NAVAL POSTGRADUATE SCHOOL CATALOG

ACADEMIC YEAR 2000

OVERVIEW

The School

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

The Campus

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

The Students

Nearly 1,400 students attend the Naval Postgraduate School in residence, and another 150 in off campus degree programs. The student body consists of U.S. officers from all branches of the uniformed services, officers from approximately 45 other countries and a small number of civilians. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background.

The Faculty

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

The Degrees

The Naval Postgraduate School offers classes leading to advanced degrees in a variety of fields.

MASTER OF ARTS DEGREE: International Security & Civil-Military Relations, National Security Affairs

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

ENGINEER DEGREE: Aeronautical and Astronautical Engineer, Electrical Engineer, Mechanical Engineer.

DOCTOR OF PHILOSOPHY: Aeronautical and Astronautical Engineering, Applied Mathematics, Applied Physics, Computer Science, Electrical Engineering, Engineering Acoustics, Mechanical Engineering,Meteorology, Modeling Virtual Environments and Simulation, Operations Research, Physical Oceanography, Physics, Software Engineering.

DOCTOR OF ENGINEERING: Aeronautical and Astronautical Engineering, Engineering Acoustics, Mechanical Engineering.

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

Director of Admissions
Code 01B3
Naval Postgraduate School
589 Dyer Road, Room 103C
Monterey, CA 93943-5100
Telephone: (831) 656-3093 / DSN 878-3093

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

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CNO GRADUATE EDUCATION STATEMENT

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

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

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

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

JAY L. JOHNSON
Admiral, U.S. Navy

INTRODUCTION

THE SCHOOL

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

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

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

THE MISSION

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

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

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

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

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs, to be responsive to technological change and innovation in the Navy, and to prepare officers to introduce and utilize future technologies.

ACCREDITATION

The Naval Postgraduate School is accredited by the Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges (WASC). Engineering curricula accredited by the Accrediting Board for Engineering and Technology (ABET) are Aeronautical, Electrical and Mechanical. The Systems Management Curricula are accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

DEGREES CONFERRED

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

DEGREES

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

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

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

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

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

DUDLEY KNOX LIBRARY

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

Through its electronic resources areas, the Library provides direct patron access to an increasing number of CD-ROM databases and other electronic resources. Access to a wide range of Internet-based on-line databases is also made possible via the Library's Home Page [http://web.nps.navy.mil/~library/]. Organized by subject, the Library's "Resources" Page provides links to many full-text online resources, indexing and abstracting services and other useful Internet sites. Library staff members actively identify and provide links to many full-text electronic publications and journals especially those pertinent to the military.

BOSUN (the Library's on-line catalog) is also web accessible and provides information regarding the Library's holdings as well some links to Internet versions of reports and publications. Through BOSUN, users can remotely renew the materials they have checked out, place holds or make book purchase suggestions. BOSUN is also the primary entry way into Hyperion, the Library's digital archive. In the archive users have one-stop access to a variety of full text materials. The selection of available archive items will continue to grow as the Library continues to add more and more relevant collections.

Presently, the Library's holdings number approximately 450,000 bibliographic volumes in hard copy, 1,500,000 volumes in microform, and 1370 journal subscriptions. A staff of 29 librarians and library support personnel identify and process materials for the collection, and assist members of the campus community and the public to find information resources useful for their work.

The Library completed an expansion project in late 1993, nearly doubling the usable space which now totals approximately 100,000 sq. ft. The Library contains photocopy facilities, individual study carrels, and group study rooms and provides reference, on-line searching, circulation, and telephone paging services. The Library has developed a map collection in support of the curriculum. The Christopher Buckley, Jr., Collection of books on naval and maritime history includes both fiction and nonfiction. The Library is a selective depository for information distributed through the Federal Depository Program. The Library administers a Secure Word Processing Facility which enables students and other members of the campus community to prepare theses and other reports of research which draw upon its collections of classified materials.

The Library is organized into service groups responsible for acquiring and processing research and instructional materials and providing user support in the use of these materials. The Information Services group provides reference, user instruction, on-line searching, interlibrary loan, document delivery and circulation services for the Library's open-literature and restricted (classified) collections. The Library Systems Office provides hardware/ software support, maintenance, planning and evaluation for both administrative and instructional computer systems within the Library. The Technical Services group purchases, catalogs, and enters materials into the Library's on-line catalog, and maintains the accuracy of that database.

The Library is a member of the Monterey Bay Area Cooperative (MOBAC) Library System which provides expedited interlibrary loan among its members. The Library also participates in the Online Computer Library Center (OCLC)'s interlibrary loan program, which facilitates borrowing of materials throughout the U.S., and the Military Education Coordinating Council, whose linked catalog project (MERLN) provides access to the catalogs of other DoD institutions delivering joint military education.

CAMPUS COMPUTING

The computing services provided at NPS have evolved over the last forty years to keep abreast of both high performance computing for problem-solving research as well as extensive data manipulation of files and on-line databases to clarify questions from a wide variety of disciplines. The current use of state-of-the-art client-server and open-systems web access solutions from the Information Technology (IT) industry has greatly improved NPS graduate student, faculty and staff computer uses for academic instruction and research. Administrative staffs and tenant agencies also have their own special campus-wide computer focus. A new DoD- and Navy-funded optical fiber Ether/Net (E/N) campus-wide network being installed over a four-year period has greatly improved everyone's access to computing.

Two more recent focuses have been on both the Year-2000 (Y2K) readiness and certification of hardware or software, as well as being more supportive of the Navy fleet, and other DoD agencies, by adapting the Information Technologies for the 21st century (IT-21) standards set by the Navy. All of the individual Academic Departments and NPS-05 IT Services are using these and other specific NPS standards as primary guidelines for current procurements on desktop computers, servers and their software.

NPS-05 Information Technology

NPS IT Network Operations Center (NOC): NPS Networking is run like a utility company with the goal of 24-hour by 7-day-a-week availability to NPS campus services via the NPS campus Intranet and the off-campus Internet. The IT staff can customize the wide bandwidth for individual educational requirements. Recent pentagon funding made possible a four year, multi-million dollar upgrade in the latest technology to our NPS campus Intranet.

The network incorporates 10/100baseT, FDDI-100, 155 and 655 ATM fiber-optic links both as the backbone between building servers as well as between major sections on each floor located in several dozen 2-12 giga-switched back-planed Hubs. These 3-COM models 7000/3000 Hubs are remotely SNMP managed back to a new communications control center in Ingersoll Hall using CISCO 7500 and 5500 routers and bridges. A major part of the ongoing install time is for category-5 covered copper wiring, with 10/100baseT connections, for each office, lab and all classrooms. Off-campus access is normally via the Internet, DoD secure networks or dial-up 33-56 kilobyte modems. This department also handles the cable TV network for individual student computer interfaces in the base housing units.

NPS IT Services: Over 2,000 users access many applications on multiple CPU Pentium NT and UNIX servers for the network access to many services for both administrative and curricular functions on the NPS campus:

- IT Services provides all NPS administrative department users with Pentium 200 MHz or better PC desktops and assure they can access the NPS network servers. These clients are migrating from Microsoft DOS, WIN/3.1, WIN95, and WIN98 to NT/Client version 4 and 5.
- The MS/Exchange post-office servers interface with the supported client MS/Outlook desktops for their e-mail access.
- Site licensing for common academic and administrative uses is managed centrally. Both the Microsoft Office 97/98 suite of WORD, EXCEL, PowerPoint and ACCESS database as the standard desktop software at NPS plus MATLAB 4.2 and 5.0 for math problem solutions are two examples.
- File systems administration, including server-centric database administration for MS/SQL Server and some ORACLE/7 applications is centrally managed.
- Centralized management and systems administration of operating systems software on SUN, SGI, IBM, DEC/ Alpha, Cray and Intel workstations or servers is a primary IT Services staff function.
- MS/Explorer and Netscape/Navigator are both supported to access both the Internet and Intranet web pages for students, faculty and staff.
- User support services management assists students, faculty and staff with the best use of NPS campus computing and provides hands on training if necessary. This includes student registration and passwords to access NPS IT services.
- The NPS-05 IT Help-Desk will assist anyone with campus-wide computing or networking needs via the web at www.helpdesk.nps.navy.mil or e-mail via helpdesk@nps.navy.mil or telephone 656-1046 and 656-1047 or via FAX to 656-1045. Eighty percent of the questions are answered at the time of the call, with the rest routed to the proper NPS-05 ITS or Academic technical staffs for follow-up. All answers are tracked in a database to be available to both end users and systems administrators to improve everyone's knowledge and staff service levels.

NPS IT Applications Development: This core group of experienced IT professionals helps NPS departments to evaluate Commercial Off the Shelf (COTS) applications, assists in the install and training for new standards like the Year-2000 issues and production systems roll-out plus make recommendations on application upgrades. If custom code is necessary, there is a small staff of application developers and database administrators using MS/SQL Server, SQL+. ORACLE/7 and IBI/FOCUS.

One of the primary NPS information dissemination methods supported by this group is using LAN and Intranet web page management, including maintaining the www.nps.navy.mil site. They also publish agreed upon NPS web guidelines and standards plus provide assistance to all departments on web pages. Several papers, guidelines, standards and department information web pages are available on many NPS Intranet web sites. These include departmental staff, research projects, NPS telephone directory and a centralized e-mail directory among others.

NPS IT S/390 Data Center: The twenty-year-old System/370 IBM mainframe architecture used at NPS with the Amdahl/1100A was upgraded January of 1997 to the latest IBM generation-III, System/390 9672 model R24. This leading edge IBM CMOS S/390 has 2,048 mega-bytes of RAM with three levels of cache to the two high-speed parallel transaction server CPUs. These CPUs can be expanded to 14 in each rack or upgraded to newer generation, higher-speed hardware racks. This is the first of 32 possible hardware rack complexes in a parallel sysplex system, if ever needed.

The 18 mega-byte ESCON channels run between cycle steal memory and the STK tape Silos as well as the 1-gigabyte 3990-006 disk control units which provide four-way interleaved, three-level cached access to RAID-1, RAID-5 and IBM 3390-002 disk drives. There are over 262gb of RAID-1 mirrored systems and data disks, 68gb expanding to 137 GB of useable RAID-5 database disks and other 3390s for a total over 400gb available disk space. The VM/ESA and three OS390 (MVS/ESA and Open Systems POSIX) now use only four of the ten possible PR/SMs that concurrently run different operating systems.

The primary file structures used under OS390 and MVS are VSAM, sequential disk or tape cartridges, HFS, plus IBI/FOCUS or ORACLE/7 as typical databases run for both NPS and tenant agencies like Defense Manpower Data Center (DMDC). DMDC and other tenant agencies are very compatible users of NPS campus computing with the synergism of students and faculty doing extensive research on the data from "live" DoD systems with resident staffs available. There are close to 10,000 different program jobs that run on the S/390 using FORTRAN, PL/I, COBOL, C and C++ compilers in background production or online debug mode for program development.

NPS IT Visualization Lab: The NPS Vis-lab is located in Ingersoll Hall room 148 to use a matrix of data to compute non-trivial solutions that can be displayed on either softcopy or broadcast quality video or hardcopy. Some of the many tools available are the SGI 4 CPU Onyx-2 with 1024 MB-RAM using a high-end infinite reality graphics hardware to marry it to the NPS Super Computing Lab CRAY and many high Mega-FLOP workstations across the campus Intranet.

NPS IT Super Computer Lab: The "jedi" CRAY Research J90 is a 4 multiprocessor CPU vector computer with 1024 MB-RAM and enough disk storage to keep jobs rapidly flowing from the Vis-lab and many SUN, DEC and SGI workstations across the campus Intranet or off-site Internet. After the multi-disciplined high end super computing is done using the 200 mega-FLOPs times the 4 CPUs on the Cray, the user can store the data in the STK Silos using Data Migration Facility (DMF) that manages the robot retrieval of 5,000 tapes.

NPS IT Computer Security: All Automatic Data Processing (ADP) security issues and standards management, including publishing NPS minimum-security standards and alerts, are monitored and enforced by this department.

NPS 05 IT Dean and Senior Computer Staff: These professors and senior staff focus on the NPS 05-IT department's Life-Cycle Management (LCM), strategic planning and other management issues.

NPS Academic and Research Departments

All academic and research department users at NPS have available tailored labs for conducting research and classroom exercises on state-of-the-art computer equipment. Some clustering by academic building and academic research groups for IT technical support has been very productive.

The Computer Users Council (CUC) meets monthly and is one of several steering committees that provide primary first-hand end-user feedback to the NPS-05 IT department. Many requirements are analyzed monthly to improve the IT computing and networking services on the NPS campus. Your feedback as a student, faculty or staff person is important to keep us informed of your requirements and satisfaction level.

NAVAL POSTGRADUATE SCHOOL FOUNDATION

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

Since its founding in December 1970, Foundation support has had an increasing impact on School operations. Currently, it administers more than a dozen major projects serving to promote excellence in teaching and research, and enhancing the academic and support facilities of the School. Individuals wishing to participate in the work of the Foundation may obtain further information by calling (831) 656-2339, by emailing npsfoundation@nps.navy.mil or by writing to the Naval Postgraduate School Foundation, P.O. Box 8626, Monterey, CA, 93943.

ALUMNI RELATIONS OFFICE

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

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

Director, Alumni Relations
1 University Circle
Code 004A
Monterey, CA 93943-5029
Telephone (831) 656-2981/DSN 878-2981/FAX (831) 656-3172
e-mail: alumni@nps.navy.mil
Homepage: http://web.nps.navy.mil/~alumni/

SCHOOL STRUCTURE AND ORGANIZATION

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

GRADUATE EDUCATION REVIEW BOARD

A Graduate Education Review Board, chaired by the Vice Chief of Naval Operations, meets semi-annually to provide policy guidance and direction for the Navy's graduate education programs. The Board acts as the School's Board of Trustees.

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 and advise the Secretary of the Navy concerning the Navy's Graduate Education Programs. In fulfilling this objective, the Board assesses the effectiveness with which the Naval Postgraduate School is accomplishing its mission and evaluates its future plans. Board members are appointed for terms of two years by the Secretary of the Navy upon the recommendation of the Superintendent. Each appointment is renewable once for a second period of two years.

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

ADMINISTRATION

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

SUPERINTENDENT
Robert C. Chaplin
Rear Admiral, U.S. Navy

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

The Superintendent has command responsibility for accomplishment of the School's mission. The Superintendent's principal assistant is the Provost/Academic Dean, who is the ranking member of the civilian faculty. 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.

ADMINISTRATIVE STAFF

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

DIRECTOR OF RESOURCE MANAGEMENT
Stu Markey
CDR, U.S. Navy

DEAN OF STUDENTS/DIRECTOR OF PROGRAMS
Randall J. Hess
Captain, U.S. Navy

COMMANDER, NAVAL SUPPORT ACTIVITY
Deane Gibson
Captain, U.S. Navy

DEAN OF COMPUTER AND INFORMATION SCIENCES AND OPERATIONS
Dan Boger
Professor of Management

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

DEAN OF OPERATIONAL AND POLICY SCIENCES
Peter Purdue
Professor of Operations Research

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

ASSOCIATE PROVOST FOR INSTRUCTION
Anthony P. Ciavarelli, Jr.
Professor of Psychology

ASSOCIATE PROVOST FOR COMPUTER INFORMATION SERVICES
Thomas Halwachs
Senior Lecturer of Operations Research

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

DIRECTOR, EXECUTIVE EDUCATION
Barry Frew
Associate Professor of Information Systems

ACADEMIC DEPARTMENTS, GROUPS AND COMMITTEES

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

ACADEMIC DEPARTMENTS

- Aeronautics and Astronautics
- Computer Science
- Electrical and Computer Engineering
- Mathematics
- Mechanical Engineering
- Meteorology
- National Security Affairs
- Oceanography
- Operations Research
- Physics
- Systems Management

ACADEMIC GROUPS

- Command, Control and Communications
- Information Systems
- Information Warfare
- Modeling Virtual Environments and Simulation
- Space Systems
- Special Operations
- Undersea Warfare

ACADEMIC COMMITTEE

- Engineering Acoustics

CURRICULAR OFFICES

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

Students are grouped in accordance with their curricular programs and are assigned to 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 Associate Provost for Instruction and Deans for the integrity and academic soundness of the academic features of curriculum options. Curricular Officers ensure their curricula meet Navy needs and ensure the proper administrative operation of their respective offices. They report to the Dean of Students/Director of Programs. Academic Associates report to the Associate Provost for Instruction.

The table beginning on page 16 summarizes the curricula offered through the Naval Postgraduate School. Specific academic requirements for enrollment are contained in each curriculum segment.

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

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

INTERNATIONAL PROGRAMS OFFICE

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

Since 1954, over 3400 International officers from 75 countries have graduated from NPS. Many have gone on to achieve positions of prominence within their military services, governments, and private industry. The International Program at NPS serves as an integral link in establishing the long term military-to-military relationships between our U.S. and international officers. The International Programs Office sponsors the courses:

IT1500 Information Program Seminar for International Officers (4-0)
Provides International students with an awareness and functional understanding of internationally recognized human rights and the American democratic way of life. Areas of emphasis introduced during the seminar include civil-military relations, human rights, relationships in a democratic society, and a comparative look at the U.S. free enterprise system.

IT1600 Communication Skills for International Officers (3-0)
Provides the opportunity to enhance English speaking and listening skills by taking part in organized oral exercises, group discussions, and instructional briefings on a variety of subjects. The course addresses pronunciation by incorporating language software programs to improve speaking. Building reading and writing skills is part of the course but not the main focus.

IT1700 Academic Writing for International Officers (2-0)
Structured to prepare students for the task of writing a research or thesis paper. The course updates students on the organization and the rhetorical styles in an academic paper by discussing, analyzing, writing, revising and editing various papers. Strategies for thesis preparation are covered.

CENTER FOR EXECUTIVE EDUCATION

Organization Overview

Unlike many other organizations focused on senior management, the center is exclusively dedicated to enhancing the knowledge and understanding of leaders within the Department of Navy and Department of Defense and those who are in partnership with the leaders who will be making critical decisions affecting the nation's readiness in this complex and rapidly changing environment.

This center has a significant influence on the management awareness of DoN/DoD relevant information resource management issues, information and human resource policies, information resource allocations, and business practices.

Mission

The mission of the center is to create and deliver high quality graduate level education programs that help flag level DoN/DoD executives better understand emerging strategic and policy issues and practices in conjunction with the opportunities and constraints provided within their organizational setting.

Purpose
The purpose of the center is to apply our unique and highly relevant educational and research skills and activities to enhance the business objectives of our sponsors and the human capital of our participants.

Strategic Direction
The center is committed to expanding existing ties with industry and other organizations and institutions, and to study emerging technologies, practices, and policies in order to enhance the capabilities of DoN/DoD systems, commands, people, and information. To accomplish this, CEE:

- Combines defense decision makers, industry decision makers, and members of the academic community in a nonpartisan forum of discussion and learning where each can benefit.
- Provides an environment where defense issues may be better defined and understood.
- Provides executive education programs that furnish the tools and skills necessary to add value to senior defense leaders.
- Provides educational content that is free from technological, political, and budget bias.

Major course offerings:

LEADING CHANGE IN THE INFORMATION AGE
The focus of this program is to increase the problem-solving ability in information superiority of senior defense executives in performing their demanding leadership roles. Participants become more familiar with:

- Development and maintenance of sound integrated technology infrastructures and application systems.
- Application delivery and operation.
- Tools and methods used to monitor and evaluate performance of installed warfare systems.

The material is concentrated on the underlying principles of technologies and on the ability to analyze and synthesize effective and flexible strategies. The intellectual framework consists of the following:

- An architectures, systems, and technologies component and an information policy, strategy, evaluation, and operation component.
- Resources and how to use them for optimal effect.

Both components aim to provide a comprehensive understanding of information.

The format for this program provides half-day modules using readings and lectures to drive discussion followed by case study analysis and practical exercises aimed at providing solutions to provocative questions or real-life situations. It includes a balanced mix of experienced practitioner and academic views. Participants meet with several industry representatives to learn about new and existing technologies.

REVOLUTION IN BUSINESS PRACTICES
Vision, Strategy, and Best Practices in the Information Age

The primary emphasis of the program is to expose participants to new and emerging approaches to business process improvements and to provide a forum for debating the relevance and applicability of such ideas to DoN. The program takes an executive-level perspective on a range of issues dealing with planning, budgeting, strategic thinking in the business sense, effective use and transfer of information, business process design for efficiency and effectiveness, and effective implementation tactics.

Presentations and discussion topics emphasize new and provocative ideas that offer promise to enhance the quality and/or speed of decisions, increase the efficiency and/or effectiveness of operations, provide leadership with improved information about results and consequences of action, or give leaders new ways of carrying out their personal responsibilities and duties. Specific topics include: how to be a good executive consumer of quality analysis; how to gain maximum leverage of information technology, keeping focused on the ‘information’ in IT, economics of IT investments; making change happen, managing momentum, implementation tools and tactics; benchmarking: whys and hows, ‘make-buy’ decisions, outsourcing: new ways of thinking about problems, new problems, knowledge management, creating and nurturing innovation in complex organizations, when and why, and relative effectiveness of alternative organizational structures.

NPS CURRICULA SUMMARY

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Aerospace Engineering				
Aeronautical Engineering	610	24	March/September	31
Aeronautical Engineering with Avionics	611	24	March/September	31
NPS/TPS	612	15 + TPS	January/July	31
Combat Systems Sciences & Technology				
Combat Systems Science/Tech..	533	24	January/July	34
Applied Physics..	534	18	January/July	34
Underwater Acoustics	535	18	January/July	34
Computer Programs				
Computer Science	368	24	March/September	32
Software Engineering	369	24	September	32
Modeling, Virtual Environments & Simulation	399	24	March/September	32
Electronics Systems Engrg				
Electronics Systems Engrg	590	24	Any Quarter	34
Electronic Warfare				
Electronic Warfare Systems International	596	24	September	37
Information Systems & Operations				
Information Systems & Operations	356	15	March/September	32
Information Systems Technology				
Information Systems Technology	370	24	March/September	32
Information Warfare				
Information Warfare	595	24	September	37
Joint Command, Control, Communications Computers & Intelligence (C4I)				
Joint Command, Control, Communications, Computers & Intelligence (C4I) Systems	365	21	September	39
Intelligence Information Management	823	21	September	39
Meteorology and Oceanography				
Meteorology	372	15	January/July	35
METOC	373	24	January/July	35
Operational Oceanography	374	24	January/July	35
Oceanography	440	24	January/July	35
National Security and Intelligence				
Middle East, Africa, South Asia	681	18	Any Quarter	38
Far East, Southeast Asia Pacific	682	18	Any Quarter	38
Western Hemisphere	683	18	Any Quarter	38
Russia, Europe, Central Asia	684	18	Any Quarter	38
Strategic Studies	688	18	Any Quarter	38
Int'l Sec & Civil-Military Relations	689	15	January	38
Regional Intelligence	824	18	Any Quarter	38
Naval/Mechanical Engineering				
Naval/Mechanical Engineering	570	24	March/September	34
Reactors/Mechanical Engineering (Distance Learning)	571	18	March/September	34

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Operations Analysis				
Operations Analysis	360	21	March/September	30
Operational Logistics	361	21	March/September	30
Advanced Science (Applied Mathematics)	380	24	July	30
Space Systems				
Space Systems Operations International	364	24	September	31
Space Systems Operations	366	24	September	31
Space Systems Engineering	591	27	September	31
Special Operations				
Special Operations	699	18	July	37
Systems Engineering/Integration				
Systems Engineering/Integration	308	18	July	31
Systems Management				
Transportation Logistics Management	813	21	July	36
Transportation Management	814	21	July	36
Acquisition & Contract Management	815	18	January/July	36
Systems Acquisition Management	816	18-21	January/July	36
Defense Systems Analysis	817	18	January/July	36
Defense Systems Management International	818	18	January/July	36
Systems Inventory Management	819	18	July	36
Resource Planning and Management for International Defense	820	18	January	36
Material Logistics Support Management	827	18	January/July	36
Contract Management (Distance Learning)	835	27	March/September	36
Program Management (Distance Learning)	836	27	March/September	36
Financial Management	837	18	January/July	36
Manpower Systems Analysis	847	21	July	36
Leadership Education and Development	856	12	June	36
Shore Installation Management	877	18	January	36
Undersea Warfare				
Undersea Warfare	525	24	March/September	35
Undersea Warfare International	526	24	March/September	35

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

Curriculum Number	Curriculum Title	Admission APC	Subspecialty Code (OLD / NEW)	Degree
308	Systems Engrg/Integration	334	6500P	MS Systems Integration
356	Information Systems & Oper	334	6100P	MS Information Systems & Operations
360	Operations Analysis	324	XX42P / 3211P	MS Operations Research
361	Operational Logistics	324	XX43P / 3212P	MS Operations Research
364	Space Systems Operations International	324	None	MS Space Systems Operations
365	Joint Cmd, Cntrl, Comm, Comp/Intel (C4I) Sys	324	XX45P / 6204P	MS Systems Tech (C3)
366	Space Systems Operations	324	XX76P / 6206P	MS Space Systems Operations
368	Computer Science	325	XX91P / 6203P	MS Computer Science
369	Software Engineering	325		MS Software Engineering
370	Information Systems Technology	325	XX89P / 6201P	MS Information Technology Management
372	Meteorology	323	XX48P / 6403P	MS Meteorology
373	METOC	323	XX47P / 6401P	MS Meteorology & Physical Oceanography
374	Operational Oceanography	323	XX49P / 6402P	MS Physical Oceanography
380	Applied Mathematics	324	XX41P / 4100P	MS Applied Mathematics
399	Modeling, Virtual Environ & Simulation	325	XX99P / 6202P	MS Modeling, Virtual Environments & Simulation
440	Oceanography	323	XX49D / 6402D	PhD Physical Oceanography
525	Undersea Warfare	323	XX44P / 6301P	MS Applied Mathematics, Applied Science, Computer Science, Operations Research, Physical Oceanography, Electrical Engineering or Engineering Acoustics.
526	Undersea Warfare - International	323	None	
533	Combat Systems Sciences & Technology	334	XX66P / 5701-08P	MS Applied Physics, Physics, Engineering Acoustics, Computer Science, Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, Material Science & Engineering, Software Engineering.
534	Applied Physics	334	None	MS Applied Physics
535	Underwater Acoustics Systems	334	None	MS Engineering Acoustics
570	Naval/Mechanical Engineering	323	XX54P / 5600-03P	MS Mechanical Engineering
571	Reactors/Mechanical Engineering	121	XX52P / 5200-02P	MS Engineering Science
590	Electronic Systems Engineering	323	XX55P / 5300-08P	MS Electrical Engineering
591	Space Systems Engineering	323	XX77P / 5500P	MS Electrical Engineering, Physics, Astronautical Engineering, Computer Science, Mechanical Engineering
595	Information Warfare	324	XX46P / 6205P	MS Systems Engineering
596	Electronic Warfare Systems International	324	None	MS Systems Engineering
610	Aeronautical Engineering	323	XX71P / 5402P	MS Aeronautical Engineering
611	Aeronautical Engineering-Avionics	323	XX72P / 5401P	MS Aeronautical Engineering
612	NPS/TPS Cooperative Program	323	XX71P / 5403P	MS Aeronautical Engineering
681	Middle East, Africa, South Asia	365	XX21P / 2101P	MA National Security Affairs
682	Far East, Southeast Asia, Pacific	365	XX22P / 2102P	MA National Security Affairs
683	Western Hemisphere	365	XX23P / 2103P	MA National Security Affairs
684	Russia, Europe, Central Asia	365	XX24P / 2104P	MA National Security Affairs
688	Strategic Studies	335	XX28P / 2300P	MA National Security Affairs
689	International Security & Civil-Military Relations	365	None	MA International Security & Civil-Military Relations
699	Special Operations	365	XX29P / 2500P	MS Defense Analysis
813	Transportation Logistics Management	345	1304P	MS Management
814	Transportation Management	345	XX35P / 3122P	MS Management
815	Acquisitions & Contract Management	345	1306P	MS Management
816	Systems Acquisition Management	345	None	MS Management
817	Defense Systems Analysis	345	None	MS Management
818	Defense Systems Management International	345	None	MS Management
819	Systems Inventory Management	345	1302P	MS Management
820	Resource Planning /Mgmt for International Defense	345	None	MS International Resource Planning and Management
823	Intelligence Information Management	324	XX17P / 6207P	MS Systems Tech (Scientific & Tech Intel)
824	Regional Intelligence	365	XX18P / 2200-04P	MA National Security Affairs
827	Material Logistics Support Management	345	XX32P / 3121P	MS Management
835	Contract Management	365	None	MS Contract Management
836	Program Management	335	None	MS Program Management
837	Financial Management	345	XX31P / 3110-12P	MS Management
847	Manpower Systems Analysis	345	XX33P / 3130P	MS Management
856	Leadership Education and Development	365	XX38P / 4500P	MS Leadership and Human Resource Development
877	Shore Installation Management	345	XX34P / 3140P	MS Management

FACULTY ORGANIZATIONS

The faculty plays a role in school-wide policy making and planning through various established Councils. The Faculty Council functions as a primary faculty input advisory vehicle to the Provost and Superintendent. The Academic Council, a representative body of each academic department and group, has cognizance over all academic standards and degree-granting considerations. The Distributed Learning Council is appointed by the Provost and is advisory to the Superintendent, Provost, and Academic Council on policies and processes related to all distributed (distance) learning programs and courses directly impacting NPS graduate education programs. The composition of each Council and its specific functions are described in the NPS Organization and Regulations Manual.

STUDENT COUNCIL

The Superintendent's Student Council (SSC) 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 SSC 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 SSC 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. SSC representation is included in the following NPS standing Councils and Committees:

Academic Council
Faculty Council
Library Council
Exchange/Bookstore Committee

ADMISSIONS

SELECTION PROCEDURES

NAVAL OFFICERS

Selection for the Navy fully funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Officers interested in this program should contact their assignment officer to determine **professional** qualification status; upon determination of academic qualification (by NAVPGSCOL), individuals are eligible for assignment. Officers who are professionally qualified, but lack academic qualifications, should contact the Director of Admissions for information on ways to improve their academic background.

OTHER U.S. MILITARY OFFICERS

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

INTERNATIONAL STUDENTS

Military officers and government civilian employees from other countries may be admitted to most curricula. The procedures for application are available from the Security Assistance Office or Defense Attache Office of the U.S. Embassy, the MLO, MAAG or ODC, as appropriate. Correspondence must be processed through official channels; requests from individual prospective students should not be sent directly to the School. All candidates must satisfy the curriculum academic standards, as described in this catalog. International candidates from non-English speaking countries will also be required to validate their fluency in English through the Test of English as a Foreign Language (TOEFL). Under the new Computer Based Testing (effective 1 July 98) a minimum TOEFL score of 207 is required for direct entry. If a candidate fails to achieve the 207 score, but does achieve a score of 173 or higher, he/she is eligible to attend the TOEFL Preparatory Academic Writing Course, MASL P177022 (16 weeks) at the Defense Language Institute in San Antonio, Texas. The only countries exempted from TOEFL testing are those countries who are exempted from all ECL testing requirements as determined by the Defense Security Assistance Agency (DSAA) MSG 131158Z MAR 98 (Antigua, Australia, Bahamas, Barbados, Canada, Dominica, Grenada, Guyana, Ireland, Jamaica, Malta, New Zealand, Singapore, St. Kitts, St. Lucia, St. Vincent, Trinidad, and the United Kingdom). When applying for a TOEFL exam, the NPS identification code is 4831.

Requests for admissions should be directed to the Director of International Programs, Code 035, Naval Postgraduate School, 699 Dyer Road, Room M5, Monterey, CA 93943-5108. Questions about available programs or admission procedures may be telephoned to (831) 656-2186 or e-mail: 035@nps.navy.mil.

CIVILIAN EMPLOYEES OF U.S. GOVERNMENT

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

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

Requests for admission should be directed to the Director of Admissions, Code 01B3, Naval Postgraduate School, 589 Dyer Rd., RM 103C, Monterey, CA 93943-5100. Questions about available programs or admission procedures may be telephoned to (831) 656-3093 or DSN 878-3093 or e-mail: grad-ed@nps.navy.mil.

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

Programs available to civilian students can be classified as follows:

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

Degree Programs: For civilian students, programs may be designed which lead to the award of a graduate degree while meeting the educational goals of each individual. In order to minimize the residency requirement, an off-campus preparatory program may be developed in consultation with a school advisor. If the available time in residence is insufficient to complete degree requirements, the thesis-project portion of the program may be completed off-campus.

Non-Degree Programs: Civilian employees may desire to pursue a program for professional advancement without a degree objective. For groups of employees from an agency, special courses can be offered to meet particular requirements, provided the demand is in an area of expertise of the school.

Admission: For admission to either a degree or a non-degree program, whether on-campus or by distance learning, the minimum qualification is an accredited baccalaureate degree with appropriate preparation for the proposed program. The school will require submission of official transcripts covering all college work completed to date.

CATALOGS

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

Director of Admissions
Code 01B3, Naval Postgraduate School,
589 Dyer Rd., RM 103C
Monterey, CA 93943-5100
Telephone (831) 656-3093 / DSN 878-3093

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

Director of International Programs
Code 035, Naval Postgraduate School,
699 Dyer Rd., RM M5
Monterey, CA 93943-5108
Telephone (831) 656-2186 / DSN 878-2186 / FAX (831) 656-3064

ACADEMIC PROFILE CODES

The Academic Profile Code (APC) is a three-digit code which summarizes pertinent portions of an officer's prior college performance. The Naval Postgraduate School routinely generates APCs for officers of most Navy communities, usually within three years of commissioning. The three independent digits reflect an individual's cumulative grade-point average (QPR), exposure to and performance in calculus-related mathematics courses and exposure to and performance in selected science/engineering areas.

First Digit

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

Code	QPR Range
0	3.60-4.00
1	3.20-3.59
2	2.60-3.19
3	2.20-2.59
4	1.90-2.19
5	0 -1.89

(Failures and repeated courses are included in the QPR calculation.)

Second Digit

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

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

Third Digit
The third digit represents previous course coverage in science and technical fields.

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

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

A technical code of 1 or 0 ordinarily is assigned only to an officer whose undergraduate major was Physics, Aeronautical, Electrical, Mechanical or Naval Engineering, or whose undergraduate technical major is consistent with the officer's designator.

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

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

GENERAL INFORMATION

COURSE CODES

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

Aeronautics and Astronautics	AA
Command, Control, Communications, Computers and Intelligence (C4I)	CC
Computer Science	CS
Electrical and Computer Engineering	EC
Interdisciplinary Courses	EO
Information Systems	IS
Information Warfare	IW
International Programs	IT
Mathematics	MA
Operational	MO
Mechanical Engineering	ME
Materials Science	MS
Total Ship System Engineering	TS
Meteorology	MR
Modeling Virtual Environments Simulation	MV
National Security Affairs	NS
Oceanography	
Oceanographic Sciences	OC
Operations Research	
Operations Analysis	OA
Service Courses	OS
Physics	PH
Science and Engineering	SE
Space Systems	SS
Special Operations	SO
Systems Management	
Management	MN
Undersea Warfare	UW

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

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

COURSE CREDIT VALUE

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

COURSE DESCRIPTIONS

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

SIX WEEK TECHNICAL REFRESHER

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

The Six Week Technical Refresher begins during week seven of the quarter.

A typical Six Week Technical Refresher consists of:

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

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

ENGINEERING SCIENCE (CURRICULUM 460)
This is not a specific curriculum, but rather a sequence of courses developed by the curricular officer and the academic associate to better prepare incoming students for entering a technical curriculum.

The Engineering Science curriculum is designed for prospective students who:

(1) have an APC which indicates a deficiency in mathematics and/or scientific and technical subject matter (i.e., their APC does not qualify them for direct entry to a technical curriculum),

or,

(2) in completing their review of the prospective student's academic record, the curricular officer and academic associate have concluded that sufficient time has expired since the student's most recent college experience and as such, the student would benefit from the Engineering Science program.

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

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

A typical Engineering Science course sequence consists of the following:

Aero Engineering	Space Systems Engineering
MA1118	MA1118
ME2502	MA1043
ME2601	PH1121
AA2042	EC1010

Prospective students are encouraged to contact the curricular officer regarding the specifics of their particular Engineering Science course sequence.

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

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

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

I	Incomplete
W	Withdrew
N	Ungraded
P	Pass
F	Fail
T	Thesis Research

The grade of Incomplete is given when an identifiable portion of the course remains unaccomplished at the end of the quarter. One additional quarter is granted to submit the delinquent work. If the “I” is not removed within the twelve weeks following the end of the term in which it was assigned, it becomes an “X.”

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

Courses may be designated for “P” and “F” grading when approved by the Academic Council.

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

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

ACADEMIC COUNSELING
The NAVPGSCOL provides academic counseling services as indicated below to assist officers in developing individual educational plans. Officers who have chosen specific curricula or who have been selected or detailed for graduate education in programs at NAVPGSCOL, are advised to contact the appropriate NAVPGSCOL curricular office listed in the Curricular Offices and Programs section of this catalog. Officers not yet selected for graduate education and seeking general information about the curricula offered at the school, or for general information on the fully-funded graduate education selection process, are advised to contact the Director of Admissions (Code 01B3), NAVPGSCOL, or telephone (831) 656-3093, DSN 878-3093.

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

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

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

If an established degree program's course matrix includes a quarter with more than 17 hours, the students in the program need not apply for a course enrollment limitation waiver. This limit is automatically waived in these cases.

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

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

Medical Absence
The academic record of a student may be deleted completely for a given term when the student is absent for a portion of the term for medical reasons. The transcript will show, “Excused for the term for medical reasons.” The student shall not be permitted to delete only a portion of the courses for this reason. The grade “W” shall be used when it is necessary to withdraw from only a part of the student’s program. Such excusals shall be requested by the Curricular Officer and approved by the Associate Provost for Instruction.

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

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

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

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

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

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

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

REQUIREMENTS FOR THE MASTER OF ARTS DEGREE AND THE MASTER OF SCIENCE DEGREE
The Master's Degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree. Such curricula shall conform to current practice in accredited institutions and shall contain a well-defined major.

General Postgraduate School minimum requirements for the Master's Degree are as follows:

- 32 quarter hours of graduate level credits of which at least 20 quarter hours must be earned in residence.
- A thesis or its equivalent is required.

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

- General undergraduate work as defined in Chapter 4 of the Academic Council Policy Manual.
- Appropriate undergraduate preparation for the curriculum to be pursued. A student entering the Postgraduate School with inadequate undergraduate preparation will be required to complete the undergraduate prerequisites in addition to the degree requirements.
- A demonstrated academic potential for completing the curriculum.

To be eligible for the Master's degree, the student must attain a minimum average quality point rating of 3.00 in all of the 3000 and 4000 level courses in his/her curriculum and either 2.5 in the remaining courses or 2.75 in all courses of the curriculum.

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

EDUCATIONAL SKILL REQUIREMENTS
Each curriculum at Naval Postgraduate School is developed based on Education Skill Requirements (ESR's). Education Skill Requirements define the fundamental concepts required in the graduate education curriculum as directed by each curriculum sponsor and Subject Matter Expert (SME). These ESR's represent the criteria essential for successful performance in each subspecialty.

The curricular offices and academic staff at Naval Postgraduate School coordinate biennial curriculum reviews with the curriculum sponsors and SME's of each curriculum. These reviews are conducted to ensure that the ESR's are current and relevant to the needs of the military, that programs meet the knowledge, skill and competencies of the ESR's, and that the changing needs of the sponsors are reflected in each curriculum. The ESR's for the curricula offered at Naval Postgraduate School have been included in this catalog at the end of each curricular office section.

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

This partnership between Naval Postgraduate School and the curriculum sponsors ensures that the educational needs of each subspecialty community are met.

ALUMNI TRANSCRIPT REQUESTS

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

1. Facsimile request: (831) 656-2891. Include your full name, Social Security Number, year last attended and current mailing address.

2. Mail request:

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

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

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

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

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

CURRICULA CONDUCTED AT OTHER UNIVERSITIES

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

If you decide to pursue your master's degree on your off-duty time, and want to ensure you receive a code for your subspecialty, call the Civilian Institutions Office (CIVINS) at NPS to get your curriculum approved. The CIVINS Office will assist in having your degree program compared against the subspecialty granting curriculum. The respective sponsors makes the final determination, and make suggestions on which courses will lead to a subspecialty code. You must provide a copy of your transcript, with degree conferred, and a course description for each course taken. For further information, call the CIVINS office at DSN 878-2319/3605 or commercial (831) 656-2319, FAX (831) 656-1014.

In order to qualify for the Civilian Institutions program, officers must be postgraduate school selected and must meet all the requirements of the perspective civilian institution.

Number	Curriculum	Length	Institution	Primary Consultant
375	Operational Oceanography	27 mos.	M.I.T.	CNO OP-096
382	Chemistry	2 yrs.	Various	NAVSEASYSCOM
47X	Facilities Engineering	1 yr.	Various	NAVFACENGCOM
472	Ocean Engineering	15-18 mos.	Various	NAVFACENGCOM
510	Naval Construction and Engineering	2-3 yrs.	M.I.T.	NAVSEASYSCOM
520	Nuclear Engineering (ED)	2 yrs.	M.I.T.	NAVSEASYSCOM
630	Petroleum Engineering	12-24 mos.	Various	NAVFACENGCOM
680	National Security (International Relations & Diplomacy)	12 mos.	Various	CNO N511
690	National Security (International Relations & Diplomacy)	12 mos.	Various	CNO N511
700	Logistics Management	15 mos.	AFIT	NAVAIRSYSCOM
810	Supply Acquisition/ Distribution Mgmt	18-21 mos.	Various	NAVSUPSYSCOM
811	Petroleum Management	18-21 mos.	Univ of Kansas	NAVSUPSYSCOM
830	Retailing	18-21 mos.	Various	NAVSUPSYSCOM
860	Subsistence Technology	18-21 mos.	Michigan State	NAVSUPSYSCOM
867	Education and Training Management	12-18 mos.	Various	CNET
88X	Law	9 mos	Various	NJAG
881	Military Law	9-12 mos.	JAG	NJAG
920	Public Affairs	1 yr.	Various	CHINFO
97X	Religion	9 mos.	Various	CHCHAP
990	Joint Intelligence	9-12 mos.	JMIC	NAVINTCOM

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

Director of Civilian Institutions Programs
Naval Postgraduate School Code 031A
1588 Cunningham Road, Hermmann Hall, Room 220E
Monterey, CA 93943-5143

Educational Skill Requirements (ESRs) for the above curricula may be obtained from the Director of Civilian Institutions Programs or by accessing the NPS catalog via the world wide web at www.nps.navy.mil.

CURRICULAR PROGRAMS AND EDUCATIONAL SKILL REQUIREMENTS

AEROSPACE ENGINEERING PROGRAMS

Curricula Officer:
William J. Welch
CDR, USN
Code 31, Halligan Hall
Room 133
(831) 656-2491
DSN 878-2491
e-mail: wwelch@nps.navy.mil

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

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

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

REQUIREMENTS FOR ENTRY

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

ENTRY DATES

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

Curricula 610 and 611
Academic Associate:
Max F. Platzer, Distinguished Professor
Code AA/Pl, Halligan Hall
Room 205A
(831) 656-2058, DSN 878-2058
e-mail: platzer@nps.navy.mil

DEGREE

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

AERONAUTICAL ENGINEERING SUBSPECIALTY (610)

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

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

TYPICAL COURSE OF STUDY

Refresher Quarter		
MAR117	(3-3)	Refresher: Single Variable Calculus
MA1042	(2-0)	Matrix Algebra
CS2971	(4-2)	Introduction to Object-Oriented Programming
EC1010	(1-1)	Introduction to MATLAB
Quarter 1		
MA1118	(5-2)	Multi-Variable Calculus
AA2042	(3-2)	Fundamentals of Thermo and Fluid Dynamics
AA2021	(4-1)	Introduction to Flight Structures
NW3230	(4-0)	Strategy & Policy
AA2440	(3-2)	Introduction to Digital Computation
Quarter 2		
MA3042	(4-0)	Linear Algebra
AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics
AA3101	(3-2)	Flight Vehicle Structural Analysis
Quarter 3		
AA3451	(3-2)	Aircraft and Missile Propulsion
AA2036	(3-2)	Performance and Static Stability
MN4310	(4-0)	Logistics Engineering
MA2121	(4-0)	Differential Equations
Quarter 4		
MA3243	(4-1)	Numerical Methods for Partial Differential Equations
AA3501	(3-2)	Aerodynamic Analysis
AA4201	(4-0)	Reliability Engineering and System Safety Management
AA2801	(3-2)	Aero-Laboratories
Quarter 5		
AA3272	(3-2)	Introduction to Systems Engineering
AA2339	(3-2)	Aerospace System Dynamics
AA3202	(3-2)	Aircraft Structural Failure, Fracture and Fatigue
AA3802	(3-2)	Aeronautical Measurement Techniques
Quarter 6		
AA4XXX		Elective
AA0810	(0-8)	Thesis Research
AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
AA4273	(3-2)	Aircraft Design
Quarter 7		
AA4XXX		Elective
AA0810	(0-8)	Thesis Research
AA0810	(0-8)	Thesis Research
AA3341	(3-2)	Control of Aerospace Vehicles
Quarter 8		
AA4XXX		Elective
AA3251	(4-1)	Aircraft Combat Survivability
AA4103	(3-2)	Mechanics of Composite Materials
AA0810	(0-8)	Thesis Research

AERONAUTICAL ENGINEERING (AVIONICS) SUBSPECIALTY (611)

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

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

TYPICAL COURSE OF STUDY

Refresher Quarter

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

Quarter 1

MA3042	(4-0)	Linear Algebra
MA2121	(4-0)	Differential Equations
EC2100	(3-2)	Circuit Analysis
CS3010	(4-0)	Computer Systems Principles

Quarter 2

AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics
EC2200	(3-3)	Introduction to Electronics Engineering
EO2413	(4-2)	Introduction to Communications Systems Engineering

Quarter 3

AA2036	(3-2)	Performance and Static Stability
AA2339	(3-2)	Aerospace System Dynamics
EO3513	(4-2)	Communications Systems Engineering
NW3230	(4-0)	Strategy & Policy

Quarter 4

AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
AA3501	(3-2)	Aerodynamic Analysis
AA3340	(3-2)	Dynamic Stability of Aerospace Vehicles
EO3523	(4-2)	Communications Systems Analysis

Quarter 5

AA4XXX		Elective
AA3341	(3-2)	Control of Aerospace Vehicles
AA3260	(3-2)	Introduction to Avionics Software Engineering
EO3678	(4-2)	Principles of Radar Systems

Quarter 6

AA0810	(0-8)	Thesis Research
AA4641	(3-2)	Digital Avionics Systems
AA3251	(4-1)	Aircraft Combat Survivability
EC3750	(3-2)	SIGINT Systems

Quarter 7

AA0810	(0-8)	Thesis Research
AA4642	(3-2)	Avionics Modeling and Simulation
SS2041	(4-1)	Introduction to Space
AA3276	(3-2)	Introduction to Avionics

Quarter 8

AA4342	(3-2)	Advanced Control of Aerospace Systems
AA0810	(0-8)	Thesis Research
AA0810	(0-8)	Thesis Research
AA4276	(3-2)	Avionics Systems Design

NPS/TPS COOPERATIVE PROGRAM (612)

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

Curriculum 612
Academic Associate:
Max F. Platzer, Distinguished Professor
Code AA/Pl, Halligan Hall
Room 205A
(831) 656-2058, DSN 878-2058
e-mail: platzer@nps.navy.mil

TYPICAL COURSE OF STUDY

Refresher Quarter

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

Quarter 1

MA3042	(4-0)	Linear Algebra
MA2121	(4-0)	Differential Equations
AA2035	(3-2)	Basic Aerodynamics
AA2043	(3-2)	Fundamentals of Gas Dynamics
EC1010	(1-1)	Introduction to MATLAB

Quarter 2

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

Quarter 3

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

Quarter 4

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

Quarter 5

AA3251	(4-1)	Aircraft Combat Survivability
AA4273	(3-2)	Aircraft Design
AA4201	(4-0)	Reliability Engineering and System Safety Management
NW3230	(4-0)	Strategy & Policy

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

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

CORE REQUIREMENTS

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

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

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

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

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

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

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

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

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

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

SPECIALIZATION OPTIONS

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

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

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

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

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

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

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
June 1998

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

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

CORE REQUIREMENTS

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

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

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

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

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

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

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

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

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

SPECIALIZATION OPTIONS

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

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

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

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

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

Curriculum Sponsor and ESR Approval Authority

Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
June 1998

COMBAT SYSTEMS PROGRAMS

Curricular Officer:
William T. McCoy
CDR, USN
Engineering & Technology, Code 34
The Mechanical Engineering Building
Building 245, Room 115
(831) 656-2033, DSN 878-2033
e-mail: wtmccoy@nps.navy.mil
http://web.nps.navy.mil/~code34

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY CURRICULUM 533

Physics Web Page http://www.physics.navy.mil/

This program is designed to meet the needs of the military services for an officer having a broad-based advanced technical education applicable to combat systems design, development, test and evaluation, acquisition, operation, and support. Included in the core are courses on electromagnetic radiation, signal processing, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, combat simulation, quantum devices, detection and engagement elements, combat systems integration, and computing resources for advanced combat systems. Additionally, the officer will take a sequence of four or more courses in one of the following concentration areas: electromagnetic sensors systems, weapons and effects, underwater acoustic systems, tactical missile systems, total ships systems engineering, or an engineering area related to combat systems. The officer will also conduct thesis research on a military relevant technical problem.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required for direct input. Courses in the physical sciences and engineering are highly desirable. An APC of 334 is required.

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Combat Systems Sciences and Technology Sub-specialist with a subspecialty code of XX66P. The curriculum sponsor is the Naval Sea Systems Command.

Typical Jobs in this Subspecialty:

NTDS-CIC: FLTCOMBDSSA, San Diego, CA
Weapons Instructor: Naval Academy, Annapolis, MD
Testing Officer: COMOPTEVFOR; Defense Nuclear Agency (DNA)
Research Associate: Lawrence Livermore Laboratory; Los Alamos National Laboratory, Naval Research Laboratory
Physics Instructor: Naval Academy, Annapolis, MD
Electro-Optics Project Officer: Naval Ocean Systems Center, San Diego CA
Project Management: NAVSEASYSCOM, SPAWARSYSCOM
Physicist: Defense Nuclear Agency (DNA) Tactical Nuclear Weapons/Plans: CINCLANT, DNA, Los Alamos
Instructor: Nuclear Weapons Training Group - Atlantic
Training Officer: PDW-124 (Undersea Surveillance)
Strategic Systems Project Officer: Director of SSPO

ENTRY DATES

Combat Systems Sciences and Technology is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum. Other entry dates are possible by special arrangement with the curricular officer.

Curriculum 533
Academic Associate:

James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200A
(831) 656-3884/2116, DSN 878-3884/2116
e-mail: jsanders@nps.navy.mil

DEGREE

Students, depending on background, may earn a Master of Science in Physics, Applied Physics, Computer Science, Engineering Acoustics, or one of the engineering disciplines.

