space systems to achieve mission objectives. Periods of vulnerability. Launch windows. Satellite defense: hardening, maneuver, encryption, covert spores, etc. ASAT operations. Launch windows. Weapons in space and threats to space systems. PREREQUISITE: SS 2001.

SS 4900 Advanced Study in Space Systems (Variable Credit up to five hours).
Directed graduate study based on journal literature, experimental projects, or other sources. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and Instructor.



DEFENSE RESOURCES MANAGEMENT EDUCATION CENTER

Robert C. Austin, Rear Admiral, U.S. Navy, Director (1986)*; MS, Naval Postgraduate School, 1963.

James Sherman Blandin, Professor (1974), Executive Director; PhD, University of Oregon, 1974.

Donald E. Bonsper, Adjunct Professor (1982); MS, Naval Postgraduate School, 1970.

Robert Edward Boynton, Associate Professor (1970); PhD, Stanford University, 1968.

Earl R. Brubaker, Professor (1983); PhD, University of Washington, 1964.

Donald H. Conrad, Lieutenant Colonel, U.S. Army, Instructor (1985); MS, Georgia Institute of Technology, 1972.

Philip Atkinson Costain, Adjunct Professor (1979); MS, Naval Postgraduate School, 1971.

John Edward Dawson, Professor (1966); DPA, Syracuse University, 1971.

Edwin John Doran, Adjunct Professor (1975); PhD, University of Santa Clara, 1977.

Peter Carl Frederiksen, Associate Professor (1974); PhD, Washington State University, 1974.

Charles J. Lacivita, Associate Professor (1985); PhD, University of California at Santa Barbara, 1981.

Francois Melese, Associate Professor (1987); PhD, University of Louvain, Belgium, 1982.

James H. Morris, Associate Professor (1982); PhD, University of Oregon, 1976.

Stephen M. Passarello, Captain, U.S. Air Force, Instructor (1987); MS, Air Force Institute of Technology, 1981.

Robert L. Pirog, Assistant Professor (1983); PhD, Columbia University, 1978.

Frank T. Proctor, Lieutenant Colonel, U.S. Army, Instructor (1987); MS, Naval Postgraduate School, 1979.

Alexander Wolfgang Rilling, Adjunct Professor (1974); PhD, University of Southern California, 1972.

Larry E. Vaughan, Lieutenant Commander, SC, U.S. Navy, Instructor (1985); MS, Naval Postgraduate School, 1974.

Robert von Pagenhardt, Professor (1967); PhD, Stanford University, 1970.

Kent D. Wall, Associate Professor (1985); PhD, University of Minnesota, 1971.

Terry L. Wray, Lieutenant Commander, CEC, U.S. Navy, Instructor (1986); MS, Naval Postgraduate School, 1979.

Frank Yohannan, Lieutenant Colonel, U.S. Marine Corps, Instructor (1985); MBA, University of Colorado.

Emeritus Faculty

William Ayers Campbell, Professor Emeritus (1970); MSIM, University of Pittsburgh Graduate School, 1949.

Frank Elmer Childs, Professor Emeritus (1965); PhD, University of Minnesota, 1956.

Norman Plotkin, Professor Emeritus (1969); PhD, Claremont Graduate School, 1969.

Ivon William Ulrey, Professor Emeritus (1966); PhD, Ohio State University, 1953.

Carlton Leroy Wood, Professor Emeritus (1966); PhD, Heidelberg University, 1936.

**The year of joining the Postgraduate School Faculty is indicated in parentheses.*

DEFENCE RESOURCES MANAGEMENT EDUCATION CENTER

Established in 1965 as the Navy Management Systems Center and redesignated to its present title in July 1974, the Defense Resources Management Education Center 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 Center 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 Center are set forth in Department of Defense Directive 5010.35.

The Center 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 5010.16-C (Defense Management Education and Training Catalog).

In addition to its regularly scheduled resident programs, the Center also provides:

MOBILE EDUCATION COURSES — normally two or three 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 of 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 Center are members of the faculty of the Naval Postgraduate School on assignment to the Center.

Since 1966, over 16,000 officials, of whom more than 5,000 represented 81 foreign nations, have participated in programs conducted by the Center.

DEFENSE RESOURCES MANAGEMENT COURSE

The objective of this four-week course is to provide an appreciation of the concepts, principles, and methods of defense management as they con-

cern 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 problems sets, as well as selected daily reading assignments.

This course is primarily for U.S. officials, although limited numbers of foreign participants are normally also enrolled.

INTERNATIONAL DEFENSE MANAGEMENT COURSE

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 50 participants. Broad national representation is desired for this course, i.e., participation of at least eight or ten 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: environmental factors; 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.

Early in the course, participants are requested to give brief presentations (by country) on their particular environmental situations, including such information as geographic factors, economic factors, social and cultural considerations, governmental and defense organizations, and unique management situations and/or problems. 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 Center conducts field trips to selected military and commercial installations in the central California area. These trips provide 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 recourses 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

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 40 to 50 senior officials from as many as 22 countries.