TYPICAL COURSE OF STUDY
APPLIED PHYSICS OPTION

Quarter 1

MA1995	(5-0)	Mathematics for Scientists and Engineers I
MA1996	(5-0)	Mathematics for Scientists and Engineers II
NW3230	(4-0)	Strategy & Policy
PH1121	(4-2)	Mechanics

Quarter 2

PH1322	(4-2)	E&M
PH2151	(4-1)	Particle Mechanics
PH3991	(4-0)	Theoretical Physics
SE2911	(4-3)	Combat Systems Simulation *

Quarter 3

PH1623	(4-2)	Optics, Thermo and Modern Physics
PH3152	(4-0)	Mechanics of Physical Systems
PH2351	(4-1)	Electromagnetism
SE2013	(4-3)	Analog and Communications Techniques *

Quarter 4

PH3352	(4-0)	Electromagnetic Waves and Radiation
PH3652	(4-1)	Quantum Mechanics *
SE3172	(4-1)	Physics of Weapon Systems*
SE2014	(4-3)	Digital Techniques*

Quarter 5

----------		Concentration Course
PH3292	(4-2)	Applied Optics
PH4653	(4-0)	Condensed Matter *
SE3015	(4-3)	Autonomous Combat System Design *
SE2020	(1-0)	Combat Systems Requirements and Design

Quarter 6

----------		Concentration Course
----------		Concentration Course
SE4050	(4-2)	Physics of E&M Sensor Systems *
XX0810	(0-8)	Thesis Research

Quarter 7

SE3400	(4-2)	Physics of Sonar Systems *
----------		Concentration Course
XX0810	(0-8)	Thesis Research
XX0810	(0-8)	Thesis Research

Quarter 8

SE4021	(4-0)	Combat Systems Project Integration *
SE4022	(3-0)	Combat Systems Capstone *
SE4860	(4-0)	Advanced Weapons Concepts *
XX0810	(0-8)	Thesis

* In development

Concentration Areas:

NOTE: Final approval of an individual student's degree rests with the Chairman of the cognizant department.

(A) MS Applied Physics:

(1) Electromagnetic Sensor Systems:
PH3782 Thermodynamics and Statistical Physics
PH4254 Thermal Imaging
PH4283 Laser Physics
PH4354 Advance Electromagnetic Radiation

(2) Weapons and Effects:
PH4856 Physics of Nuclear Weapons
PH4857 Physics of High Velocity Impact
PH4858 Weapons Lethality and Survivability
PH4911 Weapon System Simulation

(3) Underwater Acoustic Systems:
PH3119 Oscillations and Waves
PH3451 Fundamental Acoustics
PH3452 Underwater Acoustics
PH4454 Sonar Transducer Theory and Design
PH4455 Sound Propagation in the Ocean

(4) Tactical Missile Systems:
AA3701 Missile Aerodynamics
AA4452 Tactical Missile Propulsion
AA4703 Missile Flight Analysis
AA4704 Missile Design

(5) Total Ship Systems Engineering:
TS3000 Electrical Power Engineering
TS3001 Principles of Naval Architecture
TS3002 Principles of Ship Design
TS3003 Naval Combat System Elements
TS4000 Naval Combat System Engineering
TS4001 Integration of Naval Engineering Systems
TS4002 Ship Design Integration
TS4003 Total Ship System Engineering

(B) MS Physics:

PH3782 Thermodynamics and Statistical Physics
PH4353 Advanced Electricity and Magnetism
PH4984 Advanced Quantum Physics
A two course Physics sequence.

(C) MS Computer Science:

CS3971 Advanced C++ Programming
CS3200 Computer Architecture
CS3310 Artificial Intelligence
CS3450 Operating Systems
CS3650 Design and Analysis of Algorithms
CS4310 Artificial Intelligence for Military Applications
CS4311 Expert Systems
CS4313 Advanced Robotic Systems
CS4314 Symbolic Computing

(D) MS Engineering Acoustics:

PH3119 Oscillations and Waves
PH3451 Fundamental Acoustics
PH3452 Underwater Acoustics
PH4454 Sonar Transducer Theory and Design
PH4455 Sound Propagation in the Ocean
EC3500 Analysis of Random Signals
EC4450 Sonar Systems Engineering

(E) MS Electrical Engineering:

Program developed upon arrival based on educational background. Available areas are:
1) Signal Processing
2) Guidance, Control, and Navigation
3) Electromagnetic Systems
4) Computer Engineering
5) Communication Systems

This program is limited to students arriving with an ABET accredited BSEE.

(F) MS Mechanical Engineering:

Program developed upon arrival based on educational background. Available areas are:
1) Fluid Mechanics
2) Thermal Science
3) Solid Mechanics
4) Vibrations, Controls, and Materials Engineering

This program is limited to students arriving with an ABET accredited BSME

(G) MS Aeronautical Engineering:

AA3251 Aircraft Combat Survivability
AA3701 Missile Aerodynamics
AA3705 Air Defense Lethality
AA4452 Tactical Missile Propulsion
AA4505 Laser Technologies
AA4703 Missile Flight Analysis
AA4704 Missile Design

(H) MS Software Engineering:

CS3460 Software Methodology
CS4500 Software Engineering
CS4580 Design of Embedded Real-Time Systems
CS4510 Computer Aided Prototyping
CS4570 Software Reuse
CS4530 Software Research and Development
CS4540 Software Testing
CS4520 Advanced Software Engineering
CS4591 Requirements Engineering

COMBAT SYSTEMS CURRICULUM FOR NON U.S. NAVY SUBSPECIALTY CODE

For U.S. and international students not required to take all the combat systems courses for the U.S. Navy subspecialty code, the following six-quarter curricula are available. These curricula provide the science and engineering background necessary to concentrate in one selected area of combat systems and carry out a combat systems related thesis. These curricula lead to either a MS Applied Physics or MS Engineering Acoustics.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required. Courses in the physical sciences and engineering are highly desirable. An APC of 334 is required.

ENTRY DATES

These curricula are a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum. Other entry dates are possible by special arrangement with the curricular officer.

APPLIED PHYSICS
CURRICULUM 534

A program designed for the students not requiring the Naval Subspecialty upon completion. The emphasis is on Physics applied to Combat Systems. Concentration sequences include Sensors, Weapons and Effects, and Advanced Weapons Concepts.

Curriculum 534
Academic Associate:
James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200A
(831) 656-3884, DSN 878-3884
e-mail: jsanders@nps.navy.mil

DEGREE

All the requirements for the degree, Master of Science in Applied Physics are met.

TYPICAL COURSE OF STUDY (NON U.S. NAVY) (534)

Quarter 1

MA1995	(5-0)	Mathematics for Scientists and Engineers I
MA1996	(5-0)	Mathematics for Scientists and Engineers II
NS3252	(4-0)	Joint and Maritime Strategy
PH1121	(4-2)	Mechanics

Quarter 2

PH1322	(4-2)	E&M
PH2151	(4-1)	Particle Mechanics
PH3991	(4-0)	Theoretical Physics
SE2911	(4-3)	Combat Systems Simulation *

Quarter 3

PH1623	(4-2)	Optics, Thermo and Modern Physics
PH3152	(4-0)	Mechanics of Physical Systems
PH2351	(4-1)	Electromagnetism
SE2013	(4-3)	Analog and Communications Techniques *

Quarter 4

PH3352	(4-0)	Electromagnetic Waves and Radiation
PH3652	(4-1)	Quantum Mechanics *
SE2014	(4-3)	Digital Techniques*
PH0810	(0-8)	Thesis

Quarter 5

----------		Concentration Course
PH3292	(4-2)	Applied Optics
PH4653	(4-0)	Condensed Matter *
PH0810	(0-8)	Thesis

Quarter 6

----------		Concentration Course
----------		Concentration Course
SE4050	(4-2)	Physics of E&M Sensor Systems *
PH0810	(0-8)	Thesis

* In development

UNDERWATER ACOUSTICS SYSTEMS
CURRICULUM 535

Underwater Acoustics Systems is an interdisciplinary program designed for students not requiring Naval Subspecialty Codes upon completion. It consists of courses in physics and electrical engineering. Based on fundamental science and engineering, the emphasis is on underwater acoustics and signal processing applied to undersea warfare. Subjects covered include the generation, propagation, and reception of sound in the ocean; military applications of underwater sound; and acoustic signal processing.

Curriculum 535
Academic Associate:
James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200A
(831) 656-3884, DSN 878-3884
e-mail: jsanders@nps.navy.mil

DEGREE
All the requirements for the degree, Master of Science in Engineering Acoustics are met.

TYPICAL COURSE OF STUDY (NON U.S. NAVY) (535)

Quarter 1

MA1995	(5-0)	Mathematics for Scientists and Engineers I
MA1996	(5-0)	Mathematics for Scientists and Engineers II
EC2400	(3-1)	Discrete Systems
PH1121	(4-2)	Mechanics

Quarter 2

PH2151	(4-1)	Particle Mechanics
PH3991	(4-0)	Theoretical Physics
PH1322	(4-2)	E&M
EC2410	(3-1)	Analysis of Signals and Systems

Quarter 3

PH3119	(4-2)	Oscillation and Waves
PH2351	(4-1)	Electromagnetism
SE2013	(4-3)	Analog and Communications Techniques *
EC2010	(3-1)	Probabilistic Analysis of Signals

Quarter 4

PH3451	(4-2)	Fundamental Acoustics
PH3352	(4-0)	Electromagnetic Waves and Radiation
SE2014	(4-3)	Digital Techniques*
PH0810	(0-8)	Thesis

Quarter 5

PH3452	(4-2)	Underwater Acoustics
PH4454	(4-2)	Sonar Transducer Theory and Design
EC3500	(4-0)	Analysis of Random Signals
XX0810	(0-8)	Thesis

Quarter 6

EC4450	(4-1)	Sonar Systems Engineering
PH4455	(4-0)	Underwater Propagation
XX0810	(0-8)	Thesis
XX0810	(0-8)	Thesis

* In development

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

1. **MATHEMATICS, SCIENCE, AND ENGINEERING FUNDAMENTALS:** A solid foundation in mathematics, physics, and engineering to support the theoretical and experimental aspects of the technical courses in the curriculum.

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

   A. Acoustic and electromagnetic propagation, physics of solid-state, electro-optic, and quantum devices, principles of radar and sonar systems, signal analysis and decision theory.
   B. Communication systems, fiber optics, integration of computing resources in advanced systems, advanced distributed computing concepts, and automatic control systems.
   C. Fluid dynamics of subsonic and supersonic weapons, warheads and their effects (nuclear and conventional), counter measures and deception techniques.
   D. Combat systems simulation and testing including sufficient probability and statistics theory to appreciate the limits of simulation.

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

4. **MATERIALS SCIENCE:** Familiarity with the concepts of materials science sufficient for an understanding of the mechanical, electrical, and thermal properties of materials.

5. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

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

   A. ELECTROMAGNETIC SYSTEMS

   1. Statistical physics.
   2. Electromagnetics propagation in homogeneous and random media.
   3. Sensors for detecting electromagnetic radiations.
   4. Concepts of target surveillance, acquisition, and engagement.

   B. CONVENTIONAL WEAPONS, DIRECTED ENERGY WEAPONS, AND WEAPONS OF MASS DESTRUCTION AND THEIR EFFECTS

   1. Physics of High velocity Impact phenomena in Solids.
   2. Weapon Lethality and Survivability.
   3. Nuclear and other weapons of mass destruction and their effects.
   4. Physics of Directed Energy Weapons.

   C. UNDERWATER ACOUSTIC SYSTEMS

   1. Acoustical theories, mechanical vibration, wave propagation in the ocean; scattering, fluctuations and boundary interactions; transducer theory and design; and array theory.
   2. Active and passive acoustic signal processing including adaptive techniques.
   3. Acoustic influences of oceanographic phenomena including boundary characteristics, ambient noise, sound speed profiles, fronts, and eddies.

D. ENGINEERING DISCIPLINE

A series of at least six graduate-level courses in an area related to combat systems in the disciplines of either Electrical Engineering, Mechanical Engineering, Aeronautical Engineering, Computer Science, Total Ship System Engineering or Physics. This series must be approved by the Curricular Officer.

7. **THESIS:** Ability to recognize scientific and engineering advancements of potential value to the Navy, formulate a research problem, perform the necessary research, and report the results.

Curriculum Sponsor and ESR Approval Authority

Commander, Naval Sea Systems Command
July 1998

ELECTRONIC SYSTEMS ENGINEERING PROGRAM

Curricular Officer:
William T. McCoy
CDR, USN
Engineering & Technology, Code 34
The Mechanical Engineering Building
Building 245, Room 115
(831) 656-2033, DSN 878-2033
e-mail: wtmccoy@nps.navy.mil
http://web.nps.navy.mil/~code34

ELECTRONIC SYSTEMS ENGINEERING
CURRICULUM 590
ECE Web page "http://web.nps.navy.mil/~ece/"
This curriculum is designed to educate officers in current electronics technology and its application to modern naval warfare. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems, ship/weapon control systems, and communication/ information processing applicability. It will enhance individual performance in all duties through a naval career, including operational billets, technical management assignments and policy making positions, thereby preparing the officer for progressively increased responsibility including command, both ashore and afloat.

REQUIREMENTS FOR ENTRY
A baccalaureate degree in engineering or the physical sciences is desired. Differential and integral calculus, one year of calculus-based college physics and at least one semester of college chemistry are required. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

ELECTRONICS SYSTEMS ENGINEERING SUBSPECIALTY
Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code XX55P. A limited number of particularly well qualified students may be able to further their education beyond the Master's Degree and obtain the Degree of Electrical Engineer and a XX55N subspecialty code. The curriculum sponsor is Space and Naval Warfare Systems Command.

Typical Jobs in this Subspecialty:
Instructor: Naval Academy, Annapolis, MD
Project Manager: SPAWARSYSCOM; NAVSEASYSCOM
Operations Test and Evaluation: COMOPTEVFOR
Electronics Research Manager: NSA/CSS, Ft Meade
C3 Staff Officer: DISA HQ, Washington, DC
Project Officer: Warfare Systems Architecture and Engineering, SPAWARHDQTRS
Electrical Engineer: USSPACECOM

ENTRY DATES
Electronic Systems Engineering is an eight-quarter course of study with entry dates in every quarter. A six-quarter program is available for officers with an ABET accredited BSEE degree on a case-by-case basis. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 590
Academic Associate:
Monique P. Fargues, Associate Professor
Code EC/Fa, S-456
(831) 656-2859, DSN 878-2859
e-mail: fargues@nps.navy.mil

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

TYPICAL COURSE OF STUDY
COMPUTER SYSTEMS OPTION

Quarter 1

EC2100	(4-2)	Circuit Analysis
EC2820	(3-2)	Digital Logic Circuits
MA1118	(5-2)	Multi-Variable Calculus
NW3230	(4-0)	Strategy & Policy

Quarter 2

EC2110	(3-2)	Circuit Analysis II
EC2200	(3-3)	Introduction to Electronics Engineering
EC2400	(3-1)	Discrete Systems
EC2840	(3-2)	Introduction to Microprocessors

Quarter 3

CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
EC2210	(3-2)	Electronics Engineering II
EC2410	(3-1)	Analysis of Signals and Systems
EC3800	(3-2)	Microprocessor Based System Design
EC3910	(2-0)	Research Seminar in ECE

Quarter 4

ECXXXX		BSEE Elective I
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
EC3500	(4-0)	Analysis of Random Signals
EC2420	(3-0)	Systems Theory
EC3910	(2-0)	Research Seminar in ECE

Quarter 5

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

Quarter 6

EC3550	(3-1)	Fiber Optic Systems
EC4830	(3-1)	Digital Computer Design
EC3830	(3-2)	Digital Computer Design Methodology
EC0810	(0-8)	Thesis Research

Quarter 7

ECXXXX		MSEE Elective I
EC3850	(3-1)	Computer Communications Methods
EC0810	(0-8)	Thesis Research
EC0810	(0-8)	Thesis Research

Quarter 8

ECXXXX		MSEE Elective II
EC4800	(3-0)	Advanced Topics in Computer Engineering
EC4870	(3-2)	VLSI Systems Design
EC0810	(0-8)	Thesis Research

The Communications Systems option is designed to provide an advanced education in modern communication engineering topics such as digital communications, spread spectrum communication including anti-jam and low probability of intercept applications, forward error correction coding, and satellite communications.

The Computer Systems area of concentration is designed to provide an advanced education in the design, implementation, and application of military computer systems, including such topics as logic circuits, logic design and synthesis, microprocessors, computer and digital systems architecture, military computer architectures, fault tolerant computing, high speed networking, silicon VLSI and gallium arsenide digital IC design, parallel processing, and the hardware/software interface.

The Electromagnetic Systems option provides an advanced education in the application of electromagnetic phenomenology to the design and analysis of military systems used for communications, interrogation and signal intercept, and targeting. Courses are offered in a range of areas including antennas, propagation, scattering and RCS control, microwave and millimeter wave devices, as well as in modern numerical methods for analysis and simulation of electromagnetic systems.

The Guidance, Control, and Navigation Systems area of concentration is designed to provide and advanced education in the modeling and simulation advanced dynamic systems, the current state of knowledge regarding state estimation (linear and nonlinear filtering), system identification, and the control of dynamic systems, and to unite the theory with military applications. Course in specific areas of military application currently include military robotics, missile guidance and control, and integrated target tracking.

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

The Power Systems option is designed to provide education in the analysis, design, simulation, and control of power electronic and electromechanical components and integrated topologies common to existing and proposed military systems.

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

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

TOTAL SHIP SYSTEMS ENGINEERING

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

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

1. **MATHEMATICS:** The officer will have a thorough knowledge of mathematical tools which are intrinsic to electrical and computer engineering, including, but not limited to differential equations, vector analysis, linear algebra, probability, numerical analysis, and Fourier and Laplace methods.

2. **ENGINEERING SCIENCE AND DESIGN:** To acquire the requisite background needed to meet the other military education requirements, the officer will acquire proficiency in modern physics, electromagnetics, electronic devices and circuits, system theory, and modern electronic system design; also in other appropriate fields such as underwater acoustics, dynamics, fluid mechanics and thermodynamics which provide the requisite breadth to a military engineering education.

3. **COMPUTERS:** The officer will have a sound understanding of computer hardware, software, and their integration into military systems including programming in higher order languages, digital logic circuits, and microprocessor applications.

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

5. **SYSTEM DESIGN AND SYNTHESIS:** the officer will have a sound understanding of engineering principles utilized in engineering system design, particularly as they relate to military systems, including establishment of system related objectives and criteria.

6. **CONDUCTING AND REPORTING INDEPENDENT INVESTIGATION:** The officer will demonstrate the ability to conduct independent investigation of a Navy and/or DoD relevant electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

Curriculum Sponsor and ESR Approval Authority
Commander, Space and Naval Warfare Systems Command
July 1998

ELECTRONIC WARFARE

Curricular Officer:
Michael Mullady
LtCol, USAF
Code 37, Root Hall
Room 103H
(831) 656-2137
DSN 878-2137
e-mail: mmullady@nps.navy.mil

ELECTRONIC WARFARE (INTERNATIONAL)
CURRICULUM 596
The curriculum provides the services with officers thoroughly knowledgeable 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.

REQUIREMENTS FOR ENTRY
International students must meet the APC requirements and receive approval by the Director of Admissions at the Naval Postgraduate School. The procedures for application are contained under the Admissions heading in this catalog. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

ENTRY DATES
The Electronic Warfare Curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Curricular Officer or Academic Associate for this curriculum.

Curriculum 596
Academic Associate:
David Jenn, Associate Professor
Code EC/Jn, Spanagel Hall, Room 414
(831) 656-2254, DSN 878-2254
e-mail: jenn@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

MA2129	(5-0)	Multivariable Calculus
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics
EO2512	(4-2)	Introduction to Communications and Countermeasures
CS2971	(4-2)	Fundamental Object-Oriented Programming in C++

Quarter 2

OS2103	(4-1)	Applied Probability for Systems Technology
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO2652	(4-1)	Fields, Waves and Electromagnetic Engineering
EO2402	(4-1)	Introduction to Linear Systems

Quarter 3

OS3003	(4-0)	Operations Research for Information Warfare
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
CS3030	(4-0)	Computer Architecture and Operating Systems
IT1500	(4-0)	Information Program Seminar for International Officers

Quarter 4

EO4612	(4-2)	Microwave Devices and Radar
EO3402	(3-1)	Signals and Noise
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
EO3512	(3-2)	Communications and Countermeasures

Quarter 5

CS3600	(3-2)	Introduction to Computer Security
OS3604	(4-0)	Decision and Data Analysis
EC3700	(3-2)	Introduction to Joint Services Electronic Warfare
IW9999	(3-2)	Approved Elective

Quarter 6

IW9999	(3-2)	Approved Elective
MR3419	(3-2)	Atmospheric Factors in EM and EO for Interdisciplinary Students
IW0810	(0-8)	Thesis Research/Group Project
IW9999	(3-2)	Approved Elective

Quarter 7

PH3204	(3-2)	Electro-Optic Systems and Countermeasures
IW9999	(3-2)	Approved Elective
OS4601	(4-0)	Test and Evaluation
IW0810	(0-8)	Thesis Research/Group Project

Quarter 8

EC4690	(3-3)	Radar Electronic Warfare Techniques and Systems for International Students
PH4209	(3-2)	EO/IR Systems and Countermeasures
IW0810	(0-8)	Thesis Research/Group Project
IW0810	(0-8)	Thesis Research/Group Project

INFORMATION SCIENCES, SYSTEMS, AND OPERATIONS CURRICULA

OVERVIEW

Rapid advances in Information Technology are swiftly changing Warfare in the 21st Century. A key enabler of 21st Century Warfare is the concept of Information Superiority. To accomplish the needed change in concepts for warfighting and the innovative application of Information Technology to implement them in action, the officer corps must have a new intellectual basis for decision making. A significant factor in creating the needed intellectual capital is graduate education provided by the Information Science, Systems and Operations curriculum. The graduate education provided by the Information Sciences, Systems, and Operations curriculum shall satisfy the following:

GENERAL EDUCATIONAL SKILL REQUIREMENTS

1. Understand and innovatively create, maintain, and operate doctrine, systems, and procedures to assure our Information Superiority.

2. Understand and innovatively develop and implement Command and Control decision processes in organizations to assure Information Superiority.

3. Understand and innovatively employ Information Science and Technology in creating systems for Information Superiority.

4. Be able to design and deploy Information Superiority systems and components in a specialization area selected from the following:

   Computer Science
   Information Systems/Information Technology Management
   Information Warfare Systems Engineering
   Joint C4I Systems
   Modeling, Virtual Environments, and Simulation
   Space Systems Operations
   Intelligence Information Management

5. Demonstrate the ability to identify and solve a significant Information Superiority problem and communicate the results in writing and orally by means of a thesis or project and a command-oriented briefing.

PROFESSIONAL EDUCATION SKILL REQUIREMENTS

The graduates of the Information Sciences, Systems, and Operations Curriculum shall satisfy the following Professional Educational Skill Requirements:

SCIENCE AND TECHNOLOGY

The graduate will be able to understand, develop, and implement top level systems and subsystem requirements and influence innovative applications of Information Science and Technology for Information Superiority in the following areas:

Decision Support: Decision Support Systems, Group Decision Support Systems, and Artificial Intelligence (Expert Systems, Neural Networks, Fuzzy Logic)

Computer Systems: Computer Architecture, Computer Operating Systems, Distributed Computing, Computer Security, Real-Time Embedded Systems, Human-Computer Interface, and Performance Analysis

Communication Systems: Networks, Network Management, Communications Security, Communications Systems Engineering, Network Operating Systems, Digital and Analog Systems, Performance Analysis

Software Technology: Programming, Database, Database Management Systems, Computer Graphics, Software Evolution, and Virtual Environments

Software Engineering: Software Engineering Management, Software Metrics, Configuration Management, Software Reuse, Architectures, Risk Assessment, and Computer Aided Prototyping

Sensors and Signal Processing: Remote Sensing, RADAR, Imagery, SIGINT, MASINT, Digital Signal Processing, Signatures

Space Technology: Orbits, Space Environment, Spacecraft Engineering

Robotics

Environment

ANALYSIS, SYNTHESIS, AND EVALUATION
The graduate will be able to perform analysis, synthesis and evaluation of Information Superiority Doctrine, Systems, and Procedures so that Combat Potential is maximized.

Probability and Statistics
Data Analysis
Experimental Design
Operations Analysis
Human-in-the-Loop Systems
Cost and Operational Effectiveness Analysis
Business Case (Economic) Analysis
Trade-off Analysis
Modeling, Gaming, and Simulation
Strategic Analysis and Strategy Formulation

SYSTEMS ANALYSIS, DESIGN AND MANAGEMENT
The graduate will be able to innovatively develop the requirements, perform systems studies, design the systems architecture, and acquire systems for Information Superiority.

Complex Systems
Systems Analysis and Design Process (Systems Engineering Process)
Systems Engineering Management
Information Systems
Acquisition Management
Project Management
Systems Architectures (e.g. Systems, Technical, JTA)
Systems Integration
Intelligence Systems and Products
Current and Planned Information Superiority Systems Technical and Operational Analysis (e.g. GCCS, CGGS-M, National Technical Means, DISN, DII, MILSATCOM, Challenge Athena, other nations' systems)
Risk Assessment
Information Technology Industry Evolution

OPERATIONAL
The graduate will be able to create innovate Operational Policies and Plans to Support Information Superiority through Information Operations, Doctrine for Information Operations, and specific mission plans for Information Operations.

Conflict in the Information Age
Network Centric Warfare
Organizational Analysis for Information Operations and Command and Control
Operational Architectures
Joint Maritime Strategic Planning
Intelligence Preparation of the Battlespace
Command and Control
Current Joint Planning Systems (e.g. JOPES, CAP)
Information Superiority Doctrine
Information Superiority Strategy
Information Superiority Tactics
Information Operations
Information Warfare/C2W
Military Operations in Space
The Grids (Sensor, Shooter/Engagement/Information)

Curriculum Sponsor and ESR Approval Authority
Director, Space, Information Warfare, Command and Control (N6)
July 1998

COMPUTER SCIENCE

Curricular Officer:
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COMPUTER SCIENCE
CURRICULUM 368
Home page on the WWW "http://www.cs.nps.navy.mil/"
The Computer Science curriculum is designed to provide the officer with the technical knowledge and skills necessary to specify, evaluate and manage computer system design; to provide technical guidance in applications ranging from data processing to tactical embedded systems; to educate the officer in the analysis and design methodologies appropriate for hardware, software and firmware; and to provide the officer with practical experience in applying modern computer equipment and research techniques to solve military problems.

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

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

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or the equivalent, with above-average grades in mathematics, (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination), indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

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

Typical Jobs in this Subspecialty:
Computer Science Instructor, U.S. Naval Academy
Preoperational Test and Evaluation, SPAWARS, Washington, DC
Computer Systems Analyst, COMNAVSECGRU, Washington, DC
ADP Systems Director, Naval Security Group, Pensacola, FL
Chief SEID, Joint Staff, Washington, DC
Operational Test and Evaluation, COMOPTEVFOR
ADP System Security, NSA/CSS, FT Meade

ENTRY DATES
Computer Science is an eight-quarter course of study with entry dates in April and October. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 368
Academic Associate:
Thomas Wu, Associate Professor
Code CS/Wq, Spanagel Hall, Room 530D
(831) 656-3391, DSN 878-3391
Fax: (831) 656-2814, DSN 878-2814
e-mail:emwu@cs.nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

CS2971	(4-2)	Fundamental Object-Oriented Programming in C++
CS3010	(4-0)	Computer Systems Principles
MA3025	(5-1)	Logic and Discrete Mathematics
NW3230	(3-0)	Strategy and Policy

Quarter 2

CS3971	(4-2)	Data Structures and Intermediate Object-Oriented Programming in C++
CS3650	(4-0)	Design and Analysis of Algorithms
CS3600	(3-2)	Introduction to Computer Security
CS3200	(3-2)	Computer Architecture
CS4900	(0-2)	Research Seminar in Computer Science

Quarter 3

CS3310	(4-0)	Artificial Intelligence
CS3770	(4-0)	ADA as a Second Language
MA1902	(3-0)	Mathematics for ISO/ISSO
CS4900	(0-2)	Research Seminar in Computer Science
CS3460	(3-1)	Software Methodology

Quarter 4

CS3450	(3-2)	Operating Systems
CS3320	(3-1)	Database Systems
EO3502	(3-0)	Communications Systems Technology and Applications
CI9004	(3-0)	Space Technology and Applications

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
CSXXXX	(4-0)	Track Requirement*
CI9012	(2-0)	Probability and Statistics
CC3000	(4-0)	Command and Control

Quarter 6

CS4203	(3-2)	Interactive Computation Systems
CI9003	(3-0)	Sensor Technology and Applications
IS3172	(2-0)	C4ISR System Evaluation
CI9013	(3-0)	Operational Analysis
CS0810	(0-8)	Thesis Research

Quarter 7

CSXXXX	(4-0)	Track Requirement*
CSXXXX	(4-0)	Track Requirement*
IW3101	(4-1)	Information Operations
CS0810	(0-8)	Thesis Research

Quarter 8

IS3174	(2-0)	Chief Information Officer
CI9015	(2-0)	Acquisition Management
CI9006	(3-2)	C4ISR Systems
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

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

TRACK OPTIONS

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

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

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

The purposes of the Software Engineering Track are to provide knowledge of all aspects of software development and to develop skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques.

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

The Computer Systems and Security Track is designed to provide knowledge in all areas of Information Security (INFOSEC) and to develop the necessary skills for those who will be involved in development, evolution or implementation of secure computer systems.

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

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

1. JOINT AND MARITIME STRATEGIC PLANNING

Joint and maritime strategic planning to include development and execution of military strategy and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

2. SOFTWARE ENGINEERING

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

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

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

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

3. SOFTWARE TECHNOLOGY

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

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

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

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

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

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

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

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

4. COMPUTER SYSTEMS DESIGN

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

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

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

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

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

5. COMPUTER ARCHITECTURE

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

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

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

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

6. PROBLEM SOLVING AND REAL WORLD APPLICABILITY

The officer shall possess skills that permit a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to the real world in a Navy organization. This includes:

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

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

c. Clearly communicating the project in writing and verbally.

Curriculum Sponsor and ESR Approval Authority

Deputy Director, Space, Information Warfare, Command and Control (N62)
December 1996

INTELLIGENCE INFORMATION MANAGEMENT PROGRAM

Curricular Officer:
Michael Mullady
LtCol, USAF
Code 39, Root Hall
Room 103H
(831) 656-2772
DSN 878-2772
e-mail: mmullady@nps.navy.mil

INTELLIGENCE INFORMATION MANAGEMENT
CURRICULUM 823
The Intelligence Information Management curriculum is tailored to meet the billet requirements of major resource claimants, such as Unified Commanders-In-Chiefs, theater and service intelligence centers and service/agency intelligence system resource sponsors and to satisfy the educational skill requirements for Intelligence Information Management (XX17P). This is a rigorous curriculum to provide officers a broad knowledge, based upon key principles of science, technology and management which may be applied to the technological changes of the 2010 environment and beyond. Graduates will be able to effectively interface with and manage the design, acquisition and operation of National, Theater and Service intelligence information activities, personnel and systems. In addition, blocks for the Naval War College by Correspondence are built into the curriculum and reflected in the NW3230 and subsequent NW courses.

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

DEGREE
Requirements for the degree Master of Science in Systems Technology are met en route to satisfying the Educational Skill Requirements of the Intelligence Information Management program.

REQUIREMENTS FOR ENTRY
Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information (SCI). They must have a baccalaureate degree earned with above-average academic performance and minimum APC of 324.

Typical Jobs in this Subspecialty:
Combatant Command and Theater JIC Intelligence Systems Architects and Program Managers
Service Intelligence Systems Requirements and Resource Sponsors - CNO N20
Service/Agency Intelligence Command or System Command Program Manager -
NIMA, NSA, COMSPAWARSYSCOM, ESC, ONI

ENTRY DATES
Intelligence Information Management is a seven quarter program with a starting date in September. In addition, students may be required to report for a math and physics refresher in June. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 823
Academic Associate:
Dan C. Boger, Professor
Code CC, Root Hall, Room 201D
(831) 656-3671, DSN 878-3671
e-mail: boger@stl.nps.navy.mil

TYPICAL COURSE OF STUDY
INTELLIGENCE INFORMATION MANAGEMENT

Refresher (Six-week)

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

Quarter 1

MA1118	(5-2)	Multi-Variable Calculus
IW3101	(4-1)	Principles of Information Operations
CS2973	(4-2)	Object-Oriented Programming in Java
SS2041	(4-0)	Introduction to Space

Quarter 2

NW3230	(4-0)	Strategy & Policy
OS2103	(4-1)	Applied Probability for Systems Technology
CS3030	(4-0)	Computer Architectures and Operating Systems
EO2413	(4-2)	Introduction to Communication System Engineering

Quarter 3

OS3604	(4-0)	Decision and Data Analysis
SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula
IS3502	(3-2)	Computer Networks: Wide Area/Local Area
EO3513	(4-2)	Communication Systems Engineering

Quarter 4

SS3001	(3-2)	Military Applications of Space
MN3105	(4-0)	Organization & Management
IS4502	(3-2)	Telecommunications Networks
NWXXXX	(4-0)	Naval War College Block #2

Quarter 5

IS4320	(4-1)	Database and Information Resource Management for C4I
NWXXXX	(4-0)	Naval War College Block # 3
MNXXXX	(4-0)	Management Elective
EO4612	(4-2)	Microwave Devices and Radar

Quarter 6

NS4159	(4-0)	Seminar in Joint Intel Support
EO4513	(4-2)	Communication Systems Analysis
NWXXXX	(4-0)	Naval War College Block #4
CC0810	(0-8)	Thesis Research

Quarter 7

CC4913	(4-0)	Policies and Problems in C3
CC4750	(3-1)	Military C4I Systems and Networks
CC0810	(0-8)	Thesis Research
CC0810	(0-8)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
INTELLIGENCE INFORMATION MANAGEMENT
CURRICULUM (823)
Subspecialty Code XX17P

GRADUATE EDUCATION SUMMARY: The objective is to provide graduate-level education and a broad knowledge, based upon key principles of science and technology, which may be applied to technological challenges anticipated in the 2010 environment and throughout the officer's career in Naval Intelligence. Graduates should be able to effectively interface with and manage the design, acquisition, and operation of Naval Intelligence Information activities, personnel and systems. They should also have a graduate level understanding at the classified level of management practices, analysis and problem solving required to process and analyze the significant volume of data and information sources expected in this, the Information Age. In reaching these goals, the student will obtain a graduate-level knowledge of signal processing and applications; a graduate-level knowledge of computer networks and client-server environments; an understanding of information operations and command and control warfare; an understanding of how science and technology support intelligence processes and systems; a graduate-level knowledge of joint professional military education; a graduate-level understanding of the research process and data analysis; and the ability to conduct independent analysis on a complex problem involving technical intelligence processes and systems.

INTELLIGENCE MANAGEMENT: Provide a basic understanding of management and organizational theory; so that the student can manage the spectrum of intelligence information organizations, processes, and personnel. Understand the organization, products, systems, doctrine, policies, current issues and future concepts of Naval, National and Joint intelligence entities.

INTELLIGENCE INFORMATION TECHNOLOGY: Be able to formulate system requirements, understand, deploy, 'fine tune' and document the components of Information Superiority systems in support of Intelligence Operations, organizations and processes. Emphasis will be placed on the following specialization areas:

- Information Systems/Information Technology Management
- Information Warfare Systems Engineering
- Joint C4I Systems
- Modeling, Virtual Environments and Simulation
- Intelligence Support to Weapons Systems, Acquisition and Operations

SYSTEMS ENGINEERING, ANALYSIS AND SPACE: Understand systems engineering studies, develop architectures, and integrate systems, including mission requirements determination; operational, technical, and system architectures; data analysis, modeling and simulation, and experimental design and analysis; evaluation of human-in-the-loop C4I systems; technical analysis of selected C4I systems and architectures; interoperability of hardware and software within and across systems of systems; and standard and alternative acquisition process. Similar levels of understanding should be applied to military and commercial space based sensing and communications to include orbitology, space environment and spacecraft engineering.

SIGNAL PROCESSING AND APPLICATIONS: A theoretical and practical knowledge of the principles of signal processing, communications, radar, electronic warfare, signals intelligence and acoustic intelligence, to include analog and digital signals and systems, communications systems analysis, EW techniques and systems, sensor data fusion and correlation, and acoustic intelligence collection and analysis systems.

INTELLIGENCE CAPSTONE: A graduate level knowledge and understanding of intelligence processes and their applications to joint and naval warfare. An understanding of the intelligence structure at the national, theater and CJTF level with emphasis on the roles of the associated intelligence organizations as reflected in the doctrine and Tactics, Techniques and Procedures (TTP) manuals. Focus should be on the transformation in warfare resulting from revolutionary developments in technology, innovative operational concepts, and organizational adaptations within the armed forces. Students will also gain a graduate level understanding of information operations as it applies in a civil-sector environment, as well as an understanding of command and control warfare as the military application of information warfare.

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

PRACTICE: Demonstrate the ability to conduct independent analysis of intelligence organizations, processes and systems and will demonstrate proficiency in presenting the results in writing by means of a thesis.

Curriculum Sponsor and ESR Approval Authority
Director, Naval Intelligence
August 1998

INFORMATION SYSTEMS TECHNOLOGY

Curricular Officer:
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INFORMATION SYSTEMS TECHNOLOGY
CURRICULUM 370
This curriculum provides officers with the knowledge of information systems technology to include computer and telecommunications systems, software engineering, networked and distributed applications, database management systems, and decision support systems in the military services. Students will also gain proficiency in information systems, economics and management necessary for the critical management decisions needed in the development and utilization of complex and evolving computer-based military systems.

Information Systems Technology is an interdisciplinary, graduate-level master's program integrating mathematics, accounting, economics, statistics, computer science, information systems, communications engineering, networks, and management disciplines.

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

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

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination) or GMAT (Graduate Management Admission Test), indicate a capability for graduate level work. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students. While previous computer, communications or information systems experience is certainly helpful, it is not essential.

INFORMATION TECHNOLOGY MANAGEMENT SUBSPECIALTY
Completion of this curriculum qualifies a Navy officer as an Information Technology Management Subspecialist with a subspecialty code of XX89P. Other services have analogous coding. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:
CO/XO, Naval Computer and Telecommunication Station/Master Station
Staff Comm/Fleet Communications Officer, Numbered Fleets
Information Systems Officer, USS George Washington
ADP Plans Readiness Assessment Officer, COMNAVSURFLANT
ADP Systems Officer, Director Strategic Systems Procedure
SNAP System Officer, SPAWARSYSCOM
OIC, NAVMEDINFORMGMTCENDET
Data Base Management Officer, Naval Security Group
Plans and Programs, COMNAVCOMTELCOM

ENTRY DATES
Information Systems Technology is an eight-quarter course of study with entry dates in March and September. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 370
Academic Associate:
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e-mail: crjones@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

NW3230	(3-0)	Strategy and Policy
IS2020	(2-3)	Introduction to Visual Basic
CS3030	(4-0)	Computer Architecture and Operating Systems
OS3105	(4-1)	Statistical Analysis for Management I

Quarter 2

IS3020	(3-2)	Software Design
IS3201	(3-2)	Fundamentals of Database Technology
IS3502	(3-2)	Computer Networks: Wide/Local Area
OS3004	(5-0)	Operations Research

Quarter 3

MO1902	(3-0)	Mathematics for ISSO and ISO
CC3000	(4-0)	Command and Control Concepts
IS3301	(3-2)	Fundamentals of Decision Support Systems
CS3600	(4-0)	Introduction to Computer Security

Quarter 4

MN4125	(4-0)	Managing Planned Change in Complex Organizations
IS3172	(2-0)	C4ISR System Evaluation
IW3101	(4-1)	Principles of Information Operations
CI9004	(3-0)	Space Technology and Applications
EO3502	(3-0)	Communication Systems Technology and Applications

Quarter 5

EO3514	(4-0)	Communications Systems I
CI9003	(3-0)	Sensor Technology and Applications
IS3031	(4-0)	Principles of Information Systems Evaluation
IS 4300	(3-2)	Software Engineering and Management

Quarter 6

EO4514	(3-2)	Communications Systems II
IS4220	(3-2)	Architecting Information Systems
———	(4-0)	Focus Area Choice (See note)
IS 0810	(0-8)	Thesis Research

Quarter 7

MN3154	(4-0)	Financial Management in the Armed Services
MN3331	(4-0)	Acquisition and Project Management
CC4221	(4-0)	C4ISR Systems
———	(4-0)	Focus Area Choice (see note)
IS0810	(0-8)	Thesis Research for Information Technology Management Students

Quarter 8

IS4182	(4-0)	Information Systems Management
IS0810	(0-8)	Thesis Research for Information Technology Management Students
———	(4-0)	Focus Area Choice (see note)
———	(4-0)	Focus Area Choice (see note)

NOTE: Students with a strong education and background in any of the above topics can request validation of those courses and thereby avail themselves of additional course work. Typical courses include, but are not limited to:

CC4750	Military C4I Systems and Networks
CS3310	Artificial Intelligence
CS4202	Computer Graphics
IS3000	Distributed Computer Systems
IS3100	Analysis of Microcomputers and Microprocessors
IS3503	Microcomputer Networks
IS3504	Modern Network Ops System: Planning, Technology & Operations
IS4184	Information Resource Management in DoN/DoD
IS4186	Knowledge-Based Systems and Artificial Intelligence
IS4187	Information Networking & Distributed Decision Technologies
IS4503	Internet to Sea
IS4800	Directed Study in Advanced Information Systems
MN3374	Production Management: A TQM/L Perspective
MN4105	Strategic Management
MN4151	Internal Control and Auditing
MR2419	Atmospheric Factors in C3
OS3404	Man-Machine Interaction

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION SYSTEMS TECHNOLOGY
CURRICULUM (370)
Subspecialty Code XX89P

With the Information Age has come a revolution in command and control, communications, computers, weapons and Command and Control Warfare. From classical ADP systems to tactical systems there are increased needs for horizontal integration, common databases, massive communications needs, and better management and command and control decision making. Both afloat and ashore, graduates of the Information Systems Technology curriculum have the expertise and leadership to efficiently and effectively set requirements and design, implement, operate and evolve information and C4I systems using the ever changing information technology base. These graduates are a critical success factor in the adaptation of information technology to the needs of military users. They provide the integration of information systems necessary to support the push and pull of voice, video and data across the battlefield and throughout the spear of war--from the “pointy end” to the “support tail.”

The Information Systems Technology graduate shall have the knowledge skills and competencies to:

(1) Engineer Information Systems afloat and ashore;
(2) Manage Information Systems, centers and commands afloat and ashore; and
(3) Solve Information Systems engineering and management problems individually and in teams.

These general education skill requirements are supported by the following topical educational skill requirements.

1. **JOINT AND MARITIME STRATEGIC PLANNING.** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; planning to ensure Joint and Allied interoperability; the U.S. maritime component of the National Military Strategy; the organizational structure of the U.S. defense establishment; the role of Unified Commanders in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategic objectives.

2. **INFORMATION SYSTEMS TECHNOLOGY.** The officer must have a thorough knowledge of information systems technology to include:

   a. Computer System Components: central processing units, input/output devices, storage devices, operating systems, programming languages, distributed computer systems, and computer security.

   b. Computer Networks: fiber optics, wide- and local-area network hardware, software, components and systems, physical layer interfaces and protocols, and network management protocols.

   c. Communication Systems and Networks: PCM systems, AM, FM, TV, modulation, SATCOM, HF, microwave systems, error control coding, antijam communications, low probability of intercept communications, GPS, data encryption, communications software, and communications security.

   d. Software Engineering: Methodologies for the analysis, design, development, prototyping, testing, implementation and maintenance of software; software metrics and reliability; productivity analysis and software cost estimation and planning; CASE and ICASE tools.

   e. Database Management Systems: Database technologies (including object oriented) and technical and administrative issues involved in the design, implementation and maintenance of database management systems.

   f. Decision Support and Expert Systems: Problem identification, formulation, and design of systems to support decision making; application of artificial intelligence technology to preserve perishable expertise and enhance distributed expertise; understanding the design of executive information systems, office automation, group decision support systems and crisis management systems, and their potential impacts on organizations and missions.

3. INFORMATION SYSTEMS ANALYSIS AND MANAGEMENT. The officer must master the following concepts to effectively manage information system assets:

a. Managerial Concepts: Decision-making theory, microeconomics, operations analysis, financial management, organizational development, and research methodologies.

b. Evaluation of Information Systems: Cost-performance (effectiveness) analysis; selection, evaluation, acquisition, installation and effective utilization of information systems hardware and software; risk assessment; information system architectures involving alternative system concepts.

c. Systems Analysis and Design: Information systems feasibility studies and life cycle management including fact-finding techniques for determining system requirements and specifications, system performance evaluation, conversion and maintenance of legacy systems and the post-implementation evaluation, man-machine interfaces, system ergonomics, and security analysis of information systems.

d. Management of Information Systems: Information systems facilities planning, production planning and control, requirements determination of information systems personnel, human resource management, budgeting and financial control of computer centers, design of effective organization structure and information systems, and control and security (INFOSEC) policies.

e. Adapting to Technological, Organizational, and Economic Changes: Evaluation of potential impacts of new technology on information systems planning and development and on organizational strategy; appraisal of evolving responsibilities of information systems managers.

f. Military Use of Commercial Telecommunications Systems: Architectural integration, cost-performance (effectiveness), and geopolitical-legal aspects.

4. MILITARY APPLICATIONS. The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include:

a. DoD Decision Making Process on Information Systems: DoD, DoN, OMB, and congressional decision making on information systems matters.

b. Information Technology Acquisition Management: Acquisition policies and procedures of the DoD, including the planning, programming and budgeting system; project management.

c. DoD Computer and Telecommunications: Architectures and specifications of Navy and DoD systems, computers, telecommunications networks and services, including the DISN; Navy fleet communications systems including satellite communications, JMCIS, GCCS, and the Navy Telecommunications System (NTS); Decision Support Systems.

d. C4ISR and C2W: Concepts and application to strategic, operational and tactical level operations including support.

5. INDEPENDENT RESEARCH. The graduate will demonstrate the ability to conduct independent research analysis, and proficiency in communicating the results in writing and orally by means of a thesis and a command oriented briefing. The research in information technology and its management will include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis and evaluation.

Curriculum Sponsor and ESR Approval Authority

Commander, Naval Computer and Telecommunications Command
December 1996

INFORMATION WARFARE

Curricular Officer:
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INFORMATION WARFARE
CURRICULUM 595
Graduates of this curriculum are thoroughly knowledgeable in Information Operations (IO) and Information Warfare (IW). They receive a Master of Science degree in Systems Engineering which provides the services with officers well versed in the technical, theoretical, and operational aspects of interdisciplinary IO/IW as they relate to joint mission objectives. This curriculum is co-sponsored by the Joint Staff (J39) and Commander, Naval Security Group (NAVSECGRU).

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

DEGREE
Requirements for the degree Master of Science in Systems Engineering are met en route to satisfying the Educational Skill Requirements of the curricular program.

REQUIREMENTS FOR ENTRY
A baccalaureate degree with above-average grades with courses in mathematics (through integral calculus) is required for entry consideration. Additionally, applicants must have a minimum APC of 324. Applicants not meeting the mathematics requirements may be considered for entry via the Engineering Science Program (curriculum 460).

INFORMATION WARFARE SUBSPECIALTY
Graduates are designated Information Warfare Subspecialists with a XX46P code.

Typical Jobs in this Subspecialty:
Joint, Combined, Fleet and Group Staffs
Systems Commands
Navy Information Warfare Activity (NIWA)
Fleet Information Warfare Centers (FIWC)
The Joint Staff
Joint Command and Control Warfare Center (JC2WC)

ENTRY DATE
The Information Warfare curriculum is an eight quarter course of study with a single entry date in October. For further information, contact the Information Warfare Curricular Officer or Academic Associate.

Curriculum 595
Academic Associate:
Carl Jones, Professor
Code SM/Js, Ingersoll Hall, Room 307
(831) 656-2995, DSN 878-2995
e-mail: crjones@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

MA2139	(5-0)	Introduction Differential Equations and Vector Analysis
CS3030	(4-0)	Computer Architectures and Operating Systems
IW3101	(4-1)	Principles of Information Operations
NW3230	(4-0)	Strategy and Policy

Quarter 2

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OS3104	(4-0)	Statistics for Science and Engineering
CS2971	(3-2)	Introduction to Object-Oriented Programming with C++
EO2652	(4-1)	Field, Waves, and Electromagnetic Engineering

Quarter 3

OS3003	(4-0)	Operations Research for Information Warfare
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
EO2512	(3-2)	Introduction to Communications and Countermeasures
PH3802	(4-0)	Weapons, Weapons Effects, and Weaponeering

Quarter 4

EO4612	(4-2)	Microwave Devices and Radar
EC3750	(3-2)	SIGINT Systems
IS3502	(3-2)	Computer Networks
EO3512	(3-2)	Telecommunications Engineering

Quarter 5

PH2203	(4-0)	Topics in Basic Physics: Waves and Optics
EO4512	(4-2)	Communications and Countermeasures
CC3001	(4-0)	Command and Control and Information Operations
CS3600	(3-2)	Introduction to Computer Security

Quarter 6

EO4210	(3-2)	Electro Optics, IR, Lasers and Countermeasures
IW4622	(3-3)	EW for Information Warfare
IS4321	(3-0)	Decision Support and Database Technology for IW
IW0810	(0-8)	Thesis Research

Quarter 7

EC4010	(3-2)	Principles of Systems Engineering
IW4501	(4-2)	C4ISR Sensors, Systems and Products
EO4XXX	(3-2)	Fiber Optic Systems
IW0810	(0-8)	Thesis Research

Quarter 8

EC4920	(3-2)	Information Operations
IW4921	(3-2)	Network Operations
----------	(3-2)	Elective
IW0810	(0-8)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION WARFARE
CURRICULUM (595)
Subspecialty Code XX46P

1. INFORMATION WARFARE
The officer will have an in-depth understanding of IW and the attendant disciplines.

2. COMMUNICATIONS/COMPUTER/INFORMATION NETWORKS
The officer will have an in-depth understanding of the capabilities, limitations, design and operation of communications, computers and information networks.

3. INFORMATION SYSTEMS
The officer will have a systems level understanding of information systems and their vulnerabilities as well as capabilities.

4. ORGANIZATIONAL PROCESSES AND STRUCTURE
The officer will understand the organizational decision process, as well as the structure and other processes of organizations with emphasis on their vulnerabilities and capabilities.

5. INTELLIGENCE
The officer will understand the concepts, principles, methods and capabilities of joint operational intelligence, with emphasis on the operational requirements levied upon the intelligence community to support IW.

6. IW INTEGRATION
The officer will understand the integration of IW as a weapon and its role in modern warfare; understand the integral roles of EW, psychological operations, military deception, OPSEC, and physical destruction; understand INFOSEC and nodal attack in this warfare area; employ real time intelligence, tactics and EW systems; understand the physical principles of generation, transmission, propagation, reception, processing and suppression of detection and surveillance information.

7. PROBLEM SOLVING AND PRACTICAL APPLICABILITY
The officer will demonstrate the ability to conduct independent analysis in IW and proficiency in presenting the results in writing and orally by means of a thesis and command oriented briefings.

8. JOINT AND MARITIME STRATEGIC PLANNING
The officer will have an understanding of the American and world military history and joint maritime planning including the origins and evolution of national and allied strategy.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Security Group
October 1995

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

Curricular Officer:
Michael Mullady
LtCol, USAF
Code 39, Root Hall
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JOINT COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I) SYSTEMS CURRICULUM 365

The Joint C4I curriculum is designed to meet broad educational objectives endorsed by the Joint Chiefs of Staff. The overall objective is to provide officers and DoD civilian equivalents, through graduate education, with a comprehensive operational and technical understanding of the field of Command, Control, Communications, Computers, and Intelligence systems as applied to joint and combined military operations at the national and unified command levels. The program is designed with the following goals: enable individuals to develop an understanding of the role C4I systems play in the use of military power and the ability to interpret the impact of C4I on operating philosophy; provide adequate background knowledge in basic technology, human capabilities and joint military operations and how these factors are exploited in current C4I systems; and, provide the framework whereby students can perform requirement and planning studies of new C4I systems and contribute to crisis management.

These officers should be able to undertake a wide range of assignments in C4I (both joint and intra-service) over the full span of their careers.

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

DEGREE

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

REQUIREMENTS FOR ENTRY

The Joint C4I curriculum is open to all U.S. Military Services and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. Eligibility for TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required. An APC of 324 is required for direct entry. Officers not meeting the Academic Profile Code may be admitted based on transcript reviews by the registrars office and the curriculum officer.

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

Completion of this curriculum qualifies an officer as a Joint Command, Control, Communications, Computers and Intelligence (C4I) Systems Subspecialist with a subspecialty code of XX45P for U.S. Naval officers. Army graduates are awarded the 3K Special Skill Identifier. Air Force graduates fill OYTA coded billets. Marine Corps graduates are awarded the 9658 Special Skill Identifier. The curriculum sponsor is the Director for Command, Control, Computer and Communications Systems (J6), Joint Staff.

Typical Jobs in this Subspecialty:

Staff Command and Control Officer: Commander in Chief, Pacific Fleet
Surface Systems Officer: Naval Ocean Systems Center
Staff Planning and Programming Officer: OPNAV/N62
Staff Operations Plans Officer: Headquarters, European Command
Staff Operations and Plans Officer: Commander 7th Fleet
Program Manager: Naval Space and Warfare Systems Command
C3 Staff Officer: Headquarters, U.S. Space Command

ENTRY DATES
Joint Command, Control, Communications, Computers, and Intelligence (C4I) Systems is a seven-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 365
Academic Associate:
William G. Kemple, Associate Professor
Code CC, Root Hall, Room 201J
(831) 656-3309, DSN 878-3309
e-mail: kemple@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD
CC2041	(0-3)	Introduction to Systems Technology Battle Lab
CI9008	(5-0)	Computer & Software Technology
NW3230	(4-0)	Strategy & Policy
MO1901	(3-0)	Mathematics

Quarter 2

CC3101	(4-0)	Combat Analysis for C3
CI9008	(3-0)	Introduction to Space
OS3104	(4-0)	Statistics for Science and Engineering
CI9010	(3-0)	Information Assurance
EO2513	(3-2)	Introduction to Communication System Engineering

Quarter 3

IW3101	(4-1)	Introduction to Information Operations
OS3008	(4-0)	Analytical Planning Methodology
CI9003	(3-0)	Sensors
EO3513	(4-2)	Communication Systems Engineering: Modulation

Quarter 4

CC4101	(4-2)	C4I Systems Engineering
CI9011	(3-0)	Decision Support and Database Systems
CI9009	(3-0)	Networks
CI9014	(2-0)	CIO
EO4513	(4-2)	Communication System Analysis

Quarter 5

CI9006	(3-2)	C4ISR
CI9015	(2-0)	Acquisition Management
CC0810	(0-8)	Thesis
		Emphasis Elective

Quarter 6

CC4040	(3-3)	Advanced Joint C2 Systems
CC4750	(3-1)	Military C4I Systems & Networks
CC4103	(2-4)	C4I Systems Evaluation
CC0810	(0-8)	Thesis Research

Quarter 7

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

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

The graduate shall be able to:

1. **TECHNOLOGIES:** Analyze and synthesize communications, computer, and information systems, including digital and analog communications systems, computer architectures, networks, databases, decision support systems, sensors, information security techniques, user-network interface, and system tradeoff analyses.

2. **SYSTEMS ENGINEERING AND ANALYSIS:** Perform systems engineering studies, develop architectures, and integrate systems, including mission requirements determination: operational, technical and systems architectures; data analysis, modeling and simulation, and experimental design and analysis; evaluation of human-in-the-loop C4I systems; technical analysis of selected C4I systems and architectures; interoperability of hardware and software within and across systems of systems; and standard and alternative acquisition process.

3. **JOINT C4I:** Understand joint C4I systems, including national and DoD C2 and intelligence concepts, policies, doctrine, processes, and organizations; joint C4I systems and architectures; information warfare and C2 warfare environments; effects of combined operations; and future concepts and current issues.

4. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the role of the commanders of the unified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

5. **PRACTICE:** The graduate will demonstrate the ability to conduct independent analysis of joint command, control, communications, computers, and intelligence systems and will demonstrate proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority
Director, C4 Systems (J-6)
Director, Space and Electronic Warfare (N-6)
June 1997

MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES)

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

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the CNO-N6 ISSO education skill requirements as modified for MOVES.

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

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

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

DEGREE
Requirements for the degree Master of Science in Modeling, Virtual Environments and Simulation are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus), resulting in an APC of at least 325 is required for entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through the six week technical refresher or twelve week Engineering Science program, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination), indicate an ability to work in quantitative subjects. While previous academic or practical experience in modeling, virtual environments and simulation is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

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

ENTRY DATES
MOVES is an eight-quarter course of study with entry dates in April and October. Those requiring the six week refresher or twelve week Engineering Science program will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 399
Academic Associate:
Rudy Darken, AssistantProfessor
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(831) 656-4072, DSN 878-4072
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e-mail: darken@nps.navy.mil

TYPICAL COURSE OF STUDY
VISUAL SIMULATION TRACK

Quarter 1

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

Quarter 2

CS3971	(3-2)	Advanced Object-Oriented Programming in C++
CS3200	(3-2)	Computer Architecture
OA3102	(4-1)	Probability and Statistics
NW3230	(3-0)	Strategy and Policy (international students take IT1500 instead)

Quarter 3

CS3472	(3-2)	Introduction to Physically Based Modelling
OA3401	(4-0)	Human Performance Measurement I
OA3103	(4-1)	Statistics
OA3301	(4-0)	Stochastic Models I
CS4901	(0-2)	Research Seminar in MOVES

Quarter 4

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

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
CS3310	(4-0)	Artificial Intelligence
CS4470	(3-2)	Image Synthesis
CS4472	(3-2)	Physically-Based Modeling

Quarter 6

CS4112	(3-2)	Distributed Operating Systems
CS4474	(3-2)	Virtual Environment Network and Software Architectures
CS4473	(3-2)	Virtual Worlds and Simulation Systems
CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD

Quarter 7

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

Quarter 8

CS4314	(3-2)	Symbolic Computing
OA4655	(4-0)	Airland Combat Models II
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY
HUMAN-COMPUTER INTERACTION TRACK

Quarter 1

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

Quarter 2

CS3971	(3-2)	Advanced Object-Oriented Programming in C++
CS3200	(3-2)	Computer Architecture
OA3102	(4-1)	Probability and Statistics
NW3230	(3-0)	Strategy and Policy (international students take IT1500 instead)

Quarter 3

OA3401	(4-0)	Human Performance Measurement I
OA3103	(4-1)	Statistics
OA3301	(4-0)	Stochastic Models I
CS4901	(0-2)	Research Seminar in MOVES
CS3472	(3-2)	Introduction to Physically Based Modeling

Quarter 4

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

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
CC3000	(4-0)	Introduction to Command, Control, Communication, Computer and Intelligence Systems in DoD
CS3310	(4-0)	Artificial Intelligence
———		Elective

Quarter 6

CS4473	(3-2)	Virtual Worlds and Simulation Systems
OA4655	(4-0)	Airland Combat Models II (for those in the Human-Computer Interaction Track)
OA3402	(3-0)	Human Performance Measurement II
CC4103	(2-4)	C4I Systems Evaluation

Quarter 7

OA4401	(4-0)	Human Performance Evaluation
OA4333	(4-0)	Simulation Methodology
———		Elective
CS0810	(0-8)	Thesis Research

Quarter 8

CS4314	(3-2)	Symbolic Computing
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

TRACK OPTIONS

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

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

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

All officers with advanced degree education in Modeling, Virtual Environments and Simulation (MOVES) must possess skills and competencies in the fundamentals of modeling and simulation (including visual simulation), human-computer interaction, statistics and data analysis. Topics in this curriculum include: object-oriented programming, artificial intelligence, computer communications and networks, computer graphics, human-computer interaction, virtual world and simulation systems, physically based modeling, virtual environment network and software architectures, probability, statistics, stochastic modeling, data analysis, human performance measurement and evaluation, and combat modeling. The skills and competencies are detailed below.

1. JOINT AND MARITIME STRATEGIC PLANNING

The officer must understand the application and evaluation of modeling and simulation tools in Joint and Maritime Strategic Planning. This applies to development and execution of military strategy; 'what-if' analytical evaluation of proposed tactics and strategy; analysis of alternative courses of action; and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization. In view of the increasing emphasis on joint training, joint planning, and joint analysis in support of system procurement decisions, the officer must understand and be able to employ modeling and simulation in distributed simulation networks joining a variety of modeling and simulation tools, developed and operated by other Service agencies.

2. SOFTWARE DEVELOPMENT

The officer must have a thorough knowledge of modern software development to include: an understanding of the software development process; the ability to plan and implement a major programming project and develop the appropriate documentation, and; the ability to utilize object-oriented techniques in system design, and to use modern software development tools in the construction of modeling, virtual environments and simulation systems.

3. SOFTWARE TECHNOLOGY

The officer must have a thorough knowledge of software technology to include: properties of object-oriented languages; programming techniques for parallel and distributed applications; the structure of storage media; methods useful in representing structured data in storage; techniques of operating upon data structures; computer systems organization from the operating systems level down to the computer architecture level; memory management; file system design and management; object-oriented operating environments; artificial intelligence techniques including heuristic search, artificial intelligence languages, knowledge representation, expert systems, and means-end analysis; rapid prototyping for object-oriented design; and use of tools.

4. COMPUTER SYSTEMS DESIGN

The officer must have a thorough knowledge of computer system design to include: empirical and analytical methods for determining the efficiency and performance of computer systems; modeling of processes; an understanding of the design issues of hardware/software compatibility, operating systems compatibility, information systems requirements, and interoperability, especially via networks.

5. COMPUTER ARCHITECTURE

The officer must have a thorough knowledge of computer architecture to include: basic components of computer systems and their patterns of configuration and communication including large scale mainframes, microcomputers, supercomputers, parallel processors, and networks of workstations; the organization, logic design, and components of digital computing systems relating to multi-processing, parallel processing, distributed processing, networking, communication, multimedia, and peripheral devices.

6. ANALYTICAL SKILLS

The graduate must possess the skills in higher mathematics required to support graduate study in modeling, virtual environments and simulation. The graduate must understand the use of modeling and simulation in the design of experiments, including selection of the most appropriate models for specific requirements. The graduate must also gain proficiency in the development of software, and in employment of software of special importance for modeling, virtual environments and simulation.

7. DATA ANALYSIS AND STOCHASTIC MODELING

The graduate must have the ability to apply probability, statistics, and exploratory data analysis as appropriate, to formulate and execute analyses involving uncertainty, including analyses of military operations. The graduate will be proficient in the principles of probability and statistics and the use of one or more statistical graphics programs, and be able to apply interactively a variety of methods to actual data. The graduate will be able to analyze a variety of DoD data sets to answer specific operational questions utilizing modeling, virtual environment and simulation systems. The graduate will be able to formulate and solve problems involving processes with uncertainty over time, including the ability to apply the theory to warfare, and tactical decision analyses.

8. VIRTUAL ENVIRONMENTS AND COMPUTER-HUMAN INTERACTION

The graduate will be knowledgeable with the development of networked virtual environment and simulation systems, and will be able to implement such systems or manage a team capable of developing such systems. Topics included in study are: computer-human interfaces, and networking; real-time, 3D computer graphics and human-computer interaction, virtual worlds, distributed interactive simulation, virtual environment network and software architectures; intelligent displays, and computer-mediated autonomous systems; use of video, audio, haptic, and other sensory I/O to coordinate human-machine activities via remote access; and physically based modeling.

9. PROBLEM SOLVING AND REAL WORLD APPLICABILITY

The officer shall possess skills that permit a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to the real world in a Navy organization. This includes: completing a significant project applying academic skills outside of the classroom; exercising skills in problem formulation, criteria specification, analysis, and evaluation and presentation of results; and clearly communicating the project in writing and verbally.

Curriculum Sponsor and ESR Approval Authority

Deputy Director, Space, Information Warfare, Command and Control (N6M)
September 1996

SPACE SYSTEMS OPERATIONS PROGRAM

Curricula Officer:
William J. Welch
CDR, USN
Code 31, Halligan Hall
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DSN 878-2491
e-mail: wwelch@nps.navy.mil

SPACE SYSTEMS OPERATIONS
CURRICULUM 366
The Space Systems Operations curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, comprehensive, practical as well as theoretical knowledge of the operation, tasking and employment of space surveillance, communications, navigation and atmospheric/oceanographic/ environmental sensing systems and a knowledge of payload design and integration.

The Information Sciences, Systems and Operations (ISSO) curricula consists of Professional Practice Core and seven degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations\Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the ISSO education skill requirements as established by CNO-N6.

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

REQUIREMENTS FOR ENTRY
This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential equations and integral calculus, plus at least one course in calculus-based physics. Students lacking this background may matriculate through the Engineering Science program (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

SPACE SYSTEMS OPERATIONS SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of XX76P. The curriculum sponsors are N63, Navy Space Systems Division and J6, Director for Command, Control Communications and Computer Systems.

Typical Jobs in this Subspecialty
OPNAV (N63) TENCAP Assistant
SPAWAR Space Systems Project Officer
NAVSPACECOM Staff Officer
USSPACECOM Staff Officer
NAVSECGRUs/DETs

ENTRY DATES
The Space Systems Operations curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 366
Academic Associate:
Donald Wadsworth, Senior Lecturer
Code EC/Wd, Spanagel Hall, Room 222
(831) 656-3456, DSN 878-3456
e-mail: dwadsworth@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

MA1901/2	(5-0)	CI Math Refresher
CI9008	(5-0)	Comp/SW Tech
PH1998	(3-0)	Physics
NW3230	(4-0)	Strategy & Policy
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 2

CI9015	(2-0)	Acquisition Management
EO3513	(4-2)	Introduction to Communications Systems Engineering
CI9009	(3-0)	Networks
PH2514	(4-0)	Phys Space Environment
SS3011	(3-0)	Space Introduction
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 3

CI9012	(4-0)	Probability/Statistics
IW3101	(4-1)	Info Ops
CI9003	(3-0)	Sensor Tech/App
SS2500	(3-1)	Orb Mech
SS3805	(2-0)	Launch Systems
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 4

CI9013	(3-0)	Ops Analysis
EO4516	(4-2)	Comm Systems Analysis
AA4830	(3-2)	Spacecraft Systems I
CI9011	(3-0)	DS/Database
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 5

SS3613	(3-0)	SATCOM
CC3000	(4-0)	C2
AA4831	(3-2)	Spacecraft Systems II
SS3041	(4-2)	Space Systems/Operations I
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 6

		Experience Tour
		Experience Tour
SS3001	(3-2)	Military Applications of Space
SS3051	(4-0)	Space Systems/Operations II
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 7

EO4011	(3-1)	Systems Engr
CI9010	(3-0)	Info Assurance
SS4051	(3-2)	Space Architecture
SS0810	(0-8)	Thesis
	(2-0)	Tech Writing
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 8

CI9006	(3-0)	C4ISR
CI9014	(2-0)	CIO
SS0810	(0-8)	Thesis
SS0810	(0-8)	Thesis

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION SCIENCES, SYSTEMS AND OPERATIONS
SPACE SYSTEMS OPERATIONS
CURRICULUM (366)

Graduates of the Space Systems Operations Specialization of the Information Sciences, Systems, and Operations (ISSO) Curriculum shall be able to determine space systems requirements which support the following operational concepts: control of space, global engagement, full force integration, and global partnerships. The graduates shall be able to analyze courses of action for the best employment of available space assets for ongoing and future military operations and communicate this assessment to shore and afloat staffs and commanders.

Supporting these goals are the following specific requirements.

1. JOINT AND MARITIME STRATEGIC PLANNING, POLICY AND REQUIREMENTS DEVELOPMENT AND OPERATIONS.

a. Understand current American and allied military strategies that address the entire spectrum of conflict, including the U. S. maritime component of national military strategy.

b. Understand the organizational structure of the U.S. defense establishment. Understand the roles and relationships of the Joint Staff, the commanders of unified and specified commands, Fleet CINCs, the Office of the Secretary of Defense and the Services in strategic planning and DoD C3I/IO policy and requirements development.

c. Understand the organizational structure, roles and relationships of the DoD Space-related organizations, including the Joint Staff, CINCSPACE and components, Fleet CINCs, the Office of the Secretary of Defense and the Services, involved in the acquisition, implementation and operation of space systems to meet DoD C3I/IO requirements across the functions of space forces support, force enhancement, space control, and force application.

d. Understand the Navy's role and Naval organizations involved in the policy and requirements definition, acquisition, implementation, and operation of space systems to meet Naval C3I/IO requirements.

e. Understand DoD and Naval Requirements processes.

2. SPACE SUPPORT FOR MILITARY OPERATIONS

a. Understand the operational requirements and limitations of current and future Space Systems (SI and GENSER) used by DoD, including MILSATCOM (e.g. FLTSATCOM, UFO, DSCS, MILSTAR, GBS, IBS), Commercial Space Systems (e.g. INMARSAT, Challenge Athena, Iridium, ICO, Globalstar, Teledesic), Mobile User Objective System, GPS, Meteorological Systems, Space Surveillance Network (including the Navy Space Surveillance System), National Technical Means, space-based warning systems, and other nations' systems.

b. Understand the Navy's role in the development, operation and use of current and future Space Systems (SI and GENSER) used by DoD, including MILSATCOM (e.g. FLTSATCOM, UFO, DSCS, MILSTAR, GBS, IBS,), Commercial Space Systems (e.g. INMARSAT, Challenge Athena, Iridium ICO, Globalstar, Teledesic), Mobile User Objective System, GPS, Meteorological Systems, Space Surveillance Network (including the Navy Space Surveillance System), National Technical Means, space-based warning systems, and other nations' systems.

c. Understand the nature of space warfare (theory, history, doctrine, and policy) to include options for space control, global engagement, and full force integration.

d. Understand the intelligence collection and analysis processes with respect to space systems, and how warfighters access information derived from these sources.

e. Understand doctrine and operational concepts (e.g. United States Space Command's "Long Range Plan") and be able to contribute to the development of space tactics which enhance or support military operations.

f. Be able to develop and assess a course of action (COA) for best utilization of space systems. Be able to develop the space systems component of OPLANS (e.g. Annex N and Annex K).

3. ACQUISITION MANAGEMENT

a. Understand DoD System Acquisition methods and procedures to include the Planning, Programming, Budgeting System (PPBS).

b. Understand the organizational responsibilities and relationships (e.g. Congress, DoD, Services; Resource Sponsor, Systems Commands, Operating Forces, as they pertain to the acquisition of systems for Naval uses).

4. ANALYSIS, SYNTHESIS AND EVALUATION

a. Be able to derive, assess, and articulate cost-effective requirements for the operational use of space systems to meet C3I/IO requirements, using modeling and simulation, field and laboratory experiments, and other quantitative and qualitative methods as they pertain to the Federal and DoD Acquisition System.

b. Be able to perform business case (economic) and trade-off analyses for commercial and DoD Systems.

5. ORBITAL MECHANICS, SPACE ENVIRONMENT AND REMOTE SENSING

a. Understand the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks. Understand the design of orbits, how they are achieved, maintained, and controlled including the design of constellations and how spacecraft are maneuvered and repositioned. Understand causes of various orbital perturbations. Understand the relationships of orbits to mission requirements, including the advantages and disadvantages of various orbits.

b. Understand the natural and induced environment of space including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances.

c. Understand the principles of active and passive sensors used in current and future spacecraft for sensing through the atmosphere. Understand the effects of the space environment and countermeasures on sensor performance.

d. Understand the tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

6. COMMUNICATIONS

a. Understand the basic principles of communications systems engineering including the space and ground segments and the network architecture. Understand digital and analog communications architecture design, including frequency reuse, multiple access, link design, repeater architecture, waveforms and protocols applications (including coding, modulation, interleaving, pulse shaping, multiplexing and encryption), and propagation media (including wire, fiber, and radio) Understand current and future communications systems used or planned by Naval operating forces afloat and ashore. Understand how space systems are used to meet warfighters communications requirements.

b. Be able to articulate from the warfighter's perspective the advantages and disadvantages of various frequencies used by DoD for communications across the frequency spectrum. Understand the national and international issues involving use of the frequency spectrum.

c. Understand current and future MILSATCOM bandwidth allocation processes.

d. Understand the nature of the rapid evolution in commercial satellite communications systems and be able to articulate potential uses to satisfy DoD Information Operations requirements.

7. ARCHITECTING MILITARY SPACE MISSIONS

a. Understand the basic principles of architecting a complex military space mission, the life cycle process by which a space system is conceived, structured, designed, built, tested, certified and operated in a way that ensures its integrity and performance. Be able to formulate a consistent set of principles and techniques to be followed throughout all phases of the architecting process.

b. Understand the systems design of a spacecraft that includes its various subsystems: propulsion, structure, thermal, attitude determination and control; electrical power, and telemetry, tracking and command; and their integration. An appreciation of the key interactions between the various subsystems and their effects on performance requirements. An understanding of the system design criteria from stated performance requirements, and the trade-offs between payload and other spacecraft subsystems.

c. Understand the basic principles of launch vehicle performance; launch environment, launch windows, and their role in military operations. Understand the differences between the various classes of current and future launch systems including the upper stages. An appreciation of the various business issues involved (e.g.: pricing, insurance, policy) in the selection of the launch vehicle. Be familiar with the issues of integrating a spacecraft with a launch vehicle. Perform a trade-off analysis in the selection of the launch vehicle.

d. Understand the application of the principles of systems engineering to a space project from the needs assessment phase to the final operations cycle. Be able to apply the tools of project management (e.g. scheduling, costing, budgeting, planning, resource negotiation, risk management) to a space project. An appreciation of the review process from the systems requirements review to the critical design review. A familiarity with typical spacecraft testing: electromagnetic compatibility tests, vibration and thermal tests, functional tests, deployments tests, alignment tests, inertia determination tests and comprehensive system tests. Understand the necessity to ensure the integrity, workmanship, and performance of the spacecraft.

e. Understand the basic elements of mission operations: command the spacecraft, manage payloads, resolve anomalies, schedule ground station support, design failure workarounds, plan orbit maneuvers, and link users and operators.

f. Be able to develop a concept of operations for a space system.

8. ADVANCED CONCEPTS AND TECHNOLOGIES IN SPACE SYSTEMS

a. Understand the future of military space vis-a-vis the requirements stemming from information superiority.

b. Understand the future concepts of operations (e.g., Spacecast 2020) published by various DoD organizations based on an understanding of the emerging technologies and their impact on military space.

c. Develop an understanding of the advanced concepts in military space such as the space plane technology program, the space refueler, etc.

Curriculum Sponsor and ESR Approval Authority
Director, Navy Space Systems Division (N-63)
May 1999

INFORMATION SYSTEMS AND OPERATIONS

Curricular Officer:
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CDR, USN
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INFORMATION SYSTEMS AND OPERATIONS
CURRICULUM 356
This curriculum provides officers with the knowledge of information systems technology to include computer and telecommunications systems, networked and distributed applications, database management systems, and decision support systems as applied in the military services. Based on this technology understanding, students will gain proficiency in information operations, economics and management necessary for the critical warfighting decisions needed in Information Age conflicts.

Information Systems and Operations is an interdisciplinary, graduate-level master's program integrating mathematics, statistics, computer science, information systems, communications engineering, networks, and physics disciplines.

In addition to the academic degree, officers successfully completing this curriculum will obtain JPME phase I certification.

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or the equivalent resulting in an APC of at least 334 is required for direct entry. While previous computer, communications or information systems experience is certainly helpful, it is not essential.

INFORMATION SYSTEMS AND OPERATIONS SUBSPECIALTY
Completion of this curriculum qualifies a Navy officer as an Information Systems Subspecialist with a subspecialty code of 6100P. Other services have analogous coding. The Curriculum Sponsor is OPNAV N6.

Typical Jobs in this Subspecialty:
CO/XO, Naval Computer and Telecommunication Station/Master Station
Staff Comm/Fleet Communications Officer, Numbered Fleets
Operations Officer, USS John Paul Jones
ADP Plans Readiness Assessment Officer, COMNAVSURFLANT
Systems Officer, Director Strategic Systems Procedure
Systems Officer, SPAWARSYSCOM
Chief Information Officer, Numbered Fleets
Staff Officer, OPNAV Staff
Information Assessment Officer, Defense Agencies

ENTRY DATES
Information Systems and Operations is a six-quarter course of study with an entry date in September. If further information is needed contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 356
Academic Associate:
Carl Jones, Professor
Code IS/Js, Ingersoll Hall, Room 307
(831) 656-2995, DSN 878-2995
e-mail: crjones@nps.navy.mil

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

TYPICAL COURSE OF STUDY

Quarter 1

NW3230	(3-0)	Strategy and Policy
MO1902	(3-0)	Mathematics for ISSO and ISO
CC3000	(4-0)	Command and Control Concepts
CI9008	(5-0)	Computer and Software Technology

Quarter 2

IS3301	(3-2)	Fundamentals of Decision Support Systems
OS2100	(3-0)	Probability and Statistics
TBD	(4-1)	Conflict in the Information Age
TBD	(3-0)	JPME II

Quarter 3

OS3000	(3-0)	Operations Analysis
CS3600	(4-0)	Introduction to Computer Security
CI9004	(3-0)	Space Technology and Applications
TBD	(3-0)	JPME III
TBD	(4-0)	Information Operations II
TBD	(0-2)	Integrating Seminar II

Quarter 4

TBD	(3-1)	Foundations of Technology
TBD	(4-0)	Information Operations II
TBD	(0-2)	Integrating Seminar II
TBD	(3-0)	JPME IV
CI9003	(3-0)	Sensor Technology and Applications
IS0810	(0-8)	Thesis Research

Quarter 5

CC4221	(4-0)	C4ISR Systems
EO3502	(3-0)	Communication Systems Technology and Applications
TBD	(4-0)	Information Operations III
TBD	(0-2)	Integrating Seminar III
IS0810	(0-8)	Thesis Research

Quarter 6

TBD	(4-0)	Managing Information and Change in Combat Organizations
TBD	(5-0)	Information Strategy and Policy
IS0810	(0-8)	Thesis Research
IS0810	(0-8)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION SYSTEMS AND OPERATIONS
CURRICULUM (356)
Subspecialty Code 6100P

OVERVIEW

Rapid advances in Information Technology are swiftly changing Warfare in the 21st Century. A key enabler of 21st Century Warfare is the concept of Information Superiority. To accomplish the needed change in concepts for warfighting and the innovative application of Information Technology to implement them in action the officer corps must have a new intellectual basis for decision making. A significant factor in creating the needed intellectual capital is graduate education provided by the Information Sciences and Operations curriculum.

GENERAL EDUCATIONAL SKILL REQUIREMENTS:

The graduate of the Information Systems and Operations curriculum shall:

1. Understand and innovatively create strategies and policies using military and commercial conceptual models and assets for Information Operations.

2. Understand and innovatively create agile organizational structures and decision processes responsive to real time mission and situation requirements.

3. Understand information technology and systems as a provider of opportunities to gain information superiority and perform information operations.

4. Be able to integrate technology, organization, policy and strategy into an Information Operations framework and to use it in deliberate and crisis planning and execution across the range of military operations.

5. Each graduate will demonstrate the ability to identify and solve a significant information operations problem and communicate the results in writing and in a command-oriented briefing.

SPECIFIC EDUCATIONAL SKILL REQUIREMENTS:

<u>Science and Technology</u>

1. The student shall understand the terminology and methods required for the innovative application of

   - communications
   - computer systems
   - databases
   - decision support
   - information security
   - information theory
   - sensors
   - signal processing
   - signatures
   - simulation and gaming
   - software engineering
   - space systems
   - systems and networks

2. The student shall be able to apply technology elements to information operations problems.

3. The student shall be able to describe how information technology elements act to enable support and hamper the conduct of operations in a network-centric warfare environment.

Strategy, Policy and Doctrine

1. The student shall understand the terminology and processes associated with

   - conflict in the information age
   - dual use industries and commercial activities
   - network-centric warfare
   - policy and doctrine planning
   - presidential findings\national directives
   - rules of engagement

2. The student shall be able to analyze and formulate strategy, joint policy and service doctrine as affected by information operations from operational, legal and ethical bases.

3. The student shall be able to synthesize strategic elements, policy and doctrine with organization and technology to conduct information operations in a network-centric warfare environment.

Organizational and Systems

1. The student shall understand the terminology, processes and structures associated with

   - command and control
   - complex systems
   - cybernetics
   - networks and grids
   - operational architectures

2. The student shall be able to analyze and develop organizational elements to reflect best current practice for command and control (C2) and information operations.

3. The student shall be able to develop agile organizations using available technology under the governance of strategy, policy and doctrine to conduct operations in a network-centric warfare environment.

Methods and Elements

1. The student shall understand the terminology and processes associated with

   - intelligence preparation of the battlespace
   - military deception
   - psychological operations
   - electronic warfare
   - operational security
   - physical destruction (targeting, weaponeering, weapon effectiveness)
   - military operations in space
   - C4ISR systems (e.g. GCCS, GCCS-M, DISN, DII, MILSATCOM, National Technical Means)
   - intelligence systems and products
   - special information operations
   - special technical operations
   - information operations modeling

2. The student shall be able to plan and rigorously assess operations employing information operations methods and elements to achieve effective employment of information capabilities and resources.

3. The student shall be able to synthesize information operations methods and elements with science & technology, strategy, policy & doctrine, organizations and systems to conduct information operations in a network-centric warfare environment.

Curriculum Sponsor and ESR Approval Authority
Director, Space, Information Warfare, Command and Control (N6)
July 1998

METEOROLOGY AND OCEANOGRAPHY (METOC) PROGRAMS

Curricular Officer:
Jim Hill
CDR, USN
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(831) 656-2044
DSN 878-2044
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METEOROLOGY
CURRICULUM 372
This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The student will develop the technical expertise to assess and forecast the impact of atmospheric conditions on operations:

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

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

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

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

REQUIREMENTS FOR ENTRY
This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers of the U.S. Navy as a Ph.D. program.

A baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics is required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES
Meteorology is a five or six-quarter course of study with entry dates in January and July. For further information contact the Curricular Officer. Academic questions may be referred directly to the Academic Associate.

Curriculum 372
Academic Associate:
Robert L. Haney, Professor
Code MR/Hy, Root Hall, Room 257
(831) 656-4053, DSN 878-4053
e-mail: rlhaney@nps.navy.mil

DEGREE
Master of Science in Meteorology.

TYPICAL COURSE OF STUDY - (372)

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
NW3230	(4-0)	Strategy & Policy

Quarter 2

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
MR3222	(4-3)	Meteorological Analysis/Laboratory
MRXXXX	(4-0)	Elective

Quarter 4

MR4322	(4-0)	Dynamic Meteorology
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR4900	(V-0)	Directed Study in Meteorology
MRXXXX	(4-0)	Elective

Quarter 5

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR4413	(4-0)	Air Sea Interaction
MRXXXX	(4-0)	Elective
MR0810	(0-8)	Thesis Research

Quarter 6

MR3252	(3-4)	Tropical Meteorology/Laboratory
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MRXXXX	(4-0)	Elective
MR0810	(0-8)	Thesis Research

Quarter 7

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

METEOROLOGY AND OCEANOGRAPHY (METOC) CURRICULUM 373

This curriculum in meteorology and oceanography involves approximately 120-quarter hours of classroom lectures, supplemented by an additional 35-quarter hours of laboratory exercises. This program is designed to provide the student with:

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

2) The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.

3) A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics and electromagnetic/optical propagation.

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

5) A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge and develop analytical ability for practical problem solving.

REQUIREMENTS FOR ENTRY

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD Civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

METOC SUBSPECIALTY

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

Typical Jobs in this Subspecialty:

METOC Officer: CV/LHD/LHA/LPH
Submarine Group Staff
Fleet Staff

CRUDESGRU Staff
OIC Naval Meteorology and Oceanography Command Detachment
NAVMETOCCOM Center/Facility
NIMA
Office of Naval Research

ENTRY DATES
METOC curriculum is a nine-quarter course of study with entry dates in January and July. If further information is needed, contact the Curricular Officer. Academic questions may be referred directly to either of the Academic Associates.

Curriculum 373
Academic Associates:
Robert L. Haney, Professor
Code MR/Hy, Root Hall, Room 257
(831) 656-4053 DSN 878-4053
e-mail: rlhaney@nps.navy.mil

Mary Batteen, Associate Professor
Code OC/Bv, Spanagel Hall, Room 346
(831) 656-3265, DSN 878-3265
e-mail: mlbattee@nps.navy.mil

DEGREE
Master of Science in Meteorology and Physical Oceanography.

TYPICAL COURSE OF STUDY - (373) WINTER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
MR3222	(4-3)	Meteorological Analysis/Laboratory
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

MR4322	(4-0)	Dynamic Meteorology
OC4211	(4-0)	Ocean Dynamics II
OC3902	(3-2)	Fundamentals of Mapping, Charting and Geodesy
OC3260	(4-0)	Sound in the Ocean

Quarter 5

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
MR4900	(V-0)	Directed Study in Meteorology

Quarter 6

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR4416	(3-0)	Atmospheric Factors in Electromagnetic and Optical Propagation
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OC4999	(4-0)	Elective

Quarter 7

MR3252	(3-4)	Tropical Meteorology/Laboratory
OC3266	(3-2)	Operational Acoustic Forecasting
OC3570	(2-4)	Operational Oceanography and Meteorology
MR0810	(0-8)	Thesis Research

Quarter 8

NW3230	(4-0)	Strategy and Policy
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective

Quarter 9

OC3212	(4-0)	Polar Meteorology & Oceanography
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Thesis Presentation

TYPICAL COURSE OF STUDY - (373) SUMMER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
MR3222	(4-3)	Meteorological Analysis/Laboratory
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

MR4322	(4-0)	Dynamic Meteorology
OC4211	(4-0)	Ocean Dynamics II
OC3902	(3-2)	Fundamentals of Mapping, Charting and Geodesy
OC3260	(4-0)	Sound in the Ocean

Quarter 5

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
MR4900	(V-0)	Directed Study in Meteorology

Quarter 6

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
MR4416	(3-0)	Atmospheric Factors in Electromagnetic and Optical Propagation
OC4267	(4-0)	Ocean Acoustic Prediction
MR3252	(3-4)	Tropical Meteorology/Laboratory

Quarter 7

OC3212	(4-0)	Polar Meteorology & Oceanography
OC3266	(3-2)	Operational Acoustic Forecasting
OC3570	(2-4)	Operational Oceanography and Meteorology
MR0810	(0-8)	Thesis Research

Quarter 8

NW3230	(4-0)	Strategy and Policy
MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective

Quarter 9

MR/OC4999	(4-0)	Elective
MR0810	(8-0)	Thesis Research
MR0810	(8-0)	Thesis Research
MR0999	(2-0)	Thesis Presentation

OPERATIONAL OCEANOGRAPHY
CURRICULUM 374

This flexible oceanography curriculum involves approximately 100-quarter hours of classroom lectures, supplemented by an additional 20-quarter hours of laboratory exercises. This program is designed to provide the student with:

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

2) An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational techniques, statistical analyses, and numerical models.

3) An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics.

4) An educationally significant oceanographic experience at sea.

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

6) A knowledge of Joint Maritime Strategic Planning.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base and is a very flexible program. The student selects a warfare specialization area in antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare, or special warfare. This program is open to Unrestricted Line (1110, 1120, 1310, 1320) Officers, officers from other services, International Officers and DoD civilians.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in the physical sciences, mathematics or engineering is desirable. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

OPERATIONAL OCEANOGRAPHY SUBSPECIALTY

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

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

ENTRY DATES

Operational Oceanography is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 374
Academic Associate:
Mary Batteen, Associate Professor
Code OC/Bv, Spanagel Hall, Room 346
(831) 656-3265, DSN 878-3265
e-mail: mlbatteen@nps.navy.mil

DEGREE

Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY - (374) WINTER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(4-0)	Descriptive Physical Oceanography

Quarter 2

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3230	(4-0)	Strategy and Policy
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

OC3120	(4-3)	Biogeochemical Processes in the Ocean
OC4211	(4-0)	Ocean Dynamics II
OC3260	(4-0)	Sound in the Ocean
MR4900	(V-0)	Directed Study in Meteorology

Quarter 5

OC3212	(4-0)	Polar Meteorology/Oceanography
MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
MR/OC4999	(4-0)	Elective

Quarter 6

OC4220	(4-1)	Coastal Circulation
OC4267	(4-0)	Ocean Acoustic Prediction
MR/OC4999	(4-0)	Elective
MR0810	(0-8)	Thesis Research

Quarter 7

OC3266	(3-2)	Operational Acoustic Forecasting
OC3570	(2-4)	Operational Oceanography and Meteorology
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

Quarter 8

MR3262	(3-5)	Operational Atmospheric Prediction/Laboratory
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective
MR0999	(2-0)	Thesis Presentation

TYPICAL COURSE OF STUDY - (374) SUMMER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(4-0)	Descriptive Physical Oceanography

Quarter 2

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3230	(4-0)	Strategy and Policy
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

OC3120	(4-3)	Biogeochemical Process in the Ocean
OC4211	(4-0)	Ocean Dynamics II
OC3260	(4-0)	Sound in the Ocean
MR4900	(V-0)	Directed Study in Meteorology

Quarter 5

MR/OC4999	(4-0)	Elective
MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
OC3570	(2-4)	Operational Oceanography and Meteorology

Quarter 6

OC4220	(4-1)	Coastal Circulation
OC4267	(4-0)	Ocean Acoustic Prediction
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective

Quarter 7

OC3212	(4-0)	Polar Meteorology & Oceanography
OC3266	(3-2)	Operational Acoustic Forecasting
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

Quarter 8

MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research
OC4213	(3-1)	Nearshore & Wave Processes
MR0999	(2-0)	Thesis Presentation

OCEANOGRAPHY
CURRICULUM 440

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

1) Interpret and predict oceanic and air-ocean interface conditions.

2) Operate modern oceanographic data management, archival and communications systems.

3) Plan, conduct, interpret and present results of research activities.

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

REQUIREMENTS FOR ENTRY

This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers as a Ph.D. program.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Oceanography is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Curricular Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

Curriculum 440
Academic Associate:
Mary Batteen, Associate Professor
Code OC/Bv, Spanagel Hall, Room 346
(831) 656-3265, DSN 878-3265
e-mail: mlbattee@nps.navy.mil

DEGREE

Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY - WINTER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

OC3120	(4-3)	Biogeochemical Process in the Ocean
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3230	(4-0)	Strategy and Policy
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

OC4211	(4-0)	Ocean Dynamics II
OC3260	(4-0)	Sound in the Ocean
MR/OC4999	(4-0)	Elective
MR/OC4999	(4-0)	Elective

Quarter 5

MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
MR4900	(V-0)	Directed Study in Meteorology
OC3212	(4-0)	Polar Meteorology & Oceanography

Quarter 6

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC4267	(4-0)	Ocean Acoustic Prediction
OC4220	(4-1)	Coastal Circulation
OC4335	(3-2)	Naval Ocean Analysis and Prediction

Quarter 7

MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective
OC3570	(2-4)	Operational Oceanography and Meteorology
MR/OC4999	(4-0)	Elective

Quarter 8

OC4213	(3-1)	Nearshore and Wave Processes
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective
MR/OC4999	(4-0)	Elective

Quarter 9

OC4414	(3-0)	Advanced Air Sea Interaction
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Thesis Presentation

TYPICAL COURSE OF STUDY - SUMMER INPUT

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MO1995	(5-0)	Mathematics for Scientists and Engineers I
MO1996	(5-0)	Mathematics for Scientists and Engineers II
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

OC3120	(4-3)	Biogeochemical Process in the Ocean
MR3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MO3197	(5-0)	Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics

Quarter 3

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3230	(4-0)	Strategy and Policy
OC3240	(4-2)	Ocean Dynamics I

Quarter 4

OC4211	(4-0)	Ocean Dynamics II
OC3260	(4-0)	Sound in the Ocean
MR/OC4999	(4-0)	Elective
MR/OC4999	(4-0)	Elective

Quarter 5

MR4413	(4-0)	Air Sea Interaction
OC4331	(4-0)	Mesoscale Ocean Variability
MR4900	(V-0)	Directed Study in Meteorology
OC3570	(2-4)	Operational Oceanography and Meteorology

Quarter 6

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC4267	(4-0)	Ocean Acoustic Prediction
OC4220	(4-1)	Coastal Circulation
OC4335	(3-2)	Naval Ocean Analysis and Prediction

Quarter 7

MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective
OC3212	(4-0)	Polar Meteorology & Oceanography
OC4414	(3-0)	Advanced Air Sea Interaction

Quarter 8

OC4213	(3-1)	Nearshore and Wave Processes
MR0810	(0-8)	Thesis Research
MR/OC4999	(4-0)	Elective
MR/OC4999	(4-0)	Elective

Quarter 9

MR/OC4999	(4-0)	Elective
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Thesis Presentation

EDUCATIONAL SKILL REQUIREMENTS
METOC
CURRICULUM (373)
Subspecialty Code XX47P

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere and a general understanding of numerical model and numerical model process.

2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.

3. The officer must have a thorough understanding of the effects of oceanic, and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare as described in "Forward...from the Sea" with particular emphasis on oceanic acoustics and electromagnetic and optical propagation.

4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, Joint planning, and current issues in Defense reorganization.

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

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

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

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

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere and a general understanding of numerical model and numerical model process.

2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and littoral water conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.

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

4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, Joint planning, and current issues in Defense reorganization.

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

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

NATIONAL SECURITY AND INTELLIGENCE PROGRAMS

Curricular Officer:
Denise McCallacreary
CDR, USN
Code 38, Glasgow Hall, Room 220
(831) 656-2845, DSN 878-2845
e-mail: djmccall@nps.navy.mil

REGIONAL SECURITY STUDIES
CURRICULA 681-684, 824
Regional Security Studies curricula focus on specific regions of strategic interest to the United States and its allies. Students gain a knowledge of the essential historical, cultural, and social characteristics of a region, on which to base an understanding of contemporary security issues; prevailing economic and political structures; and existing or emerging military forces and capabilities.

REQUIREMENTS FOR ENTRY
Prospective students must be military officers or civilian employees of the U.S. Federal Government or other nations. Students must have a baccalaureate degree earned with above-average academic performance and an APC of 365. A minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students. Students in the Regional Intelligence curriculum (824) must possess a TOP SECRET clearance with access to Sensitive Compartmented Information, based on a Special Background Investigation completed within the past five years.

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

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

Curricula 681-684
Academic Associate:
Dan Moran, Professor
Code NS/Md, Glasgow Hall, Room 316
(831) 656-2059/2521, DSN 878-2059/2521
e-mail: djmoran@nps.navy.mil

Curriculum 824
Academic Associate:
Peter Lavoy, Assistant Professor
Code NS/La, Glasgow Hall, Room 307
(831) 656-2143, DSN 878-2143
e-mail: plavoy@nps.navy.mil

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

Typical Jobs in this Subspecialty:
Staff Plans and Policy (N5): COMFIFTHFLT
POL-MIL Planner: Joint Chiefs of Staff, Washington, DC
Mid East/Southwest Asia Policy: CINCUSNAVEUR LONDON
Area Officer: DIA
Head, Middle East, Asia, Southwest Asia: CNO (N-521)
Military Assistance Program: Military Liaison Office Tunisia

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

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

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

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

RUSSIA, EUROPE, CENTRAL ASIA SUBSPECIALTY
Completion of the 684 curriculum qualifies an officer as a Russia, Europe, Central Asia Subspecialist with a subspecialty code of XX24P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

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

REGIONAL INTELLIGENCE SUBSPECIALTY
The Regional Intelligence curricula focuses on area specific knowledge from an intelligence perspective, and is designed to meet the intelligence requirements for area expertise of a geographic Unified Commander, and more generally of all U.S. armed services and some related federal agencies. Completion of the 824 curriculum qualifies an officer as a Regional Intelligence Subspecialist with a subspecialty code of XX18P. Course requirements for this curriculum also convey Joint Professional Military Education Phase I qualification. The curriculum sponsor is by the Director of Naval Intelligence.

Typical Jobs in this Subspecialty:
Regional Area Intelligence Analyst: Joint Intelligence Center Pacific (JICPAC)
Major Staff Intelligence Program Manager: USCINCPAC, J22.
Operational Forces ACOS Intelligence (N2): COMPHIBGRU THREE, COMFIFTHFLT.
Naval Attache: Attache Russia
Intelligence Liaison Officer: COMNAVFOR JAPAN
Intelligence Area Analyst: Defense Intelligence Agency (DIA)

TYPICAL COURSE OF STUDY
MIDDLE EAST - CURRICULUM 681

Quarter 1

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

Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy
NS3040	(4-0)	The Politics of Global Economic Relations
NS3XXX		Elective

Quarter 3

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

Quarter 4

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

Quarter 5

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

Quarter 6

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

TYPICAL COURSE OF STUDY
ASIA - CURRICULUM 682

Quarter 1

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

Quarter 2

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

Quarter 3

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

Quarter 4

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

Quarter 5

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

Quarter 6

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

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

Quarter 1

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

Quarter 2

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

Quarter 3

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

Quarter 4

NS0810	(0-8)	Thesis Research
NS3XXX	(4-0)	Elective
NS3XXX	(4-0)	Elective
NS4560	(4-0)	Seminar in Latin American Security Issues

Quarter 5

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

Quarter 6

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

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

Quarter 1

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

Quarter 2

NS3024	(4-0)	Introduction to International Relations
NS3030	(4-0)	American National Security Policy
NS3040	(4-0)	The Politics of Global Economic Relations
NS3720	(4-0)	European Security Institutions

Quarter 3

NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3041	(4-0)	Comparative Economic Systems
NS3460	(4-0)	Government and Security in Eastern Europe
NS4710	(4-0)	Seminar in European Politics

Quarter 4

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

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS3902	(4-0)	Modern Revolution
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 6

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

TYPICAL COURSE OF STUDY
RUSSIA, EUROPE, AND CENTRAL ASIA - CURRICULUM 684
TRACK 2 - RUSSIA, EASTERN EUROPE, CENTRAL ASIA

Quarter 1

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

Quarter 2

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

Quarter 3

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

Quarter 4

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

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS3XXX	(4-0)	Elective
NS4XXX	(4-0)	Elective
NS0810	(0-8)	Thesis Research

Quarter 6

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

TYPICAL COURSE OF STUDY
REGIONAL INTELLIGENCE - CURRICULUM 824

Quarter 1

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

Quarter 2

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

Quarter 3

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

Quarter 4

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

Quarter 5

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

Quarter 6

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

STRATEGIC STUDIES CURRICULUM 688

This curriculum provides students with a wide knowledge and thorough understanding of the complex, interrelated variables in both the domestic and international security environments when evaluating strategic options and supportive negotiating positions in the formulation of U.S. national security policy. The curriculum is designed to produce individuals who can think critically about U.S. strategic interests, develop strategic visions for the future, and then elucidate the vision to the highest levels of Navy and other service leadership.

REQUIREMENTS FOR ENTRY

The 688 curriculum 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 (SCI) based on a Special Background Investigation within the past five years. A baccalaureate degree earned with above-average academic performance and a minimum APC of 335 are required.

CURRICULUM LENGTH AND START DATE REQUIREMENTS

The Strategic Studies curriculum is six quarters (18 months) in length. It may be started in any quarter.

DEGREE

Requirements for the degree Master of Arts in National Security Affairs are met while satisfying the Educational Skill Requirements of the curriculum.

Curriculum 688
Academic Associate:
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STRATEGIC STUDIES SUBSPECIALTY

Completion of the 688 curriculum qualifies an officer as a Strategic Planning Specialist with a subspecialty code of XX28P. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations). Individuals coded with the XX28P subspecialty fill billets as analysts and planners on most major CINC staffs, the OSD and Joint staffs, the OPNAV staff, and as faculty at the Naval War College and the Naval Postgraduate School.

688 CURRICULUM COURSE REQUIREMENTS

Since students may begin the 688 curriculum in any quarter, the below listed courses are scheduled at least once every six quarters. For student scheduling flexibility, many are scheduled a few times each academic year.

NS0810	(0-8)	Thesis Research (Three Quarters)
NS3011	(4-2)	Policy Analysis and Research Methods
NS3012	(4-2)	Forecasting and Gaming Methods for Strategic Planners
NS3020	(4-0)	Operational Level of War
NS3024	(4-0)	Introduction to International Relations

NS3038	(4-0)	International Naval Power and Policy
NS3040	(4-0)	The Politics of Global Economic Relations **OR** NS3250 Economics of U.S. Defense Policy
NS3159	(4-0)	Principles of Joint Operational Intelligence **OR** NS3154 joint Intel and Military Command
NS3230	(4-1)	Strategic Planning and the Military
NS3240	(4-0)	Military Innovation and Joint Warfare
NS3252	(4-0)	Joint & Maritime Strategy
NS3280	(4-0)	Nuclear Strategy and National Security
SO3882	(4-0)	Deterrence, Compellance, and Crisis Management
NS3900	(4-0)	International Law and Organizations
NS3XXX	(4-0)	Regional Security Studies Elective (Note 1)
NS3/4XXX	(4-0)	Elective (Note 2)
NS4036	(4-0)	Comparative Strategic Cultures
NS4080	(2-0)	Research Colloquium
NS4230	(4-0)	Seminar in Joint Strategic Planning
NS4251	(4-0)	Net Assessment Seminar OR NS4225 Civil-Military Relations and Transition to Democracy
NS4280	(4-0)	Seminar in Nuclear Strategy, WMD and Counter-Proliferation
NS4900	(4-0)	Seminar in International Negotiations

Note 1: NS3XXX Regional Security Studies Elective Course Choices

Courses with numbers between NS3300 and NS3799.

Note 2: NS3/4XXX Elective Course Choices

NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3030	(4-0)	American National Security Policy
NS403X	(4-0)	Special Topics Seminar
NS4200	(4-0)	Seminar in the National Interest
NS4250	(4-0)	Seminar in Security Assistance and Arms Transfers
NS4253	(4-0)	Technology and Strategic Planning
NS4261	(4-0)	Survey of Strategic Studies

INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS CURRICULUM 689

The International Security and Civil-Military Relations Curriculum is an inter-disciplinary program, tailored for officers and civilian employees of other countries. The program is designed to meet three related needs. First, the program gives students the skills they need to resolve the security problems confronting their own democracies. Second, the program offers an in-depth understanding of civil-military relations. Finally, the program prepares students to resolve the civil-military issues raised by participation in U.N. peacekeeping operations, membership in the Partnership for Peace and other alliances, and security cooperation between the student's own nation and the United States.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

Officers and civilian employees in defense and other agencies of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Validation or credit by examination is encouraged.

ENTRY DATES

The International Security and Civil-Military Relations Curriculum 689 is a five-quarter (15 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

DEGREE

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

Curriculum 689
Academic Associate:
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e-mail: tbruneau@nps.navy.mil

TYPICAL COURSE OF STUDY

Quarter 1

NS3025	(4-0)	Introduction to Civil-Military Relations
NS3023	(4-0)	Introduction to Comparative Politics
NS3000	(4-0)	War in the Modern World
IT1600	(3-0)	Communications Skills for International Officers **OR**
		Elective
NS2011	(2-0)	Policy Analysis and Research Methods

Quarter 2

NS3225	(4-0)	Civil-Military Relations and Defense Budgeting
NS4225	(4-0)	Civil-Military Relations and Transitions to Democracy
NS3024	(4-0)	Introduction to International Relations
NS0810	(0-8)	Thesis Research
_____		Elective
IT1500	(4-0)	Information Program Seminar for International Officers
_____		CMR Writing Workshop

Quarter 3

NS4880	(4-0)	Seminar in Legal and Military Responses to Political Violence
_____		Elective
NS0810	(0-8)	Thesis Research **OR**
NS0811	(0-0)	Preparation for Comprehensive Examination
NS0810	(0-8)	Thesis Research **OR**
NS0811	(0-0)	Preparation for Comprehensive Examination

Quarter 4

NS3252	(4-0)	Joint and Maritime Strategy
NS4235	(4-0)	Seminar on Diplomacy and Strategy of Coalition Warfare and Ops Other than War
NS4080	(2-0)	Research Colloquium
NS0810	(0-8)	Thesis Research **OR**
NS0811	(0-0)	Preparation for Comprehensive Examination

Quarter 5

NS3155	(4-0)	Intelligence and Democracy
NS4030-34	(4-0)	Seminar on Special Topics in National Security Affairs (Topics vary)
_____		Elective
NS0810	(0-8)	Thesis Research **OR**
NS0811	(0-0)	Preparation for Comprehensive Examination

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

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

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

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

ESRs COMMON TO REGIONAL SECURITY STUDIES AND STRATEGIC STUDIES

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

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

3. **THE INTERNATIONAL ECONOMY:** Graduates will gain a basic understanding of the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interest affect military strategy and force structure.