The course is presented in English.

The lecture, small discussion group, environmental seminar, case study and problem format and content described above for IDMC 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.

TENTATIVE FY 88 SCHEDULE OF RESIDENT COURSES

*IDMC 87-2 (11 weeks)	14 Sep - 25 Nov 87
DRMC 88-1 (4 weeks)	4 Jan - 29 Jan 88
IDMC 88-1 (11 weeks)	1 Feb - 13 Apr 88
DRMC 88-2 (4 weeks)	18 Apr - 12 May 88
DRMC 88-3 (4 weeks)	16 May - 10 Jun 88
19th Annual SIDMC 88 (4 weeks)	20 Jun - 15 Jul 88
DRMC 88-4 (4 weeks)	18 Jul - 11 Aug 88
DRMC 88-5 (4 weeks)	15 Aug - 9 Sep 88
*IDMC 88-2 (11 weeks)	12 Sep - 23 Nov 88

*These courses convene in one fiscal year and continue into the next.

NOTE: The above dates are tentative.

DISTINGUISHED ALUMNI

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers (USN or USMC unless otherwise indicated) have attained flag rank and were on the active list as of 1 July 1987:

Admiral Lee Baggett, Jr.
Admiral James B. Busey
Vice Admiral Glenwood Clark, Jr.
Vice Admiral John D. Costello, USCG
Vice Admiral George W. Davis, Jr.
Vice Admiral Robert F. Dunn
Vice Admiral Albert J. Herberger
Vice Admiral Thomas J. Hughes, Jr.
Vice Admiral Paul F. McCarthy, Jr.
Vice Admiral Joseph Metcalf, III
Vice Admiral Kendall E. Moranville
Vice Admiral Henry C. Mustin
Vice Admiral Walter T. Piotti, Jr.
Vice Admiral William H. Rowden
Vice Admiral James E. Service
Vice Admiral Jerry O. Tuttle
Vice Admiral Joseph B. Wilkinson, Jr.
Rear Admiral Robert H. Ailes
Rear Admiral Theodore A. Almstedt, Jr.
Rear Admiral Stanley R. Arthur
Rear Admiral Robert C. Austin
Rear Admiral Warren E. Aut
Rear Admiral Roger F. Bacon
Rear Admiral John R. Batzler
Rear Admiral Jerry C. Breast
Rear Admiral Dennis M. Brooks
Rear Admiral Denny B. Cargill
Major General W.G. Carson, Jr.
Rear Admiral Ming E. Chang
Rear Admiral Michael C. Colley
Major General Clayton L. Comfort
Rear Admiral David P. Donohue
Rear Admiral James F. Dorsey, Jr.
Rear Admiral Thomas R.M. Emery
Rear Admiral William J. Finneran
Rear Admiral Salvatore F. Gallo
Rear Admiral Richard C. Gentz
Rear Admiral Richard J. Grich
Major General Richard A. Gustafson
Rear Admiral Benjamin T. Hacker
Rear Admiral Warren C. Hamm, Jr.
Rear Admiral David L. Harlow
Rear Admiral Peter M. Hekman, Jr.
Rear Admiral B.F. Hollingsworth, USCG
Rear Admiral Jerome L. Johnson
Rear Admiral Robert J. Kelly
Rear Admiral Robert K.U. Kihune
Rear Admiral Stephen F. Loftus
Rear Admiral Thomas T. Matterson, USCG
Rear Admiral Henry H. Mauz, Jr.
Rear Admiral William F. Merlin, USCG
Rear Admiral John W. Nyquist
Rear Admiral Richard F. Pittenger
Rear Admiral James G. Reynolds
Rear Admiral Myron V. Ricketts
Rear Admiral Donald P. Roane
Rear Admiral Grant A. Sharp
Rear Admiral John F. Shaw
Rear Admiral Robert H. Shumaker
Rear Admiral Jeremy D. Taylor
Rear Admiral Richard C. Ustick
Rear Admiral Hush L. Webster
Rear Admiral Donald E. Wilson
Rear Admiral Daniel J. Wolkensdorfer
Major General John J. Yeosock, USA
Rear Admiral John W. Adams
Rear Admiral Richard C. Allen
Rear Admiral Clarence E. Armstrong, Jr.
Brigadier General James D. Beans
Rear Admiral James B. Best
Rear Admiral Larry E. Blose
Rear Admiral Bruce R. Boland
Rear Admiral William C. Bowes
Rear Admiral Richard F. Butts
Rear Admiral John F. Calhoun
Rear Admiral John F. Calvert
Rear Admiral Arlington F. Campbell
Rear Admiral Kenneth L. Carlsen
Rear Admiral Stephen K. Chadwick
Rear Admiral Charles F. Clark
Rear Admiral Eugene D. Conner
Rear Admiral Craig E. Dorman
Rear Admiral William A. Dougherty, Jr.
Rear Admiral Philip F. Duffy
Rear Admiral Gerard J. Flannery, Jr.
Rear Admiral R.D. Friichtenicht
Rear Admiral George N. Gee
Rear Admiral W. Lewis Glenn, Jr.