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

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

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

7. **JOINT AND MARITIME STRATEGY:** Graduates will understand the organization, formulation, and execution of national security strategy and national military strategy, the effects of technical developments on warfare, the capabilities and roles of military forces, joint planning, joint and service doctrine, and current defense issues.

ESRs SPECIFIC TO REGIONAL SECURITY STUDIES

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

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

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

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

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

EDUCATIONAL SKILL REQUIREMENTS
STRATEGIC STUDIES
CURRICULUM (688)
Subspecialty Code XX28P

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

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

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

ESRs SPECIFIC TOO STRATEGIC STUDIES
(COMMON ESRs LISTED PREVIOUSLY WITH 681-684 CURRICULA)

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

2. **PROGRAM FOR JOINT EDUCATION (PJE):** Students will demonstrate a graduate-level understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, joint and multinational forces and systems integration at the operational level of war. Knowledge of this subject is pursued in a joint learning environment.

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

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

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

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

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

Curriculum Sponsor and ESR Approval Authority

Deputy CNO for Plans, Policy and Operations (N-3/5)
January 1997

EDUCATIONAL SKILL REQUIREMENTS
REGIONAL INTELLIGENCE
CURRICULUM (824)
Subspecialty Code XX18P

GRADUATE EDUCATION SUMMARY: The objective is to attain a graduate-level understanding of: the political, military, cultural and economic aspects in a geographic region. The curriculum includes a specific series of courses focused on the history and culture of the region, politics and government, security structures and processes, relationships with the United States and other countries and organizations, and specific security issues. The student will gain knowledge in political and security processes and systems. The student will attain a graduate level understanding of joint and naval warfare; the joint national military structure, strategy, doctrine, operations, and planning, to include the integration of intelligence organizations, systems and architectures. The curriculum draws upon other NPS curricula including Area Studies, Strategic Planning, Civil-Military Relations and Special Operations/Low Intensity Conflict (SOLIC). Upon entry, students will concentrate their studies on a single Geographic CINCs area of responsibility (AOR). Special emphasis is placed on writing papers and a thesis, which gives the student the opportunity to develop the skills required for analysis, critical thought and coherent expression.

GLOBAL POLITICAL AND SECURITY PROCESSES: A graduate level knowledge of global political, diplomatic, cultural, religious, ethnic, and security issues. Areas of study will include the mission of international and multinational organizations in conflict resolution, the role of Non-Governmental Organizations (NGOs) and Private Volunteer Organizations (PVOs) in nation building and development, cultural and ethnic sources of conflict, and the threats posed to U.S. personnel and forces by terrorism. While providing a broad understanding applicable across all geographic CINCs, specific examples will be drawn from recent and ongoing military operations.

REGIONAL POLITICS, CULTURE AND SECURITY: A comprehensive knowledge of the political, economic, cultural, and security (aspects of one particular geographic CINC region. This study will include review of current U.S. policies and commitments in the region and provide detailed awareness of the current relationships, attitudes and perspectives toward the United States.

EMERGING SECURITY CHALLENGES: Graduates will develop a graduate level understanding of the major global and regional security issues, including political and military relationships between states. Emphasis is placed on the potential for military conflicts, insurgencies, terrorism, espionage, the threat from foreign intelligence services and social and economic problems affecting the status of nations. Graduates will examine sources of political and social instability and violence, including ethnic conflict, and their influence on regional security planning and U.S. national security policy. Graduates will understand the implication of WMD proliferation for the security of the United States and other countries. Students will learn how and why states and other actors seek nuclear, chemical, and/or biological weapons and associated delivery systems, and will analyze the strategic effects and counterproliferation options in different regions.

ECONOMICS AND E CONOMIC INTELLIGENCE: A knowledge of economic issues as they influence the interaction between political and security decision-making processes linking the economy to military goals and objectives and intelligence support to national security policy objectives. Graduates will understand public finance, budget analysis and priorities, and the effects of trade and trade sanctions, aid, security assistance, multi-national corporations, technology and strategic resources.

INTELLIGENCE CAPSTONE: A graduate level knowledge and understanding of intelligence processes and their applications to joint and naval warfare, and an understanding of the role of the intelligence structure at the national, theater and CJTF level with emphasis on the roles of the associated intelligence organizations as reflected in doctrine and Tactics, Techniques and Procedures (TTP) Manuals. Focus should be on the transformation in warfare resulting from revolutionary developments in technology, innovative operational concepts, and organizational adaptations within the armed forces. An understanding of the role of intelligence in supporting Joint Vision 2010 and in the Revolution in Military Affairs (RMA) will be attained. Students will also gain a graduate level understanding of information operations as it applies in a civil-sector environment, as well as an understanding of command and control warfare as the military application of information warfare.

INTELLIGENCE INFORMATION SYSTEMS: A practical knowledge of communications, servers and clients in support of intelligence emphasizing network, web and broadcast technologies in support of intelligence and command and control.

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

RESEARCH, ANALYTICAL AND PRESENTATION SKILLS: A graduate-level knowledge of traditional library and automated classified and unclassified research methods as applied to intelligence. Graduates must be able to analyze and integrate facts, primary source classified data and opinions using a range of logical and numerical analytical tools to address a range of political and military issues in a coherent and well-organized manner. Results will be presented clearly and concisely in writing and orally in a range of classified and unclassified formats and venues as integral elements of other courses. Use of automated systems to assist in the analysis, preparation and presentation will be included.

PRACTICE: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority
Director, Naval Intelligence
August 1998

NAVAL/MECHANICAL ENGINEERING PROGRAMS

Curricular Officer:
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NAVAL/MECHANICAL ENGINEERING PROGRAMS
CURRICULUM 570

ME Web page "http://vislab-www.nps.navy.mil/~me"

The objective of this program is to provide graduate education, primarily in the field of Naval/Mechanical Engineering, to produce graduates with the technical competence to operate and maintain modern warships and naval systems. It establishes a broad background of basic engineering knowledge leading to advanced studies in heat transfer, fluid mechanics, control systems, solid mechanics and vibrations and material science. The graduate will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum.

REQUIREMENTS FOR ENTRY

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 via Engineering Science - Curriculum 460). This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of XX54P. The curriculum sponsor is Naval Sea Systems Command. A limited number of particularly well qualified students may be able to further their education beyond the Master's Degree and seek the Degree of Mechanical Engineer and a XX54N Subspecialty Code.

TYPICAL SUBSPECIALTY ASSIGNMENTS

Upon award of the XX54P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval/Mechanical Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility, SIMA
Mechanical Engineering Instructor, USNA
Tender Repair Officer (Engineering Duty Officer)
Fleet/Type Commander Staff
Board of Inspection and Survey
Propulsion Examining Board
OPNAV/NAVSEA
Chief Engineer (Ships and Submarines)

ENTRY DATES

Naval/Mechanical Engineering is typically a nine-quarter course of study with preferred entry dates in March or September. Time in residence may be reduced by validations depending on the officer's specific academic background. If further information is needed, contact the Curricular Officer or the Academic Associate.

Curriculum 570
Academic Associate:
Young S. Shin, Professor
Code ME/Sg, Mechanical Engineering Building, Room 326
(831) 656-2568, DSN 878-2568
e-mail: yshin@np.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY (570)

Quarter 1

MA1042	(2-0)	Matrix Algebra
MA1118	(5-2)	Multi-Variable Calculus
MS2201	(3-2)	Materials Science
NW3230	(4-0)	Strategy & Policy
EC1010	(1-1)	MATLAB

Quarter 2

MA2139	(5-0)	Intro to Differential Equations & Vector Calculus
ME2503	(5-0)	Engineering Statics & Dynamics
ME2101	(4-2)	Thermodynamics
ME2801	(3-2)	System Dynamics

Quarter 3

MA3132	(4-0)	Partial Differential Equations
MA3232	(4-1)	Numerical Analysis
ME2601	(4-1)	Mechanics of Solids I
ME3801	(3-2)	Automatic Controls

Quarter 4

ME3711	(4-1)	Machine Design
ME2201	(3-2)	Introduction to Fluid Dynamics
MS3202	(3-2)	Failure Analysis and Prevention
ME3611	(4-0)	Mechanics of Solids II

Quarter 5

ME3150	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
ME3521	(3-2)	Mechanical Vibration
TS3001	(3-2)	Naval Architecture

Quarter 6

ME3240	(4-2)	Marine Power and Propulsion
ME3410	(2-4)	Mechanical Engineering Instrumentation and Measurement Lab
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4XXX	( )	Specialization Elective

Quarter 7

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
EO2102	(4-2)	Intro to Circuit & Power Systems Analysis
ME4XXX	( )	Specialization Elective

Quarter 8

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
MS3606	(3-2)	Introduction to Welding and Joining Metallurgy **OR**
MS3304	(3-2)	Corrosion and Marine Environmental Deterioration
ME4XXX	( )	Elective

TOTAL SHIP SYSTEMS ENGINEERING

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Technology students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590 curricula.

REQUIREMENTS FOR ENTRY

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

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Completion of this program will contribute toward the graduates' subspecialty code within his/her designated curriculum. The student will also receive an AQD (Additional Qualification Designator) for completion of the TSSE Program.

Typical Jobs in this Subspecialty:
Upon award of the subspecialty code and AQD, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

ENTRY DATES
Total Ship Systems Engineering will generally fit as part of a nine quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the curriculum officer as early as possible.

Academic Associate:
Young S. Shin, Professor
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e-mail: yshin@nps.navy.mil

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

TYPICAL COURSE OF STUDY

Quarter 1

ME2503	(5-0)	Engineering Statics & Dynamics
MA1118	(5-2)	Multi-Variable Calculus
MA1042	(2-0)	Matrix Algebra
NW3230	(4-0)	Strategy & Policy
EC1010	(1-1)	MATLAB

Quarter 2

MA2139	(5-0)	Intro to Differential Equations & Vector Calculus
ME2601	(4-1)	Mechanics of Solids I
MS2201	(3-2)	Materials Science
EO2102	(4-2)	Intro to Circuit & Power Systems Analysis

Quarter 3

ME2201	(3-2)	Fluid Mechanics I
ME3611	(4-0)	Mechanics of Solids II
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
ME2101	(4-2)	Thermodynamics

Quarter 4

TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3150	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
MA3232	(4-1)	Numerical Analysis
ME3521	(3-2)	Mechanical Vibrations

Quarter 5

TS3000	(3-2)	Electrical Power Engineering
ME2801	(3-2)	System Dynamics
ME3711	(4-1)	Design of Machine Elements
MS3202	(3-2)	Failure Analysis & Prevention

Quarter 6

TS3002	(3-2)	Principles of Ship Design and Case Studies
TS3003	(3-2)	Naval Combat System Elements
ME3801	(3-2)	Automatic Controls
ME4999	( )	Specialization Elective

Quarter 7

TS4000	(3-2)	Naval Combat System Design
TS4001	(2-4)	Design of Naval Engineering Subsystems
ME3410	(2-4)	Instrumentation Measurements Lab
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4999	( )	Specialization Elective

Quarter 8

TS4002	(2-4)	Ship Design Integration
ME3240	(4-2)	Marine Power and Propulsion
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research

Quarter 9

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

REACTORS/MECHANICAL ENGINEERING PROGRAM CURRICULUM 571

The objective of this program is to provide both naval officers and civilian employees of Naval Reactors (NR), which is part of the Naval Sea Systems Command (NAVSEA), an advanced education leading to a Master of Science in Engineering Science with major in Mechanical Engineering. This is a non-thesis program for individuals who work as engineers and who wish to pursue a Masters Degree via Distance Learning. The program sponsor is NAVSEA and the subject matter expert is SEA-08.

REQUIREMENTS FOR ENTRY

Entrance into this program is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES). Further requirements include an Academic Profile Code of 121. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors. The nomination to the Director of Admissions must include original transcripts of the student's undergraduate and BRES records. The Director of Admissions will provide copies of all records to the Academic Associate in Mechanical Engineering.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Graduates of BRES earn a Navy Subspecialty Code of xx52, which applies to their reactor design training. This Naval Postgraduate School curriculum will not affect that subspecialty code nor provide any additional subspecialty code education or training. No additional subspecialty codes will be earned through this program.

CREDIT FOR COMPLETION OF BRES

The study program is designed to build upon the BRES program and includes 16 hours of credit from the BRES, as well as credit for the BRES Reactor and Power Plant Design Project Report. The following BRES courses are considered as integral to this program and equivalent to 16 credit hours of ME3XXX level NPS courses:

BRES 200 Mathematics
BRES 340 Applied Structural Mechanics
BRES 350 Heat Transfer and Fluid Flow
BRES 360 Reactor Dynamics, Control and Safeguards

The following course and associated report is also considered integral to this program:

BRES 370 Reactor and Power Plant Design Project

The NPS transcript will include a listing of these five courses and the student's overall grade point average for the BRES program. The Quality Point Rating (QPR) for NPS courses will be computed based only on the NPS courses completed by the student.

PROGRAM REQUIREMENTS

The student must complete 20 hours of graduate level (ME4XXX) NPS courses. This requirement may be met by completing a sequence of five courses via Distance Learning in a program approved by the Chairman of the Department of Mechanical Engineering.

ENTRY DATES

This Master of Science in Engineering Science (Major in Mechanical Engineering) program may be completed in five academic quarters following completion of BRES, with entry dates normally in either October or April. Students will usually enter this program at the beginning of the academic quarter immediately following completion of the BRES. Application for entry is to be made through the program coordinator and primary consultant for Naval Reactors. The program is also available to civilian employees of Naval Reactors who have completed BRES. For further information, contact the Department Chairman, the Academic Associate or the Primary Consultant for this program.

Chairman:
Terry R. McNelley, Professor
Code ME/Me
Department of Mechanical Engineering
700 Dyer Road
Naval Postgraduate School
Monterey, CA 93943-5146
(831) 656-2589, DSN 878-2589, FAX (831) 656-2238
e-mail: tmcnelley@nps.navy.mil

Primary Consultant:
Mr. James Eimes
Naval Sea Systems Command
2531 Jefferson Davis Highway (SEA-08)
Arlington, VA 22242-6160
(703) 603-6007/6008, FAX (703) 603-5377
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Academic Associate:
Professor Young Shin, Code ME/Sg
Department of Mechanical Engineering
700 Dyer Road
Naval Postgraduate School
Monterey, CA 93943-5146
(831) 656-2568, DSN 878-2568, FAX (831) 656-2238
email: yshin@nps.navy.mil

EDUCATIONAL SKILL REQUIREMENTS (ESRs)

The ESRs required by Naval Reactors are met upon completion of the BRES. This is a degree program only, leading to the Master of Science in Engineering Science with Major in Mechanical Engineering.

TYPICAL COURSES IN THE STUDY PROGRAM

Upon entry into the program students will typically enroll in one course per quarter, to be taken via Distance Learning. All requirements must be completed within three calendar years from entry. Students will select a program of study from available courses and submit a program for approval by the Chairman of Mechanical Engineering. Typical course offerings in the program include:

ME4161	(4-0)	Conduction Heat Transfer
ME4162	(4-0)	Convection Heat Transfer
ME4220	(4-0)	Viscous Flow
ME4522	(4-0)	Finite Element Methods in Structural Dynamics
ME4525	(4-0)	Ship Shock and Vibration
ME4550	(4-0)	Random Vibrations and Spectral Analysis
ME4612	(4-0)	Advanced Solid Mechanics
ME4613	(4-0)	The Finite Element Method
ME4731	(4-0)	Optimization

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

Officers entering into the Naval/Mechanical Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET).

At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, design, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core program requirements, specialization and thesis research.

In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the following topics. It is recognized that all students may not meet all ESR's depending on individual circumstances determined by the curricular officer and the academic associate. However, each student will be exposed to fundamentals in all ESR areas.

1. **THERMODYNAMICS AND HEAT TRANSFER:** Fundamentals of thermodynamics and heat transfer with applications to all marine engineering power cycles as well as propulsion and auxiliary system cycle analysis and design.

2. **FLUID MECHANICS:** Compressible and incompressible flow, both viscous and inviscid, with emphasis on propellers, cavitation, and design of shipboard fluid systems (e.g., fluid machinery, pumps, turbomachinery).

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

4. **STRUCTURAL MECHANICS AND VIBRATION:** Statically determinant and indeterminant structural analysis, stress/strain analysis, buckling and fatigue. Shock and vibration response of marine structures, including surface ships and submarines.

5. **MATERIALS AND FABRICATION:** Metallurgical processes and transformations; analytical approach to failure of materials in Naval Engineering use and a basic understanding of the materials technology associated with welding and marine corrosion; an introduction to the developing fields of composites and superconducting materials.

6. **COMPUTERS:** A basic understanding of computer system architecture, operating systems (such as UNIX), networking and introduction to engineering software design. Practical experience of structured programming languages (such as FORTRAN, C), and the use of integrated design tools for computational and symbolic manipulation (such as MATLAB and Maple). Use and application of mainframe, workstation and personal computers for the solution of Naval engineering design and analysis tasks. Exposure to finite element and finite difference tools and techniques, with application to the thermo-fluid and structural mechanics/dynamics areas, including experience of representative software packages.

7. **MATHEMATICS:** Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.

8. **DESIGN/SYNTHESIS:** Design synthesis and introduction to optimization techniques, with emphasis on the design of mechanical subsystems and their integration into the ship system.

9. **ELECTRICAL ENGINEERING:** Electromagnetic and circuit theories, dc circuits, steady-state ac circuits, methods of circuit analysis, including Laplace transforms. Exposure to the construction and operating characteristics of rotating machinery, static converters, and power distribution systems and multiphased circuits.

10. **NAVAL ARCHITECTURE:** Fundamentals of naval architecture including the geometry, hydrostatics and hydrodynamics of monohull floating and submerged structures. Wave and skin friction analysis, power requirements of particular designs. Longitudinal and transverse stability of floating and submerged bodies, hull girder strength requirements. Introduction to seakeeping and survivability principles.

11. **SPECIALIZATION:** Each officer will also acquire technical competence in one or more of the following areas: THERMAL/FLUID SCIENCES, SOLID AND STRUCTURAL MECHANICS, DYNAMICS AND CONTROLS, MATERIAL SCIENCE, OR TOTAL SHIP SYSTEMS ENGINEERING through additional graduate level courses and their associated prerequisites.

12. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

13. **THESIS:** The graduate will demonstrate the ability to conduct independent analysis, in the area of Naval/Mechanical Engineering and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Deputy Commander, Engineering Directorate
NAVSEA (SEA-03)
June 1997

OPERATIONS RESEARCH PROGRAMS

Curricular Officer:
Mike Giancatarino
CDR, USN
Code 30, Glasgow Hall
Room 219
(831) 656-3116
DSN 878-3116
Fax (831) 656-2458
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OPERATIONS ANALYSIS
CURRICULUM 360

Operations Analysis is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning and common sense to the improvement of real-world operations. Practitioners are called upon to advise military and civilian decision makers on the allocation of scarce resources, the selection of new equipment and processes, and the optimal deployment of given resources to achieve required missions. The OA curriculum was founded by the Navy in 1951 in order to retain, develop, and promulgate the methods that were used so successfully in World War II.

Mathematics, probability, statistics, economics, human factors, and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above average grades is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONS ANALYSIS SUBSPECIALTY

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

Typical Billets in this Subspecialty:

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

ENTRY DATES

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

Curriculum 360
Academic Associate:
Dave Olwell, Associate Professor
Code OR/Ol, Glasgow Hall, Room 225
(831) 656-2281, DSN 878-2281
e-mail: dholwell@nps.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY (Naval Warfare Option)

Quarter 1

OA2600	(4-0)	Introduction to Operations Analysis
MA1118	(5-2)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2

OA2200	(4-1)	Computational Methods for Operations Research II
MA3110	(3-0)	Intermediate Analysis
OA3102	(4-1)	Statistics
NW3230	(4-0)	Strategy & Policy

Quarter 3

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

Quarter 4

OA4202	(4-0)	Network Flows and Graphs
OA3302	(4-0)	OA System Simulation
OA4655	(4-0)	Joint Combat Modeling
OA3602	(4-0)	Search Theory and Detection

Quarter 5 (First six weeks)

OA4201	(4-0)	Nonlinear Programming
OA4604	(4-0)	Wargaming Analysis
(Last six weeks)		Thesis Tour/Research

Quarter 6

OAXXXX		Elective
OA4301	(3-2)	Stochastic Models II
OA0810	(0-8)	Thesis Research
OA4602	(4-0)	Joint Campaign Analysis

Quarter 7

OA4702	(4-0)	Cost Estimation
OA0810	(0-8)	Thesis Research
OAXXXX		Elective
OAXXXX		Elective

OPERATIONAL LOGISTICS CURRICULUM 361

This program provides education in mathematics, probability and statistics, physical science, economics, logistics and computer science. These disciplines supply the theoretical background for planning and analysis of Naval and Joint Logistics.

The course of study develops skills in computational capability, identifying relevant information, generating decision criteria and selecting alternatives. This education enhances performance in all duties throughout a military career, including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above average grades is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students, and there are other indicators of potential, such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONAL LOGISTICS SUBSPECIALTY

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

Typical Billets in this Subspecialty:

Joint Chiefs of Staff - Joint Logistics Planning, Mobility Analyst
OPNAV - Operational Logistics Analyst, Logistics Assessment
USACOM - Ordnance Planning Analyst
CINCLANT FLT - Logistics Plans Officer
CINCPAC FLT - Logistics Plans Officer
CINCEUR - Logistics Plans Officer
TRANSCOM - Operations and Plans Officer, Sealift Analyst
Afloat Staffs - Logistics Planning Officer

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

Curriculum 361
Academic Associate:
David A. Schrady, Distinguished Professor
Code OR/So, Glasgow Hall, Room 271
(831) 656-2801, DSN 878-2801
e-mail: dschrady@nps.navy.mil

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

TYPICAL COURSE OF STUDY

Quarter 1

OA2600	(4-0)	Introduction to Operations Analysis
MA1118	(5-2)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2

OA2200	(4-1)	Computational Methods for Operations Research II
MA3110	(3-0)	Intermediate Analysis
OA3610	(4-0)	Introduction to Naval Logistics
OA3102	(4-1)	Statistics

Quarter 3

OA3201	(4-1)	Linear Programming
MN4376	(4-0)	Defense Transportation System
OA3301	(4-0)	Stochastic Models I
OA3103	(4-1)	Data Analysis

Quarter 4

OA4611	(4-0)	Joint and Combined Logistics
OA3302	(4-0)	OA System Simulation
OA4655	(4-0)	Joint Combat Modeling
OA4202	(4-0)	Network Flows and Graphs

Quarter 5 (First six weeks)

OA4201	(4-0)	Nonlinear Programming
OA4604	(4-0)	Wargaming Analysis
(Last six weeks)		Experience Tour (Off Campus)

Quarter 6

OA4602	(4-0)	Joint Campaign Analysis
MN4613	(4-0)	Theory and Practice of Systems Analysis
OA0810	(0-8)	Thesis Research
OA4612	(4-0)	Logistics Models

Quarter 7

NW3230	(4-0)	Strategy & Policy
OAXXXX		Elective
OA0810	(0-8)	Thesis Research
OA0810	(0-8)	Thesis Research

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 applying concepts of higher mathematics. The objective of the program is to equip an officer with the skill to analyze a military problem, formulate it in mathematical terms, solve or approximate a solution and interpret and present the results.

Completion of this curriculum also qualifies an officer as an Applied Mathematics Subspecialist with a subspecialty code of XX41P. The curriculum sponsor is the U.S. Naval Academy Department of Mathematics. A typical job in this subspecialty is an instructor in mathematics at the U.S. Naval Academy or the U.S. Military Academy at West Point.

REQUIREMENTS FOR ENTRY
Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level or the first three quarters of the mathematics core sequence, which includes linear algebra, advanced calculus in one and several variables, ordinary differential equations, probability and statistics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) curriculum. An APC of 324 is required.

ENTRY DATES
Advanced Science (Applied Mathematics) is an eight-quarter course of study with preferred entry date in June. A seven quarter option is available with a September entry date. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 380
Academic Associate:
Beny Neta, Professor
Code MA/Nd, Glasgow Hall, Room 342
(831) 656-2235, DSN 878-2235
e-mail: bneta@nps.navy.mil

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

TYPICAL COURSE OF STUDY

Quarter 1

MA1117	(5-2)	Single Variable Calculus
MA1042	(2-0)	Matrix Algebra
MA1025	(4-0)	Finite Mathematics for Operations Research
EC1010	(1-1)	Introduction to MATLAB

Quarter 2

MA3046	(4-1)	Matrix Analysis
MA2121	(4-0)	Differential Equations
MA1118	(5-2)	Multi-Variable Calculus
MA3025	(5-1)	Logic and Discrete Mathematics

Quarter 3

MA3110	(3-0)	Intermediate Analysis
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MA3232	(4-1)	Numerical Analysis
MA2049	(3-0)	Vector Analysis with Applications
NW3230	(4-0)	Strategy & Policy

Quarter 4

MA3605	(3-0)	Fundamentals of Analysis I
MA3560	(3-0)	Modern Applied Algebra
MA3610	(3-0)	Topology, Fractals, and Chaotic Dynamics
OA3101	(4-1)	Probability

Quarter 5

MA3606	(3-0)	Fundamentals of Analysis II	
MA4311	(3-0)	Calculus of Variations	**or approved alternatives**
MA4372	(3-0)	Integral Transforms	**or approved alternatives**
OA3102	(4-1)	Probability and Statistics	

Quarter 6

OA3103	(4-1)	Statistics
MA4322	(3-0)	Principles and Techniques of Applied Mathematics I
MA4393	(3-0)	Janus
MA3675	(3-0)	Theory of Functions of a Complex Variable I

Quarter 7

MA4XXX		Elective
MA4323	(3-0)	Principles and Techniques of Applied Mathematics II
MA3676	(3-0)	Theory of Functions of a Complex Variable II
MA0810		Thesis Research

Quarter 8

MA0810		Thesis Research
MA0810		Thesis Research
MA4103	(3-0)	Thesis Topics Seminar
MA4XXX		Elective

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

1. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have a knowledge of development and execution of military strategy and the effects of technical developments on warfare, an understanding of the means of formulation of U.S. policy, the roles of military forces and joint planning, and current issues in defense organization.

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

3. **OPTIMIZATION:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

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

5. **HUMAN ENGINEERING:** The graduate will be familiar with the man-machine interface and also will be able to quantify the limitations imposed on systems designed for use by human operators.

6. **WARFARE ANALYSIS:** The graduate will be familiar with U.S./Allied and potential enemy capabilities, doctrine, and tactical concepts. The graduate will be able to model and analyze military operations using Operations Analysis techniques, and be able to develop new tactical concepts based on theory and exercise reconstruction and analysis.

7. **SYSTEMS ANALYSIS:** The graduate will understand the basic principles of economics and systems analysis as well as their application to various defense problems.

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

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

Curriculum Sponsor and ESR Approval Authority
Director, Assessment Division (N-81)
September 1999

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

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

2. **OPTIMIZATION:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

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

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

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

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

7. **SYSTEMS ANALYSIS:** The graduate will understand the basic principles of economics and system analysis as well as their application to various defense problems.

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

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

10. **JOINT MARITIME STRATEGY:** The graduate will have a knowledge of development and execution of military strategy and the effects of technical developments on warfare, an understanding of the means of formulation of U.S. policy, the roles of military forces and joint planning, and current issues in defense reorganization.

Curriculum Sponsor and ESR Approval Authority
Deputy CNO Logistics (N-4)
September 1999

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

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

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

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

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

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

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

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

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

Curriculum Sponsor and ESR Approval Authority
Chairman, Mathematics Department, USNA
July 1998

SOFTWARE ENGINEERING PROGRAMS

Curricular Officer:
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CDR, USN
Code 32, Spanagel Hall
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(831) 656-4656/4660
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SOFTWARE ENGINEERING
CURRICULUM 369

The phrase software engineering was coined in 1968 as a sort of rallying cry when NATO convened a workshop by that name to assess the state and prospects of software production. Since that time, software development has slowly emerged from ad hoc practice into an engineering discipline that is based on scientific knowledge from computer science. While computer science provides good models and theories to analyze problems and synthesize solutions, it fails to package the results for operational use, leading to the criticism sometimes made by software producers that computer science is irrelevant to practical software.

The software engineering curriculum was designed to address this problem. It builds upon the student's scientific knowledge in computer science from their undergraduate education and the insight into software problems from work experience. The curriculum introduces students to a set of engineering practices that enable ordinary practitioners to create sophisticated software systems that work. It teaches students the principles and methods of software development process management. The curriculum provides in-depth coverage of management processes, software tooling, and design activities for software development.

The program offers both M.S. and Ph.D. degrees in Software Engineering. The MSSE program comes with a 1-year full-time option and a 2-year part-time distance learning option. Students not enrolled in the MSSE degree program may also enroll in individual courses and receive NPS credit upon successful course completion.

MASTER OF SCIENCE IN SOFTWARE ENGINEERING, NON NAVY SUBSPECIALTY GRANTING PROGRAM (369)

REQUIREMENTS FOR ENTRY

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

ENTRY DATE

The MSSE is a four-quarter curriculum with entry dates in October. If further information is needed, contact the Curricular Officer or the Academic Associate for this curriculum.

Curriculum 369
Academic Associate: N/A

DEGREE

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

TYPICAL COURSE OF STUDY FOR FULL-TIME MSSE PROGRAM

Quarter 1

CS3460	(3-1)	Software Methodology
IS3171	(4-1)	Economic Evaluation of Information Systems II
CS3502	(4-0)	Computer Communications and Networks
IS4300	(3-2)	Software Engineering and Management

Quarter 2

CS4500	(3-1)	Software Engineering
CS4540	(3-0)	Software Testing
CS4560	(3-0)	Software Evolution
CS4580	(3-0)	Design of Embedded Real-Time Systems

Quarter 3

CS4520	(3-0)	Advanced Software Engineering
CS4570	(3-0)	Software Reuse
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

Quarter 4

CS4530	(3-1)	Software Research and Development in DoD
CS4510	(3-0)	Computer-Aided Prototyping
CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

TYPICAL COURSE OF STUDY FOR PART-TIME MSSE DISTANCE LEARNING PROGRAM

Quarter 1

CS3460	(3-1)	Software Methodology
IS4300	(3-2)	Software Engineering and Management

Quarter 2

CS4500	(3-1)	Software Engineering
CS4560	(3-0)	Software Evolution

Quarter 3

IS3171	(4-1)	Economic Evaluation of Information Systems II
CS4520	(3-0)	Advanced Software Engineering

Quarter 4

CS4510	(3-0)	Computer-Aided Prototyping
CS4580	(3-0)	Design of Embedded Real-Time Systems

Quarter 5

CS3502	(4-0)	Computer Communications and Networks
CS4540	(3-0)	Software Testing

Quarter 6

CS4570	(3-0)	Software Reuse
CS4530	(3-1)	Software Research and Development in DoD

Quarter 7

CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

Quarter 8

CS0810	(0-8)	Thesis Research
CS0810	(0-8)	Thesis Research

DOCTOR OF PHILOSOPHY IN SOFTWARE ENGINEERING, NON NAVY SUBSPECIALTY GRANTING PROGRAM (369)

REQUIREMENTS FOR ENTRY

An applicant should have a Master's Degree in Software Engineering (MSSE) or a related field. Applicants not meeting this requirement are encouraged to apply to the Master's program. Ph.D. applicants should have above-average grades in a typical Master's degree program and demonstrate the ability to think creatively and work independently. Other evidence of research or academic ability, such as work experience or publications, is also taken into consideration when evaluating applicants.

ENTRY DATE

Admitted Ph.D. students may begin in any quarter, but it is recommended that the student start in either the Fall Quarter (beginning in October) or the Spring Quarter (beginning in April) due to the requirements and timing of the Written Qualifying Examination. If further information is needed, contact the Curricular Officer or Academic Associate) for this curriculum.

DEGREE

The Ph.D. program in Software Engineering is designed for DoD software practitioners who want to acquire the skill and knowledge to perform state-of-the-art research on issues related to the development and evolution of large complex software systems, and to intelligently manage the research of other software practitioners. It offers the software professionals a unique program of study and advances software engineering principles and technology vital to DoD researchers and program managers. Students typically take three years to complete the doctoral program.

The first milestone in the Ph.D. program is the Written Qualifying Examination. This provides early feedback to students and faculty so that a course of study that leads to the successful completion of all the requirements can be determined.

TYPICAL COURSE OF STUDY

Ph.D. students are expected to complete the following steps:

1. Form a Dissertation Committee,
2. Pass the Written Qualifying Examination,
3. Fulfill Minor Requirements,
4. Pass the Oral Qualifying Examination,
5. Pass the Final Dissertation Examination,
6. Complete the Dissertation.

Students are expected to complete steps 1 and 2 by the fourth quarter of doctoral study, complete steps 3 and 4 by the sixth quarter, and complete steps 5 and 6 by the twelfth quarter.

Additional information is available on the Software Engineering web page **http://www.cs.nps.navy.mil/~se/phd.html.**

For more information on Curriculum 369, please contact any of the following:

Luqi, Professor and Chair SE Programs
Code Cs/Lq, Spanagel Hall, Room 530A
(831) 656-2735, DSN 878-2735
e-mail: luqi@cs.nps.navy.mil

Man-Tak Shing, Associate Professor
Code CS/Sh, Spanagel Hall, Room 544B
(831) 656-2634, DSN 878-2634
e-mail: mantak@cs.nps.navy.mil

Ted Lewis, Professor
Code Cs/Lt, Spanagel Hall, Room 544A
(831) 656-2830, DSN 878-2830
e-mail: tlewis@nps.navy.mil

Validis Berzins, Professor
Code CS/Be, Spanagel Hall, Room 528B
(831) 656-2610, DSN 878-2610
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Bruce C. Shultes, Assistant Professor
Code CS/Sb, Spanagel Hall, Room 531B
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e-mail: shultes@cs.nps.navy.mil

Norman Schneidewind, Professor
Code SM, Ingersoll Hall, Room 311
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e-mail: nschneid@nps.navy.mil

EDUCATIONAL SKILL REQUIREMENTS
SOFTWARE ENGINEERING
CURRICULUM (369)

All officers with advanced degree education in Software Engineering must possess skills and competencies in software design, development processes, and related software technology applicable to large-scale military systems. The skills and competencies are detailed below.

1. SOFTWARE DESIGN

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

a. System analysis and design theory encompassing the basics of requirements engineering and specification, system modeling and software architecture and its application to automation of military processes;

b. An understanding of the design issues related to digital data processing, interfacing to hardware systems, real-time command and control, distributed computation, and end-to-end systems integration. An understanding of the design issues related to software system interoperability, system reengineering, design rationales, system architecture, and software reuse;

c. The ability to design systems that are readily adaptable to changing military needs;

d. An understanding of system reliability issues and quality assurance methods for achieving high software reliability; and

e. The ability to understand, diagnose and recover from software failures.

2. DEVELOPMENT PROCESSES

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

a. An understanding of the software development process, including requirements determination, feasibility assessment, design, configuration management, implementation, quality assurance, and system evolution;

b. The ability to perform feasibility assessments of complex computer-based systems via prototyping, simulation, and static analysis;

c. The ability to plan, evaluate, and manage major software projects, choose appropriate design automation tools and develop appropriate documentation; and

d. The ability to assess software development risks and improve software development processes to reduce costs and produce more reliable systems.

e. An understanding of the development process issues related to improving maintainability and upgradeability of software in integrated systems.

3. SOFTWARE TECHNOLOGY

The officer must have a thorough knowledge of software technology that includes:

a. Methods for efficiently representing data and techniques for efficiently operating upon data structures;

b. The structure, control, and design of software systems involving multiprocessing, distributed processing and network-centric computing;

c. Representations and automatable methods for design and analysis of software systems;

d. Tools and techniques for simulation and modeling of systems; and

e. Engineering automation capabilities for design and assessment of software systems, program generation, and computer aided software design tools.

4. PROBLEM SOLVING AND MILITARY APPLICABILITY

The officer shall possess skills that enable a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to military concerns such as information warfare and command and control. This includes:

a. Completing a significant project applying software engineering skills to Navy and/or DoD relevant problems;

b. Exercising skills in problem formulation, criteria specification, analysis, design, and evaluation of results as they relate to military requirements; and

c. Clearly communicating the results of a project orally and in writing.

5. JOINT AND MARITIME STRATEGIC PLANNING

The officer will have a graduate level understanding of strategy, especially maritime strategy, naval doctrine, and the effect of technical developments on warfare. The officer must become familiar with the following subjects for the United States, its' allies, and opponents: The roles and missions of military services, policy-making processes regarding the armed forces, history of joint and general staffs, joint planning for acquisition and operations, and current issues in defense reform and reorganization.

SPACE SYSTEMS PROGRAMS

Curricula Officer:
William J. Welch
CDR, USN
Code 31, Halligan Hall
Room 133
(831) 656-2491
DSN 878-2491
e-mail: wwelch@nps.navy.mil

SPACE SYSTEMS OPERATIONS (INTERNATIONAL)
CURRICULUM 364
A course of study modeled after Curriculum 366 (page 79) is available for international students. Further information is available from the Curricular Officer or Academic Associate.

Curriculum 364
Academic Associate:
Donald Wadsworth, Senior Lecturer
Code EC/Wd, Spanagel Hall, Room 222
(831) 656-3456, DSN 878-3456
e-mail: dwadsworth@nps.navy.mil

SPACE SYSTEMS ENGINEERING
CURRICULUM 591
The Space Systems Engineering program provides officers, through graduate education, with a comprehensive scientific and technical knowledge of military and Navy space systems. This curriculum is designed to equip officers with the theoretical and practical skills required to design and integrate military space payloads with other spacecraft subsystems. Graduates will be prepared by their education to design, develop and manage the acquisition of space communications, navigation, surveillance, electronic warfare and environmental sensing systems.

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or its equivalent, in engineering or the physical sciences is preferred. An APC of 323 is required for direct entry. The Engineering Science program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. For those undertaking the electrical engineering program, the officer will have earned the equivalent of an accredited BSEE. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students.

SPACE SYSTEMS ENGINEERING SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of XX77P. The curriculum sponsor is N-63, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

LT level
- Project Engineer: SPAWAR
- Communications Engineer: NAVSOC
- Fleet Information Warfare Center: Little Creek, Va

LCDR - CDR level
- Assistant Project Management: SPAWAR
- Joint Interoperability Division D6: DISA
- Space Warfare Center: USSPACECOM, Colorado Springs
- NCCOSC RDTE: San Diego

ENTRY DATES
Space Systems Engineering is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 591
Academic Associate:
Oscar Biblarz, Professor
Code AA/Bi, Halligan Hall, Room 234
(831) 656-3096, DSN 878-3096
e-mail: obiblarz@nps.navy.mil

DEGREE

Requirements for one of five technical degrees are met as a milestone en route to satisfying the Educational Skill Requirements of this curricular program. The possible degrees are: Master of Science in Electrical Engineering, Physics, Astronautical Engineering, Computer Science or Mechanical Engineering. Degrees in other disciplines are available for students with appropriate backgrounds, on a case by case basis.

TYPICAL COURSE OF STUDY - FALL ENTRY

Quarter 1

MA2121	(4-0)	Differential Equations
PH1322	(5-0)	Electricity and Magnetism
EO2402	(4-1)	Introduction to Linear Systems
CS2971/3	(4-2)	Introduction to Object-Oriented Programming
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 2

PH2514	(4-0)	Introduction to Space Environment
PH2511	(4-0)	Introduction to Orbital Mechanics
AA2820	(3-2)	Introduction to Spacecraft Structures
EO3402	(3-1)	Signals and Noise
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 3

EC2820	(3-2)	Digital Logic Circuits
SS3525	(3-2)	Air/Ocean Remote Sensing for Interdisciplinary Curricula
SS9999	(4-0)	Specialization Elective
AA3815	(3-2)	Introduction to Spacecraft Dynamics
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 4

AA3851	(3-2)	Spacecraft Propulsion
EC2300	(3-2)	Control Systems
SS9999	(4-0)	Specialization Elective
SS3001	(3-2)	Military Applications of Space
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 5

SS3035	(3-2)	Microprocessors for Space Applications
AA3818	(3-2)	Spacecraft Attitude, Dynamics and Control
SS9999	(4-0)	Specialization Elective
PH3360	(4-1)	Electromagnetic Waves Propagation
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 6

SS0810	(0-8)	Thesis Research
EC3230	(3-1)	Space Power and Radiation Effects
AA3804	(3-0)	Thermal Control of Spacecraft
NW3230	(4-0)	Strategy & Policy

Quarter 7

AA4870	(4-0)	Spacecraft Design and Integration
EO3535	(3-2)	Spacecraft Communication Engineering
SS9999	(4-0)	Specialization Elective
SS9999	(4-0)	Specialization Elective
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 8

MN3301	(4-0)	Systems Acquisition and Program Management
AA4871	(2-2)	Spacecraft Design and Integration II
SS9999	(4-0)	Specialization Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminars and Field Trips

Quarter 9

SS9999	(4-0)	Specialization Elective
SS9999	(4-0)	Specialization Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminars and Field Trips
TBD	(4-0)	N6 Capstone Course

EDUCATIONAL SKILL REQUIREMENTS
SPACE SYSTEMS ENGINEERING
CURRICULUM (591)
Subspecialty Code XX77P

1. **JOINT AND MARITIME STRATEGIC PLANNING:** A graduate level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

2. **ORBITAL MECHANICS AND SPACE ENVIRONMENT:** An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Demonstrate an understanding of perturbations due to nonspherical earth and due to atmospheric drag.

   An understanding of the natural and induced environment of space including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances.

   An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

3. **SPACECRAFT:** Communications and Signal Processing An understanding of signal processing techniques, both digital and analog, as applied to spacecraft communications, surveillance, and SEW.

4. **COMPUTERS: HARDWARE AND SOFTWARE:** A programming skill in at least one current high-level computer programming language, such as ADA, PASCAL or FORTRAN.

   An understanding of the fundamentals of digital logic and digital system design. An ability to design simple digital computer subsystems.

   Knowledge of a current computer architecture, such as one of the common 16-bit or 32-bit micro-processor systems. Understanding of the ways in which computers are used in complex systems such as guidance, signal processing, communications and control systems.

5. **SPACECRAFT GUIDANCE AND CONTROL:** An understanding of the field of attitude dynamics and control which includes: Classical Newtonian Dynamics, 3 axis attitude stabilization, dual spin stabilization, nutation damping control; momentum wheels, gravity gradient booms, attitude beam pointing accuracy and thrust vector control. Knowledge of minimum fuel and time type control systems.

6. **SPACECRAFT STRUCTURES, MATERIALS AND DYNAMICS:** An understanding of the engineering of space structures including simplified sizing calculation and analytical modeling of advanced materials which can be incorporated in system design and integration.

   An ability to apply reliability and maintainability to testing, evaluation, and manufacturing which can be used to predict the functional dependability of spacecraft structures.

7. **PROPULSION SYSTEMS:** An understanding of the operating principles of current and proposed propulsion devices for space applications; including launch, orbit changing and maneuvering engines.

   An understanding of the interaction between mission requirements and propulsion requirements.

8. **SPACECRAFT THERMAL CONTROL AND POWER:** An understanding of the principles of heat transfer by radiation and of the variations in the radiative properties of surfaces with respect to wavelength and temperature.

   A knowledge of the sources of heat in space (solar, terrestrial, reflected solar, internal vehicle generation) and their variation as a function of vehicle orbit.

   A knowledge of the major power generating systems for spacecraft and their operating characteristics, including the performance of photovoltaic sources in the natural and artificial radiation environment. An understanding of the role of energy storage devices in power systems design.

9. **SPACECRAFT DESIGN AND INTEGRATION:** An understanding of the principles of space systems design, integration, and systems engineering, and their application to an overall spacecraft/mission. Consideration will be given to life cycle costs, performance, maintainability, reliability, configuration control and systems integration.

   An appreciation of system design criteria from stated performance requirements, trade-offs between payload and other spacecraft subsystems, and a familiarity with test and evaluation procedures will be included.

10. **MILITARY OPERATIONS IN SPACE:** An appreciation of space weapons, space support to Fleet tactical operations, space defense and warfare; including options available to protect space assets and to deny the use of space to others. A familiarity with the role, responsibilities and relationships of national and Joint DoD organizations in establishing policies, priorities, and requirements for space systems; and in the design, acquisition and operation of spacecraft and supporting ground systems. An understanding of the capabilities and use of space systems to enable and support Joint air, land, and sea military operations.

11. **PROJECT MANAGEMENT:** An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships, contract management, financial management and control and the Planning, Programming and Budgeting System (PPBS).

12. **CONDUCT AND REPORT INDEPENDENT RESEARCH:** The ability to conduct independent research on a space systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

Curriculum Sponsor and ESR Approval Authority
Director, Navy Space Systems Division (N63)
May 1997

SPECIAL OPERATIONS PROGRAM

Curricular Officer:
Michael Mullady
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SPECIAL OPERATIONS
CURRICULUM 699
The Special Operations Curriculum is designed to provide a focused course of study of the conflict spectrum below general conventional war. Graduates of this curriculum will possess a close knowledge of the broad range of factors involved in the planning and conduct of these forms of conflict and a detailed understanding of the role of special operations and related forces in U.S. foreign and defense policy. The curriculum examines the sources and dynamics of inter-state and intra-state conflict, the challenge these forms of conflict have posed and are likely to increasingly pose for U.S. security planning, the doctrinal and institutional evolution of the U.S. special operations community, the recent history of political violence and "small wars" in Latin America, Asia, and the Middle East, the history of irregular warfare, and contemporary perspectives on low intensity conflict resolution. These curriculum specific requirements are supported by a larger program of study which provides the graduate with a broad background in the areas of international relations, comparative strategy, the technological revolution in military affairs, and advanced analytical methods.

REQUIREMENTS FOR ENTRY
The Special Operations Curriculum is open to officers and civilian employees of the U. S. Federal Government and other countries. U. S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the last five years. A baccalaureate degree earned with above-average academic performance and a minimum APC of 365.

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

Curriculum 699
Academic Associate:
Gordon H. McCormick, Associate Professor
Code CC/Mc, Root Hall, Room 207
(831) 656-2933, DSN 878-2933
e-mail: gmccormick@nps.navy.mil

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

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

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

TYPICAL COURSE OF STUDY: IRREGULAR WARFARE TRACK

Quarter 1

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

Quarter 2

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

Quarter 3

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

Quarter 4

NW3230	(4-0)	Strategy & Policy
OA4602	(4-0)	Campaign Analysis
SO3801	(4-0)	International Terrorism
IW3101	(4-0)	Warfare in the Information Age

Quarter 5

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

Quarter 6

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

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

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

1. JOINT MARITIME AND STRATEGIC PLANNING AFTER THE COLD WAR

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

2. THE DYNAMICS OF INTER-STATE AND INTRA-STATE CONFLICT

An understanding of the political, ethnic, and cultural dynamics that explain the outbreak of war between and within modern states. Particular attention should be given to the issues of intra-state conflict, unconventional forms of inter-state military rivalry, the integrated role of force and diplomacy in crisis management operations short of war, problems of escalation in a crisis environment, military alliance behavior, the dynamic differences between zero sum and nonzero sum conflicts, the special problems associated with suppressing and resolving zero sum engagements, military and nonmilitary approaches to conflict resolution. Students must have a close understanding of the prevailing analytical literature on these and related subjects and be able to apply this literature to a broad range of contemporary and historical cases.

3. TERRORISM, SOCIAL REVOLUTION, AND UNCONVENTIONAL WARFARE

A detailed understanding of the problems of domestic and international terrorism, social revolution, and other forms of irregular conflict. Close attention must be given to problems of both threat and response. The student must have a close knowledge of the prominent contending theoretical perspectives on the problems of terrorism and social revolution, a detailed knowledge of the operational and organizational dynamics underlying each of these forms of conflict, and a strong working understanding of the ways in which these and similar forms of irregular conflict have been countered historically. Where appropriate, the courses designed to satisfy this requirement should survey the U.S. experience in irregular warfare as well as that of other states that have been prominently engaged in such actions in the past, such as Great Britain, France, Israel, and the former Soviet Union.

4. HISTORICAL AND COMPARATIVE PERSPECTIVES ON SPECIAL OPERATIONS

A close understanding of the historical use of special operations forces, to include how these and similar forces have been organized, trained, equipped, directed, and employed. Attention should be given not only to the U.S. experience but to other national experiences as well, such as those of Great Britain, Germany, Italy, and the former Soviet Union. Similarly, this examination should not be restricted to contemporary history alone, but should extend back into the historical record to examine the ways in which special operations and related forces have been employed creatively to support state objectives in the more distant past. Throughout this inquiry attention should be given to the contemporary lessons that can be drawn from historic experience.

5. SPECIAL OPERATIONS DOCTRINE, CONCEPTS, AND INSTITUTIONS

A detailed and conception understanding of the development of doctrine for special operations. Work in this area should focus, first, on the defining events and experiences that have stimulated doctrinal and institutional innovations in SO and, second, on the forms these innovations have taken. This examination should cover the period from the end of World War II through the post-Cold War era. These and related issues should be explored creatively in an effort to uncover the appropriate roles and missions and strengths and limitations of military power in the emerging multipolar environment.

6. CRISIS MANAGEMENT AND THE CONTINGENT USE OF MILITARY POWER

An understanding of the political role played by military power in operations short of war, the problem of military crisis management, and the contingent use of force in support of local U.S. policy objectives. Attention should be given to the "signaling" role that can be played by military force, the special problems of deterrence and coercion in a crisis environment, and the military consequences of deterrence failure. The student should have a close knowledge of the historical record of "armed diplomacy" throughout the post-war period. This should include a knowledge of the individual cases of U.S. military intervention in the Third World, from Lebanon (1958) to Somalia (1993). Attention should be given to both the theoretical and empirical literature on these subjects to provide the student with an understanding of the special political and operational issues associated with operating in a crisis environment.

7. COMPARATIVE CASES OF AND RESPONSES TO REGIONAL CONFLICT

A close knowledge of historical and contemporary "small wars" and other forms of low intensity conflict in Latin America, Asia, and the Middle East. The courses that satisfy this requirement should examine the pertinent theoretical literature on political violence in the region in question, review the recent history of regionally-based terrorism, insurgency, and communal conflict, the regional and international implications of these conflicts, and any functional issues that are of particular interest or concern in the particular area under investigation, such as, the religious or communal sources of political violence or the relationship between narcotics and insurgency.

8. SPECIAL OPERATIONS AND THE REVOLUTION IN MILITARY AFFAIRS

An understanding of the ways in which the proliferation of new and emerging technologies is changing the shape of modern warfare. An important aspect of this requirement is to examine the likely impact of these developments on the dynamics and characteristics of 21st century warfare within both the inter-state and intra-state arena. The student must have a working knowledge of the major technological developments and trends in this area (both lethal and non lethal) and their conflict implications.

9. SPECIAL OPERATIONS AND INFORMATION WARFARE

An understanding of the likely and potential implications of information warfare on future special operations. An important aspect of this requirement is to examine the principles of information warfare and examine the ways in which SOF can contribute to U.S. information dominance on the 21st century battlefield. This examination should address the problem of information dominance at the inter-state and intra-state level of war.

10. WEAPONS OF MASS DESTRUCTION (WMD) PROLIFERATION AND COUNTERPROLIFERATION

Students will have an understanding of the developing problem of WMD proliferation and counterproliferation. Students may have a technical or operational perspective on WMD. The student must have an understanding of the political dynamics of WMD proliferation and an understanding of recent and possible future trends in this areas. Close attention should also be given to the problem of counterproliferation and the ways in which SOF might approach this task. Students having a technical focus should have a working knowledge of nuclear and non-nuclear WMD Technologies..

11. ANALYTICAL METHODS AND APPLICATIONS

Each student will receive a grounding in analytical methods and their application to military modeling, simulations, and gaming. Close attention will be given to the ways in which such analytical techniques can be used as heuristic and decision making tools for strategic and operational planning. Attention will be given to both historical and contemporary military applications with particular focus on the ways in which such techniques can be used to address issues of interest to the special operations community.

12. STRATEGIC AND OPERATIONAL COMPLEXITY

Special Operations (SO) is a style of warfare. No traditional single academic discipline can adequately address the educational requirements of the special operations community, so an interdisciplinary approach is required. Each student will develop a course of study that permits he or she to pursue a disciplinary orientation that best suits their particular academic background and interests within the substantive limits of the other ESRs.

Curriculum Sponsor and ESR Approval Authority

Commander in Chief, U.S. Special Operations Command
May 1995

SYSTEMS ENGINEERING AND INTEGRATION PROGRAM

Curricular Officer:
William J. Welch
CDR, USN
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DSN 878-2491
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SYSTEMS ENGINEERING AND INTEGRATION PROGRAM
CURRICULUM 308

This curriculum will enable the student to exploit emerging technologies to achieve war-fighting advantages. The students will blend their operational experience with a thorough technical education to expeditiously integrate new technological capabilities into operational applications. The officer will be able to evolve current tactics and doctrine to expeditiously leverage imminent technological advances.

This war-fighter oriented program provides a solid understanding of the principles and applications of systems engineering, and employs these principles to gain insight into operational problems. This program includes a core of courses, in fields of modeling, simulation, weapons, and sensors, that will enhance understanding and analysis of selected cases studies and weapons systems. This educational program is focused on educating URL officers to rapidly exploit emerging technologies to achieve warfighting advantages. The students will blend their operational experience with a thorough technical education to expeditiously integrate new technological capabilities into operational applications. The officer will be able to evolve current tactics and doctrine to expeditiously leverage imminent technological advances.

The program is designed as a highly integrated graduate education experience. There will be lectures, team projects, and individual research as well as seminars from visiting experts. Each arriving officer is evaluated for existing knowledge, skills and competencies and an individual course of study developed. The length of this program will be six quarters.

REQUIREMENTS FOR ENTRY

For entry, the officer must have at least a C+ undergraduate grade point average, with at least one calculus course with a C or better and at least one calculus based physics course with a C or better (APC 334). If an officer is an outstanding performer but lacks the necessary academic preparation, the Naval Postgraduate School offers refresher and transition courses before the program starts.

SYSTEMS ENGINEERING AND INTEGRATION SUBSPECIALTY

6500P pending approval of the new subspecialty system.

ENTRY DATES

The Systems Engineering and Integration curriculum is a six-quarter curriculum with entry dates in July. If it is necessary due to APC requirements, the twelve-week refresher will begin study prior to this entry date. If further information is needed, contact the Curricular Officer or Academic Associate for this curriculum.

Curriculum 308
Academic Associate:
Bard Mansager, Professor
Glasgow Hall, Room 364
(831) 656-2695 , DSN 878-2695
e-mail: bardman@nps.navy.mil

DEGREE

Exact wording is in work. Requirements for the degree Master of Science in Systems Integration are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

The first 2 quarters of the SEI curriculum reflect an intensive non-traditional course of study providing academic preparation in the following areas to prepare for higher level coursework and exploration: Mathematics, Probability and Statistics, Operations Analysis, Simulation, Physics, Weapons Effects, Acquisition of Military Weapons Systems and Systems Engineering. In addition, a large focus of this curriculum consists of an in-depth study of a significant technical challenge faced by the US Navy in contemporary operations. The students will gain additional knowledge and insight through studies and extensive field trips.

Quarter 1

SI3001		Special Topics in Strategic Analysis I	(Weeks 1,7,12)
SI3002		Math I	(Weeks 2,3)
SI3003		Probs and Stats	(Week 4)
SI3004		Physics I	(Week 5,6)
SI3005		Policy Planning/Acq Sys	(Week 8)
SI3006		Proj Mgmt/Tech Forecast	(Week 9)
SI3007		Sys Eng/Int	(Week 10)
SI3008		Search Theory/Firing Theory	(Week 11)
NW3223	(2-0)	Joint Maritime Operations	

Quarter 2

SI3101		Special Topics in Strategic Analysis II	(Week 1,12)
SI3102		Math II	(Week 2)
SI3103		Comms/Networks	(Week 3)
SI3104		Physics II	(Week 4,5)
SI3105		Intro to Sensors	(Week 6)
SI3106		Intro to Weapons	(Week 7)
SI3107		Info Sys/Programming	(Week 8)
SI3108		IO/IW	(Week 9)
SI3109		C4I Systems	(Week 10)
SI3110		Simulation	(Week 11)
NW3224	(2-0)	Joint Maritime Operation	

Quarter 3

TBD	(4-0)	Combat Systems 1
TBD	(4-0)	Ops/Analysis 1
TBD	(4-0)	Information Operations 1
NW3210	(2-0)	National Security and Decision Making

Quarter 4

TBD	(5-0)	Combat Systems 2
TBD	(4-0)	Ops/Analysis 2
TBD	(4-0)	Information Operations 2
TBD	(4-0)	Systems Engineering 1
NW3211	(2-0)	National Security and Decision Making

Quarter 5

TBD	(4-0)	Systems Management
TBD	(4-0)	Project Management
TBD	(4-0)	Systems Eng 2
NW3230	(4-0)	Strategy and Policy

Quarter 6

SI0810	(0-8)	Project Report
SI0810	(0-8)	Project Report
SI0810	(0-8)	Project Report
SI0810	(0-8)	Project Report

EDUCATIONAL SKILL REQUIREMENTS
SYSTEMS ENGINEERING AND INTEGRATION
CURRICULUM (308)
Subspecialty Code 6500P

1. **BASICS:** Introduction to the mathematics, physics, and computer skills needed to understand the technical aspects of combat, information, and decision systems.

2. **SYSTEMS ENGINEERING:** Understand the systems engineering process and how to perform systems engineering studies, to include a knowledge of system design, development, and deployment; technical and economic trade-offs; human-in-the-loop issues; project management; systems acquisition and the planning, programming and budgeting system (PPBS). Be able to integrate relevant technological disciplines that bear on weapons, sensor and information systems. Understand responsiveness to realistic military requirements, specifications and cost limitations. Study the linkage between strategic planning, requirements, project organization, and technology.

3. **INFORMATION SYSTEMS TECHNOLOGY:** Develop a knowledge of information systems technology, to include: computer systems; computer networks and communications systems; software engineering; data base management. Demonstrate awareness of the capabilities, limitations, design and operation, and vulnerabilities of information systems. Understand the concepts of defensive and offensive Information Warfare.

4. **SENSOR AND WEAPON SYSTEMS:** Gain a solid understanding of the scientific, mathematical and engineering principles behind existing and future military systems. Understand the elements that impact sensor system performance. Understand the principles behind existing and emerging sensor technologies, including radar, sonar, electro-optical sensors, and sensors based on novel physical principles. Understand the technologies underlying weapons systems, and the principles that guide successful integration of weapons and sensors with platforms. Understand the basics of weapons of mass destruction, and their utilization.

5. **OPERATIONS ANALYSIS:** Understand uncertainty and risk and their impact on military planning, decision making and operations. Become familiar with complexity and the modeling of competitive systems. Gain a working knowledge of modeling, simulation and gaming. Learn how OR techniques, including experimental design, are applied to operational test and evaluation; planning and analyzing fleet battle experiments; and to military decision making. Learn how to apply advanced management and operations research ideas to defense problems, to include cost benefit and cost effectiveness analysis.

6. **PROFESSIONAL MILITARY EDUCATION:** The officer will meet all requirements to gain PJE Phase 1 certification through the NPS/NWC PME program.

7. **INDEPENDENT STUDY:** Each student must demonstrate the ability to conduct independent and team oriented research and analysis on problems that link technical solutions to tactical problems, and to present the results in writing and oral briefings. A thesis or substantive project report will be required of all participants.

March 1999

SYSTEMS MANAGEMENT PROGRAMS

Curricular Officer:
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TRANSPORTATION LOGISTICS MANAGEMENT CURRICULUM 813

This curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration into an understanding of the process by which the defense mission is accomplished. Inputs from the Navy are from the Supply Corps. The programs is designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, it is intended to provide the officer with a Navy/Defense Systems-oriented graduate management education and to provide the officer with the specific functional skills required to effectively manage in this subspecialty area.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Supply Corps Officers from the U.S. Navy start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION LOGISTICS MANAGEMENT SUBSPECIALTY

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

Typical Jobs in this Subspecialty:
Transportation Officer: CINCLANTFLT
Transportation Director: Fleet and Industrial Support Center (FISC) Norfolk, VA.
Air Terminal Coordinator: COMFAIRMED
Cargo Handling Officer, Operations Officer: NAVCHAPRU
CO and XO: NAVMTO
Deputy Commander: MTMC

ENTRY DATE

Transportation Logistics Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 813
Academic Associate:
Donald Eaton, Logistics Chair (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(831) 656-3616, DSN 878-3616
e-mail: deaton@nps.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
IS2010	(1-2)	Introduction to Information Technology
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Domestic Transportation Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy and Budgeting
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 4

IS3185	(3-0)	Management of Information Technology
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
OA4611	(4-0)	Joint and Combined Logistics
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN3372	(4-0)	Material Logistics
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3377	(4-0)	Inventory Management
MN3371	(4-0)	Contracts Management and Administration
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 7

MN0810	(0-8)	Thesis Research
MN4105	(4-0)	Strategic Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
NW3230	(4-0)	Strategy and Policy
MN3375	(4-0)	Materials Handling Systems Design

One additional course must be selected from the following curriculum options:

MN3111	Personnel Management Processes
MN3374	Production Management
MN4310	Logistics Engineering
MN4470	Strategic Planning and Policy for the Logistic Manager

TRANSPORTATION MANAGEMENT CURRICULUM 814

The objectives of this curriculum are to prepare officers for naval logistics system positions, emphasizing worldwide transportation aspects. Graduate logistics courses cover topics such as the transportation system within CONUS, warehouse siting, materials management, production management, inventory management (both Navy and private sector), materials handling, purchasing and physical distribution. Students take additional courses in transportation in the private sector and military transportation in support of contingencies, as well as, options in corporate financial management, production management, or logistics engineering.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Transportation Management Subspecialist with a subspecialty code of XX35P. The Curriculum Sponsor is The Navy Military Sealift Command Headquarters.

Typical Jobs in this Subspecialty:
Commander: MSCO, COMSCEUR, COMSCMED, COMSCPAC, United Kingdom and Northern Europe
Tanker Control Officer: Military Sealift Command (MSC) Headquarters
Commander and Deputy Commander: Military Sealift Command Officer (MSCO), Norfolk, VA

ENTRY DATE

Transportation Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 814
Academic Associate:
Donald Eaton, Logistics Chair (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(831) 656-3616, DSN 878-3616
e-mail: deaton@nps.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
IS2010	(1-2)	Introduction to Information Technology
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Domestic Transportation Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy and Budgeting
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 4

IS3185	(3-0)	Management of Information Technology
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN3372	(4-0)	Material Logistics

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN3111	(4-0)	Personnel Management Processes
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3371	(4-0)	Contracts Management and Administration
NW3230	(4-0)	Strategy and Policy

Quarter 7

MN0810	(0-8)	Thesis Research for Systems Management Students
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3375	(4-0)	Materials Handling Systems Design
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student selects option from the following courses:

MN3374	Production Management
MN4310	Logistics Engineering
OA3610	Introduction to Naval Logistics
OA4611	Joint and Combined Logistics

ACQUISITION AND CONTRACT MANAGEMENT CURRICULUM 815

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

REQUIREMENTS FOR ENTRY

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

Because students enter the curriculum with widely varied academic backgrounds, each student's prior academic work and related experience is evaluated for courses previously completed and applicable to the student's curriculum. Course validation is encouraged.

ACQUISITION AND CONTRACT MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies Naval officers as Acquisition and Contract Management Subspecialists with a subspecialty code of 1306P, Army officers as Functional Area 97, and Marine Corps officers with a 9656 MOS. The Curriculum Sponsor is the Deputy to the Assistant Secretary of the Navy (Research, Development and Acquisition) for Acquisition, and Business Management. The curriculum satisfies the mandatory Defense Acquisition University (DAU) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

Typical Jobs in this Subspecialty:

Contracting Officer:
- Naval Inventory Control Point, Philadelphia, PA

Director of Contracts:
- Marine Corps Field Contracting System, Fleet and Industrial Supply Centers, Army and Navy Laboratories, Naval Regional Contracting Centers

Procuring Contracting Officer, (PCO):
- Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR)
- Army Material Command
- Major Subordinate Commands (CECOM, AMCOM)

Business/Financial Manager (BFM):
- Hardware Systems Commands (NAVAIR, NAVSEA,SPAWAR)

Contracts and Business Policy:
- Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)
- Staff of Assistant Secretary of the Army (Acquisition, Logistics and Technology)
- Staff of Under Secretary of Defense (Acquisition & Technology)

Administrative Contracting Officer (ACO):
- Defense Contract Management Command (DCMC)
- Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)

ENTRY DATES

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

Curriculum 815
Academic Associate:
David V. Lamm, Associate Professor
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(831) 656-2775, DSN 878-2775
e-mail: dlamm@nps.navy.mil

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 (Navy, Air Force, Coast Guard, International*)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 3

MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(4-1)	Contract Law
MN3105	(4-0)	Organization and Management
NW3230	(4-0)	Strategy and Policy
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3315	(4-0)	Acquisition Management and Contract Administration
MN4145	(4-0)	Policy Analysis
IS3185	(3-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4301	(4-0)	Contracting for Major Systems
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
OS3006	(4-0)	Operations Research for Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4999	(4-0)	Curriculum Option**
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

*International students take IT1500 and IT1600 in first quarter, MN3333 in third quarter and do not take MN3172 and NW3230.

**Curriculum options:

MN3384	Principles of Acquisition Production and Quality Management
MN4152	Corporate Financial Management
MN4162	Cost Management
MN4305	Defense Technology Policy
MN4310	Logistics Engineering
MN4372	Seminar in Acquisition and Contract Management
MN4470	Strategic Planning and Policy for the Logistics Manager
MN3155	Financial Management for Acquisition Managers **AND**
MN4151	Internal Control and Auditing

TYPICAL COURSE OF STUDY (U. S. Marine Corps)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 3

MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(4-1)	Contract Law
MN3105	(4-0)	Organization and Management
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3315	(4-0)	Acquisition Management and Contract Administration
MN3384	(5-1)	Principles of Acquisition Production and Quality Management
IS3185	(3-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4304	(2-0)	Defense Systems Contracting
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
NW3230	(4-0)	Strategy and Policy
OS3006	(4-0)	Operations Research for Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4145	(4-0)	Policy Analysis
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

TYPICAL COURSE OF STUDY (U.S. Army)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Management Accounting
OS3105	(4-1)	Statistical Analysis for Technical Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 3

MN3304	(5-2)	Contract Pricing and Negotiations
MN3312	(4-1)	Contract Law
MN3105	(4-0)	Organization and Management
MN3309	(4-1)	Acquisition of Embedded Weapon System Software
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 4

MN3315	(4-0)	Acquisition Management and Contract Administration
IS3185	(3-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

Quarter 5

MN4304	(2-0)	Defense Systems Contracting
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
OS3006	(4-0)	Operations Research for Management
MN2302	(0-3)	Seminar for Acquisition and Contracting Students
OS4602	(2-0)	Test and Evaluation Management

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4145	(4-0)	Policy Analysis
MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2302	(0-3)	Seminar for Acquisition and Contracting Students

SYSTEMS ACQUISITION MANAGEMENT CURRICULUM 816

The Systems Acquisition Management Curriculum is an interdisciplinary program designed to integrate business principles, management theory, operations/systems analysis, and engineering applications. It is uniquely tailored to Federal Government acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curriculum present the structure of acquisition management, the decisions and problems facing the acquisition manager, the various forces at work within industry and Government, and the impact of acquisition policies and strategies. Student input includes officers and civilians from all DoD Services, other Federal Agencies and allied nations.

REQUIREMENTS FOR ENTRY

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

Because students enter the curriculum with widely varied academic backgrounds, each student's prior academic work and related experience is evaluated for courses previously completed and applicable to the student's curriculum. Course validation is encouraged.

SYSTEMS ACQUISITION MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an Army officer for Functional Area 51 and a Marine Corps officer for MOS 9657. Department of Defense civilians are typically members of the acquisition workforce as specified by the Defense Acquisition Workforce Improvement Act (DAWIA). This curriculum satisfies the mandatory requirements for the Advanced Program Management Course (APMC) (PMT302) at the Defense Systems Management College (DSMC). The Curriculum Sponsor is the Deputy Director, Acquisition Career Management, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology).

Typical Jobs in this Subspecialty:

Program Manager/Deputy Program Manager/Program Office:
- Army/Navy/Marine Corps Aircraft, Missile, Vehicle and Ship programs

Program Executive Officer (PEO) staff

Matrix Organization staff:
- Army Aviation Missile Command (AMCOM)
- Naval Air Systems Command (NAVAIR)
- Naval Sea Systems Command (NAVSEA)
- Army Communications - Electronics Command (CECOM)
- Marine Corps Systems Command (MARCORSYSCOM)

Test and Evaluation Officer

Logistics Officer:
- Marine Corps Logistics Base (MCLB)

ENTRY DATES

Systems Acquisition Management is a seven-quarter course of study (six quarters for U.S. Army Students) with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 816
Academic Associate:
David V. Lamm, Associate Professor
Code SM/Lt, Ingersoll Hall, Room 331A
(831)656-2775, DSN 878-2775
e-mail: dlamm@nps.navy.mil

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 (Navy, Marine Corps, Air Force, Coast Guard)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology
MN2303	(0-3)	Seminar for Program Management Students

Quarter 2

MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
OS3105	(4-1)	Statistical Analysis for Technical Management
MN2303	(0-3)	Seminar for Program Management Students

Quarter 3

MN3105	(4-0)	Organization and Management
IS3185	(3-0)	Management of Information Technology
OS3006	(4-0)	Operations Research for Management
MN2303	(0-3)	Seminar for Program Management Students
MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software

Quarter 4

MN4310	(4-0)	Logistics Engineering
EO4011	(3-2)	Systems Engineering for Acquisition Managers
MN3371	(4-0)	Contracts Management and Administration
MN3155	(2-0)	Financial Management for Acquisition Managers
MN2303	(0-3)	Seminar for Program Management Students

Quarter 5

MN3172	(4-0)	Public Policy and Budgeting
OS4602	(2-0)	Test and Evaluation Management
OS3302	(4-0)	Quality Assurance and Reliability Methods
MN4999	(4-0)	Curriculum Option*
MN2303	(0-3)	Seminar for Program Management Students

Quarter 6

MN4307	(4-0)	Program Management Policy and Control
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4145	(4-0)	Policy Analysis
MN2303	(0-3)	Seminar for Program Management Students
MN3384	(5-1)	Principles of Systems Acquisition and Program Management

Quarter 7

MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
NW3230	(4-0)	Strategy and Policy
MN2303	(0-3)	Seminar for Program Management Students

*One additional course must be selected from the following curriculum options:

MN4305	Defense Technology Policy
MN4372	Seminar in Acquisition and Contract Management
MN4470	Strategic Planning and Policy for the Logistics Manager
OA4702	Cost Estimation

TYPICAL COURSE OF STUDY (U.S. Army)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology
MN2303	(0-3)	Seminar for Program Management Students

Quarter 2

MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3155	(2-0)	Financial Management for Acquisition Managers
MN3105	(4-0)	Organization and Management
OS3105	(4-1)	Statistical Analysis for Technical Management
MN2303	(0-3)	Seminar for Program Management Students

Quarter 3

OS3006	(4-0)	Operations Research for Management
OS3302	(4-0)	Quality Assurance and Reliability Methods
MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MN2303	(0-3)	Seminar for Program Management Students

Quarter 4

MN3303	(4-0)	Principles of Acquisition and Contract Management
MN4310	(4-0)	Logistics Engineering
EO4011	(4-0)	Systems Engineering for Acquisition Managers
IS3185	(3-0)	Management of Information Technology
MN3384	(5-1)	Principles of Acquisition Production and Quality Management
MN2303	(0-3)	Seminar for Program Management Students

Quarter 5

MN3172	(4-0)	Public Policy and Budgeting
MN3304	(5-2)	Contract Pricing and Negotiations
OS4602	(2-0)	Test and Evaluation Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4470	(4-0)	Strategic Planning and Policy for the Logistics Manager
MN2303	(0-3)	Seminar for Program Management Students

Quarter 6

MN4145	(4-0)	Policy Analysis
MN4105	(4-0)	Strategic Management
MN4307	(4-0)	Program Management Policy and Control
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN2303	(0-3)	Seminar for Program Management Students

TYPICAL COURSE OF STUDY (International)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
IT1500	(4-0)	Information Program Seminar for International Officers
IT1600	(3-0)	Communication Skills for International Officers
MA2300	(5-0)	Mathematics for Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 2

MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
OS3105	(4-1)	Statistical Analysis for Technical Management
MN2303	(0-3)	Seminar for Program Management Students

Quarter 3

MN3105	(4-0)	Organization and Management
MN3371	(4-0)	Contracts Management and Administration
OS3006	(4-0)	Operations Research for Management
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MN2303	(0-3)	Seminar for Program Management Students

Quarter 4

MN4310	(4-0)	Logistics Engineering
EO4011	(3-1)	Systems Engineering for Acquisition Managers
MN3384	(5-1)	Principles of Acquisition Production and Quality Management
MN3155	(2-0)	Financial Management for Acquisition Managers
MN2303	(0-3)	Seminar for Program Management Students

Quarter 5

OS4602	(2-0)	Test and Evaluation Management
MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software
OS3302	(4-0)	Quality Assurance and Reliability Methods
MN4999	(4-0)	Curriculum Option*
MN2303	(0-3)	Seminar for Program Management Students

Quarter 6

MN4307	(4-0)	Program Management Policy and Control
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4145	(4-0)	Policy Analysis
MN2303	(0-3)	Seminar for Program Management Students

Quarter 7

MN4105	(4-0)	Strategic Management
MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
IS3185	(3-0)	Management of Information Technology
MN2303	(0-3)	Seminar for Program Management Students

*One additional course must be selected from the following curriculum options:

MN4305	Defense Technology Policy
MN4372	Seminar in Acquisition and Contract Management
MN4470	Strategic Planning and Policy for the Logistic Manager
OA4702	Cost Estimation

DEFENSE SYSTEMS ANALYSIS CURRICULUM 817

These programs provide officers with the fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management. The curricula educate students to evaluate others' research and analysis and to develop in them sound management and leadership skills.

These curricula are interdisciplinary programs which integrate mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are determined after consultation with the Academic Associate.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, and DoD employees, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experiences are evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES

The 817 curricula for USCG, USMC and DoD civilians are six-quarter courses of study with entry dates in January and July. If further information is needed, contact the Academic Associates for these curricula or the Curricular Officer.

Curriculum 817
Academic Associate:
USCG and DoD Civilians - Systems Management
USMC - Defense Systems Analysis
James E. Suchan, Associate Professor
Code SM/Sa, Ingersoll Hall, Room 215A
(831) 656-2905, DSN 878-2905
e-mail: jsuchan@nps.navy.mil

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

TYPICAL COURSE OF STUDY (U.S. Coast Guard)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3111	(4-0)	Personnel Management Processes
MN3172	(4-0)	Public Policy and Budgeting
MN4161	(4-0)	Management Control Systems
MN4125	(4-0)	Managing Planned Change in Complex Organizations
IS2010	(1-2)	Introduction to Information Technology

Quarter 4

MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3185	(3-0)	Management of Information Technology
OS3006	(4-0)	Operations Research for Management

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
NW3230	(4-0)	Strategy and Policy

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

TYPICAL COURSE OF STUDY (U.S. Marine Corps)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 3

MN3172	(4-0)	Public Policy and Budgeting
MN3221	(2-1)	Principles of Acquisition and Program Management I
OS3006	(4-0)	Operations Research for Management
IS3185	(3-0)	Management of Information Technology
NW3230	(4-0)	Strategy and Policy

Quarter 4

MN3154	(4-0)	Financial Management in the Armed Forces
MN4145	(4-0)	Policy Analysis
MN3222	(3-2)	Principles of Acquisition and Program Management II
MN4163	(4-0)	Decision, Cost and Policy Analysis

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
OA4702	(4-0)	Cost Estimation

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

TYPICAL COURSE OF STUDY (DoD Civilian Program)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN4999	(4-0)	Curriculum Option*
MN3172	(4-0)	Public Policy and Budgeting
MN4999	(4-0)	Curriculum Option*
OS3006	(4-0)	Operations Research for Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 4

MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3185	(3-0)	Management of Information Technology
MN4999	(4-0)	Curriculum Option*

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

Quarter 6

MN4999	(4-0)	Curriculum Option*
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student must consult with Academic Associate to select additional courses that meet student and sponsor needs.

DEFENSE SYSTEMS MANAGEMENT - INTERNATIONAL
CURRICULUM 818

This program is designed to provide the officers with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management, and to enable the officers to evaluate the written research, study and analysis products of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required to effectively manage.

The curriculum integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are selected by the student by their choice of course options.

International students are free to choose any of the specific management curricula available. Most choose the more general Defense Systems Management International Curriculum. The 818 curriculum allows students to design a program of course work specific to management effectiveness in the host country's military system. The student may elect to specialize in the relevant portion of a functional area such as financial, logistics, human resources and organization, or manpower and personnel analysis. Or, the student may choose to follow a general management program which would include an overall balance of courses from many functional areas.

REQUIREMENT FOR ENTRY

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

International officers start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES

The 818 curriculum for International officers is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 818
Academic Associate:
International Officers - Systems Management
Roger Evered, Professor
Code SM/Ev, Ingersoll Hall, Room 201
(831) 656-2646, DSN 878-2646
e-mail: revered@nps.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY
INTERNATIONAL OFFICERS (818)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
IT1500	(4-0)	Information Program Seminar for International Officers
IT1600	(3-0)	Communication Skills for International Officers

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 3

MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN4999	(4-0)	Curriculum Option*
MN4145	(4-0)	Policy Analysis
IS3185	(3-0)	Management of Information Technology
MN4999	(4-0)	Curriculum Option*

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*
MN4999	(4-0)	Curriculum Option*

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4999	(4-0)	Curriculum Option*

*Student must consult with academic associate to select additional courses that meet student and sponsor needs.

SYSTEMS INVENTORY MANAGEMENT CURRICULUM 819

This curriculum emphasizes the management of Navy owned inventories at all levels. Curriculum 819 students take additional courses in general inventory model development and the specific details of the Navy's inventory models, spanning the three levels of wholesale, intermediate and retail customer support. Officers are responsible for developing procedures for establishing, maintaining and controlling inventories of material, distributing that material to the Navy customer, and developing the budgets for financing these inventories.

The Systems Inventory Management curriculum is interdisciplinary, integrating mathematics, accounting, economics, management theory, operations analysis and the specialty concentration into an understanding of the process by which the defense mission is accomplished.

REQUIREMENTS FOR ENTRY

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

Officers from the Navy's Supply Corps start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

SYSTEMS INVENTORY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Systems Inventory Management Subspecialist with a subspecialty code of 1302P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Inventory Control Methods and Requirements: Fleet and Industrial Support Center
Stock Control: Naval Air Station
Director of Program Support Office, Navy Inventory Control Point, Mechanicsburg, PA
Director of Nuclear Reactor Stock Control Requirements, Ships Parts Control Center, Mechanicsburg, PA
Division Director, Defense Electronic Supply Center, Dayton, OH
Stock Control Requirements Planning, Naval Submarine Support Facility, New London, CN
Director of Logistics Strategic Planning, Bureau of Medicine, Washington D.C.
Director, Supply Systems Design Department, Ships Part Control Center, Mechanicsburg, PA
Chief, Navy Systems Readiness Group, Defense General Supply Center, Richmond, VA

ENTRY DATES

Systems Inventory Management is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 819
Academic Associate:

Donald Eaton, Logistics Chair, (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(831) 656-3616, DSN 878-3616
e-mail: deaton@nps.navy.mil

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

***TYPICAL COURSE OF STUDY**

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
IS2010	(1-2)	Introduction to Information Technology

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
OS3105	(4-1)	Statistical Analysis for Management
MN3172	(4-0)	Public Policy and Budgeting

Quarter 3

IS3185	(3-0)	Management of Information Technology
MN3105	(4-0)	Organization and Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3372	(4-0)	Material Logistics
OS3006	(4-0)	Operations Research for Management

Quarter 4

OA3501	(4-0)	Inventory I
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
MN4312	(4-0)	Simulation Modeling for Managerial Decision Making

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
NW3230	(4-0)	Strategy and Policy
OA4501	(4-0)	Seminar in Supply Systems

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN4105	(4-0)	Strategic Management
MN3154	(4-0)	Financial Management in the Armed Forces
MN3371	(4-0)	Contracts Management and Administration

*If a course is validated, an alternate course may be selected from the following list:

MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN3374	(4-0)	Production Management
MN3375	(4-0)	Materials Handling Systems Design
MN3111	(4-0)	Personnel Management Processes

RESOURCE PLANNING AND MANAGEMENT FOR INTERNATIONAL DEFENSE CURRICULUM 820
The Resource Planning and Management for International Defense Curriculum is an interdisciplinary program designed exclusively for officers and civilian employees in defense agencies of other countries. The program focuses on economic analysis, the management of financial, material, and human resources, domestic and international political institutions, civil-military relations, and the role of international law. The curriculum is made up of a combination of existing courses within the Systems Management and National Security Affairs departments and courses especially designed for this program. In the majority of courses, international students will study and learn with U.S. students from several other management and national security affairs curricula.

REQUIREMENT FOR ENTRY
A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum TOEFL score of 207 (173-207 with supplemental language training) is required for international students.

Officers and civilian employees in defense agencies of allied countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Validation or credit by examination is encouraged.

ENTRY DATES
Resource Planning and Management for International Defense Curriculum 820 is a six-quarter (18 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

Curriculum 820
Academic Associate:
Roger Evered, Professor
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(831) 656-2646, DSN 878-2646
e-mail: revered@nps.navy.mil

DEGREE
Master of Science in International Resource Planning and Management

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
NS3023	(4-0)	Introduction to Comparative Politics
MA2300	(5-0)	Mathematics for Management
IT1500	(4-0)	Information Program Seminar for International Officers
IT1600	(3-0)	Communication Skills for International Officers
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Management Accounting
NS3030	(4-0)	American National Security Policy
MN3140	(4-0)	Microeconomic Theory
IS2010	(1-2)	Introduction to Information Technology
NS2011	(2-0)	Policy Analysis and Research Methods

Quarter 3

MN3333	(4-0)	Managerial Communication Skills in the DoD Management
MN3172	(4-0)	Public Policy and Budgeting
NS3041	(4-0)	Comparative Economic Systems
MN3105	(4-0)	Organization and Management

Quarter 4

IS3185	(3-0)	Management of Information Technology
NS3900	(4-0)	International Law and Organizations
MN4145	(4-0)	Policy Analysis
MN3111	(4-0)	Personnel Management Processes

Quarter 5

NS4080	(2-0)	Research Colloquium
NS3025	(4-0)	Introduction to Civil-Military Relations
MN0810	(0-8)	Thesis Research for Systems Management Students
NS4240	(4-0)	Seminar on Regional Planning Security Problems

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN4999	(4-0)	Curriculum Option
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management

MATERIAL LOGISTICS SUPPORT MANAGEMENT
CURRICULUM 827

The Material Logistics Support Management curriculum emphasizes all of the aspects for providing integrated logistics support of weapons systems. Besides study in mathematics, accounting, economics, behavioral science, management theory and operations analysis, the curriculum delves into production management, inventory management, integrated logistic support, procurement and contract administration, systems acquisition, and project management. Skills resulting from the curriculum will prepare those responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phaseout.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

MATERIAL LOGISTICS SUPPORT MANAGEMENT SUBSPECIALIST

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

Typical Jobs in this Subspecialty:

Aircraft Intermediate Maintenance: Naval Air Stations and Aircraft Carriers
Project Management Staff: Naval Air Systems Command, Washington, DC
Integrated Logistics Support Coordinator for Operational Support: Naval Air Systems Command, Washington, DC
Director of Receiving: Fleet & Industrial Support Centers (FISC)
Director of Storage: FISC & DLA Depots

ENTRY DATES

Material Logistics Support Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 827
Academic Associate:

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e-mail: deaton@nps.navy.mil

DEGREE

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

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
IS2010	(1-2)	Introduction to Information Technology

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3172	(4-0)	Public Policy and Budgeting
OS3101*	(4-1)	Statistical Analysis for Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 3

MN3105	(4-0)	Organization and Management
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN3372	(4-0)	Material Logistics
OS3006	(4-0)	Operations Research for Management
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

Quarter 4

IS3185	(3-0)	Management of Information Technology
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3371	(4-0)	Contracts Management and Administration

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management
MN3374	(4-0)	Production Management
MN4999	(4-0)	Curriculum Option**

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN3154	(4-0)	Financial Management in the Armed Forces
NW3230	(4-0)	Strategy and Policy
MN3370	(0-2)	Seminar on Leadership in Supply Chain Management

*OS3105 may be taken instead of OS3101. This substitution will allow certain curriculum option courses below to be taken from the Operations Research Department. The decision to take OS3105 must be made early in the first quarter.

**One additional course must be selected from the following curriculum options:

MN3111	Personnel Management Processes
MN3373	Domestic Transportation Management
MN3375	Materials Handling Systems Design
MN3377	Inventory Management (required for Supply Corps Officers)
OA3401	Human Factors in Systems Design I
OA3501	Inventory I
OA4302	Reliability and Weapon Systems Effectiveness Measurement
OA4303	Sample Inspection and Quality Assurance
MN4470	Strategic Planning and Policy for Logistics Managers***

**(OA3401, 3501, 4302 and 4303 may only be taken after OS3105 is taken.)
***This course is certified as Defense Acquisition Workforce Improvement Act (DAWIA) Level III for Logistics and is the equivalent of Defense Acquisition University (DAU) course Acquisition Logistic 304.

MASTER OF SCIENCE IN CONTRACT MANAGEMENT (MSCM) CURRICULUM 835

The Master of Science in Contract Management (MSCM) Degree is designed to provide civilians in the Department of Defense (DOD) and other Federal Government agencies an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of acquisition and contracting within complex organizations. The curriculum focuses on problem-solving and decision-making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation and other similar activities. Lecture and laboratory tasks require the application of critical thinking to problem-solving within actual situations. Student input includes civilians from all DOD Services and other Federal agencies. The curriculum is designed to provide civilians with the knowledge, skills and abilities to manage and lead effectively in systems buying offices, field contracting offices, contract administration offices and contracting policy offices.

REQUIREMENTS FOR ENTRY

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20; full certification at Level II or higher in the contracting career field under the provisions of the Defense Acquisition Workforce Improvement Act (DAWIA) (or equivalent certification for non-DOD personnel); and completion of the following two courses: (1) a course in management accounting (similar to NPS course MN2155 Accounting for Management), and (2) a course in management principles (similar to NPS course MN3105 Organization and Management).

TRANSFER CREDIT
NPS will accept up to 12 quarter hours (eight semester hours) of transfer credit for graduate courses taken at an accredited college/university which have been evaluated as satisfying one or more of the graduate courses in the MSCM curriculum.

MASTER OF SCIENCE IN CONTRACT MANAGEMENT (MSCM) PROGRAM
The Curriculum Sponsor is the Director, Acquisition Career Management (DACM) in the Office of the Assistant Secretary of the Navy (Research, Development and Acquisition). The curriculum satisfies the mandatory Defense Acquisition University (DAU) contracting course requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) through Level III.

ENTRY DATES
The Master of Science in Contract Management (MSCM) is a nine-quarter course of study (eight distance learning quarters and one resident quarter) with entry dates in October and April of each year. Navy Department civilians may apply for the MSCM by submitting an application to the DACM via the chain of command for the ASN(RD&A) Scholarship. Applicants from other Services and Federal agencies will use their organization's application process. For further information, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 835
Academic Associate:
David V. Lamm, Associate Professor
Code SM/Lt, Ingersoll Hall, Room 331A
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DEGREE
Requirements for the degree Master of Science in Contract Management (MSCM) are met as a milestone en route to satisfying the Educational Skill Requirements of the program.

TYPICAL COURSE OF STUDY

Quarter 1

MN3001	(4-0)	Economics for Defense Managers

Quarter 2

MN3341	(4-2)	Advanced Contracting Principles

Quarter 3

MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MN3172	(4-0)	Public Policy and Budgeting

Quarter 4

MN3312	(4-1)	Contract Law
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 5

MN3384	(5-1)	Principles of Acquisition Production and Quality Management
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 6

MN3342	(4-1)	Advanced Contract Management
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 7

MN4473	(4-1)	Strategic Acquisition and Contract Management
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 8

MN3155	(2-0)	Financial Management for Acquisition Managers
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 9 **(Eight Week Accelerated Resident Quarter)**

MN4371	(4-0)	Acquisition and Contracting Policy
MN4105	(4-0)	Strategic Management
MN43XX	(2-0)	Curriculum Option (Select one)
MN2302	(0-3)	Seminar for Acquisition and Contracting Students
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Curriculum Options (Select one):

MN4304	(2-0)	Defense Systems Contracting
MN4306	(2-0)	Research & Development Contracting
MN4308	(2-0)	Field Contract Management
MN4309	(2-0)	Facilities Contracting

MASTER OF SCIENCE IN PROGRAM MANAGEMENT
CURRICULUM 836

The Master of Science in Program Management (MSPM) Degree is designed to provide civilians in the Department of Defense (DOD) and other Federal agencies an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of programs/projects within complex organizations. The curriculum focuses on problem-solving and decision-making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation and other similar activities. Lecture and laboratory tasks require the application of critical thinking to problem-solving within actual situations. Student input includes civilians from all DOD Services and other Federal agencies. The curriculum is designed to provide civilians with the knowledge, skills and abilities to manage and lead effectively in the Federal Government acquisition environment.

REQUIREMENTS FOR ENTRY

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20; full certification at Level II or higher in one of the following career fields: program management; acquisition logistics; test & evaluation; systems planning, research, development and engineering; or manufacturing, production, quality assurance under the provisions of the Defense Acquisition Workforce Improvement Act (DAWIA) (or equivalent certification for non-DOD personnel); and completion of the following two courses: (1) a course in statistics (similar to NPS course OS3101 Statistical Analysis for Management), and (2) a course in calculus (similar to NPS course MA2300 Mathematics for Management).

TRANSFER CREDIT

NPS will accept up to 12 quarter hours (eight semester hours) of transfer credit for graduate courses taken at an accredited college/university which have been evaluated as satisfying one or more of the graduate courses in the MSPM curriculum.

MASTER OF SCIENCE IN PROGRAM MANAGEMENT (MSPM) PROGRAM

The Curriculum Sponsor is the Deputy Director, Acquisition Career Management (DDACM) in the Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology). The curriculum satisfies the mandatory Defense Acquisition University (DAU) program management and acquisition logistics course requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) through Level III. (For those who have not already obtained certification in the Test & Evaluation; Systems Engineering; and Manufacturing/Production, Quality Assurance career fields, this program achieves Level II in these career fields, as well as satisfying Intermediate Software Acquisition Management (SAM 201)).

ENTRY DATES

The Master of Science in Program Management (MSPM) is a nine-quarter course of study (eight distance learning quarters and one resident quarter) with entry dates in October and April of each year. For further information, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 836
Academic Associate:
David V. Lamm, Associate Professor
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e-mail: dlamm@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Program Management (MSPM) are met as a milestone en route to satisfying the Educational Skill Requirements of the program.

TYPICAL COURSE OF STUDY

Quarter 1

MN3001	(4-0)	Economics for Defense Managers

Quarter 2

MN3172	(4-0)	Public Policy and Budgeting
MN3302	(2-0)	Advanced Program Management

Quarter 3

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

Quarter 4

OS4602	(2-0)	Test and Evaluation Management
OS3302	(4-0)	Quality Assurance and Reliability

Quarter 5

EO4011	(3-2)	Systems Engineering for Acquisition Managers
MN4474	(2-0)	Organizational Analysis
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 6

MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 7

MN3384	(5-1)	Principles of Acquisition Production & Quality Management
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 8

MN4470	(4-0)	Strategic Planning & Policy for the Logistics Manager
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

Quarter 9 (Resident/Accelerated)

MN4307	(4-0)	Program Management Policy and Control
MN4105	(4-0)	Strategic Management
MN3155	(2-0)	Financial Management for Acquisition Managers
MN2303	(0-3)	Seminar for Program Management Students
MN0811	(0-4)	Thesis Research for Non-resident Systems Management Students

FINANCIAL MANAGEMENT CURRICULUM 837

The objective of the Financial Management Curriculum is to prepare officers for business and financial positions within the Navy. Financial Managers assist the Navy's decision-making processes at all levels by providing accurate, timely and relevant information. They are concerned with the optimal allocation of human, physical and financial resources to achieve the Navy's goals and objectives while assuring efficient and effective expenditure of public funds.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting, internal control, auditing, management planning and control systems, quantitative techniques used in planning and control, and the Planning Program and Budgeting System used within the Department of Defense.

Graduates of the Financial Management Curriculum will be prepared for assignment to positions in budgeting, accounting, business and financial management, and internal control and auditing.

REQUIREMENTS FOR ENTRY

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

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

FINANCIAL MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Financial Management Subspecialist, subspecialty code XX31P. The Curriculum Sponsor is N-82, Fiscal Management Division.

Typical Jobs in this Subspecialty:

Comptroller: Naval Air Stations
Budgeting: Commander, Naval Medical Command, Washington, DC
Accounting: Commander, Naval Medical Command, Washington, DC
Budget Officer: Commander, Naval Air Forces Atlantic, Norfolk, VA

Comptroller: Naval Supply Depots/Naval Supply Centers
Fiscal Officer: Naval Supply Depots/Naval Supply Centers
Public Works Officer: Weapons Stations, CONUS
Cost Analysis: Office of Secretary of the Navy, Washington, DC
Special Assistants: Program, Planning Office (NAVY), Fiscal Management Division (N-82)

ENTRY DATES
Financial Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 837
Academic Associate:
Douglas Moses, Associate Professor
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e-mail: dmoses@nps.navy.mil

DEGREE
Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 3

MN4161	(4-0)	Management Control Systems
MN3172	(4-0)	Public Policy and Budgeting
MN4162	(4-0)	Cost Management
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN3154	(4-0)	Financial Management in the Armed Forces
MN4163	(4-0)	Decision, Cost and Policy Analysis
MN4151	(2-0)	Internal Control and Auditing
IS3185	(3-0)	Management of Information Technology
MN4153	(2-0)	Seminar in Financial Management

Quarter 5

MN0810	(0-8)	Thesis Research for Systems Management Students
MN3331	(5-1)	Principles of Systems Acquisition and Program Management
MN4XXX	(4-0)	Curriculum Option*
NW3230	(4-0)	Strategy and Policy

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
MN4XXX	(4-0)	Curriculum Option*

*The student will select two courses from the following curriculum options:

MN4122	Planning and Control: Measurement and Evaluation
MN4152	Corporate Financial Management
MN4159	Financial Reporting and Analysis
MN4302	Defense Resource Policy and Management
MN4305	Defense Technology Policy
OA4702	Cost Estimation

MANPOWER SYSTEMS ANALYSIS
CURRICULUM 847

Officers enrolled in the Manpower Systems Analysis (MSA) curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill the leadership roles in military manpower personnel and training management. The XX33P subspecialists are responsible for developing and analyzing policies to ensure that the Navy and DoD are recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MSA is an analytical curriculum intended to develop skills necessary to perform and evaluate manpower analyses. As such, the curriculum emphasizes mathematical, statistical and other quantitative methods. Successful completion of the curriculum yields an officer skilled in conducting manpower personnel and training policy analysis.

The areas covered in the MSA curriculum include an understanding of manpower, personnel, and training policy development, compensation systems, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix, enlistment and reenlistment incentives, training effectiveness measures and hardware/manpower trade-offs. Students gain familiarity with current models and methods of manpower analysis as well as military manpower organizations and issues.

REQUIREMENTS FOR ENTRY

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

Prospective students electing MSA as a curriculum must be adequately prepared by their undergraduate course work and comfortably oriented to a quantitatively rigorous graduate curriculum.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Validation by examination is encouraged.

MANPOWER SYSTEMS ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Manpower Systems Analysis Subspecialist, subspecialty code XX33P. The Curriculum Sponsor is N12, Assistant Chief of Naval Personnel for Personnel Policy and Career Progression.

Typical Jobs in this Subspecialty:

Enlisted Plans Branch, ACNP for Military Personnel Policy and Career Progression (N13)
Joint Manpower Management Branch, JCS (J-1) Manpower Resources Branch, Director Total Force Programming/ Manpower (N12)
Manpower and Training Analyst, DCNO (Resources, Warfare Requirements and Assessment (N801D)
Manpower Plans, CINCPACFLT/CINCLANTFLT (N1)
Analysis, Naval Manpower Analysis Center (NAVMAC)
Director, Personnel Plans and Policy, BUMED
Personnel and Manpower Management, Naval Medical Center, San Diego, CA

ENTRY DATES

Manpower Systems Analysis is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 847
Academic Associate:
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e-mail: gwthomas@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY FOR U.S. NAVAL OFFICERS

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN2111	(0-2)	Seminar in Manpower, Personnel and Training Issues I
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment

Quarter 2

MN2112	(0-2)	Seminar in Manpower, Personnel and Training Issues II
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3101	(4-1)	Statistical Analysis for Management
MN3105	(4-0)	Organization and Management
IS2010	(1-2)	Introduction to Information Technology

Quarter 3

MN3760	(4-0)	Manpower Economics
MN3902	(2-0)	MPT Computer Skills Enhancement
MN4110	(4-0)	Multivariate Manpower Data Analysis I
IS3185	(3-0)	Management of Information Technology
MN3172	(4-0)	Public Policy and Budgeting

Quarter 4

MN3111	(4-0)	Personnel Management Processes
MN4111	(4-2)	Multivariate Manpower Data Analysis II
OS3006	(4-0)	Operations Research for Management
MNXXXX	(4-0)	Manpower Elective*

Quarter 5

MN4115	(4-0)	Training Foundations and Management
MN4761	(4-0)	Applied Manpower Analysis
MN4106	(4-0)	Manpower/Personnel Policy Analysis
OS4701	(4-0)	Manpower and Personnel Models

Quarter 6

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4118	(3-2)	Modeling Decision Support in Manpower Systems Analysis
MN4119	(4-0)	Manpower Requirements Determination

Quarter 7

MN0810	(0-8)	Thesis Research for Systems Management Students
MN0810	(0-8)	Thesis Research for Systems Management Students
MN4105	(4-0)	Strategic Management
NW3230	(4-0)	Strategy and Policy

*Requires approval of Academic Associate.

LEADERSHIP EDUCATION AND DEVELOPMENT CURRICULUM 856

The Leadership Education and Development (LEAD) curriculum prepares officers to develop leadership in others through knowledge of managing organizations, diagnosing individual and group performance, understanding learning processes, motivating subordinates, providing feedback, and serving as positive role models. The curriculum was designed in response to a need for graduate education for Company Officers at the United States Naval Academy (USNA). The coursework provides knowledge and skills that officers will use as Company Officers and in other leadership roles as they become more senior in the military.

The LEAD curriculum is taught at USNA by Naval Postgraduate School faculty in one- to two-week modularized courses over a one-year period. Courses include topics related to ethics, leadership, DoD policy and resource analysis, quantitative analysis, educational theory, and organizational behavior.

REQUIREMENTS FOR ENTRY

Prospective students must have a baccalaureate degree earned with above-average academic performance and an APC of 365.

LEADERSHIP EDUCATION AND DEVELOPMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer for subspecialty code 4500P. The Primary Curriculum Sponsor is the United States Naval Academy.

Typical Jobs in this Subspecialty:

Currently this program qualifies the graduate to serve as a Company Officer at USNA. Eventually, other jobs could include billets at ROTC units, in recruit training and school houses, and other locations where officers develop leadership in junior members of military organizations.

ENTRY DATES
The Leadership Education and Development program is a one-year course of study with entry in June. If further information is needed, contact the Academic Associate for this curriculum.

Curriculum 856
Academic Associate:
Alice Crawford, Senior Lecturer
Code SM/Cr, Ingersoll Hall, Room 341
(831) 656-2481, DSN 878-2481
e-mail: acrawford@nps.navy.mil

DEGREE
Requirements for the degree Master of Science in Leadership and Human Resource Development are met as a result of satisfying the Educational Skill Requirements of the program.

TYPICAL COURSE OF STUDY

MN3101	(2-0)	Models of Leadership in Complex Organizations
MN3109	(3-0)	Ethics and Moral Development
MN3129	(2-0)	Organizational Design
MN3160	(3-0)	Methods of Inquiry
MN3162	(3-0)	Tools of Inquiry
MN4143	(2-0)	Defense Manpower and Personnel Analysis
MN0163	(0-1)	Thesis Writing Workshop
MN3170	(4-0)	DoD Policy and Resource Analysis
MN4113	(2-0)	Military Sociology and Psychology: Leadership Dimensions
MN3102	(2-0)	Military Leadership
MN4120	(3-0)	Managing Diversity
MN3135	(3-0)	Educational Theory
MN3137	(1-0)	Instructional Design
MN4124	(3-0)	Defense Management of Change
MN4129	(2-0)	Performance Assessment
MN3103	(2-0)	Group Dynamics/Team Building
MN3106	(1-0)	Conflict Management
MN3112	(3-0)	Counseling
MN3138	(2-0)	Adult Development
MN3104	(1-0)	Motivation and Empowerment
MN4101	(2-0)	Leadership in the Military Culture
MN4104	(3-0)	Strategic Management Issues in Military Organizations
IS3181	(3-0)	Integrating and Leveraging Information Technologies
MN4080	(2-0)	Research Colloquium
MN0810	(0-8)	Thesis
MN3333	(4-0)	Managerial Communication Skills in the DoD Environment

SHORE INSTALLATION MANAGEMENT
CURRICULUM 877
This curriculum is an interdisciplinary program which integrates accounting and financial management, economics, organization and management, quantitative methods, and a subspecialty concentration into an understanding of the process by which the shore installation management mission is accomplished. The program is designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management sciences, 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, a QPR of 2.20, and completion of at least two semesters of pre-calculus courses with B or better average are required for admission.

Officers from the U.S. Navy, other U.S. Services, and DoD employees, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experiences are evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

SHORE INSTALLATION MANAGEMENT SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Shore Installation Subspecialist, subspecialty code XX34P. The Curriculum Sponsor is Deputy Chief of Staff Logistics.