Rear Admiral James B. Green, Jr.
Rear Admiral Roland G. Guilbault
Rear Admiral Lowell J. Holloway
Brigadier General Joseph E. Hopkins
Rear Admiral R.B. Horne, Jr.
Rear Admiral John H. Kirkpatrick
Rear Admiral Bobby C. Lee
Rear Admiral Irve C. Lemoyne
Rear Admiral Richard C. Macke
Rear Admiral Kenneth C. Malley
Rear Admiral Daniel P. March
Rear Admiral Henry C. McKinney
Rear Admiral Phillip F. McNall
Rear Admiral Eric A. McVadon, Jr.
Rear Admiral Thomas A. Meinicke
Rear Admiral George R. Meinig, Jr.
Rear Admiral Thomas A. Mercer
Rear Admiral Fredrick J. Metz
Rear Admiral James E. Miller
Rear Admiral Richard D. Milligan
Rear Admiral Riley D. Mixson
Rear Admiral Alvin S. Newman
Rear Admiral Phillip R. Olson
Rear Admiral Oakley E. Osborn
Rear Admiral Thomas D. Paulsen
Rear Admiral Harry S. Quast
Rear Admiral Joseph P. Reason
Rear Admiral Daniel C. Richardson
Rear Admiral Gerald L. Riendeau
Rear Admiral David N. Rogers
Rear Admiral John R. Seesholtz
Rear Admiral Thomas U. Seigenthaler
Brigadier General David V. Shuter
Brigadier General Stephen Silvasy, Jr., USA
Rear Admiral Vernon C. Smith
Rear Admiral Rodney K. Squibb
Rear Admiral George H. Strohsahl, Jr.
Rear Admiral James E. Taylor
Rear Admiral Robert L. Topping
Rear Admiral Robert E. Traister
Rear Admiral Robert E. Unruh
Rear Admiral Douglas Volgenau
Rear Admiral Raymond M. Walsh
Rear Admiral John C. Weaver
Rear Admiral Ronald C. Wilgenbusch
Rear Admiral Raymond G. Zeller

ACADEMIC CALENDAR

Fall Quarter AY '88

Reporting Date ..... Monday, 21 September 1987
Instruction Begins ..... Monday, 28 September
Columbus Day (Holiday) ..... Monday, 12 October
Reporting Date for Refresher ..... Thursday, 5 November
Refresher Begins ..... Monday, 9 November
Veteran's Day (Holiday) ..... Wednesday, 11 November
Thanksgiving Day (Holiday) ..... Thursday, 26 November
Quarter Final Exams ..... Monday-Thursday, 14-17 December
Graduation Exercises ..... Thursday, 17 December

Winter Quarter AY '88

Reporting Date ..... Monday, 28 December 1987
New Year's Day (Holiday) ..... Friday, 1 January 1988
Instruction Begins ..... Monday, 4 January
Martin Luther King's Birthday (Holiday) .. Monday, 18 January
Reporting Date for Refresher ..... Thursday, 11 February
Washington's Birthday (Holiday) ..... Monday, 15 February
Refresher Begins ..... Tuesday, 16 February
Quarter Final Exams ..... Monday-Thursday, 21-24 March
Graduation Exercises ..... Thursday, 24 March

Spring Quarter AY '88

Reporting Date ..... Monday, 21 March 1988
Instruction Begins ..... Monday, 28 March
Reporting Date for Refresher ..... Thursday, 5 May
Refresher Begins ..... Monday, 9 May
Memorial Day (Holiday) ..... Monday, 30 May
Quarter Final Exams ..... Monday-Thursday, 13-16 June
Graduation Exercises ..... Thursday, 16 June

Summer Quarter AY '88

Reporting Date ..... Monday, 27 June 1988
Independence Day (Holiday) ..... Monday, 4 July
Instruction Begins ..... Tuesday, 5 July
Reporting Date for Refresher ..... Thursday, 11 August
Refresher Begins ..... Monday, 15 August
Labor Day (Holiday) ..... Monday, 5 September
Quarter Final Exams ..... Monday-Thursday, 19-22 September
Graduation Exercises ..... Thursday, 22 September

Fall Quarter AY '89

Reporting Date ..... Monday, 19 September 1988
Instruction Begins ..... Monday, 26 September
Columbus Day (Holiday) ..... Monday, 10 October
Reporting Date for Refresher ..... Thursday, 10 November
Veteran's Day (Holiday) ..... Friday, 11 November
Refresher Begins ..... Monday, 14 November
Thanksgiving Day (Holiday) ..... Thursday, 24 November
Quarter Final Exams ..... Monday-Thursday, 12-15 December
Graduation Exercises ..... Thursday, 15 December

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