Typical Jobs in this Subspecialty:
Operations Officer
Supply Officer
Public Works Officer
CO and XO of Shore Installations
Staff Officer at Regional or Shore Installation Management Headquarters

ENTRY DATES
Shore Installation Management is a six-quarter course of study with a single entry date in January. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 877
Academic Associate:
Donald Eaton, (RADM Ret)
Code SM/Et, Ingersoll Hall, Room 241
(831) 656-3616, DSN 878-3616
e-mail: deaton@nps.navy.mil

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

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN3001	(4-0)	Economics for Defense Managers
MN3105	(4-0)	Organization and Management
MA2300	(5-0)	Mathematics for Management
MN0123	(0-2)	Computer Skills Development
IS2010	(1-2)	Introduction to Information Technology

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3172	(4-0)	Public Policy and Budgeting
OS3101	(4-1)	Statistical Analysis for Management
MN3402	(0-2)	Seminar in Base Installation Management I

Quarter 3

MN3333	(4-0)	Managerial Communication Skills in the DoD Environment
MN3403	(0-2)	Seminar in Base Installation Management II
MN3471	(4-0)	Installation Management in the Armed Forces
MN4161	(4-0)	Management Control Systems
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN4472	(4-0)	Base Installation Issues
MN3154	(4-0)	Financial Management in the Armed Forces
MN3371	(4-0)	Contracts Management and Administration
MN4145	(4-0)	Policy Analysis

Quarter 5

MN0810	(0-8)	Thesis Research
MN4333	(2-1)	Media Relations and Inter-organizational Communications
MN4125	(4-0)	Managing Planned Change in Complex Organizations
IS3185	(3-0)	Management of Information Technology

Quarter 6

MN0810	(0-8)	Thesis Research
MN0810	(0-8)	Thesis Research
NW3230	(4-0)	Strategy and Policy
MN4103	(4-0)	Installation Strategic Management

EDUCATIONAL SKILL REQUIREMENTS
MATERIAL MOVEMENT
CURRICULUM (813)
Subspecialty Code 1304P

1. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art-quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.

2. **MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.

3. **CONTRACT AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD process for contracting of material and services. The graduate will also have an understanding of the processes to be followed for a major weapon system's procurement and its support.

4. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning for transportation services.

5. **TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, type of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.

6. **TRANSPORTATION RESOURCE MANAGEMENT:** The graduate will have the ability to manage transportation resources to move material from the Navy and DoD supply depots to the fleet customers.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority
Commander, Naval Supply Systems Command
February 1998

EDUCATIONAL SKILL REQUIREMENTS
TRANSPORTATION MANAGEMENT
CURRICULUM (814)
Subspecialty Code XX35P

1. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.

2. **MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.

3. **MANAGEMENT OF PERSONNEL:** The graduate will have the ability to apply current innovations in personnel management to the management of civilian and military personnel involved in DoD transportation activities.

4. **CONTRACTS AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD processes for contracting for transportation and other services. An in-depth knowledge of the DoD project management processes will allow the graduate to participate in MSC/NAVSEA projects for procurement of new MSC ships.

5. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning for transportation services.

6. **TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, types of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.

7. **TRANSPORTATION SYSTEM DESIGN TO SUPPORT STRATEGIC SEALIFT AND MOBILIZATION:** The graduate will have a detailed understanding of the plans and processes of the Navy and DoD for providing support of strategic sealift and mobilization. The graduate will be able to determine, obtain, and schedule the transportation and materials handling resources to support strategic sealift operations and to move material to the operating fleet and troop units in the event of a mobilization.

8. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

9. **ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority
Commander, Military Sealift Command
May 1998

EDUCATIONAL SKILL REQUIREMENTS
ACQUISITION & CONTRACT MANAGEMENT
CURRICULUM (815)
Subspecialty Code 1306P

1. **MANAGEMENT FUNDAMENTALS:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.

2. **ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision-making.

3. **ACQUISITION AND CONTRACTING PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the Federal Government including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement (DFARS); the unique legal principles applied in Government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to Defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision-making occurs.

4. **ACQUISITION AND CONTRACTING POLICY:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the federal and military contracting offices, the Boards of Contract Appeals, and the court system.

5. **CONTRACTING PROCESS:** The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and small purchase contracting methodologies; a comprehensive knowledge of all contract types and their application in defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.

6. **BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business philosophy, concepts, practices and methodologies of the defense/commercial industrial base and the ability to apply these to the federal government acquisition environment.

7. **FEDERAL AND DEFENSE BUDGETING:** The graduate will have an ability to apply economic and accounting principles, including monetary and fiscal theories, to defense acquisition and contracting issues.

8. **PROGRAM MANAGEMENT:** The graduate will have an understanding of the basic principles and fundamentals of Program Management, with particular emphasis on the Procuring Contractor Officer's and Administrative Contracting Officer's roles and relationships with the Program Manager.

9. **ACQUISITION WORKFORCE:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at levels I, II, and III.

10. **ETHICS AND STANDARDS OF CONDUCT:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.

11. JOINT AND MARITIME STRATEGY: American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

12. ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Deputy Assistant Secretary of the Navy (RD&A),
Acquisition and Business Management (ABM)
December 1997

EDUCATIONAL SKILL REQUIREMENTS
SYSTEMS ACQUISITION MANAGEMENT
CURRICULUM (816)

1. **MANAGEMENT FUNDAMENTALS:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.

2. **ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision-making.

3. **PROGRAM MANAGEMENT PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of program management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using cost, schedule and performance parameters over the entire life cycle of a project.

4. **PROGRAM MANAGEMENT POLICIES:** The graduate will have an ability to formulate and execute defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the Executive, Legislative and Judicial branches of the government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

5. **SYSTEMS ACQUISITION PROCESS:** The graduate will understand the theory of and have an ability to manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

6. **CONTRACT MANAGEMENT:** The graduate will understand the role of the contracting process within the acquisition environment including financial, legal, statutory, technical and managerial constraints in the process.

7. **BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.

8. **GOVERNMENT AND INDUSTRY BUDGETING AND FINANCIAL MANAGEMENT:** The graduate will have an understanding of and an ability to apply the principles of Government and private organizational financing including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and defense financial management and budgeting processes to include the Government Planning, Programming and Budgeting System (PPBS).

9. **ACQUISITION WORKFORCE:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory Program Management courses required by the Defense Acquisition University (DAU) at levels I, II, and III.

10. **ETHICS AND STANDARDS OF CONDUCT:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. JOINT AND MARITIME STRATEGY: American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

12. ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Deputy Director, Acquisition Career Management,
Assistant Secretary of the Army (Acquisition, Logistics and Technology)
April 1998

EDUCATIONAL SKILL REQUIREMENTS
SYSTEMS INVENTORY MANAGEMENT
CURRICULUM (819)
Subspecialty Code 1302P

1. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as participant in the long range strategic planning efforts of the Navy and DoD.

2. **MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations. These are essential for the officer graduate to be an effective leader in any of the agencies of the Navy and DoD.

3. **INTEGRATED LOGISTICS SUPPORT MANAGEMENT:** The graduate will have a detailed understanding of the processes associated with designing an integrated support system for a new weapon system. The graduate will also have detailed knowledge about the DoD processes for contracting for and acquiring a new weapon system which has adequate integrated support.

4. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial and management practices of DoD, will be able to conduct cost/ benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.

5. **INVENTORY MANAGEMENT:** The graduate will have an in-depth understanding of inventory management theory and application within DoN and DoD. As a consequence, the graduate will be able to make decisions on the validity of new models and management procedures being proposed for use by the Joint Logistics Support Center, Navy and Defense Logistics Agency Inventory Control Points, Fleet and Industrial Supply Centers, and Fleet and Shore based customers.

6. **MATERIALS AND PHYSICAL DISTRIBUTION MANAGEMENT:** The graduate will be able to apply the techniques of material management and physical distribution management in designing and operating of fleet and troop support systems both during peacetime and during rapidly developing wartime contingencies. This will include acquiring material and transportation assets to insure that cost-effective and efficient.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Commander, Naval Supply Systems Command
February 1998

EDUCATIONAL SKILL REQUIREMENTS
MATERIAL LOGISTICS SUPPORT MANAGEMENT
CURRICULUM (827)
Subspecialty Code XX32P

1. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.

2. **MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.

3. **INTEGRATED LOGISTICS SUPPORT MANAGEMENT:** The graduate will have a detailed understanding of the processes associated with designing an integrated logistics support system for a new weapon system. The graduate will also have detailed knowledge about the DoD processes for contracting for and acquiring a new weapon system. The graduate will be able to serve as an assistant program manager for logistics (APML) for a major weapon system.

4. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.

5. **PRODUCTION/OPERATIONS MANAGEMENT:** The graduate will be able to apply the techniques of production/operations management at Naval Aviation Intermediate Activities and Depots, Navy Fleet Industrial and Support Activities, and other DoD maintenance and maintenance support activities.

6. **MATERIALS AND PHYSICAL DISTRIBUTION MANAGEMENT:** The graduate will be able to apply the techniques of material management and physical distribution management in designing and operating of fleet and troop support systems for both peacetime and rapidly developing wartime contingencies. This will include acquiring material and transportation assets to insure that the distribution of material is both cost-effective and efficient.

7. **JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.

8. **ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Commander, Naval Air Systems Command
(NAVAIR Code Air-00)
May 1998

EDUCATIONAL SKILL REQUIREMENTS
CONTRACT MANAGEMENT
CURRICULUM (835)

1. **ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management theory and techniques to problems in both the public and private sectors. This includes policy formulation and execution, strategic planning, resource allocation, Federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated approaches. The graduate will have the ability to apply state-of-the-art management concepts and practices to problem solving and decision-making responsibilities as middle and senior managers.

2. **ACQUISITION AND CONTRACTING PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the Federal Government including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the Defense FAR Supplement (DFARS); the unique legal principles applied in Government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to Defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision-making occurs.

3. **CONTRACTING PROCESS:** The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and small purchase contracting methodologies; a comprehensive knowledge of all contract types and their application in Defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.

4. **ACQUISITION AND CONTRACTING POLICY:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the Government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the Federal and military contracting offices, the Boards of Contract Appeals, and the court system.

5. **BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business philosophy, concepts, practices and methodologies of the commercial industrial base (both domestic and global) and the ability to apply these to the Federal Government acquisition environment.

6. **DEFENSE FINANCIAL MANAGEMENT AND BUDGETING:** The graduate will have an ability to apply sound financial management theories, principles and practices to defense acquisition and contracting issues, including fiscal and monetary policy.

7. **PRODUCTION AND QUALITY MANAGEMENT:** The graduate will have an understanding of the basic principles and fundamentals of Production and Quality Management, with particular emphasis on the Procuring Contracting Officer's and Administrative Contracting Officer's roles and relationships with industry and the Government Program Manager.

8. **ANALYSIS AND APPLICATION:** The graduate will demonstrate an ability to apply acquisition, contracting and management principles in dealing with the significant issues encountered in managing the contracting process in one of the following areas: (1) major weapon systems acquisition, (2) research and development, (3) field procurement, and (4) facilities contracting.

9. **ETHICS AND STANDARDS OF CONDUCT:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.

10. ACQUISITION WORKFORCE: The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at Level III.

11. ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Director, Acquisition Career Management (ASN (RD&A))
January 1998

EDUCATIONAL SKILL REQUIREMENTS
PROGRAM MANAGEMENT
CURRICULUM (836)

1. **ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management theory and techniques to defense problems. This includes policy formulation and execution, strategic planning, Defense resource allocation, Federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated approaches. The graduate will have the ability to apply state-of-the-art management concepts and practices to problem solving and decision-making responsibilities as middle and senior managers.

2. **PROGRAM MANAGEMENT PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of Program Management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using cost, schedule and performance parameters over the entire life cycle of a project.

3. **SYSTEMS ACQUISITION PROCESS:** The graduate will understand the theory of and have an ability manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

4. **PROGRAM MANAGEMENT POLICIES:** The graduate will have an ability to formulate and execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various Federal agencies of the Executive, Legislative and Judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), Congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

5. **CONTRACT MANAGEMENT:** The graduate will understand the role of the contracting process within the acquisition environment including financial, legal, statutory, technical and managerial constraints in the process.

6. **BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.

7. **GOVERNMENT AND INDUSTRY BUDGETING AND FINANCIAL MANAGEMENT:** The graduate will have an understanding of and an ability to apply the principles of Government and private organizational financing including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and Defense financial management and budgeting processes to include the Government Planning, Programming and Budgeting System (PPBS).

8. **ACQUISITION WORKFORCE:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory Program Management courses required by the Defense Acquisition University (DAU) at Levels I, II, and III.

9. **ETHICS AND STANDARDS OF CONDUCT:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.

10. **ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

Deputy Director, Acquisition Career Management (ASA (ALT))
August 1998

EDUCATIONAL SKILL REQUIREMENTS
FINANCIAL MANAGEMENT
CURRICULUM (837)
Subspecialty Code XX31P

1. **MANAGEMENT FUNDAMENTALS:** The graduate will have the ability to apply quantitative, accounting, economics, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practices, embracing leadership, communication, organization design, staffing, quality, and planning within large private and public sector organizations, as well as military subunits and activities.

2. **FEDERAL AND DEFENSE BUDGETING:** The graduate will understand the roles of the executive and legislative branches in setting federal fiscal policy, allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, and Budgeting System with emphasis on budget formulation and execution.

3. **FUNDS MANAGEMENT:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and nonappropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Financial Accounting Systems and the Federal Accounting Standards Advisory Board are relevant.

4. **INTERNAL CONTROL AND AUDITING:** In accordance with the auditing standards of the U.S. General Accounting Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to apply audit procedures and techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.

5. **ACQUISITION MANAGEMENT:** The graduate will understand the purpose and concepts of the Defense systems acquisition process and the application of project management methods within this process.

6. **ECONOMY, EFFICIENCY, AND EFFECTIVENESS:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, and application of relevant Defense instructions.

7. **COST MANAGEMENT AND ANALYSIS:** The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standard for major suppliers of goods and services to the federal government.

8. **STRATEGIC PLANNING AND CONTROL:** The graduate will have knowledge of strategic planning and management control concepts for setting goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. The graduate will be able to assess existing management systems and determine appropriate policies, procedures, organization structure, and information systems to ensure optimal use of available human, physical, and financial resources to satisfy the mission.

9. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

10. INNOVATION AND CREATIVITY: The graduate will demonstrate initiative and creativity in performing independent research. This includes specifying research questions, formulating a research program, performing the research, and presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to the financial management curriculum.

Curriculum Sponsor and ESR Approval Authority
Director, Budgets and Reports (N-82)
March 1998

EDUCATIONAL SKILL REQUIREMENTS
MANPOWER SYSTEMS ANALYSIS
CURRICULUM (847)
Subspecialty Code XX33P

1. **MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have the ability to apply contemporary management principles, organizational theory, and social science methodology to the development, implementation, and management of effective MPT polices and programs throughout DoN/DoD. The graduate will have the ability to use and understand computer systems in problem solving and will have a basic understanding of management information systems.

2. **MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will be able to apply mathematical, statistical, accounting, economic and other quantitative techniques and concepts to day-to-day military management issues. The graduate will also be able to use these techniques and concepts as a participant in the long range strategic planning efforts of the Navy and DoD.

3. **ADVANCED QUANTITATIVE ANALYSIS:** The graduate will have the ability to apply a wide range of advanced economics, statistical, and mathematical techniques and concepts to manpower and personnel polices and issues. These include complex econometric techniques in the quantitative analysis of large-scale DoN/DoD manpower and personnel databases and Markov models in the analysis of force structure and manpower planning, forecasting and flow models.

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

5. **AUTOMATED DATA ANALYSIS:** The graduate will possess the skills in data manipulation, statistics, and exploratory data analysis to be able to formulate and execute analyses of a wide variety of manpower, personnel and training issues. The graduate will have proficiency in computing with mainframe and microcomputer systems to interactively apply a variety of methods to large-scale DoN and DoD databases.

6. **MANPOWER SYSTEMS ANALYSIS - FUNDAMENTAL CONCEPTS:** The graduate will have an understanding of the fundamental concepts and basic functional areas of manpower, personnel and training (MPT) within DoN/DoD including topics such as:

   MANPOWER: Requirements determination; billet authorizations; billet costs; end strength planning; and total force planning and programming.

   PERSONNEL: Recruiting; accession plans and policies; officer and enlisted community management; attrition; retention; compensation; and readiness.

   TRAINING: Applications of theories of learning; instructional technologies; the systems approach to training; evaluation of training effectiveness and cost; and the relationship between training and fleet readiness.

7. **MANPOWER SYSTEMS ANALYSIS - POLICY ANALYSIS:** The graduate will have the ability to analyze critically the strengths and weaknesses of proposed MPT polices and to suggest alternatives that recognize the potential impact on DoN/DoD program planning, resources and objectives.

8. **JOINT MILITARY STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning, and current issues in the defense organization.

9. EVALUATION, INNOVATION AND CREATIVITY: The graduate will demonstrate individual initiative and creativity in the application of the skills and knowledge gained from the Manpower Systems Analysis program. The graduate will select a manpower, personnel, or training policy or management issue of importance to DoN/DoD, develop a plan to investigate the issue, analyze all of its aspects, suggest a solution as appropriate, and report the significant findings and recommendations in writing by means of a thesis.

Curriculum Sponsor and ESR Approval Authority

Assistant Chief of Naval Personnel for Military Personnel Policy and Career Progression (N12)
December 1996

EDUCATIONAL SKILL REQUIREMENTS
LEADERSHIP EDUCATION AND DEVELOPMENT
CURRICULUM (856)
Subspecialty Code 4500P

1. **MANAGEMENT FUNDAMENTALS - LEADERSHIP, MANAGEMENT, AND ORGANIZATION:** Officers will have the ability to apply basic management and leadership practices to organizational operations.

   Officers will understand the fundamental principles of leadership and management in military organizations. They will be able to implement appropriate structures for organizations and jobs; they will understand state-of-the-art information technologies and planning and budgeting tools; they will become skilled in spoken and written communications; and they will understand the higher-level leadership skills and the systems perspective of organizations in which day-to-day organizational operations and strategy formulation occur.

2. **EVALUATING AND IMPROVING GROUP PERFORMANCE:** Officers will become skilled at analyzing and improving group morale, cohesion, and performance.

   Graduates of the program will have the ability to analyze and improve group effectiveness through leadership practices that also develop the leadership abilities of subordinates. This ability will be based on knowledge of managing people from diverse backgrounds, teambuilding, conflict management, group dynamics and management of change. Officers will be exposed to varied approaches for building strong shared values within the military.

3. **MOTIVATING SUBORDINATES:** Officers will effectively motivate subordinates to achieve high standards in all military endeavors.

   Program graduates will have the ability to motivate subordinates in order to provide focus and encouragement as they face the rigorous requirements and goals of the military. This ability requires an understanding of how effective leaders use goal setting, equitable discipline, reward systems, analysis of individual needs, empowerment, coaching, and high expectations to achieve peak performance from individuals.

4. **EVALUATING AND IMPROVING INDIVIDUAL PERFORMANCE:** Officers will become skilled in analyzing and improving the performance of individuals.

   The officers will have the ability to evaluate the performance of subordinates and provide appropriate feedback and counseling. This includes activities that range from formal performance appraisal to informal assessment on an ongoing basis. These skills require knowledge of basic performance measurement and giving feedback, as well as knowledge of how to deal with performance outside of the norms that may lead to violations of military rules and regulations.

5. **BEING A ROLE MODEL FOR SUBORDINATES:** Officers will model and otherwise communicate the information about the military that subordinates will need to know to successfully transition to Naval and Marine Corps Leaders.

   Officers will utilize the operational experience they bring to the job, in addition to a broader base of knowledge created through the program, to visibly embody the high standards and values of Naval and Marine Corps officers. The Officer will communicate knowledge of the military culture, current policy and operations, and future plans for the Navy and joint operations in the Department of Defense. These abilities are based on a knowledge of the military in a democratic society, managing organizational cultures, DoD policy, and the behaviors of good role models and mentors.

6. **MANAGING EDUCATIONAL PROCESSES:** Officers will have a foundation of knowledge about educational processes that will enable them to effectively teach and develop their subordinates.

   The program graduate will have the ability to formulate and answer research questions about educational experiences within the Navy and Marine Corps. Through the thesis process, the officer will explore important issues while concurrently broadening his/her knowledge of training and education in the military.

Curriculum Sponsor and ESR Approval Authority
United States Naval Academy
August 1997

EDUCATIONAL SKILL REQUIREMENTS
SHORE INSTALLATION MANAGEMENT
CURRICULUM (877)
Subspecialty Code XX34P

1. **MANAGEMENT FUNDAMENTALS:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.

2. **MANAGEMENT AND ORGANIZATION FUNDAMENTALS:** The graduate will have the ability to apply contemporary management principles and organization theory to the management of military organizations. Graduates will gain knowledge and skills embracing policy formulation and execution, communication, organizational design, staffing, directing, planning and controlling of military organizations.

3. **BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of business and operating philosophies, concepts, and practices and methodologies with regard to operating quality, cost effective base-related services. The graduate will have a knowledge of the fundamentals of marketing goods and services and will understand the relevant importance of fiduciary responsibility, efficiency and efficacy in profit, non-profit, and governmental organizations.

4. **BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of financial management practices of DoD. This includes understanding the management of appropriated, non-appropriated, and revolving funds at base level, the ability to analyze financial reports and make recommendations regarding the reallocation or reprogramming of funds. The graduate will also have knowledge of significant directives and instruction dealing with make/buy decisions and budgetary planning related to installation management, such as: Office of Management and Budget Circular No. A-76, Performance of Commercial Activities (outsourcing).

5. **MANAGEMENT OF PERSONNEL:** The graduate will have the ability to apply current innovations in personnel management to the management of civilian and military personnel and possess understanding of the models and concepts of the employment, management, and retention of human resources and of collective bargaining and its impact on a military installation.

6. **LEGAL AND CONTRACTS ADMINISTRATION:** The graduate must have an understanding of legal services management and the limits to which those services can be provided such as: executing the Uniform Code of Military Justice, executing environmental law, claims processing, government litigation and mutual jurisdictional and support agreements with local authorities. The graduate will also understand the contracting process to include financial, legal, statutory, technical and managerial constraints.

7. **INFRASTRUCTURE MANAGEMENT:** The graduate will understand the complexities associated with installation infrastructure to include the relationships between facilities management, material management, urban planning, infrastructure services such as morale, welfare and recreation, public works to include water, sanitation, streets and facilities maintenance, public safety and planning for future installation infrastructure needs.

8. **MEDIA AND COMMUNITY RELATIONS:** The graduate will become familiar with techniques on communicating with media, base personnel and local and state agencies to include influencing the media, internal/external communications, dealing with the public at large, preparing and giving speeches, and political testimony. The graduate will also have an understanding of non-profit organizations, the role of non-profit boards, public interest items, interacting with local agencies, political interaction at the local level and joint agreements between local governments and military installations for services such as public safety and health care.

9. INFORMATION RESOURCE MANAGEMENT: The graduate will be able to formulate and integrate an information technology strategy that reflects and supports the command strategy and vision. Graduates will understand how successful information technologies (people, money, time, processes and technologies) are organized in an effective way. They will understand appropriate business analysis measurements (ROI, ROA, business cases, cost/benefit, etc.) and how they support or justify information resource management investments. Graduates will understand how appropriate Life Cycle Management, IT Budget, and IT Inventory processes are used. They will be able to oversee the building and maintaining of a strong enterprise-wide information infrastructure, how data is accessed and shared, and how polices and controls are established to insure accuracy, timeliness and completeness. The graduate will be capable of developing policies and procedures that enhance integration of multiple systems, will understand how technological decisions result in societal, organizational, and personal consequences and will be prepared to address surprise results of system implementations.

10. JOINT AND MARITIME STRATEGIC PLANNING: The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating US policy, the roles of military forces, joint planning, and current issues in the defense organization.

11. ANALYSIS, PROBLEM SOLVING AND CRITICAL THINKING: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and by means of a thesis appropriate for this curriculum.

Curriculum Sponsor and ESR Approval Authority
Deputy Chief of Naval Operations for Logistics
December 1997

UNDERSEA WARFARE PROGRAMS

Curricular Officer:
Jim Hill
CDR, USN
Code 35, Spanagel Hall, Room 302
(831) 656-2044
DSN 878-2044
e-mail: jahill@monterey.nps.navy.mi

UNDERSEA WARFARE
CURRICULUM 525
The Undersea Warfare Curriculum educates officers in the engineering fundamentals, physical principles and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. This interdisciplinary program divides naturally into four major academic areas, allowing the student to specialize in the area of choice and to complete a Master of Science in Engineering Acoustics (with emphasis on underwater acoustics and weapons effects), Physical Oceanography (with emphasis on environmental factors affecting acoustic surveillance), Electrical Engineering (with emphasis on signal processing), Operations Research (with emphasis on tactical applications and decision analysis), or in other disciplines depending on the student's academic background.

UNDERSEA WARFARE (INTERNATIONAL)
CURRICULUM 526
A course of study modeled after curriculum 525 is available for international students. Further information is available from the Curricular Officer or Academic Associate.

REQUIREMENTS FOR ENTRY
A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of Engineering Science (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

UNDERSEA WARFARE SUBSPECIALTY
Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of XX44P. The curriculum sponsors are N87 (Submarine Warfare) and N85 (Expeditionary Warfare).

Typical Jobs in this Subspecialty:

Naval Undersea Warfare Center	COMINEWARCOM
Naval Air Warfare Center	Submarine Development Squadron Twelve
Program Executive Offices	Patrol Wing Staffs
Carrier Group Staffs	Naval Air Systems Command
Naval Surface Warfare Development Group	OPNAV
	Destroyer Squadron Staffs
Fleet Mine Warfare Training Center	Operational Test and Evaluation Force

ENTRY DATES
The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 525 & 526
Academic Associate:
James V. Sanders, Assoc. Professor
Code 33A, Spanagel Hall, Room 200B
(831) 656-3884, DSN 878-3884
e-mail: jsanders@nps.navy.mil

DEGREE
Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for Master of Science in Engineering Acoustics, Physical Oceanography, Electrical Engineering, Operations Research, or other disciplines, depending upon academic qualifications, the specialization sequence selected, and the thesis.

TYPICAL COURSE OF STUDY - FALL ENTRY

Quarter 1

MA2138	(5-0)	Multi variable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations
NW3230	(4-0)	Strategy and Policy
EC2400	(3-1)	Discrete Systems
UW0001	(0-1)	Seminar

Quarter 2

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OS2103	(4-1)	Applied Probability for Systems Technology
UW0001	(0-1)	Seminar
OC3230	(3-1)	Descriptive Physical Oceanography
EC2410	(3-1)	Analysis of Signals and Systems

Quarter 3

UW3303	(4-1)	Modeling and Simulation for Undersea Warfare
OS3604	(4-0)	Decision and Data Analysis
UW3301	(4-0)	Undersea Warfare in the 20th Century
UW0001	(0-1)	Seminar
EC3400	(3-1)	Digital Signal Processing

Quarter 4

OA3602	(4-0)	Search Theory and Detection
OC3240	(4-2)	Ocean Dynamics I
PH3479	(4-0)	Physics of Underwater Weapons
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 5

OA4607	(4-0)	Tactical Decision Aids
OC3260	(4-0)	Sound in the Ocean
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 6

OC3266	(3-2)	Operational Acoustic Forecasting
OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
UW0810	(0-8)	Thesis Research Group/Project
EC4450	(4-1)	Sonar Systems Engineering
UW0001	(0-1)	Seminar

Quarter 7

PH3002	(4-0)	Non-Acoustic Sensor Systems
UW0810	(0-8)	Thesis Research Group/Project
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

Quarter 8

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project
UW0810	(0-8)	Thesis Research Group/Project
UW9999	(4-0)	Specialization Elective
UW0001	(0-1)	Seminar

EDUCATIONAL SKILL REQUIREMENTS
UNDERSEA WARFARE
CURRICULUM (525)
Subspecialty Code XX44P

1. PHYSICS
The officer will understand physical principles applicable to acoustic, non-acoustic USW systems and underwater weapons systems.

2. ACOUSTICS
The officer will understand acoustical phenomena affecting the design, performance, and operation of acoustic USW systems.

3. OCEANOGRAPHY AND METEOROLOGY
The officer will understand atmospheric and oceanographic processes influencing the performance and tactical use of USW systems.

4. SIGNAL PROCESSING
The officer will understand principles of signal processing as they apply to USW systems.

5. OPERATIONS RESEARCH AND SYSTEMS TECHNOLOGY
The officer will understand computer simulation; search, detection, and localization; and USW modeling.

The officer will understand principles of data analysis in the evaluation of USW systems.

The officer will understand tactical decision aids for USW systems.

6. JOINT AND MARITIME STRATEGIC PLANNING
The officer will have a knowledge of American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

7. PROBLEM SOLVING AND PRACTICAL APPLICABILITY
The graduate will demonstrate the ability to conduct independent analysis in undersea warfare and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority
Director, Submarine Warfare Division (N-87)

ACADEMIC DEPARTMENTS, GROUPS, COMMITTEE AND COURSES

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Chairman:
Gerald H. Lindsey
Professor
Code AA/Li, Halligan Hall
Room 139
(831) 656-2311
DSN 878-2311

Associate Chairs:
Brij N. Agrawal
Professor
Code AA/Ag, Halligan Hall
Room 277
(831) 656-3338
DSN 878-3338

Oscar Biblarz
Professor
Code AA/Bi, Halligan Hall
Room 234
(831) 656-3096
DSN 878-3096

Max F. Platzer
Distinguished Professor
Code AA/Pl, Halligan Hall
Room 205A
(831) 656-2058
DSN 878-2058

Brij N. Agrawal, Professor of Aeronautics and Astronautics (1989)*; PhD, Syracuse University, 1970.

Oscar Biblarz, Professor of Aeronautics and Astronautics (1968); PhD, Stanford University, 1968.

M.S. Chandrasekhara, Research Professor and Associate Director, Navy-NASA Joint Institute of Aeronautics (1987); PhD, University of Iowa, 1983.

Russell W. Duren, Associate Professor of Aeronautics and Astronautics (1996), PhD, Southern Methodist University, 1991.

Garth Hobson, Associate Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Richard M. Howard, Associate Professor of Aeronautics and Astronautics (1987); PhD, Texas A & M University, 1987.

Kevin D. Jones, Research Assistant Professor (1997); PhD, University of Colorado, 1993.

Isaac I. Kaminer, Associate Professor of Aeronautics and Astronautics (1992); PhD, University of Michigan, 1992.

Gerald H. Lindsey, Chairman and Professor of Aeronautics and Astronautics (1965); PhD, California Institute of Technology, 1966.

David W. Netzer, Distinguished Professor of Aeronautics and Astronautics and Dean of Research (1968); PhD, Purdue University, 1968.

Conrad F. Newberry, Professor of Aeronautics and Astronautics (1990); D.Env., University of California at Los Angeles, 1985.

Max F. Platzer, Distinguished Professor of Aeronautics and Astronautics, Associate Chair for Instruction and Director, Navy-NASA Joint Institute of Aeronautics (1970); Dr. Tech. Science, Technical University of Vienna, Austria, 1964.

I. Michael Ross, Associate Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Raymond P. Shreeve, Professor of Aeronautics and Astronautics (1971); PhD, University of Washington, 1970.

E. Roberts Wood, Professor of Aeronautics and Astronautics (1988); D. Eng, Yale University, 1967.

Edward Ming-Chi Wu, Professor of Aeronautics and Astronautics (1984); PhD, University of Illinois, 1965.

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

The Department of Aeronautics and Astronautics provides advanced education in Aeronautical and Astronautical Engineering to develop technical subspecialists in the field. Upper division undergraduate and graduate courses are offered in aerodynamics, structures, guidance and control, flight mechanics, propulsion and design, with applications to rotary wing and fixed wing aircraft, missiles and spacecraft.

Students specializing in either Aeronautical Engineering (Curriculum 610) or Aeronautical Engineering/Avionics (Curriculum 611) receive the degree Master of Science in Aeronautical Engineering, as well as select students in Combat Systems Sciences and Technology (Curriculum 533). Students in the 533 curriculum may also get a Master of Science degree in Engineering Science with an option in Aeronautics. A Master of Science degree in Astronautical Engineering is offered to students in Space Systems Engineering (Curriculum 591). Selected students may be eligible to pursue the degree Aeronautical and Astronautical Engineer, Doctor of Philosophy or Doctor of Engineering.

The Department of Aeronautics and Astronautics and the degree Master of Science in Aeronautical Engineering have been accredited by the Accreditation Board for Engineering and Technology since 1949. The degree Master of Science in Astronautical Engineering has been accredited by the Accreditation Board for Engineering and Technology since 1995.

ENTRANCE REQUIREMENTS TO STUDY AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The entrance requirement for graduate study in the Department of Aeronautics and Astronautics is a baccalaureate in the field, earned with above-average academic performance. For those without this preparation, this requirement can be met by taking the equivalent of an undergraduate major in aeronautical engineering at NPS before embarking upon graduate study. This may require up to 2 1/2 years total to obtain the Master's degree, depending upon background. Students who have not majored in aeronautics, or who have experienced a significant lapse in continuity with previous academic work, will initially take preparatory courses in aeronautical engineering and mathematics at the undergraduate upper division level, which may extend through as much as the first three academic quarters. Final approval of programs leading to degrees in aeronautical engineering must be obtained from the Chairman, Department of Aeronautics and Astronautics.

Subject coverage specifically to be approved includes mathematics and basic science, engineering science, including adequate laboratory and computer experience, and engineering design, including at least one capstone graduate level design course.

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

The Master of Science degree requires a minimum of 36-credit hours of graduate courses in aeronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in aeronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

In very exceptional circumstances, the thesis requirement may be waived by the Department Chairman, in which case 10 hours of 4000 level courses, normally in Aeronautical Engineering, will be required in addition to those specified above, increasing the total requirement to 46 quarter hours of graduate-level credits.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students may elect Aeronautics or Astronautics as a specialization option and receive the degree Master of Science in Engineering Science. The program must include at least 36 credit hours of graduate work in engineering, science and mathematics, at least 12 of which must be at the 4000 level. Of these 36 hours at least 20, including work at the 4000 level, must be in the Department of Aeronautics and Astronautics. Cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Aeronautics and Astronautics.

The program must contain at least 12 hours at the graduate level in courses other than those presented in the Department of Aeronautics and Astronautics.

The candidate must present an acceptable thesis on a topic which is given prior approval by the Department of Aeronautics and Astronautics. Final approval of the program leading to the Master of Science in Engineering Science with specialization in Aeronautics or Astronautics shall be obtained from the Chairman of the Department of Aeronautics and Astronautics.

MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING

The Master of Science degree in Astronautical Engineering requires a minimum of 36 credit hours of graduate courses in astronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics and Astronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in astronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

In very exceptional circumstances, the thesis requirement may be waived by the Department Chairman, in which case 10 hours of 4000 level courses, normally in Astronautical Engineering, will be required in addition to those specified above, increasing the total requirement to 46 quarter hours of graduate-level credits.

AERONAUTICAL AND ASTRONAUTICAL ENGINEER

The degree Aeronautical and Astronautical Engineer is offered in the department of Aeronautics and Astronautics and requires a minimum of 72 hours of graduate course credit. The degree also requires a graduate QPR of 3.5, with hours distributed as follows: at least 36 credit hours must be at the 4000 level, of which at least three must be in mathematics; not less than 64 graduate credit hours shall be in the disciplines of engineering, physical science or mathematics; a minimum of 36 hours must be in the Department of Aeronautics and Astronautics and at least 12 hours must be in other departments. An acceptable thesis is required for the degree, and six course equivalents, spread over four quarters, will be allowed in the program for it.

Formal application to work toward the degree must be made by memorandum to the Department of Aeronautics and Astronautics prior to commencement of thesis research, and it is required that the applicant document a graduate QPR of 3.5, an approved program of study, which contains no overloads during the quarters of thesis research, a thesis advisor and an approved Engineer's Thesis research project.

Students admitted to work for the degree Aeronautical and Astronautical Engineer may satisfy requirements for the Master of Science in Aeronautical Engineering or the Master of Science in Astronautical Engineering degree concurrently. The respective master's degrees may be conferred at the time of completion of the requirements for that degree.

An appropriate allowance will be made for work performed while earning the master's degree at another institution, not to exceed the maximum waivers in required graduate level courses specified in Section 5.3 of the Academic Council Policy Manual. Final approval of the program leading to the degree Aeronautical and Astronautical Engineer shall be obtained for each student from the Chairman, Department of Aeronautics and Astronautics.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING IN AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautics and Astronautics offers programs leading to the doctorate in the fields of gas dynamics, flight structures, flight dynamics, propulsion, aerospace physics and aerospace vehicle design.

Entrance into the doctoral program may be requested by officers currently enrolled in the Aeronautical and Astronautical Engineers Degree Program who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The Department of Aeronautics and Astronautics also accepts officer students selected in the Navy-wide Doctoral Study Program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Aeronautics and Astronautics shall submit current GRE results, transcripts of their previous academic and professional records to the Director of Admissions Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100. Upon receipt, the application shall be reviewed by the Aeronautics and Astronautics Committee for Advanced Studies. Following a successful review, the candidate is admitted to work toward the Aeronautical and Astronautical Engineer's Degree as an interim step before being formally admitted to study for the doctorate. As soon as feasible, the student shall take a screening examination, which if successfully completed, will admit him or her to study for the doctorate. A doctoral committee will then be appointed to oversee the student's study and research program.

A distinctive feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are outlined in general school requirements for the doctor's degree.

In the event that a student is unable to finally satisfy the above requirements for the doctorate, but has in the course of his or her doctoral studies actually completed all of the requirements for the degree of Aeronautical and Astronautical Engineer, he or she shall be awarded the latter degree.

AERONAUTICAL ENGINEERING LABORATORIES

Eight major laboratory divisions support instructional and research programs in subsonic aerodynamics, gas dynamics, rocket and ramjet propulsion, turbomachinery, computer-aided engineering, flight mechanics, structures, composite materials and space systems.

The Subsonic Aerodynamics Laboratory consists of two low-speed wind tunnels, a large continuous-flow visualization tunnel and a 15x20 inch water tunnel. Standard wind tunnel techniques are used in the 32x45 inch and 42x60 inch tunnels and laser sheet visualization is used in the 5x5x12 foot test section of the three-dimensional flow visualization tunnel.

The Gas Dynamics Laboratory includes a 4x4 inch blowdown supersonic wind tunnel, a cold driven, three-inch double-diaphragm shock tube, a 2x2x18 foot open-circuit oscillating flow tunnel and a vertically mounted, supersonic free jet. Laser interferometers, schlieren systems, hot wire anemometry and laser-doppler anemometers are used. Ruby, He-Ne, Argon and CO lasers are available. Extensive use is made of laser holography. An electro-hydrodynamic research facility permits studies of electric power generation, turbulence and fuel sprays into gas turbine combustors.

The Combustion Laboratory consists of an instrumented control room, a propellant evaluation laboratory, a high-pressure air facility and three test cells equipped with diagnostic apparatus and motor hardware for investigating solid, liquid, gaseous and hybrid rocket, solid fuel ramjet and gas turbine combustion. Vitiated air heaters are used to generate temperatures to 1300ºF. Several CW and one pulsed laser with holocamera, high-speed motion picture cameras, light scattering and transmission measurement systems, schlieren systems, sampling probes and a dark room equipped for holographic reconstruction and data retrieval are utilized.

The Turbo-Propulsion Laboratory (TPL) houses a unique collection of experimental facilities for research and development related to compressors, turbines and advanced air-breathing propulsion engine concepts. In a complex of specially designed concrete structures, one building, powered by a 750 HP compressor, contains 10x60 inch rectilinear and 4 to 8 foot diameter radial cascade wind tunnels and a large 3-stage axial research compressor for low speed studies. A two-component, automated traverse, LDV system is available for CFD code verification experiments. A second building, powered by a 1250 HP compressed air plant, contains fully instrumented transonic

turbine and compressor rigs in explosion proof test cells. A spin-pit for structural testing of rotors to 50,000 RPM and 1800°F is provided. Model experiments and equipment for instrumentation development are located in a separate laboratory. Data acquisition from 400 channels of steady state and 16 channels of non-steady state measurements at up to 200kHz is controlled by the laboratory's Pentium workstations.

The Computational Instruction Laboratory consists of 17 SGI workstations and a 8 cluster pentium parallel computing system.

The Flight Mechanics Laboratory consists of a general-aviation flight simulator and the Unmanned Air Vehicle Flight Research Laboratory (UAV FRL). The simulator is used for teaching flight test engineering. The UAV FRL conducts flight research with scaled radio-controlled aircraft to study problems identified with current fleet UAVs and to test new concepts for manned and unmanned aircraft application. Research vehicles include fixed-wing, VTOL and rotary wing aircraft. The department's wind tunnels are also used for aircraft performance, stability and control measurements.

The Structural Test Laboratory contains testing machines for static and dynamic tests of materials and structures and a MTS electrohydraulic closed-loop machine for fatigue testing. Aircraft components as large as an actual aircraft wing are accommodated on a special loading floor where static and vibration tests are conducted. An adjacent strain gage facility provides support to test programs and instruction in structural testing techniques.

The Mechanics of Materials for Composites Laboratory is equipped with fabrication and testing facilities for characterizing the mechanical behavior of fiber-reinforced composites. The fabrication facilities include an oven and press with provisions for computer control of temperature and pressure profile for fabrication of laminates and strands. The testing facilities include five mechanically driven universal testing machines for general testing and for life testing. These testing facilities are supported by a wide array of modern data acquisition instruments including computer-controlled data loggers, digital voltmeters, acoustic emission analyzer and laser diffraction instruments. Personal computers and a VAX-725 provide ample capacity for analytical interpretation of data and for model formulation.

The Dynamics and Nondestructive Evaluation Laboratory is equipped for research on vibration of structures, particularly lightweight components for space structures made from composite materials like graphite/epoxy. It contains shaker tables, a four channel FFT analyzer, microcomputers with model analysis software and associated accelerometer instrumentation. For the study of wave propagation in these structures, the laboratory has high-speed transient recorders, narrow and wideband transducers, pulse generators and an arbitrary waveform generator. Static and fatigue loading of samples can be carried out on the 100 kip servo hydraulic MTS machine. The detection of flaw growth during a test can be accomplished using the acoustic emission analyzer. A 2x4 foot ultrasonic C-scan tank can be used for post-test imaging of internal damage. Phase locked loop and quadrature phase detector circuitry allow precise spatial location of flaws. This instrumentation can also be used for very accurate wavespeed measurements.

The Controls Laboratory presently consists of five experimental apparatuses with associated computers and graphic interfaces. Each experiment is a physical device which possesses, for example, input limitations, hysteresis effects and dead-space, among other effects. A computer interface and software program permits the design of a wide range of controllers for the experiments. The purpose of the laboratory is to improve understanding of control theory by design of controllers for physical devices.

The Avionics Lab is used in the design, analysis and integration of the avionics systems for unmanned air vehicles. The Lab's five workstations and three PC's are equipped with the hardware and software necessary for the development of navigation, guidance and control algorithms, as well as the complete process of testing these algorithms; first on the nonlinear simulation, then on the hardware in-the-loop simulation, and finally the flight test. The Avionics Lab is also getting involved in the design and real-time, 3D testing of cockpit display concepts.

SPACECRAFT LABORATORIES

There are four spacecraft laboratories within the department, viz., the FLTSATCOM laboratory, the Spacecraft Test Laboratory, the Spacecraft Attitude Dynamics and Control Laboratory and the Spacecraft Design Laboratory. The FLTSATCOM laboratory houses a qualification model of the Navy's communication satellite (which provides global UHF coverage) along with the associated hardware and software used to test the satellite's subsystems. The test laboratory contains a vibration shaker system and a thermal vacuum chamber system. The former is used for testing typical vibration loads on a spacecraft, and is capable of simulating both low frequency (swept sinusoidal) and random vibrations. The latter is used to test the operation of spacecraft materials/subsystems under the combined conditions of space vacuum (below 10-5 torr) and thermal environment. The third laboratory contains a scaled model of a generic flexible spacecraft and simulates the pitch motion. It is used to study the interaction between the attitude control and the dynamics of flexible spacecraft, where the flexibility may be due to structures and/or liquid propellants. It also has experiments on vibration isolation and antenna shape control using smart structures. The fourth laboratory contains computer-aided spacecraft design tools and a spacecraft design library.

NAVY-NASA JOINT INSTITUTE OF AERONAUTICS

Through a Memorandum of Understanding with the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA), a Joint Institute of Aeronautics was established in July 1986. The purpose of the Institute is to provide NPS students with opportunities to perform their thesis research in an ARC Laboratory, to involve NPS faculty and students in NASA scientific and engineering projects, to develop special courses and seminars for NPS and ARC scientists and engineers to refresh and strengthen professional knowledge at NPS and ARC, and to encourage the enrollment of federal employees for graduate study at NPS with the possibility of performing the thesis research at ARC. Information about research opportunities and admission procedures can be obtained from the Institute Director, Dr. M.F. Platzer, or the Associate Director, Dr. M.S. Chandrasekhara.

AERONAUTICAL AND ASTRONAUTICAL COURSE DESCRIPTIONS

AAR242 THERMODYNAMICS/FLUID MECHANICS REFRESHER (NO CREDIT) (Meets last six weeks of quarter.) (5 - 0).
This course is intended for students returning to school after a prolonged absence and will be taught as refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered include the first and second laws of thermodynamics, entropy, perfect gas laws, conservation of mass/momentum/energy from a control-volume point of view with constant density, and external viscous flow including both laminar and turbulent flows.

AAR261 SOLID MECHANICS REFRESHER (NO CREDIT) (Meets last six weeks of quarter.) (5 - 0).
This course is intended for the student returning to school after a prolonged absence and will be taken as a refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered include centroids, moments of inertia, equilibrium and free-body diagrams, bending and torsion, shear and moment distributions, stress and strain.

AA0020 AERONAUTICAL ENGINEERING PROGRAM PLANNING (NO CREDIT) (0 - 1).
Oral presentations to prospective thesis students by the department faculty, covering thesis research opportunities in specialty areas of Aeronautical Engineering.

AA0810 THESIS RESEARCH (0 - 8).
Represents an equivalent of one four hour course spent in thesis research. Every student working on a thesis will enroll in this course, and more than one call may be made for the course in any given quarter.

AA2021 INTRODUCTION TO FLIGHT STRUCTURES (4 - 1).
Engineering analytical stress analysis methods for wing and fuselage structures, beginning with the field equations for solid bodies and specializing to calculations of multiaxial bending and shear stresses of composite structures, with temperature loading, in open and multicelled closed sections. PREREQUISITE: ME2601.

AA2035 BASIC AERODYNAMICS (3 - 2).
Conservation equation for inviscid incompressible flow; dimensional analysis; fundamentals of potential flow theory; source flow, doublet flow, vortex flow; Kutta-Joukowski theorem; airfoil theory; finite wing theory; panel and vortex lattice method; slender body theory.

AA2036 PERFORMANCE AND STATIC STABILITY (3 - 2).
Concepts of aircraft thrust, power, range, endurance and energy management are developed with application to propeller-driven and jet-powered aircraft. Longitudinal and lateral-directional static stability and flight control principles are derived, with relevant issues such as canards and longitudinal instability considered. Applications of Navy aircraft (P-3, A-6, A-7, E-2C, F-14, F-16 and F/A-18) and needs for future military aircraft are treated. PREREQUISITE: AA2035.

AA2042 FUNDAMENTALS OF THERMO & FLUID DYNAMICS (3 - 2).
Review of zero, first and second laws of thermodynamics; entropy and irreversibilities. Equations of state for gases. Control volume formulations to determine properties of fluids. Principles of continuity, momentum and energy applied to incompressible fluids. Carnot and Brayton power cycles. Viscous flow in ducts; boundary layer concepts; flow separation and drag. PREREQUISITE: MA1118.

AA2043 FUNDAMENTALS OF GAS DYNAMICS (3 - 2).
Concepts of compressible flows, adiabatic/isentropic flow; normal shocks, moving and oblique shocks, Prandtl-Meyer flow; Fanno and Rayleigh flow; introduction to reaction propulsion systems. Design problems include a supersonic intake and engine design point selection. PREREQUISITE: AA2042.

AA2339 AEROSPACE SYSTEM DYNAMICS (3 - 2).
A general class of frequency-domain-based and state space control theories for aircraft and missile guidance and control are covered. Various feedback stabilization schemes are investigated with practical application to flight control system design. Examples of using classical control techniques to design a typical autopilot are given.

AA2440 INTRODUCTION TO DIGITAL COMPUTATION (3 - 2).
Introduction to system operations and program development on the department UNIX work stations and the NPS computer facilities. High-level programming languages, including C, MATLAB, and FORTRAN. Development of computer programs, subroutine organization, input and output. Applications of programming techniques to the solution of selected problems in engineering. PREREQUISITE: MA1118.

AA2502 DYNAMICS (3 - 2).
Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear and space curvilinear motion. Newton's laws, work and energy, impulse and momentum, and impact. Plane motion of rigid bodies and introduction to gyroscopic motion. PREREQUISITE: ME2501.

AA2801 AERO-LABORATORIES (3 - 2).
An introduction to modern experimental techniques and instrumentation. Lectures and demonstrations in the use of sensing devices and data acquisition systems, data reduction and analysis, and report writing. Selected experiments from all aeronautical disciplines. PREREQUISITES OR CONCURRENTLY: AA2021, AA2035, AA2043.

AA2820 INTRODUCTION TO SPACECRAFT STRUCTURES (3 - 2).
Review of statics and strength of materials. Beam theory: axial, bending, shear and torsional loading, stress analysis and deflection of beams. Design of spacecraft structures for launch loads and a survey of typical launch vehicles. Beam buckling and vibration, critical buckling loads, natural frequencies, and mode shapes. Truss structures and introduction to the finite element method.

AA3101 FLIGHT VEHICLE STRUCTURAL ANALYSIS (3 - 2).
Energy methods of analytical structural analysis applied to aircraft structures, buckling of stiffeners and longerons in the elastic and plastic range, column buckling theory applied to stiffened and unstiffened wing skins; introduction to finite element theory through the truss, beam and constant strain triangle element. PREREQUISITE: AA2021.

AA3202 AIRCRAFT STRUCTURAL FAILURE, FRACTURE AND FATIGUE (3 - 2).
Theories of yield and fracture for aircraft design limit loads and ultimate loads; stress-life and strain-life fatigue theories of crack initiation in aircraft structures subjected to realistic flight load spectra, using Neuber's approximation and incorporating the Miner concept of cumulative damage. Fatigue crack propagation concepts and Navy methods of fleet aircraft fatigue tracking and monitoring. PREREQUISITE: AA2021.

AA3251 AIRCRAFT COMBAT SURVIVABILITY (4 - 1).
This course brings together all of the essential ingredients in a study of the survivability of fixed wing aircraft, rotary wing aircraft, and cruise missiles in a hostile (non nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of survival in a AAA/SAM environment are presented in some detail. Topics covered include: current and future threat descriptions; the mission/threat analysis; combat analysis of SEA and Desert Storm losses; vulnerability reduction technology for the major aircraft systems; susceptibility reduction concepts, including stealth; vulnerability, susceptibility, and survivability assessment; and trade-off methodology. In-depth studies of the survivability of several fixed wing and rotary wing aircraft will be presented. (May be taken for 3 credits through self study as AA3250). PREREQUISITE: U.S. Citizenship and SECRET clearance.

AA3260 INTRODUCTION TO AVIONICS SOFTWARE ENGINEERING (3 - 2).
This course will introduce students to the concepts of software engineering with particular emphasis on avionics applications. Software development, management and process improvement as described in DoD-STD-2176A, MIL-STD-498, and the SEI Capability Maturity Model will be presented. The design of real-time embedded avionic systems will be discussed with particular attention to mission-critical and safety-critical software. Avionics architectures and interfaces will be examined. Languages and automated tools used for software engineering on avionics projects will be reviewed. Program examples will be presented in ADA, C++ and MIL-STD-1750 assembly language. PREREQUISITE: AA2440.

AA3272 INTRODUCTION TO SYSTEMS ENGINEERING (3 - 2).
This course uses system engineering as a design methodology throughout the formal system acquisition life-cycle process: mission need, concept exploration & definition, demonstration & validation, engineering & manufacturing development, production, deployment and operations support. It includes quality function deployment (QFD), Taguchi methods, review processes, test & evaluation, survivability, modeling, simulation, and cost functions associated with the development of all airborne systems. Attention is given to requirement analysis, functional analysis/allocation and synthesis. Students become familiar with design software in their emphasis area (aircraft, missiles, engine or helicopter) of choice. Students form an Integrated Process and Product Development (IPPD) Team for the purpose of initiating a response to a given Request-for-Proposal (RFP) associated with a major aeronautical system. Application of systems engineering concepts to an airborne system/subsystem RFP. PREREQUISITES: AA3101, AA3341, AA3451 and AA3501 or their equivalents.

AA3276 INTRODUCTION TO AVIONICS (3 - 2).
This course will introduce the students to the general functional and system architecture of a typical avionics system. It will then proceed to discuss in greater detail the tools necessary to better understand such systems. In particular the course will cover topics related to commonly used coordinate systems and transformations for modern aircraft guidance and navigation. We will discuss the inertial measurement sensors and how they can be used to compute the aircraft's inertial position. The errors associated with this approach will be analyzed. The course will then cover the external navigation aids such as LORAN, TACAN, DME/VOR and GPS. The lab demonstrating the GPS receiver will be included. Next, the students will be introduced to Kalman filtering as a way to integrate onboard inertial measurement sensors with external navigation aids. PREREQUISITES: AA2339 or equivalent, AA4641 concurrently or permission of the instructor.

AA3340 DYNAMIC STABILITY OF AEROSPACE VEHICLES (3 - 2).
Eigenvalue-problem solutions for undamped and damped systems with free and forced responses are developed. Aircraft dynamic equations of motion are derived to analyze longitudinal and lateral-directional flight modes using state-space methods. Military aircraft problems considered include inertial cross-coupling, limit-cycle wing rock, and yaw damper feedback. A short introduction to spacecraft dynamics is also included. PREREQUISITES: AA2036 and AA2339.

AA3341 CONTROL OF AEROSPACE VEHICLES (3 - 2).
This course will introduce students to basic concepts of linear systems such as controllability, observability, detectability and stabilizability. The course will then present the fundamentals of realization theory and will go on to discuss internal and input/output stability of linear systems. The course will also investigate the effect of white noise excitation on aerospace vehicles through covariance analysis based on Lyapunow equation. The course will then proceed to introduce the Linear Quadratic Regulator and Kalman Filtering Theory. All the concepts in the course will be done for both continuous and discrete-time systems. Relevant military examples will be presented at each step of the material development. PREREQUISITES: AA2339, AA3340.

AA3402 HELICOPTER AEROMECHANICS (3 - 2).
This course introduces the student to the fundamentals of helicopter aeromechanics which includes: (1) aerodynamics; (2) dynamics; (3) vibrations; (4) aeroelasticity; and (5) controls. Aerodynamics of the helicopter. Hover and vertical flight. Actuator disk, momentum theory, blade element theory, tip loss, rotor flow states, autorotation, hover and forward flight analysis, rotor trim, and performance analysis. Helicopter dynamics, rotor blade motion and control, rotor-as-a-filter, blade dynamic response, coupled blade-fuselage response, ground and air resonance, vibration control devices, and higher harmonic control. PREREQUISITE: AA2035.

AA3451 AIRCRAFT AND MISSILE PROPULSION (3 - 2).
Overview of engine types. Introduction to rocket propulsion and performance prediction. Solid propellant selection, combustion and nozzle flow analyses for Sidewinder-type missiles. Ideal theory, design point selection and off-design performance of turbo-jet, ramjet, turbo- fan, turbo-prop and turbo-shaft engines. Application to multi-purpose fighter aircraft, ocean-surveillance aircraft and helicopter propulsion. Use of design and off-design computer codes. Basic analysis of engine components, including inlets, compressors and fans, combustors, turbines, after-burners and nozzles. PREREQUISITE: AA2043.

AA3501 AERODYNAMIC ANALYSIS (3 - 2).
Conservation equations for viscous compressible flow; incompressible boundary layer theory for steady airfoil flows; laminar boundary layer solutions, Blasius and Falkner-Skan; transitional and turbulent boundary layers; turbulence modeling; Cebeci-Smith model; finite-difference boundary layer code; compressible subsonic airfoil theory; Prandtl-Glauert rule; sweep effect; transonic flow effects; area rule; supercritical airfoils; linearized supersonic airfoil theory; supersonic wing theory; fundamentals of hypersonic flow theory. PREREQUISITES: AA2035, AA2043.

AA3701 MISSILE AERODYNAMICS (4 - 1).
Potential flow, thin-airfoil and finite wing theories. Linearized equations, Ackeret theory, Prandtl-Glauert transformations for subsonic and supersonic wings. Planform effects. Flow about slender bodies of revolution, viscous crossflow theory. PREREQUISITE: AA2043.

AA3705 AIR DEFENSE LETHALITY (4 - 1).
This course examines the design and effectiveness of anti-aircraft guns and missiles, both surface based and airborne. The techniques and procedures for target detection, target tracking, and propagator flyout (both guided and ballistic) are presented and quantified. Target signatures for radar, IR, and visually directed systems are examined. The types of warheads and fuzes on small arms, anti-aircraft artillery, and guided missiles are presented. Vulnerability of the target to the damage mechanisms is examined, and the procedures for assessing the measures of target vulnerability are described. Total system lethality is evaluated by determining the probability of target kill given a single shot and given an encounter. Countermeasures used by the target for reducing air defense lethality are also described.

AA3802 AERONAUTICAL MEASUREMENT TECHNIQUES (3 - 2).
Hands-on exposure to modern laboratories including measuring and evaluation techniques. Introduction to test facilities at NASA and aerospace industry relevant to research, development and testing phases (RDT&E) of military hardware. Topics vary somewhat from offering to offering but cover significant current laboratory work within aerospace disciplines. PREREQUISITE: AA2801.

AA3804 THERMAL CONTROL OF SPACECRAFT (3 - 0).
Conduction, radiation, thermal analysis, isothermal space radiator, lumped parameter analytical model, spacecraft passive and active thermal control, heat pipes, and louvers.

AA3811 SPACE SYSTEMS LABORATORY (1 - 2).
Principles of spacecraft test programs; component, subsystem, and system level tests; military standard test requirements for space vehicles, laboratory experiments in Fltsatcom Laboratory on satellite performance, in Spacecraft Test Laboratory for vibration, modal and thermal tests; and in Spacecraft Attitude Control Laboratory for spacecraft control performance. Graded Pass/Fail. PREREQUISITE: Consent of Instructor.

AA3815 INTRODUCTION TO SPACECRAFT DYNAMICS (3 - 2).
Coordinate system transformations (GCI, LVLH, etc.), time differentiation operator, velocity and acceleration in 3D-frames of reference, Poisson's equations, spacecraft application examples (strapdown INS, etc.), angular momentum, inertia tensor transformations, Newton-Euler equations of motion, spin stability, single-spin spacecraft, nutation and precession, energy-sink analysis, passive nutation control, dynamics and stability of dual spin spacecraft, gravity-gradient stabilization. PREREQUISITES: PH1121, PH2511, MA2121.

AA3818 SPACECRAFT ATTITUDE, DYNAMICS AND CONTROL (3 - 2).
Stability of dual-spin stabilized spacecraft, active nutation control, disturbance torques: solar, magnetic, gravity gradient, and aerodynamic, attitude sensors, antenna beam pointing accuracy, three-axis-stabilized spacecraft, fixed momentum wheel with thrusters, three reaction wheel system, attitude control pointing requirements for military spacecraft. PREREQUISITES: EC2300, AA3815.

AA3820 DYNAMICS OF SPACE SYSTEMS (3 - 2).
This course is an intermediate level analysis of the dynamics of space systems, including: ascent and descent of rockets, tethers, yo-yo despin, spinning hubs with flexible appendages, single stage to orbit, and various problems in spacecraft attitude dynamics such as nutation dampers. The analysis will include developing the equation of motion, equilibrium and stability analysis, solutions of nonlinear systems using perturbation methods and numerical techniques. Computational and symbolic manipulator packages will be used extensively. PREREQUISITE: MA2121.

AA3851 SPACECRAFT PROPULSION (3 - 2).
Introduces concepts and devices in spacecraft propulsion. It reviews fundamental fluid mechanics, electricity and magnetism, and thermodynamics with molecular structure. Conventional chemical means such as H2/O2 and monopropellants are discussed. Electric propulsion schemes (resistojets, arc-jets, ion, magneto-plasma-dynamic, etc.) are introduced and their performances contrasted with chemical schemes. Characteristics of more advanced concepts (laser, solar, nuclear, etc.) are also considered. PREREQUISITE: Graduate standing in science or engineering.

AA3852 PROPULSION FOR LAUNCH VEHICLES (4 - 0).
Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices. Performance analysis, operating characteristics and propellant selection criteria are considered for air breathing and solid, liquid and nuclear rocket motor propulsion systems. PREREQUISITES: AA2042, AA2043.

AA3900 SPECIAL TOPICS IN AERONAUTICS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman. Graded Pass/Fail.

AA4000 AERONAUTICAL ENGINEERING SEMINAR (NO CREDIT) (1 - 0).
Oral presentations on subjects not covered in formal courses, which treat a wide spectrum of topics ranging from reports of current research to survey treatments of Navy issues and problems of scientific and engineering interest.

AA4103 MECHANICS OF COMPOSITE MATERIALS (3 - 2).
A course covering the mechanics of multi-phased composite materials. Prediction of composite properties from the constituent fiber/matrix properties. Design of composite structural components including laminates and sandwich construction. Fabrication and manufacturing techniques for aircraft, missiles and ship structures. Survey of strength theory, damage and repair. PREREQUISITE: AA2021 or ME3611.

AA4201 RELIABILITY ENGINEERING AND SYSTEM SAFETY MANAGEMENT (4 - 0).
An introduction to System Safety based on the foundations of statistical sampling and probability modeling with applications to military standard requirements. Mathematical foundations (probability, set theory, Boolean algebra, distribution functions); reliability testing (experimental planning via Monte Carlo simulations, parameter estimation); safety analysis (hazard analysis, fault-tree analysis, monolithic and redundant components) safety criteria and life cycle considerations. Application to aircraft maintenance, repair and retirement strategies.

AA4273 AIRCRAFT DESIGN (3 - 2).
Conceptual military and/or military related aircraft design methodology utilization and application centers around a student team design project focused on a military need defined by a Request-For-Proposal. Performance, cost supportability, deployment, manufacturing, product quality and environmental consideration are all included in the design process. The project draws on all of the aeronautical disciplines and provides students with experience in the application of the aerospace disciplines to military aircraft design. PREREQUISITE: Completion of the Aero Graduate Core.

AA4276 AVIONICS SYSTEM DESIGN (3 - 2).
This course will take students through each stage involved in the design, modelling and testing of a core avionics system, i.e., guidance, navigation and control (GNC) systems. Students will be asked to choose an airplane, model its dynamics on a nonlinear simulation package such as SIMULINK and then design a GNC system for this airplane. The complete design is to be tested on SIMULINK. Course notes and labs will cover all the relevant material. PREREQUISITES: AA3276, AA4641.

AA4304 HELICOPTER STABILITY AND CONTROL (3 - 2).
This course is especially important to students who will later be involved in helicopter flight testing or helicopter design. Rotorcraft general equations of motion. Rotor blade forces and motions in hover and forward flight. Derivation of trim equations and stability derivatives. Rotorcraft static and dynamic stability requirements. State space and frequency response methods of analysis. Control response. Helicopter flight simulation using real-time “FLIGHTLAB” code. Design of helicopter to meet military flying quality requirements as set forth in MIL-H-8501 and ADS-33 specifications. PREREQUISITE: AA3402.

AA4305 V/STOL AIRCRAFT TECHNOLOGY (3 - 2).
Types of V/STOL aircraft, fundamental principles, main performance characteristics, and propulsion requirements; STOL technology: mechanical and powered high-lift devices, jet flaps, augmentor wings; VTOL technology: flow vectoring devices, lift engine and lift fan technology, airframe/propulsion system interactions, ground interference effects; review of past and current military V/STOL aircraft programs, Joint Strike Fighter and V-22 programs. PREREQUISITES: Undergraduate core.

AA4306 HELICOPTER DESIGN (3 - 2).
A capstone course in helicopter design where students complete preliminary design of a helicopter to meet mission and military specification requirements. The course is conducted as part of national AHS/Industry competition. It begins with vehicle design trade-off selection to meet speed, range, maneuver, and air transportability requirements. Rotor design for solidity aerodynamic, autorotation, and blade dynamics. Includes design for physical parameters, aircraft structure, armament/weapons system, cockpit cooling, engine and drive train system, weights and balance, performance, handling qualities, combat survivability, safety and crash worthiness, maintainability, and determination of production and direct operating costs. PREREQUISITE: AA4304.

AA4318 AEROELASTICITY (4 - 0).
Fundamental aeroelastic phenomena, static aeroelasticity; types of flutter; unsteady inviscid flow theory; indicial and oscillatory aerodynamics; subsonic and supersonic flutter analysis; dynamic response phenomena and prediction methods, buffet and stall flutter, helicopter and turbomachinery aeroelasticity. PREREQUISITE: Undergraduate Core.

AA4323 FLIGHT TEST ENGINEERING (3 - 2).
Methods for pilot-static calibration, cruise and climb performance, stall testing, longitudinal static and dynamic stability, maneuvering stability, lateral-directional stability, and transonic flying qualities, are treated. An introduction to parameter-estimation methods is presented with military aircraft as examples. PREREQUISITES: AA2036, AA3340.

AA4362 ASTRODYNAMICS (3 - 0).
Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. PREREQUISITE: SS2500 or equivalent.

AA4342 ADVANCED CONTROL FOR AEROSPACE SYSTEMS (3 - 2).
This course is a continuation of AA3341. Here the students will be introduced to more recent developments in control theory. First, the course will concentrate on the analysis of the feedback systems. Such ideas as induced norms, small gain theorem, Kharitonov Theorem and structured singular value as well as Bode gain-phase relationship will be introduced. The course will then proceed to discuss the recently developed H infinity synthesis technique. Applications of these techniques to the design and analysis of fighter and missile control systems will be presented. Whenever possible, the development will be done for both continuous and discrete-time systems. PREREQUISITE: AA3341.

AA4431 TURBOMACHINES: ANALYSIS, DESIGN & EXPERIMENT (3 - 2).
The underlying principles governing flow through and energy exchange in turbomachines are developed to provide a basis for understanding both design and advanced computational methods. Key considerations and procedures followed in the design of new aircraft engine fans, compressors and turbines are introduced. Lectures are coordinated with experimental test experience at the Turbopropulsion Laboratory. PREREQUISITE: AA2043.

AA4451 AIRCRAFT ENGINE DESIGN (3 - 2).
The conceptual and preliminary component design of military, or military related, airbreathing engines is experienced within student design teams. The course is focused on a team response for a Request-for-Proposal (RFP) for an airbreathing engine meeting specific requirements. Performance, cost, supportability, deployment, manufacturing, product quality and environmental considerations may be included in the design process. The project draws on all of the aeronautical disciplines and provides students with experience in the integration and application of these disciplines to military air breathing engine design. PREREQUISITES: AA3451 and AA3501.

AA4452 TACTICAL MISSILE PROPULSION (4 - 0).
Applications and analysis of solid propellant rockets, ramjets, dual-combustion ramjets, scramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, combustor design, combustion instabilities and damping, mission and flight envelope effects on design requirements and technology requirements. Use of performance and grain design codes (SPP, PEP, and NASA SP233) and laboratory test firings for comparison with measured performance of rockets and ramjets. Introduction to insensitive munitions and plume signature considerations. Use of NATO/AGARD performance calculation and plume classification methods. PREREQUISITES: AA2042 or PH2724, AA2043.

AA4502 HIGH-SPEED AERODYNAMICS (4 - 0).
Transonic, vortex lift, and unsteady aerodynamics. Elements of hypersonic flow, area rule, supercritical airfoils, plus other topics of current military research importance. Numerical techniques as well as perturbation methods of solution. PREREQUISITE: AA3501.

AA4505 LASER/PARTICLE BEAM TECHNOLOGIES (3 - 2).
Elements of lasers and particle beams are presented together with a survey of their technologies. High energy lasers, including electrical, gas dynamic, excimer and chemical lasers, are typically treated. Concepts in beam management, propagation and damage mechanisms are discussed. Current military applications and future trends are covered as special topics. PREREQUISITES: Aero Preparatory Phase or equivalent.

AA4506 RAREFIED GAS DYNAMICS (4 - 0).
Topics include advanced thermodynamics with molecular structure, kinetic theory, distribution functions, Boltzmann equation and transport phenomena from a kinetic theory point of view. Types of flow range from free-molecule to transition, to high temperature continuum. Numerical approaches are discussed. Applications to space problems and hypersonics are treated. PREREQUISITES: Aero Preparatory Phase or equivalent.

AA4507 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER (3 - 2).
The emphasis will be on the numerical solution of sets, of partial differential equations, that describe fluid flow and heat transfer. The governing equations for fluid dynamics are reviewed and turbulence modeling is introduced. Discretization techniques are applied to selected model equations and numerical methods are developed for inviscid and viscous, compressible and incompressible flows. Individual term projects include application of CFD to thesis research and to current military flight and propulsion problems. PREREQUISITE: MA3232 or MA3243.

AA4641 DIGITAL AVIONICS SYSTEMS I (3 - 2).
An introduction to microprocessor technology and embedded computer system design with emphasis on avionics applications. Topics include binary number systems and data representation, instruction set architecture design and usage, microprocessor architectures, static and dynamic memory systems, and inter-computer communications. Emphasis will be given to communication methods used in avionics systems including MIL-STD-1553, ARINC 429, ARINC 629, HSDB, etc. PREREQUISITE: AA3260 (may be taken concurrently), EC2200, CS3010 or EC2820.

AA4642 DIGITAL AVIONICS SYSTEMS II (3 - 2).
A design-project oriented course, utilizing microprocessor technology with emphasis on aeronautical engineering applications. Both software and hardware aspects of system integration will be considered for engineering tradeoffs during problem definition and solution. PREREQUISITE: AA4641.

AA4703 MISSILE FLIGHT ANALYSIS (4 - 1).
Static and dynamic stability and control; transient modes; configuration determinants; subsonic, transonic, supersonic force and moment data for performance calculations with short and long-range cruciform missiles and cruise missiles; acceleration, climb, ceiling, range and agility in maneuvering trajectories. PREREQUISITE: AA3701.

AA4704 MISSILE DESIGN (3 - 2).
Conceptual missile design methodology centered around a student team design project, focused on a military need defined by a Request-for-Proposal. It stresses the application of all of the aeronautical disciplines, including aerodynamics, propulsion, flight mechanics, cost, supportability, stability and control and provides the student with their application to design. Consideration is given to trade-offs among propulsion requirements, air loads, quality sensors, guidance laws, quality, controls and structural components. PREREQUISITES: AA3701, AA4452 and AA4703.

AA4816 DYNAMICS AND CONTROL OF SMART STRUCTURES (4 - 0).
Principles of Lagrange's equation, Kane's equation, finite element method, structural natural frequencies and mode shapes, controllability and observability, optimal control, and observers. Equations of motion for a flexible spacecraft simulator. Smart sensors, actuators, and finite element models of smart structures. Application of smart structures to active vibration and shape control of space structures. PREREQUISITES: EC2300 or equivalent and AA2820 or equivalent.

AA4830 SPACECRAFT SYSTEMS I (Intended for curriculum 366.) (3 - 2).
This course emphasizes the systems analysis of geosynchronous spacecraft and covers the analysis of GNC (orbit and attitude control), structures, propulsion, thermal and electrical power subsystems. Basic mathematical equations will be used in the preliminary design of the subsystems and the tradeoff studies involved. The differences and similarities between dual-spin and three-axis stabilized spacecraft will be covered in detail. Systems aspect of a typical mission profile will be illustrated. Throughout, emphasis will be on the spacecraft bus. Students will be engaged in problem solving during most of the laboratory period. PREREQUISITES: Completion of Space Operations core-curriculum.

AA4831 SPACECRAFT SYSTEMS II (Intended for curriculum 366.) (3 - 2).
In this course, students will be involved in a group project to design a spacecraft to meet mission requirements. Material presented in AA4830 as well as AA4831 will be utilized. In parallel, this course covers some or all of the following aspects of spacecraft systems: spacecraft testing, TT&C subsystem, and design of observation payloads. Differences and similarities between geosynchronous spacecraft and LEO/HEO spacecraft will be discussed. Topics include gravitational perturbation (J2 effects), gravity-gradient stabilization and atmospheric drag effects. PREREQUISITE: AA4830.

AA4844 HYPERSONIC FLIGHT (4 - 0).
Trajectories and characteristic features of flow over re-entry and hypersonic flight vehicles. Effects of Mach number, high enthalpy and low density. Analysis and computational methods for blunt and slender bodies, and for practical vehicle shapes. Ground simulation of re-entry and sustained flight environments. Waverider aircraft and missiles. The hypersonic air breathing SSTO vehicle and potential military derivatives. PREREQUISITES: AA2035 or consent of instructor, AA2043.

AA4850 SPACECRAFT PERFORMANCE AND OPTIMIZATION (3 - 2).
This course develops basic measures of performance of a space vehicle (including launch vehicles) with methods to target a set of conditions and optimize the performance. Topics include an overview of the Guidance, Navigation and Control System, state-space formulation, vehicle and environmental models, performance measures, problem of Bolza, Maximum Principle, Hamiltonian and transversability conditions, and the Bang-Bang Principle. The course is focused on a number of problems in Astronautics such as the Goddard problem, bi-linear tangent steering, Single-Stage-To-Orbit problem, Low-Earth-Orbit maintenance, Moon-landing problem, aerobraking and aerocapture. Where appropriate, the course will illustrate systems aspects of mission design. PREREQUISITES: PH2511, PH2514, AA3341, AA3815, AA3851, or equivalent.

AA4870 SPACECRAFT DESIGN AND INTEGRATION I (4 - 0).
Principles of spacecraft design considerations, spacecraft configurations, design of spacecraft subsystems, interdependency of designs of spacecraft subsystems, launch vehicles, mass power estimation, and trade-offs between performance, cost, and reliability. The emphasis is on military geosynchronous communications satellites. The course includes an individual design project. PREREQUISITES: AA2820, AA3804, AA3851, AA3818, EC3230, PH2511.

AA4871 SPACECRAFT DESIGN AND INTEGRATION II (2 - 2).
A team project oriented course on design of non-geosynchronous spacecraft systems. Provides understanding of the principles of space system design, integration, and systems engineering, and their application to an overall spacecraft mission. Considerations are given to cost, performance, and test plan. Several DOD/NASA organizations, such as Naval Research Laboratory and Jet Propulsion Laboratory, provide support in the definition of the mission requirements for the project, spacecraft design, and design reviews. PREREQUISITE: AA4870.

AA4900 ADVANCED STUDY IN AERONAUTICS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman. Graded Pass/Fail.

COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS AND INTELLIGENCE (C4I) ACADEMIC GROUP

Chairman:
Dan C. Boger, Professor
Code CC, Root Hall
Room 201D
(831) 656-3671/2535 (Voice)
DSN 878-3671/2535
(831) 656-3679 (Fax)

Dan C. Boger, Chairman and Professor (1979)*; PhD, University of California at Berkeley, 1979.

Rex A. Buddenberg, Lecturer (1993); MS, Naval Postgraduate School, 1986.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Donald P. Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

John H. Gibson, Lt Col, U.S. Air Force, Lecturer (1995); MS, Naval Postgraduate School, 1990.

Carl R. Jones, Professor (1965); PhD, Claremont Graduate School, 1965.

William G. Kemple, Associate Professor (1990); PhD, University of California at Riverside, 1991.

David Kleinman, Visiting Professor (1994); PhD, Massachusetts Institute of Technology, 1967.

Hershel H. Loomis, Jr., Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Orin E. Marvel, Research Associate Professor (1994); PhD, University of Illinois, 1970.

Gordon McCormick, Associate Professor (1992); PhD, Johns Hopkins University, 1985.

Michael Mullady, Lt Col, U.S. Air Force, Curricular Officer (1997); MA, Webster University, 1986.

John Osmundson, Associate Professor (1995); PhD, University of Maryland, 1968.

Patrick J. Parker, Professor (1974); MBA, University of Chicago, 1955.

Gary R. Porter, Research Assistant Professor (1993); MS, Naval Postgraduate School, 1980.

Craig Rasmussen, Associate Professor (1991); PhD, University of Colorado at Denver, 1990.

Nancy C. Roberts, Professor (1986); PhD, Stanford University, 1983.

Timothy J. Shimeall, Associate Professor (1988); PhD, University of California at Irvine, 1988.

Donald van Z. Wadsworth, Senior Lecturer (1988), PhD, Massachusetts Institute of Technology, 1958.

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

The Command, Control and Communications (C3) Academic Group is an interdisciplinary association of faculty. The C3 Academic Group has responsibility for the academic content of the Joint Command, Control, Communications, Computers and Intelligence curriculum, the Scientific and Technical Intelligence curriculum, and a C4I research program. Thesis topics are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree Master of Science in Systems Technology (Command, Control and Communications) or the degree Master of Science in Systems Technology (Scientific and Technical Intelligence) will be awarded at the completion of the appropriate interdisciplinary program carried out in accordance with the following degree requirements.

The Master of Science in Systems Technology (Command, Control and Communications) or the Master of Science in Systems Technology (Scientific and Technical Intelligence) requires a minimum of 45 quarter hours of graduate level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines. Within the course program there must be a specialization sequence consisting of at least three courses.

In addition to the 45 hours of course credit, an acceptable thesis must be completed.

The program must be approved by the Chairman of the Command, Control and Communications Academic Group.

SYSTEMS TECHNOLOGY LABORATORIES (STL)

The NPS Systems Technology Laboratories provide centrally managed, supported, and funded facilities where students and faculty can conduct research and instruction using tomorrow's C4I systems technologies today. The facilities provide for classified and unclassified capabilities for students and faculty to use for immediate classroom reinforcement, student projects, and theses and for faculty and students to conduct leading edge research in their fields. The labs, through advanced telecommunications and networking, allow local platforms of various types to communicate at very high data rates with each another over the NPS backbone and with other national laboratories and research facilities worldwide using Internet, SIPRNET, and ATM networks, such as DARPA's Leading Edge Services ATM network, the California Research and Education Net (CALREN), Defense Research and Evaluation Net (DREN), and other wideband wide area networks that define the nation's information infrastructure. Using these capabilities, researchers can collaborate with leading researchers and can participate in systems technology research efforts of national prominence.

The NPS Systems Technology Laboratories contain (or have distributed access to) actual command and control systems for exercises and experiments. The prime example of this is a fully-functional CINC version of the Global Command and Control System (GCCS) with SECRET interconnectivity to all CINCs and supporting sites. GCCS permits CINCs to complete crisis action plans including assessment, evaluation, and development of options, as well as selection, dissemination and monitoring of execution. The STL routinely conducts experiments with humans in the loop. Operational teams of officer-students can be trained/tested using wargames as stimuli and using data collection techniques to evaluate performance under varied, but controlled, conditions. Insights into requirements for new doctrine, training and other aspects of the joint environment may be identified that will speed the acceptance of new approaches to decision-making and training.

COMMAND, CONTROL AND COMMUNICATIONS (C3) COURSE DESCRIPTIONS

CC0001 SEMINARS, VIDEOTELECONFERENCES, AND FIELD TRIPS FOR C4I STUDENTS (0 - 3).
Seminars (consisting of guest lectures, videoteleconferences, and field trips) are scheduled to provide background information on specific Joint C4I systems and activities.

CC0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

CC2040 INTRODUCTION TO SYSTEM TECHNOLOGIES (3 - 2).
This course is a technical introductory course for students in the Systems Technology curricula. It discusses the GCCS Common Operating Environment (COE) as it relates to modern C4I technology and combat, as well as selected relevant emerging technologies in operational information processing. It addresses the elements of COTS (Commercial Off-The-Shelf) workstations, architectures, operating systems, and National Information Infrastructure (NII). Students are provided relevant experiences through a focused introduction to GCCS, C programming, Unix operating systems, and Internet applications in the secure Systems Technology Lab. This is a required course for all Joint C4I Systems Curriculum and Space Systems Operations Curriculum students. PREREQUISITE: None. Taking CC3000 concurrently is recommended.

CC3000 INTRODUCTION TO COMMAND, CONTROL, COMMUNICATION, COMPUTER AND INTELLIGENCE SYSTEMS IN DOD (4 - 0).
Knowledge of current C4I systems and practice is introduced. A basic framework for understanding C4I is provided. Case studies are used as well as lessons learned from crises, field exercises and wargaming. PREREQUISITES: Enrollment in the Joint C4I systems curriculum, OS2103 concurrently, and SECRET clearance.

CC3040 INTRODUCTION TO JOINT COMMAND AND CONTROL SYSTEMS (JCCS) (3 - 3).
This course introduces students to the principles, methods, and various joint command and control systems that enable our military commanders to plan and successfully execute their assigned new world order missions. It features use of the Global Command and Control System (GCCS) in a lab environment to provide practical reinforcement to theory and principles taught in the classroom. This classified real-time world-wide C4I system will allow students to plan and conduct joint operations and exercises using actual military data. It also allows students to observe how actual combatant commanders plan and conduct their missions and exercises on a real-time collaborative basis. PREREQUISITES: U.S. citizenship, a SECRET clearance, and CC2040. CC3000 or NS3252, or equivalent, is also recommended.

CC3101 COMBAT ANALYSIS FOR C3 (4 - 0).
Introduction to combat modeling and analysis for C4I students. Emphasis is on the use of mathematical models of search and attack on land and sea to help operational and tactical commanders solve wartime problems or improve the effectiveness of their forces. The course is the basis for later study of models of the command and control process, wargaming and simulation, and C4I systems engineering. A required course for the 365 curriculum. PRE-REQUISITES: CC3000, and OS2103 (may be concurrent).

CC3111 C4I MISSION AND ORGANIZATION (4 - 0).
A survey of command, control and communications organizations within OSD, JCS, and the Service headquarters. Execution of National Security Policy and planning for joint employment of general purpose forces are discussed. Service combat organization and service tactical C3 systems are covered. Emphasis is on description of existing C4I organizations and systems, with brief historical perspective. PREREQUISITE: SECRET clearance.

CC3524 JOINT AND MARITIME STRATEGIC PLANNING (4 - 0).
This course develops a realistic understanding of the processes and ideas that determine our national security posture and behavior: in short, how we design, develop and acquire our forces, and how we use them to influence international events, hopefully to deter war, and eventually, if necessary, to fight and win. This takes place in a world of political and economic change, fast moving technological developments and stringent fiscal constraints. The course is taught with a system emphasis, i.e., it links strategic needs to technological opportunities and the creation of new weapon systems. It also emphasizes the importance of operational art in the introduction of new systems: how to use new developments is often as important as the developments themselves, thus the associated doctrinal development and training are also a vital part of the course. Roles and missions of the services, the evolution and intellectual basis of the PPBS system, recent changes in the Joint Staff and its role, joint operations, and the changing role of the Congress are treated. To drive these ideas home, historical cases are developed in sufficient depth to provide a sense of the interplay among strategy, technology, economics, operational art, and force employment.

CC3900 SPECIAL TOPICS IN COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE SYSTEMS (V - 0).
Supervised study in selected areas of command, control and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on Pass/Fail basis only.

CC4004 C3 IN NATO (4 - 0).
Application of C4I principles to the special problems of NATO. The range of alternatives to improving arms stability in Europe will be explored, including high-tech solutions such as FOFA, low-tech "green" barriers and militia, as well as arms negotiations. C4I planning and evaluation will be covered in application. PREREQUISITES: U.S. citizenship and SECRET clearance; CC4103 or equivalent.

CC4006 ADVANCED C2 ANALYTICAL CONCEPTS (4 - 0).
The study of the combat organization's C2 in equilibrium and disequilibrium. The use of Petri Nets in understanding equilibrium is emphasized. The role of catastrophe and chaos theory in understanding disequilibrium is covered. PREREQUISITE: CC4103 or equivalent.

CC4040 ADVANCED JOINT COMMAND AND CONTROL SYSTEMS (JCCS) (3 - 3).
Advanced instruction in the integration of various existing and emerging joint command and control systems that enable military commanders to plan and successfully execute their missions. Hands-on use of the Global Command and Control System (GCCS), both existing and emerging applications, in a lab environment to provide practical reinforcement to theory and principles covered in lectures. Students will plan, conduct, and analyze joint operations and exercises using real-time, current military data. Students will observe how combatant commands plan and conduct their missions and exercises on a real-time collaborative basis. PREREQUISITES: CC3040, CC4103 (concurrently) and SECRET clearance.

CC4101 SYSTEMS ENGINEERING FOR JOINT C4I SYSTEMS (4 - 2).
Provide an introduction to systems engineering by performing systems engineering activities, using the tools that a systems engineer uses, analyzing the procedures a systems engineer follows, and performing an actual systems design on a joint C4I system element. The course will use practical examples to explain the fundamental principles, while maximizing the hands-on practical systems design activities. A required course for the 365 curriculum. PREREQUISITES: CC3000, OS3604, and TOP SECRET clearance with eligibility for SI/SAO.

CC4103 C4I SYSTEMS EVALUATION (2 - 4).
Experiments in determining C4I system effectiveness using war gaming and simulation. Design of experiments. Survey of current C4I systems evaluation techniques. PREREQUISITES: CC4101, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4200 COMBAT SYSTEMS ENGINEERING (4 - 0).
This course examines the generation of combat system requirements and the relationships between operational, financial planning, and technical communities in fielding a combat system that fulfills those requirements. The contribution of the technical disciplines to the statement and solution of decision problems in design, priority setting, and scheduling are explored through the use of currently outstanding issues. PREREQUISITES: Consent of the Instructor, basic probability and statistics, 4th quarter standing, SECRET clearance. Graded on a Pass/Fail basis only.

CC4750 MILITARY C4I SYSTEMS AND NETWORKS (3 - 1).
By means of case studies of tactical and strategic military C4I systems, student familiarity is developed concerning system aspects such as network architecture, joint and combined interoperability, measures of performance, and vulnerability to ECM. Models and simulations in current use by DoD are used to determine the operational constraints imposed on the commander by system technical parameters, including environmental factors, under both limited objective and major combat scenarios. A required course for the 365 curriculum. PREREQUISITES: EO3523 (may be concurrent) or equivalent, and SECRET clearance.

CC4900 ADVANCED STUDY IN COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE SYSTEMS (V - 0).
Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on a Pass/Fail basis only.

CC4913 POLICIES AND PROBLEMS IN C3 (4 - 0).
Study of the fundamental role C3 systems fulfill in operational military situations, including crisis warning and crisis management. Analysis of the changing role of intermediate level headquarters and its impact on C4I system requirement and design. Consideration of the complexities imposed on C4I systems as the force structure becomes more heterogeneous as in the case of NATO. Case study of selected incidents and systems. Specifically for students in the 365 curriculum. PREREQUISITES: CC4103, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

DEPARTMENT OF COMPUTER SCIENCE

Chairman:
Dan C. Boger
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Academic Associate of Computer Science Curriculum
Thomas C. Wu
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Associate Chairman for Research
Neil Rowe
Code CS/Rp, Spanagel Hall
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Associate Chairman for Instruction
Robert McGhee
Code CS/Mz, Spanagel Hall
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Chair MOVES Academic Group & Academic Associate of MOVES Curriculum
Michael J. Zyda
Code CS/Zk, Spanagel Hall
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Academic Associate of Software Engineering Curriculum
Luqi
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Eric Bachmann, Lecturer (1997); MS, Naval Postgraduate School, 1995.

Wolfgang Baer, Research Assistant Professor (1996); Ph.D., University of California at Berkeley, 1972. Physics. Real world database generation and real world simulation.

Valdis Berzins, Professor (1986); Ph.D., Massachusetts Institute of Technology, 1979. Software engineering, specification languages, computer-aided design and engineering databases.

Rudy Darken, Assistant Professor (1996); DSc, George Washington University, 1995. Computer graphics.

Chris Eagle, LCDR, U.S. Navy; MS, Naval Postgraduate School, 1995. Software engineering, databases and client server.

John Falby, Senior Lecturer (1991); MS, Naval Postgraduate School, 1986.

Debra Hensgen, Associate Professor (1995); Ph.D., University of Kentucky, 1989. Distributed parallel operating systems; tools for distributed/parallel processing, including performance analysis, automatic concurrency control, and task assignment and scheduling.

Cynthia E. Irvine, Assistant Professor (1994); Ph.D., Case Western University, 1975. Computer security, trusted systems methodologies, operating systems.

Yutaka J. Kanayama, Professor Emeritus (1990); Ph.D., Tokyo University, 1965. Robotics, artificial intelligence, and mathematical foundation of computer science.

Deborah R. Kern, CDR, U.S. Navy, Instructor (1997); MS, Naval Postgraduate School, 1990. Software engineering.

Taylor Kidd, Associate Professor (1995); Ph.D., University of California at San Diego, 1991. Distributed systems, heterogeneous systems, probability and uncertainty as applied to computer systems, and stochastic systems theory.

Ted Lewis, Professor (1993); Ph.D., Washington State University (1971), Parallel Computing, object-oriented frameworks, and software engineering.

G.M. Lundy, Associate Professor (1988); Ph.D., Georgia Institute of Technology, 1988. Data communications, computer networks, formal models of communications protocols.

Luqi, Professor and Academic Associate of Software Engineering (1986); Ph.D., University of Minnesota, 1986. Software engineering, scientific computing, rapid prototyping and real-time embedded systems.

Robert B. McGhee, Professor and Associate Chair for Instruction (1986); Ph.D., University of Southern California, 1963. Robotics and artificial intelligence.

David R. Pratt, Associate Professor (1993); Ph.D., Naval Postgraduate School, 1993. 3D computer graphics, virtual worlds and environments, user interfaces and computer architecture.

Neil C. Rowe, Associate Professor and Associate Chair for Research (1983); Ph.D., Stanford University, 1983. Artificial intelligence: path planning, database interfaces, vision and tutoring.

Timothy J. Shimeall, Associate Professor (1988); Ph.D., University of California at Irvine, 1988. Software engineering: testing, fault-tolerance, empirical evaluation techniques.

Man-Tak Shing, Associate Professor (1988); Ph.D., University of California at San Diego, 1981. Design and analysis of algorithms, real-time system scheduling, rapid prototyping and embedded systems.

Dennis M. Volpano, Associate Professor (1991); Ph.D., Oregon Graduate Institute, 1986. Programming language foundations and type theory.

Daniel F. Warren, Lecturer (1996); MS, University of California at Santa Cruz, 1986.

Thomas C. Wu, Associate Professor and Academic Associate of Computer Science Curriculum (1985); Ph.D., University of California at San Diego, 1983. Multimedia database systems, object-oriented data modeling and programming, and user interface design.

Geoffrey Xie, Assistant Professor (1996); Ph.D., University of Texas at Austin, 1996. Networks and multimedia systems.

Michael J. Zyda, Professor, Chair of MOVES Academic Group and Academic Associate of MOVES Curriculum (1984); DSc, Washington University, 1984. Computer graphics: virtual worlds and visual simulation systems.

* The year of joining the Naval Postgraduate School faculty is indicated in parenthesis.

The Department of Computer Science provides graduate training and education in major areas of computer science. Thus, both basic and advanced graduate courses are offered. Course work and research lead to either the degree of Master of Science or Doctor of Philosophy. The requirements to complete either program are rigorous and are comparable to those of other major universities.

MASTER OF SCIENCE IN COMPUTER SCIENCE
The degree Master of Science in Computer Science is awarded upon the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

a. At least 40 quarter hours of graduate-level work of which at least 12-quarter hours must be at the 4000 level.

b. Completion of an approved sequence of courses constituting specialization in an area of Computer Science.

c. Completion of an acceptable thesis in addition to the 40-quarter hours of course work.

MASTER OF SCIENCE IN SOFTWARE ENGINEERING
The Master of Science in Software Engineering program is intended for DoD software practitioners with a Bachelor's degree in Computer Science/Engineering (or equivalent) and at least two years of software development experience. Students enrolled in the program typically complete the program in two years on a part-time basis by the completion of a total of 12 graduate-level Software Engineering courses, which are taught at NPS and televised to the distant site, and an acceptable thesis in addition to the required course work.

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION
The degree Master of Science in Modeling, Virtual Environments and Simulation is awarded upon satisfactory completion of a program, approved by the Chairman of the Modeling, Virtual Environments and Simulation Academic Group, which satisfies, as a minimum, the following degree requirements:

a. At least 40 quarter hours of graduate-level work, of which at least 12 quarter hours must be at the 4000 level.

b. Completion of an approved sequence of courses constituting specialization in an area of Modeling, Virtual Environments and Simulation.

c. Completion of an acceptable thesis in addition to the required course work.

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE
The Department of Computer Science has a program leading to the degree Doctor of Philosophy. Areas of special strength in the department are artificial intelligence & engineering, and computer systems & architectures. A noteworthy feature is that the candidate's research may be conducted off-campus in the candidate's sponsoring laboratory or unit of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

DOCTOR OF PHILOSOPHY IN SOFTWARE ENGINEERING
The program is specifically designed for DoD software practitioners who want to acquire skills and knowledge needed to perform state-of-the art research on issues related to the development and evolution of large complex software systems, and to direct and manage teams of software professionals. It provides a unique program of study supporting the advancement of software engineering principles and technology vital to DoD researchers and program managers.

COMPUTER SCIENCE LABORATORIES

Laboratory Overview

There are currently seven laboratories:

- Computer Science Academic Laboratory
- Artificial Intelligence and Robotic Laboratory
- Computer Systems and Security Laboratory
- Computer Graphics and Video Laboratory
- Microcomputer Systems Laboratory
- Software Engineering Laboratory
- Visual Database and Interface Laboratory

These laboratories are configured in a complex network system with remote file system access and resource sharing facilities. A backbone network also provides a gateway to the Internet.

Computer Science Academic Laboratory

The laboratory provides a general purpose, time-sharing environment for a variety of programming languages and software tools. Approximately half of the client workstations are located within the laboratory for student access while the remaining client workstations are distributed to individual faculty and staff offices.

Artificial Intelligence and Robotic Laboratory

The Artificial Intelligence Laboratory consists of Unix and IRIS based, general purpose workstations. They are outfitted with LISP, Prolog and various knowledge-based software tools. The Autonomous Mobile Robots "Yamabico" and "Shepherd" with an image-grabbing capability color TV camera are fundamental research tools in robotics and AI. This laboratory also supports the research of planning, navigation, dynamics and control of Autonomous Underwater Vehicle sponsored by NAVSEA.

Computer Systems and Security Laboratory

The Computer Systems and Security Laboratory has three distinct sub-laboratories: the Database Systems Lab, the Multimedia DBMS Lab and Computer Security Lab. The Database System Lab has a focus on multi-back end database machines. The multimedia DBMS Lab has a focus on utilizing low-cost workstations and PC technology for the intelligent storage and retrieval of multimedia data. The Computer Security Lab has a focus on a secure heterogeneous, distributed computing environment.

Computer Graphics and Video Laboratory

The Graphics and Video Laboratory consists of several Silicon Graphics, Inc. IRIS workstations used to provide instructional support for the Computer Graphics and Visual Simulation track of the Department of Computer Science and to provide research support for efforts in virtual world and visual simulation system construction. The laboratory is equipped with a variety of video and multimedia support hardware. Recent efforts of the laboratory currently revolve around the NPSNET system, a low- cost, workstation-based, 3D visual simulator that utilizes SIMNET databases and networking formats.

Microcomputer Systems Laboratory

The Microcomputer Systems Laboratory is used for instruction in beginning programming with the Department of Defense's standard computer language Ada. The PCs are also used for research and instruction in microprocessor programming, microprocessor architectures, networking and distributed systems. The PCs are networked together to provide access to shared resources such as printers. The laboratory also supports ongoing research on transputer applications to real-time embedded military systems.

Software Engineering Laboratory

The purpose of this laboratory is to provide a state-of-the-art educational environment for graphics-based software development automation. Current work in the laboratory is on rapid prototyping, specification languages and computer-aided software system design, software verification and testing, software safety and computer-aided instruction.

Visual Database and Interface Laboratory

The Visual Database and Interface Laboratory is used for research and instruction in human-computer interfaces for data retrieval systems. The main project in the laboratory is a visual query language for databases project sponsored by the Naval Weapons Station, Concord.

COMPUTER SCIENCE COURSE DESCRIPTIONS

CSR100 REFRESHER FOR BEGINNING PROGRAMMING (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 1).
An introduction to computer algorithms, programs and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded.

CSR101 REFRESHER FOR LABORATORY SYSTEMS (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 1).
Intended for computer science majors, to provide an introduction to computer science and computing laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CSR100. Not graded.

CS0001 COLLOQUIUM (NO CREDIT) (0 - 1).
Departmental lecture series. Attendance is required by students in their fourth quarter. Graded on Pass/Fail.

CS0102 REVIEW FOR DIRECT INPUT STUDENTS (NO CREDIT) (Meets entire quarter.) (2 - 1).
An individualized course to cover the topics of CSR100 and CSR101. The course is open only to first quarter computer science majors who did not take CSR100 and CSR101. This course is not graded.

CS0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

CS2101 INTRODUCTION TO THE MODERN PC (3 - 1).
This course is designed to introduce to students the modern PC technology. Part one of the class covers the hardware and software design of the PC. This section details the feature of the Windows operating system including the window interface, multitasking, memory and device management, and other operating system services. Part two introduces the basic concepts of office automation, multimedia applications, and networking technology. This section covers some of the popular applications, including Microsoft Office, Eudora, Netscape, Adobe Photoshop, and FrameMaker. This class combines classroom theory, demonstration, discussion, and plenty of hands-on experience with the latest PC technology. The material covered in this course is targeted to students at any level of prior PC experience. PREREQUISITE: None.

CS2920 INTRODUCTORY TOPICS IN COMPUTER SCIENCE (Hours vary 2-4 to 4-1.) (V - V).
Designed to support introductory subject matter of special interest, dependent upon faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture/lab oriented or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS2970 FUNDAMENTAL OBJECT-ORIENTED PROGRAMMING IN ADA (4 - 2).
This course is designed as an introductory course in object-oriented programming. The core emphasis of the course is to teach the program development skills. Some of the topics covered in the course include program construction, data types, operations, control flow, arrays, records, file I/O, inheritance, and polymorphism. Six to seven programming projects will be assigned. PREREQUISITE: None.

CS2971 FUNDAMENTAL OBJECT-ORIENTED PROGRAMMING IN C++ (4 - 2).
This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using C++. The topics covered include: problem solving, documentation, C++ Integrated Programming Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. PREREQUISITE: None.

CS2973 FUNDAMENTAL OBJECT-ORIENTED PROGRAMMING IN JAVA (4 - 2).
This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using Java. The topics covered include: problem solving, documentation, Java Integrated Programming Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. PREREQUISITE: None.

CS3010 COMPUTER SYSTEMS PRINCIPLES (4 - 0).
Designed to provide computer science majors with a basic understanding of computer systems hardware. The course includes the following topics. Basic computer concepts, number systems and data representation, digital logic and Boolean algebra, storage devices and organization, basic computer organization and control, and instruction formats, addressing modes and the assembler process. No previous background in computer hardware is assumed. PREREQUISITE: None.

CS3030 COMPUTER ARCHITECTURE AND OPERATING SYSTEMS (For Non-CS students.) (4 - 0).
This course, designed for non-computer science majors, provides an overview of basic computer hardware concepts and operating systems software. The following topics are covered: basic computer concepts; data representation; elements of computer architecture and operation; processor and process management; multiprogramming; memory management; and file management. Future trends in computer hardware and operating systems will be discussed. PREREQUISITE: CS2971 or consent of instructor.

CS3050 SOFTWARE DEVELOPMENT FOR COMBAT SYSTEMS (3 - 2).
This course covers the unique characteristics of software development for mission-critical embedded computer systems. Students will be introduced to real-time systems issues including analysis, design, process scheduling, operating systems, communications, architecture and fault-tolerance. The DoD Standard 2167A life cycle model will be explored along with analysis, design, programming, and verification methodologies used in developing combat systems software. Students will learn the Ada programming language's real time tasking and inter-process communication techniques and be introduced to tools for prototyping, code reuse, and automatic code generation and documentation. The laboratory experience includes work with software analysis, design and programming tools to build a combat-type software system from requirements analysis through verification. Intended for non-CS majors. PREREQUISITE: CS2970 or consent of instructor.

CS3111 PRINCIPLES OF PROGRAMMING LANGUAGES (4 - 0).
This course is an introduction to the design, evaluation and implementation of programming languages. Imperative, functional, logic, and concurrent programming methodologies are investigated, with an emphasis on practical issues. Tradeoffs in choosing different programming languages for a given task are discussed and principles on which an objective assessment of programming language design can be made are presented. PREREQUISITE: CS2971 or consent of instructor.

CS3113 INTRODUCTION TO COMPILER WRITING (3 - 2).
This course is intended to explore the basics of modern compiler design and construction techniques. The fundamentals of scanning, parsing and compiler semantics are developed in the framework of modern compiler-compiler and translator-writing systems technology. The laboratory periods will be used to develop a small model compiler/assembler. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS3130 SOFTWARE DESIGN FOR MOBILE COMPUTERS (3 - 2).
Designing applications for portable, hand held, personal digital assistants (PDAs) and organizers is much different than designing and implementing applications for desktop and/or departmental computers due to their novel architectures, network connectivity (wireless), and requirements for rapid development cycles. For example, languages like Newton Script are functional and object-oriented rather than procedural; Telescript is a software agent language which implements security features not found in most languages, and Magic Cap C is a "slot language" which shares features with both functional and object-oriented languages. This course introduces the student to rapid application development environments, programming languages, and operating systems used by commercial off-the-shelf hand held computers running operating systems such as Newton Intelligence, Magic Cap, GEOS, and PalmOS. Lab programming exercise for one PDA-class operating system platform. PREREQUISITE: CS3300.

CS3200 COMPUTER ARCHITECTURE (3 - 2).
This course examines the organization of computer and processor architectures. Instruction set design alternatives, processor implementation, memory system hierarchy, and I/O systems are the main topics of study. A quantitative approach is taken in which different design alternatives are evaluated and compared through analysis and/or experimentation. The course is accompanied by a set of labs which reinforce and extend the lecture subject matter. PREREQUISITES: CS3010 and either CS2971, or permission of instructor.

CS3202 INTRODUCTION TO MULTIMEDIA PRODUCTION (3 - 2).
This is the first of a two-course sequence in multimedia production. The course introduces students to fundamentals of 2-D/3-D graphics, sound and animation. Basic principles of multimedia production are covered including pre-press, file formats, image filtering, morphing, distortions, textures, geometry, and perspective in a lecture format, and practical skill development in a hands-on laboratory. Scripting in an event-driven programming language is a major portion of the course. PREREQUISITE: None.

CS3203 ADVANCED MULTIMEDIA PRODUCTION (3 - 2).
This is the second of a two-course sequence in multimedia production. The course goes into more depth than CS3202 by focusing on video production. Fundamentals of digital video tape, CD-ROM, and camera hardware, video multimedia software, and file formats are covered in addition to the tools and design techniques used to do professional quality movie production. It is expected that the material will change rapidly in the next few years, hence the content will also undergo rapid change. PREREQUISITE: CS3202.

CS3300 DATA STRUCTURES (3 - 2).
The purpose of this course is to introduce modern techniques for design, analysis, and implementation of data structures. This includes: theoretical material (time and space analysis, abstract data types); current practice (applications to memory management, compiler design, sorting/searching algorithms); programming techniques (information hiding, packages, programming from specifications, testing); programming practice (non-trivial assignments which emphasize pointers, file I/O, recursion, and teamwork). Weekly programming projects are required in this course PREREQUISITE: CS2971 or consent of instructor.

CS3310 ARTIFICIAL INTELLIGENCE (4 - 1).
Survey of topics and methods of Artificial Intelligence. Methods include rule-based systems, heuristic search and exploitation of natural constraints, means-ends analysis, semantic networks, and frames. Emphasis is placed on solving problems that seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. PREREQUISITES: CS3010 or consent of instructor.

CS3315 LEARNING SYSTEMS (3 - 1).
Survey of methods by which software and hardware can improve their performance over time. Methods include case-based reasoning, concept learning, neural networks, simulated annealing, and genetic algorithms. Students will do projects with software tools. PREREQUISITE: A programming course.

CS3320 DATABASE SYSTEMS (3 - 1).
This course presents an up-to-date introduction to database systems including database system architectures, data models, query languages, and design of databases. PREREQUISITE: CS3300 or consent of instructor.

CS3450 OPERATING SYSTEMS (3 - 2).
A theoretical and practical treatment of operating concepts. Major course topics include concurrency, Ada tasking, virtual memory including demand paging and segmentation, dynamic linking and loading, file structures and information security. The laboratory portion of the class will give students the opportunity to write and test components of a modern operating system. PREREQUISITES: CS2972, CS3200 and CS3300, or consent of instructor.

CS3460 SOFTWARE METHODOLOGY (3 - 1).
Introduction to the software life cycle. Methods for requirements definition, design, and testing of software. Basic concepts of software engineering, including stepwise refinement, decomposition, information hiding, debugging, and testing. PREREQUISITES: CS2972 and CS3300.

CS3502 COMPUTER COMMUNICATIONS AND NETWORKS (4 - 0).
An introduction to the structure and architecture of computer networks. The physical, data link and network layers of the ISO model are covered, as well as some aspects of the higher layers. Several important communication protocols are studied, including the currently used models for their specifications and analysis. Local Area Networks, such as Ethernet and Token Ring, are also covered. Term papers and/or a project are an important aspect of this course. PREREQUISITES: CS3200 and CS3010 and a basic course in probability.

CS3505 THE INTERNET AND THE INFORMATION HIGHWAY (3 - 2).
Recent advances in telecommunications and computers have resulted in an explosive growth in the Internet. This growth in computer networking has already had a major impact on the world. In this class, the Internet and related technologies are explored. Major objectives are (1) to learn what the Internet and the “Information Highways” are; (2) to learn how to use the Internet for both business, academic and personal uses; (3) to learn what is the current and especially future direction the Internet is going. Students will gain experience in exploring the World Wide Web, in creating their own home pages using the language HTML. They will also learn how to use the “big three” Internet tools, which are FTP, E-mail, and Telnet. Some background on how these protocols developed is also presented. Lectures also discuss the origins of the Internet, and the various physical and software layers which make up the Internet are also discussed. The class requires a series of laboratory assignments. PREREQUISITE: None. Open to all graduate students.

CS3600 INTRODUCTION TO COMPUTER SECURITY (3 - 2).
This course is concerned with fundamental principles of computer and communications security for modern monolithic and distributed systems. It covers privacy concerns, data secrecy and integrity issues, as well as DoD security policy. Security mechanisms introduced will include access mediation, cryptography, authentication protocols, and

multilevel secure systems. Students will be introduced to a broad range of security concerns including both environmental as well as computational security. Laboratory facilities will be used to introduce students to a variety of security-related technologies including, discretionary access controls in Class C2 systems, mandatory access controls in both low and high assurance systems, identification and authentification protocols, the use of cryptography in distributed systems, and database technology in trusted systems. PREREQUISITE: Either CS3010, CS3030, or the consent of instructor.

CS3601 THEORY OF FORMAL LANGUAGES AND AUTOMATA (4 - 0).
This course will cover the Chomsky hierarchy of Formal Languages (regular sets, context-free languages, context-sensitive languages, and recursively enumerable languages) and the types of grammars and automata associated with each class in the hierarchy. Emphasis is placed on the major results of the theory as they apply to language and compiler design. In addition, the major results involving the concept of undecidability are covered. PREREQUISITE: MA3025, MA3030 or equivalent.

CS3650 DESIGN AND ANALYSIS OF ALGORITHMS (4 - 0).
This course focuses on the design and analysis of efficient algorithms. Techniques for analyzing algorithms in order to measure their efficiency are presented. Control structure abstractions, such as divide and conquer, greedy, dynamic programming, backtrack (branch and bound), and local search methods are studied. The theory of NP-completeness is presented along with current approaches to NP-hard problems. PREREQUISITES: CS3300, MA3025, MA3030 or equivalent.

CS3651 COMPUTABILITY THEORY AND COMPLEXITY (3 - 1).
This course covers the concepts needed to argue about the decidability and computational complexity of problems. Topics include recursive enumerability, undecidability, diagonalization, computational complexity classes, intractability, Turing reduction, and many-one reducibility. Basic techniques are presented for proving undecidability and for establishing a lower bound on the computational complexity of a problem. PREREQUISITES: CS3601 and CS3650.

CS3670 SECURE MANAGEMENT OF SYSTEMS (3 - 2).
This course is intended to provide students with an understanding of management concerns associated with computer-based information systems. Students will examine the security concerns associated with managing a computer facility. The impact of configuration management on system security, the introduction of software that must be trusted with respect to computer policies, environmental considerations, and the problems associated with transitions to new systems and technology will be studied in the context of Federal government and especially DoD ADP systems. PREREQUISITE: CS3600.

CS3675 INTERNET SECURITY RESOURCES AND POLICY (3 - 2).
This course covers the threats currently facing organizations that access the Internet, the technological basis for such threats and policy options for dealing with such threats. The course is designed to involve students directly in the composition of meaningful security policies. Lab exercises will be used to improve the student's detailed knowledge of security threats and of the options for dealing with such threats. PREREQUISITE: None.

CS3680 BUILDING DEFENSIBLE COMPUTER SYSTEMS (3 - 2).
This course will focus on the threats to computer systems. External attacks, malicious artifacts, such as Trojan Horses, and techniques to eliminate or contain them will be addressed. Assurance methods to create trusted computing bases for both monolithic and distributed systems will be presented. Leveraging high assurance policy enforcement mechanisms in the design of applications will be discussed. System architecture considerations, the application of information security policies in networked systems, the importance of cryptographic methods of communication in distributed systems, and critical topics in database security will be presented. Demonstrations, exercises and experiments with techniques for achieving defensible computer systems will be presented. Building applications for trusted systems will be addressed. Students will examine the use of COTS product to meet system security requirements. Students will gain hands-on experience with methods of distributed identification and authentication and various uses of cryptography as it complements trusted systems. PREREQUISITE: CS3600.

CS3690 NETWORK SECURITY (For Non-CS; CS majors take CS4605.) (4 - 0).
This course presents an integrated view of INFOSEC disciplines in the context of today's dynamic threat environments. It will present security standards, certification, and accreditation as they relate to the management of risks and INFOSEC techniques. Students will learn about several current security policies and will study scenarios where these policies may be silent or ambiguous. Mandatory, discretionary, commercial, and dissemination policies will be addressed. Life cycle issues for INFOSEC systems and organizational impacts on security will be presented. System changes that potentially impact security will be presented such as increased threats or risks, security breaches, hardware changes, policy changes, and environmental factors. PREREQUISITE: CS3600.

CS3700 ADVANCED OBJECT-ORIENTED PROGRAMMING IN C++ (4 - 2).
A course in advanced object-oriented programming using C++ for students having an intermediate-level experience with C++. Students will learn guidelines for using C++ effectively through general design strategies and language specific features to make C++ programs and Object-Oriented Designs more efficient, robust, maintainable and portable. Topics include: Memory management; Constructor, Destructor, and Assignment Operator Issues; Classes and Functions; Inheritance and Object-Oriented Design; Standard Template Library; Exceptions; Efficiency. PREREQUISITE: CS3971 or CS3771.

CS3770 ADA AS A SECOND LANGUAGE (4 - 2).
A first course in Ada for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of Ada. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays and pointers. The object-oriented topics include: data abstraction and encapsulation, packages, inheritance, polymorphism, and generics. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS3971 or CS3973, or recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3771 C++ AS A SECOND LANGUAGE (4 - 2).
A first course in C++ for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of C++, a language used in military and government applications as well as commercial applications used by the military and government. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays and pointers. The object-oriented topics include: data abstraction and encapsulation, classes, objects, operator overloading, inheritance, polymorphism, templates and reusable class libraries. Weekly programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS3970 or CS3973, or recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3773 JAVA AS A SECOND LANGUAGE (4 - 2).
A first course in Java for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of Java. Topics include: program structures and environment, arrays, exceptions, constructors and finalizers, class extension, visibility and casting, overriding vs overloading, abstract classes and interfaces, files and streams, class loaders, threads and sockets. Programming projects provide students the opportunity to implement techniques covered in class. PREREQUISITE: CS3970 or CS3971, or recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3800 DIRECTED STUDY IN COMPUTER SCIENCES (Variable hours 0-2 to 0-8.) (0 - V).
Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in depth subjects not fully covered in formal class work. PREREQUISITE: Consent of Instructor. Graded on Pass/Fail basis only.

CS3920 TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support subject matter of special interest, dependent upon faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. PREREQUISITE: Consent of instructor.

CS3970 DATA STRUCTURES AND INTERMEDIATE OBJECT-ORIENTED PROGRAMMING IN ADA (4 - 2).
This course is a continuation of CS2970. The course covers intermediate level object-oriented programming topics and data structures. The core emphasis of the course is to go beyond the basic programming development skills taught in CS2970. Some of the topics covered in the course include abstract data types, inheritance, polymorphism, basic data structures: trees, hashing, recursion, sorting and searching, and file I/O. Six to seven programming projects will be assigned. PREREQUISITE: CS2970.

CS3971 DATA STRUCTURES AND INTERMEDIATE OBJECT-ORIENTED PROGRAMMING IN C++ (4 - 2).
A second course in object-oriented programming using C++ and first course in data structures for students having an introductory-level experience with C++. Students learn to implement problem solutions involving data structures using the object-oriented language features of C++. Data structures topics include: recursion, lists, stacks, queues, trees, searching, sorting and hash tables. C++ topics include: data abstraction, classes, objects, operator overloading, inheritance, containers, virtual functions, polymorphism, templates and the Standard Template Library. PREREQUISITE: CS2971.

CS3973 DATA STRUCTURES AND INTERMEDIATE OBJECT-ORIENTED PROGRAMMING IN JAVA (4 - 2).
A second course in object-oriented programming using Java and first course in data structures for students having an introductory-level experience with Java. Students learn to implement problem solutions involving data structures using the object-oriented language features of Java. Data structures topics include: recursion, lists, stacks, queues, trees, searching, sorting and hash tables. Java topics include method overloading, abstract classes, inheritance, containers, polymorphism, exception handling, interface and the standard packages. PREREQUISITE: CS2973.

CS4112 DISTRIBUTED OPERATING SYSTEMS (3 - 2).
An advanced treatment of operating systems concepts. Major course topics include distributed operating systems, distributed operating system architectures and concurrent programming. Other topics including secure operating systems and real-time operating systems as time permits. PREREQUISITE: CS3450 or equivalent.

CS4113 ADVANCED LANGUAGE TOPICS (4 - 0).
This course is designed to explore concepts considered essential to the study of programming languages. These concepts include the lambda calculus, the Church-Rosser Theorem, reduction strategies, continuations, semantics, and recursion. PREREQUISITES: CS3111 and CS3450 or consent of instructor.

CS4114 ADVANCED TOPICS IN OBJECT-ORIENTED PROGRAMMING (3 - 2).
This course covers the area of object-oriented programming (OOP) in detail. Investigating current OOP research will be the mainstay of the class. Typical topics will include data abstraction, inheritance, encapsulation, delegation, object-oriented databases and concurrency. Object-oriented languages and applications will also be discussed. A significant programming project is also required. PREREQUISITE: Consent of instructor.

CS4118 RAPID APPLICATION DEVELOPMENT OF INFO WARFARE SYSTEMS (3 - 2).
Rapid application development of client/server information systems that play over wired and wireless networks will become increasingly important to joint forces as the battlefield becomes digitized. This course describes the field of database front-end tools, client/server applications, visual programming, and database middleware. It also provides an analysis and skill development in design and implementation of sample applications using current state-of-the-art development tools such as Optima++, Prospero, and JFactory. A key feature of this course is that it covers a variety of rapid application development approaches and tools. PREREQUISITE: IS3502.

CS4130 WIRELESS MOBILE COMPUTING (3 - 2).
This course will focus on a new paradigm in computing; wireless mobile computing. Portable handheld computing devices are now being used for many applications previously accomplished by larger desktop computers or dedicated small devices. Some of these devices contain powerful RISC CPUs, user-accessible flash RAM storage, networking and peripheral connectivity, handwriting recognition, and built-in infrared networking capabilities. The goal of this course is to provide a fundamental understanding of the devices, communications, and design and implementation issues in building such mobile networked applications. Students will be required to research, design, and/or implement a project that integrates multiple technologies to solve a real-world problem requiring mobile computing. PREREQUISITES: CS3502, CS3971 (or CS3973) or consent of instructor.

CS4150 PROGRAMMING TOOLS AND ENVIRONMENTS (4 - 1).
This course covers the design and implementation of tools to aid software development, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, type checkers, macroprocessors and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented programming environment. PREREQUISITE: CS3460 or consent of instructor.

CS4202 COMPUTER GRAPHICS (3 - 2).
An introduction to the principles of the hardware and the software used in the production of computer generated images. The focus of the course is a major design project utilizing the departmental computer graphics facilities. The course is intended for Computer Science students proficient in the development of software systems. PREREQUISITES: CS2971, CS3300, CS3700 or consent of the instructor.

CS4203 INTERACTIVE COMPUTATION SYSTEMS (3 - 2).
This course studies principles of human-computer interaction (HCI). The design of an interactive system is much different than that of a conventional, non-interactive one. An understanding of the users of the system and how best to design for their needs is of vital importance to the success of an application. In addition, an understanding of implementation issues and constraints is equally important. All interactive systems have constructional as well as behavioral components. The primary focus of the course is on a design project that takes students through an entire interactive design process; from problem statement and requirements definition through prototyping and implementation, evaluation, and field testing. Course material will survey the field of HCI including interaction techniques and styles, design methodologies, evaluation techniques, software development, and input/output devices. Students will learn how to approach problems from the user's point of view, how to study usability issues, and how to incorporate the strengths and limitations of people into the design of interactive systems. PREREQUISITE: CS3300 or consent of instructor.

CS4310 ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MILITARY APPLICATIONS (4 - 0).
This course will survey key areas of current research and applications in artificial intelligence. Areas covered include: representation and logic, search, planning, neural nets, etc.. Students are required to complete a team project relating to a military application. PREREQUISITE: CS3310 or consent of instructor.

CS4311 EXPERT SYSTEMS (3 - 2).
This course covers fundamental issues in expert system design and construction. Topics include: knowledge representation schemes and reasoning methods, uncertainty management, system building tools and shells, and validation and measurement methods. Several projects related to these topics will be assigned throughout the course. In addition, each student will be required to complete a term project. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4312 ADVANCED DATABASE SYSTEMS (3 - 1).
This course is a sequel to CS3320, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, transaction management, recovery, security and other advanced topics. Topics will be illustrated using both commercial and prototype database systems. PREREQUISITE: CS3320 or consent of instructor.

CS4313 ADVANCED ROBOTIC SYSTEMS (4 - 0).
This course covers the fundamental concepts, theories and practices in autonomous robotics. Especially, theories and techniques in motion planning, motion design, vehicle kinematics, sensing, guidance, learning, environmental representation, and control architectures for autonomous mobile vehicles will be discussed. The autonomous mobile robot Yamabico-II will be used for hand-on experiments. We will also discuss on several existing significant robotic research projects and control architectures in the U.S. and other countries. PREREQUISITE: CS3310 or consent of instructor.

CS4314 SYMBOLIC COMPUTING (3 - 2).
This course is concerned with symbolic computing, that is, using computers to manipulate symbols. The first part of the course will focus on the fundamentals of Lisp programming including list processing, function definition, recursion, data structures, Common Lisp Object System (CLOS), and Lisp I/O. The second part of the course will emphasize the use of Lisp to support different Artificial Intelligence applications: search techniques, neural networks, genetic algorithms, etc. Students are required to complete several homework exercises and a term project. Enrollment will be limited to ensure adequate student involvement in class presentations. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4322 ADVANCED DATABASE SYSTEMS SEMINAR (3 - 1).
This course covers the advanced and current research on database topics that have not been discussed fully in the prior database courses CS3320 and CS4312. Possible topics to be discussed in the course include object-oriented databases, database machines (especially multilingual and multibackend systems), multimedia DBMS, semantic modeling, DB security, knowledge-based DBMS, nonnormalized relations, temporal information handling, advanced data structures, real-time database systems, etc. The studies may be theoretical, pragmatic and analytical, or experimental using some advanced prototype database systems. PREREQUISITE: CS4312, or consent of instructor.

CS4450 ADVANCED COMPUTER ARCHITECTURE (4 - 0).
This course covers advanced topics in computer architecture and the application of concepts in computer architecture to the design and use of computers. The topics discussed include classes of computer architecture, application oriented architecture and high performance architecture. PREREQUISITE: CS3200 or equivalent.

CS4451 INTRODUCTION TO PARALLEL COMPUTING (4 - 1).
An introduction to the basic issues of parallel computing. The course brings the students to acknowledge of different models of current parallel computers, and the interconnection networks that support them. Students are introduced to metrics that describe the performance of parallel computer systems. The students are introduced to a variety of parallel algorithms to put different parallel models into perspective. A major design project utilizing NPS parallel and/or distributed computing facilities is assigned.

CS4452 PROGRAMMING PARALLEL COMPUTERS (CS & Non-CS majors) (2 - 4).
A hands-on introduction to parallel computing. The course introduces the student to different scientific and engineering applications that can benefit from parallel computing. The performance trade-offs among different ways of parallelizing an application are discussed. With the aid of parallel programming development tools, the students design, implement, debug, and monitor parallel programs for a few of the applications discussed. Every student is required to complete a nontrivial parallel program for solving some problem pertaining to his/her academic fields of study. The course is intended for CS and non-CS majors.

CS4470 IMAGE SYNTHESIS (3 - 2).
This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Planned topics include illumination, shading, transparency, antialiasing, shadows, raytracing, texturizing and radiosity. PREREQUISITE: CS4202 or the consent of the instructor.

CS4471 COMPUTER ANIMATION (3 - 2).
This course covers advanced topics in the state-of-the-art in animating 3D computer models. Computational techniques for real-time animation, parallel programming, motion control systems, interactive keyframe systems, motion simulation, event driven animation, kinematic methods for figure animation, dynamics for figure animation, task-level animation and other high-level approaches will be examined. Labs utilize Wavefront's Advanced Visualizer animation system, Silicon Graphics workstations, VCR, and large-screen television monitors. PREREQUISITE: CS4202 or consent of instructor.

CS4472 PHYSICALLY-BASED MODELLING (3 - 2).
A physically-based model is a mathematical representation of an object (or its behavior) which incorporates forces, torques, energies and other attributes of Newtonian physics. The goal of this course is to use such modeling to simulate, and graphically depict, the realistic behavior of flexible and rigid 3D objects. Topics covered in the course include teleological modeling, kinematic constraints, behavior functions, inverse dynamics, collision detection, distributed behavioral models, flexible bodies, energy constraints and physically-based rendering. PREREQUISITE: CS4202 or consent of the instructor.

CS4473 VIRTUAL WORLDS AND SIMULATION SYSTEMS (3 - 2).
This course covers the design and implementation of real-time, visual simulation systems for animating and interacting with virtual environments. The course pays special attention to practical issues involving performance/realism tradeoffs; experience with computer/human interaction, especially novel input devices and paradigms; and simulating kinematic and dynamic behaviors in real-time. COREQUISITE: CS4202 or consent of the instructor.

CS4474 VIRTUAL ENVIRONMENT NETWORK AND SOFTWARE ARCHITECTURES (3 - 2).
This course covers the design and implementation of network and software architectures for real-time, interactive 3D virtual environments (VEs). Network architecture topics include a taxonomy for networked virtual environments, distributed interactive simulation protocols (DIS and HLA), virtual reality modeling language (VRML), agent-based network protocols (Java/Telescript), proposed solutions for large-scale networked virtual environments (area of interest mangers and object brokers), multicast backbone tools and developments, and virtual reality transfer protocol proposals. Software architecture topics include representative software architectures for VEs (NPSNET, DIVE, MASSIVE,...), commercial toolkits for VE development (WorldToolKit, Division's dvs, Performer,...), lag in multiprocessor virtual environments, and the HCI implications on VE network and software architectures. PREREQUISITE: CS4473 or the consent of instructor.

CS4500 SOFTWARE ENGINEERING (3 - 1).
The techniques for the specification, design, testing, maintenance and management of large software systems. Specific topics include software life cycle planning, cost estimation, requirements definition and specification, design, testing and verification, maintenance and reusability. The laboratory sessions will discuss special topics. PREREQUISITE: CS3460 or consent of instructor.

CS4510 COMPUTER-AIDED PROTOTYPING (3 - 0).
This course covers the concept and application of computer-aided prototyping to the development and acquisition of DoD software systems. Specific topics include the prototyping software life cycle, system models, design methods, automatic code generation, prototyping languages and tools, and their unique systematic system construction methods for increasing productivity, reliability and portability of software development in comparison with other development methods. PREREQUISITE: CS4500 or consent of instructor.

CS4520 ADVANCED SOFTWARE ENGINEERING (3 - 0).
This course is a sequel to CS4500. The methods for specifying, designing, and verifying software systems are covered in depth, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check Ada programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4530 SOFTWARE RESEARCH AND DEVELOPMENT IN DOD (3 - 0).
This course builds on the material covered in CS4500. Fundamental principles of computer system/network security and distributed computing are covered along with advanced methods, techniques and standards aimed at improving the development and acquisition of DoD software systems. Specific topics include: the application of software engineering principles for designing large, secure, embedded real-time computer systems; the application of software engineering principles for the design of distributed systems; automated tools for the specification, design and generation of code for applications; and existing emerging DoD standards for software development, security and acquisition. PREREQUISITE: CS4500 or consent of instructor.

CS4540 SOFTWARE TESTING (3 - 1).
This course covers the theory and practice of testing computer software with the intent of preventing, finding and eliminating bugs in software. Planning and executing software tests are covered, including requirements-based testing, and advanced testing techniques. These topics are discussed in the context of a realistic development environment, illustrated using a variety of software testing tools. PREREQUISITE: CS4500 or consent of instructor.

CS4550 COMPUTER NETWORKS II (4 - 0).
This course is a continuation of CS3502. The course study emphasizes metropolitan area networks and wide area networks, including the recently developed optical fiber network standards. Integrated networks and ISDN/BISDN are covered. The public telephone network and its relationship to computer networks. Applications of high speed networks and potential future developments. PREREQUISITE: CS3502.

CS4555 ENGINEERING NETWORK CENTRIC SYSTEMS (3 - 1).
This course covers the concepts, methods, techniques and tools for engineering the development of network centric systems. Specific topics include the evolution of client/server models to distributed objects, and introduction to and comparison of CORBA/OpenDoc and OLE/COM, intelligent software agents, application development in distributed environments, security issues in network centric computing, and DoD software system development. PREREQUISITES: CS4500 or consent of instructor.

CS4560 SOFTWARE EVOLUTION (3 - 0).
This course covers the concepts, methods, techniques and tools for supporting the evolution and maintenance of software systems. Specific topics include the use of formal specifications to support software evolution, design databases, configuration management, software changemerging, and software re-engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4570 SOFTWARE REUSE (3 - 0).
This course covers the concepts, methods, techniques and tools for systematic reuse of software components and systems. Specific topics include design and re-engineering for reuse, mechanisms for enhancing reuse, domain specific reuse and software architectures, reuse of requirements models, specifications and designs, tools for reuse, software library organization, and methods for component search. PREREQUISITE: CS4500 or consent of instructor.

CS4580 DESIGN OF EMBEDDED REAL-TIME SYSTEMS (3 - 0).
This course covers the concepts, methods, techniques and tools for supporting the design of embedded real-time systems. Specific topics include real-time systems and concurrency models, object-oriented methods for real-time system design, real-time scheduling, and Ada 95 support for concurrent and real-time systems. PREREQUISITE: CS4500 or consent of instructor.

CS4590 SOFTWARE ARCHITECTURE (3 - 1).
This course covers design suitable architecture for given applications, the use of well-understood paradigms for designing new systems, how formal notation and models can characterize system design, and the study of actual system architecture as models for new designs. It covers architectural styles; shared information systems; linguistic issues; and case studies in areas such as mobile robotics and cruise control. PREREQUISITE: CS4500 or consent of instructor.

CS4591 REQUIREMENTS ENGINEERING (3 - 1).
This is an in-depth treatment of requirements engineering concepts, methods, and tools. The role of requirements engineering within software engineering is explored as well as consistency, cost-benefit analysis, resolving multiple viewpoints, dependency tracing, and automated decision support. Topics are reinforced with examples from DoD applications. Prototyping is introduced as a means of assessing requirements early in the design process. PREREQUISITE: CS4500 or consent of instructor.

CS4592 SOFTWARE RISK ASSESSMENT IN DOD (3 - 1).
Risk assessment is very important for software development and project management. This course will introduce some concepts, techniques and tools for software risk assessment. Specific topics include project management, system engineering, duration and cost calculation, implementation planning, reliability modeling, and comparison of software reliability models. PREREQUISITE: CS4500 or consent of instructor.

CS4593 ADVANCED LOGIC & ALGEBRA FOR SOFTWARE R&D IN DOD (3 - 1).
The aim of this course is to present fundamentals of advanced logic & algebra for software R&D. Specific topics include equational specifications, algebra, characterization of equation classes, the equation calculus, term rewriting, first and second order logic, temporal logic, model theory and generalized induction. PREREQUISITE: CS4500 or consent of instructor.

CS4594 FORMAL MODELS FOR SOFTWARE AUTOMATION (3 - 1).
This course covers the concepts, methods, techniques and tools for designing and developing systems. Specific topics include the use of knowledge-based tools for software evolution and techniques for specification, methods for program derivation and generation, domain-specific program synthesis techniques, and cognitive and planning approaches to software design. PREREQUISITE: CS4500 or consent of instructor.

CS4595 LIGHTWEIGHT INFERENCE TECHNIQUES (3 - 1).
This course covers the fundamental principles and technologies for automated decision support and automated software evolution with an emphasis on techniques for lightweight inference. Specific topics include: decision support systems, software evolution systems, gaps in exiting technology that prevent automation, models and methods for lightweight inference, state of the art theory and practice. PREREQUISITE: CS4500 or consent of instructor.

CS4596 ALOGRITHM DESIGN AND ANALYSIS IN SOFTWARE ENGINEERING (3 - 1).
This course covers algorithm design and analysis in software engineering. Specific topics include advanced data structures (such as Binomial heaps and Fibonacci Heaps), graph algorithm (such as minimum spanning trees, maximum flow, all-pairs shortest paths, and single-source shortest paths), and advanced design and analysis techniques (such as dynamic programming, greedy algorithms, and amortized analysis). PREREQUISITE: CS4500 or consent of instructor.

CS4597 ROBUST GENERATION OF SOFTWARE CONTROL SYSTEMS (3 - 1).
This course covers the concepts, methods, techniques and tools needed to methodically generate robust software for system control. Specific topics include specification and analysis of control requirements, hard and soft real-time constraints, embedded software control, code generation, software reliability through software reuse and redundancy, and DoD requirements for control systems. A survey of computer-aided tools that support the generation of robust systems is provided. PREREQUISITE: CS4500 or consent of instructor.

CS4598 SOFTWARE MERGING AND SLICING TECHNIQUES (3 - 1).
The fundamental concepts, methods and tools for software merging and slicing are covered in this course, with applications to software evolution, configuration management, and testing. This is followed by advanced topics including the state of the art in this field. PREREQUISITE: CS4500 or consent of instructor.

CS4599 AUTOMATED SOFTWARE/HARDWARE INTEGRATION IN DOD (3 - 1).
Automated software/hardware integration is a key problem for current software development in DoD. This course covers some important aspects of this field, including software prototyping, interface integration, data integration, and control integration. Automatable decision support methods for software/hardware integration are also discussed. PREREQUISITE: CS4500 or consent of instructor.

CS4600 SECURE COMPUTER SYSTEMS (3 - 2).
The course covers implementation of protection for both monolithic and distributed secure computer systems. The importance of system architecture to assurance methodologies for security kernels will be emphasized. Topics will include the use of protection hardware, the implementation of virtual machines through the effective use of memory management techniques including segmentation and paging, synchronization mechanisms, critical sections, software engineering methodologies as applied to the development of secure computer systems, and configuration management techniques. Critical topics in database security will be discussed. PREREQUISITES: CS3450, CS3502, CS3600.

CS4603 DATABASE SECURITY (3 - 1).
This course covers the logical issues associated with database security. Policies for integrity and confidentiality of information will be reviewed in the context of database systems. Modeling of secure database systems will be covered along with implementation issues including atomicity, serialization, and view-based control. Releasability issues in secure database design will be addressed. Security in statistical databases will be addressed along with security approaches for object oriented databases. Novel approaches to the collection and use of audit databases will be addressed including intrusion detection. PREREQUISITES: CS3600, CS3320, CS3450.

CS4605 SECURITY POLICIES, MODELS AND FORMAL METHODS (3 - 1).
The course covers the methods used to specify, model, and verify computational systems providing access control. The identification of the security policy and its interpretation in terms of a technical policy for automated systems is covered. Informal and formal security policy models are discussed and several access-control models are explored including information-flow models, the Access Matrix Model, the Bell and LaPadula Model, nondeducibility, and noninterference policy expressed in terms of the entities on a computer is reviewed. Formal models and proof of their correctness provide the bridge between a written statement of security policy and the implementation of a particular secure system. Topics include access control, information flow, safety, verification. Verification methods will be discussed. PREREQUISITES: MA3025, CS3600, CS3651.

CS4614 ADVANCED TOPICS IN COMPUTER SECURITY (3 - 1).
This course covers advanced topics in software, communications, and data security. Military and commercial information security and integrity policies will be studied, software and hardware subversions of computer systems; advances in operating systems, databases and network security, evaluation criteria for secure systems, modal logic and linear and branching-time temporal logics, cryptographic and authentication protocols and techniques for implementing supporting policies. PREREQUISITES: CS3600, CS4600, and CS4605 or consent of the instructor.

CS4800 DIRECTED STUDY IN ADVANCED COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Advanced group studies in computer science on a subject of mutual interest to student and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS4900 RESEARCH SEMINAR IN COMPUTER SCIENCE (0 - 2).
This course will examine the current and planned research of Computer Science faculty in multiple fields of study. The course is designed to support Computer Science students in their third quarter of study in the selection of an emphasis track and an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. PREREQUISITE: Computer Science students in third quarter or consent of Department Chairman.

CS4910 ADVANCED READINGS IN COMPUTER SCIENCE (Variable hours 0-2 to 0-8.) (0 - V).
Directed readings in computer science on a subject of mutual interest to student and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor.

CS4920 ADVANCED TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1.) (V - V).
Designed to support advanced group study of subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subject of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Chairman:
Jeffrey B. Knorr
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David C. Jenn
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Murali Tummala
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David Adamiak, Major, U.S. Marine Corps; Military Instructor (1998)*; MSEE, Naval Postgraduate School, 1998.

Richard W. Adler, Senior Lecturer (1970); PhD, Pennsylvania State University, 1970.

Robert W. Ashton, Associate Professor (1992); PhD, Worchester Polytechnic Institute, 1991.

Robert Barsanti, LCDR, U.S. Navy; Military Instructor (1997); MSEE and MSEA, Naval Postgraduate School, 1996.

Raymond Bernstein, Research Associate (1989); PhD, Naval Postgraduate School, 1995.

Jon T. Butler, Professor (1987); PhD, Ohio State University, 1973.

John G. Ciezki, Assistant Professor (1994); PhD, Purdue University, 1993.

Roberto Cristi, Associate Professor (1985); PhD, University of Massachusetts, 1983.

Monique P. Farques, Associate Professor (1989); PhD, Virginia Polytechnic Institute and State University, 1988.

Douglas J. Fouts, Associate Professor (1990); PhD, University of California at Santa Barbara, 1990.

Vincente Garcia, NSA Chair and Visiting Associate Professor (1994); MSEE, Naval Postgraduate School, 1984.

Gurnam S. Gill, Senior Lecturer (1990); PhD, Southern Methodist University, 1981.

Tri T. Ha, Professor (1987); PhD, University of Maryland, 1977.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Robert (Gary) Hutchins, Associate Professor (1993); PhD, University of California at San Diego, 1988.

Ramakrishna Janaswamy, Associate Professor (1987); PhD, University of Massachusetts, 1986.

David C. Jenn, Associate Professor and Associate Chair for Student Programs (1990); PhD, University of Southern California, 1989.

Jeffrey B. Knorr, Chairman and Professor (1970); PhD, Cornell University, 1970.

Jovan E. Lebaric, Visiting Associate Professor (1993); PhD, University of Mississippi, 1987.

Jace LeBlanc, Visiting Instructor (1997); MSEE, Naval Postgraduate School, 1989.

Chin-Hwa Lee, Professor (1982); PhD, University of California at Santa Barbara, 1975.

Hung-Mou Lee, Associate Professor (1982); PhD, Harvard University, 1981.

Frederic H. Levien, Senior Lecturer (1990); MS, Lehigh University, 1967.

Herschel H. Loomis, Jr., Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Gus Lott, CDR, U.S. Navy; Assistant Professor (1995); PhD, Naval Postgraduate School, 1990.

John McEachen, Assistant Professor (1996); PhD, Yale University, 1995.

Sherif Michael, Associate Professor (1983); PhD, University of West Virginia, 1983.

Michael A. Morgan, Professor (1979); PhD, University of California at Berkeley, 1976.

Phillip E. Pace, Associate Professor (1992); PhD, University of Cincinnati, 1990.

Rudolph Panholzer, Professor, Dean of Science and Engineering and Chairman for Space Systems Academic Group (1964); DSc, Technische Hochschule in Graz, Austria, 1961.

Andrew Parker, Visiting Research Assistant (1996); MS, University of Maryland, 1994; MSES, Naval Postgraduate School, 1992 .

Ron J. Pieper, Visiting Associate Professor (1990); PhD, University of Iowa, 1984.

James R. Powell, CAPT, U.S. Navy; Chair of Information Warfare (IW), Chair of Tactical Analysis and Military Instructor (1996); MSSE, Naval Postgraduate School, 1984.

John P. Powers, Professor (1970); PhD, University of California at Santa Barbara, 1970.

R. Clark Robertson, Professor and Associate Chair for Instruction (1989); PhD, University of Texas at Austin, 1983.

D. Curtis Schleher, Professor (1994); PhD, Polytechnic University, 1975.

Rasler W. Smith, Visiting Instructor (1994); MSEE and EE, Naval Postgraduate School, 1990.

Robert D. Strum, Professor Emeritus (1958); MS, University of Santa Clara, 1964.

Frederick Terman, Senior Lecturer (1983); MSEE, Stanford University, 1964.

George J. Thaler, Professor Emeritus (1951); DEng, Johns Hopkins University, 1947.

Charles W. Therrien, Professor (1984); PhD, Massachusetts Institute of Technology, 1969.

Harold A. Titus, Professor Emeritus (1962); PhD, Stanford University, 1962.

Murali Tummala, Professor and Associate Chair for Research (1987); PhD, India Institute of Technology, 1984.

Donald van Z. Wadsworth, Senior Lecturer (1988); PhD, Massachusetts Institute of Technology, 1958.

Todd Weatherford, Assistant Professor (1995); PhD, North Carolina State University, 1993.

Randy Wight, Research Instructor (1991); MSEE, Naval Postgraduate School, 1990.

Lonnie Wilson, Visiting Research Associate (1997); PhD, University of California at Los Angeles, 1973.

Xiaoping Yun, Associate Professor (1994); ScD, Washington University, 1987.

Lawrence J. Ziomek, Professor (1982); PhD, Pennsylvania State University, 1981.

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

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering curriculum and the Space Systems Engineering curriculum. Additionally, the department offers courses in support of other curricula such as Information Warfare/Electronic Warfare; Avionics; Information Technology Management; Command, Control, Communications, Computers and Intelligence; Space Systems Operations; Underwater Acoustics and Engineering Acoustics.

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.) as well as the Master of Science in Computer Engineering (MSCE) and the Master of Science in Engineering Science with a major in EE (MSES/EE). The department typically graduates over 80 MSEE degree candidates, four EE degree recipients and one Ph.D. per year.

An MSEE student will usually spend six to twelve months learning or reviewing material at a junior or senior level before entering into graduate studies. The graduate study portion of a typical program is about one year in duration with a combination of course study and thesis work being performed. The thesis portion of the study is the equivalent of four courses with an acceptable written thesis being a requirement for graduation.

The curriculum is organized to provide the students with coursework spanning the breadth of Electrical and Computer Engineering. In addition, students concentrate in one major area of Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

Communications Systems
Computer Systems
Guidance, Navigation and Control Systems
Electromagnetic Systems (Radar/EW)
Joint Services Electronic Warfare
Power Systems
Signal Processing Systems
Signals Intelligence Systems

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The department has about forty-five faculty members either on a permanent or visiting basis contributing to the instructional and research programs.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING
A Bachelor of Science in Electrical Engineering or its equivalent is required. Credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve the degree equivalence.

To complete the course requirements for the master's degree, a student needs a minimum of 52 credit hours of graduate level work. There must be a minimum of 36 credits in the course sequence 3000 - 4999 of which at least 24 credits must be in Electrical and Computer Engineering and at least 3 must be in mathematics. The remainder of these 36 credits must be in engineering, mathematics, physical science, and/or computer science. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits, must be in the course sequence 4000 - 4999.

An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the department.

MASTER OF SCIENCE IN COMPUTER ENGINEERING
Computer Engineers are in very high demand in DOD military and civilian positions, paralleling the high demand for Computer Engineers in American industry and business. The program leading to the Master of Science in Computer Engineering (MSCE) degree is designed to provide students with a comprehensive, systems-level education in hardware, software, and the hardware/software interface, while at the same time allowing for in-depth study in an area such as Fault Tolerant Computing, Computer Security, High-Speed Networking, Distributed Operating Systems, VLSI Design, Parallel and Distributed Processing, Embedded Computing, etc.

A Bachelor of Science degree in Computer Engineering (BSCE) from an ABET accredited institution, or its equivalent, is required for admission. For entering students without a BSCE from an ABET accredited institution, credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve degree equivalence. The MSCE student without a BSCE will usually spend six to twelve months learning or reviewing material at the junior/senior undergraduate 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 program leading to the MSCE is not yet accredited at the advanced level by the Accreditation Board for Engineering and Technology (ABET). However, accreditation is being sought. Once accreditated, it is expected that already-granted degrees will be retroactively accredited.

To complete the course requirements for the MSCE degree, a minimum of 52 credit hours of graduate work is required. There must be a minimum of 36 credits in courses numbered 3000 to 4999, of which at least 24 credits must be in approved Computer Engineering courses and at least 3 must be in mathematics. The remainder of the 36 credits must be in engineering, mathematics, physical science, and/or computer science. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits must be in 4000-level courses.

An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the department.

MASTER OF SCIENCE IN ENGINEERING SCIENCE
Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science. The program of each student seeking this degree must contain at least 52 credit hours of graduate level work including 36 credit hours in the course sequence 3000 - 4000. Of these 36 course credits, at least 20 must be in Electrical and Computer Engineering, and an additional 12 must be in engineering, mathematics, physical science and/or computer science. At least 12 of the 36 must be in the course sequence 4000-4999. All students must submit an acceptable thesis of at least 16 credit hours. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The department Chairman's approval is required for all programs leading to this degree.

ELECTRICAL ENGINEER
Students with strong academic backgrounds may enter a program leading to the Degree of Electrical Engineer.

A minimum of 96 total graduate credits is required for the award of the engineer's degree of which at least 24 must be in accepted thesis research and at least 54 credits must be in Electrical and Computer Engineering courses.

At least 36 of the total hours are to be in courses in the sequence 4000 - 4999. Approval of all programs must be obtained from the Chairman, Department of Electrical and Computer Engineering.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM
The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer Degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that may address system design issues are welcome.

DOCTOR OF PHILOSOPHY
The Department of Electrical and Computer Engineering has an active program leading to the degree Doctor of Philosophy. Joint programs with other departments are possible. A noteworthy feature of these programs is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

LABORATORIES
The laboratories of the department serve the dual role of supporting the instructional and research activities of the department. The department has well-developed laboratories in each specialty area.

The Controls Laboratory is primarily an instructional laboratory, supporting experiments in simulation and in hardware manipulation. The Circuits/Electronics Laboratory is also an instructional laboratory supporting courses in circuit analysis and design as well as electronic devices and applications.

The Digital Signal Processing Laboratory is primarily for research and thesis work. The laboratory provides a special subnetwork of SUN workstations, some of which are equipped for advanced digital, audio and image processing. A set of smaller microcomputers to support instruction in digital signal and image processing is available elsewhere in the department.

The Digital Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including an HP64000 for advanced course work and thesis research. CAD facilities are capable of schematic capture, circuit simulation and fault detection. Major systems in the Computer Laboratory include a modem distributed server system with a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system provides resource-sharing and integrates these systems with office and laboratory microcomputers and workstations.

The VLSI Laboratory supports work in system design using integrated circuits and design of custom integrated circuits. Color graphic displays are used for layout of N- channel MOS (Metal-Oxide-Semiconductor) (NMOS) and Complementary MOS (CMOS) circuits.

The Optical Electronics Laboratory supports both research and courses in the areas of optics that use electronics. The laboratory has low and medium power lasers including CO lasers, an argon ion laser, a dye laser, a Nd:YAG laser and a variety of HeNe and diode lasers. A variety of detectors and imaging equipment is also available.

The Radar and EW Laboratories support courses and thesis work. Working radar systems and EW systems have been modified to allow student access to the signal processing portions of the equipment.

The Academic Computing Laboratories provide programming, wordprocessing, and engineering software support for students and faculty. Four (4) servers with 13 GBytes storage capacity support 24 workstations distributed throughout the department. Twenty-four (24) high-power personal computers, flatbed scanners, laser and color printers with a variety of software are available for student use. A secure computing laboratory is available for doing classified computing and word processing.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems to support instructional activities and research in the frequency range from 100 MHz to 300 GHz. A high quality anechoic chamber with HP8510C Network Analyzer is available for broad band antenna pattern and impedance measurements.

The Transient Electromagnetics Scattering Laboratory supports research related to impulse antenna design and impulse radar target classification.

The Power Systems Laboratory supports research and instruction in all aspects of electric power generation, distribution and utilization for ships, submarines and other military systems.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory and the Supply and Issue Facility for the ordering of instrumentation and electronic components. Classified instruction and research is supported by appropriately certified facilities.

ELECTRICAL AND COMPUTER ENGINEERING COURSE DESCRIPTIONS

EC0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

EC0950 SEMINAR (NO CREDIT) (0 - 1).
Lectures on subjects of current interest will be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School.

EC1010 INTRODUCTION TO MATLAB (1 - 1).
An introductory course for students with little or no programming background using MATLAB. Basic concepts of the MATLAB environment are considered such as matrix operations, vector and matrix manipulations, equation solving, simulation, programming, and graphing. This course prepares students for using MATLAB in future course work in the ECE department. Graded on a Pass/Fail basis only.

EC2010 PROBABILISTIC ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on signal processing, communication systems, and computer networks relevant to military applications. Topics include probability, random variables, and random sequences; density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and the r.m.s. values of nondeterministic signals, correlation and covariance; radar and sonar signal detection; LTI systems, transformation of random variables and the central limit theorem; basic queuing theory and computer communication networks. PREREQUISITE: EC2410 (may be taken concurrently).

EC2100 CIRCUIT ANALYSIS (3 - 2).
The fundamental circuit analysis course for Electrical Engineering majors. The course considers circuit principles, circuit topology, direct current circuits, natural response, forced response, total response, impedance concepts, the application of the Laplace transformation to solve circuit problems and device transfer functions. The laboratories will utilize both computer software and hands-on exercises. PREREQUISITES: PH1322, MA1043 and MA2121 (may be concurrent).

EC2110 CIRCUIT ANALYSIS II (3 - 2).
A continuation of EC2100. The course considers circuit principles, impedance concepts and steady-state ac circuits, ac power, frequency response and selectivity, basics of operational amplifiers and an introduction to machines and power converters. PREREQUISITE: EC2100.

EC2200 INTRODUCTION TO ELECTRONICS ENGINEERING (3 - 3).
An introduction to electronic devices and circuits. Solid state physics and semiconductor fundamentals. Properties of p-n junctions in diodes; Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET); static and dynamic models for these devices, and their linear and nonlinear applications. Applications of transistors in the design of amplifiers and digital systems. Ideal operational amplifier characteristics and applications. Fabrication and the design of integrated circuits. PREREQUISITE: EC2100 or EC2170.

EC2220 APPLIED ELECTRONICS (2 - 4).
A project course covering the design and applications of analog and digital integrated circuits (ICs). Includes an introductory overview of important communications ICs and practical experimental design, constructions, and testing of circuits and systems using these devices. PREREQUISITE: EC2200.

EC2300 CONTROL SYSTEMS (3 - 2).
The main subject of this course is the analysis of feedback systems using basic principles in the frequency domain (Bode plots) and in the s-domain (root locus). Performance criteria in the time domain such as steady-state accuracy, transient response specifications, and in the frequency domain such as bandwidth and disturbance rejection, will be introduced. Simple design applications using root locus and Bode plot techniques will be addressed in the course. Laboratory experiments are designed to expose the students to testing and evaluating mathematical models of physical systems, using computer simulations and hardware implementations. PREREQUISITES: EC2100, and ability to program in MATLAB.

EC2320 LINEAR SYSTEMS (3 - 1).
Formulation of system models including state equations, transfer functions, and system diagrams for continuous and sampled-data systems. Computer and analytical solution of system equations. Stability, controllability, and observability are defined. Introduction to design by pole placement using measured and estimated state feedback. Application to military systems is introduced via example. PREREQUISITE: EC2100 and ability to program in MATLAB.

EC2400 DISCRETE SYSTEMS (3 - 1).
Principles of discrete systems, including modeling, analysis and design. Topics include difference equations, convolution, stability, bilateral z-transforms and application to right-sided and left-sided sequences, system diagrams and realizations, and frequency response. Simple digital filters are designed and analyzed. PREREQUISITE: MA2051 (may be taken concurrently) and ability to program in MATLAB.

EC2410 ANALYSIS OF SIGNALS AND SYSTEMS (3 - 1).
Analysis of digital and analog signals in the frequency domain; properties and applications of the discrete Fourier transform, the Fourier series, and the continuous Fourier transform; analysis of continuous systems using convolution and frequency domain methods; applications to sampling, windowing, and amplitude modulation and demodulation systems. PREREQUISITE: EC2400.

EC2450 ACCELERATED REVIEW OF SIGNALS AND SYSTEMS (4 - 0).
An advanced review of continuous and discrete system theory intended for students who have previous education in these areas. Topics covered by each student will depend upon background and competence in the subject matter of EC2400, EC2410, and EC2320. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 COMMUNICATIONS SYSTEMS (3 - 2).
In this first course on the electrical transmission of signals, the theory, design, and operation of analog and digital communication systems are investigated. Included are A/D conversion, modulation, demodulation, frequency division multiplexing, and time-division multiplexing. PREREQUISITES: EC2200 and EC2410.

EC2600 ELECTROMAGNETIC FIELDS AND WAVES (4 - 0).
Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions and plane wave propagation in vacuum and materials. PREREQUISITE: MA2051 or equivalent.

EC2610 ELECTROMAGNETIC ENGINEERING (3 - 1).
A continuation of EC2600. Topics include the analysis and design of transmission lines, waveguides, resonators, and high frequency components. Applications of military and other interest are presented in the laboratory. PREREQUISITE: EC2600.

EC2650 ACCELERATED REVIEW OF ELECTROMAGNETICS (4 - 2).
A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC2600 and EC2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC2820 DIGITAL LOGIC CIRCUITS (3 - 2).
An introductory course in the analysis and design of digital circuits. These circuits are the basis for all military computers and digital control systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, truth tables, logic gates, integrated circuit families, decoders, multiplexers, arithmetic circuits, PLAs, ROMs, design of combinational circuits using SSI and MSI components, sequential logic including latches, flip-flops, registers, counters, and memories, analysis and design of synchronous circuits using state tables and state diagrams. The laboratories are devoted to study of combinational and sequential circuits and include a sequence of design projects involving increasingly complex digital functions. PREREQUISITE: None.

EC2840 INTRODUCTION TO MICROPROCESSORS (3 - 2).
An introduction to the organization and operation of microprocessors and microcomputers, both key embedded elements of military systems. Topics include: the instruction set, addressing methods, data types and number systems, stack and register organization, exception processing, assembly language programming techniques including macros, assembly language implementation of typical control structures, data structures, and subroutine linkage methods. Laboratory sessions teach a systematic method for program design and implementation. The laboratory assignments consist of a series of programs which collectively implement a major software project. PREREQUISITES: A high level language and EC2820 (may be taken concurrently).

EC2990 DESIGN PROJECTS IN ELECTRICAL ENGINEERING (0 - 8).
Design projects under the supervision of faculty members. Individual or team projects involving the design of devices or systems. Projects will typically be in support of faculty members. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC3130 ELECTRICAL MACHINERY THEORY (4 - 2).
An introduction to the analysis of magnetically-coupled circuits, dc machines, induction machines, and synchronous machines. The course will include explicit derivations of torque, voltage, and flux linkage equations, formulation of steady-state circuits, development of reference frame theory, and the basics of machine simulation as required in shipboard electric drive analysis. PREREQUISITE: EC2100.

EC3150 SOLID STATE POWER CONVERSION (3 - 2).
A detailed analytical approach is presented for the operation, performance, and control of the important types of solid state power converters found in naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices. A systems approach is used to analyze high power converters: phase controlled rectifiers, line commutated inverters, self-commutated inverters, transistors converters, and switching regulators. PREREQUISITE: EC2100 or consent of instructor.

EC3200 ADVANCED ELECTRONICS ENGINEERING (3 - 2).
Characteristics of differential and multistage amplifiers. Transistors frequency response, including Bipolar Junction Transistors (BJT), Junction Field Effect Transistors (JFET), and Metal Oxide Semiconductor Field Effect Transistors (MOSFET); characteristics and design consideration. Integrated circuit OPAMP applications; analysis and design of non-ideal OPAMPS. Applications of BJTs and Complimentary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor Transistor Logic (TTL), Emitter Coupled Logic (ECL), and CMOS logic families. Applications and design feedback amplifiers and operational amplifiers applications in analog filters and oscillators. PREREQUISITE: EC2200.

EC3210 INTRODUCTION TO ELECTRO-OPTICAL ENGINEERING (3 - 1).
An overview of the elements that comprise current electro-optical and infrared (EO/IR) military systems. Topics include radiation sources (both laser and thermal), detector devices, modulators, optical elements, and propagation characteristics. Examples of the application of the concepts taught to various military EO/IR systems such as missile seekers, laser communications, and laser designators are discussed. PREREQUISITE: EC3200 (may be taken concurrently).

EC3230 SPACE POWER AND RADIATION EFFECTS (Formerly EO3205.) (3 - 1).
Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid-state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics. Radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design. PREREQUISITE: EC2200.

EC3310 OPTIMAL ESTIMATION: SENSOR AND DATA ASSOCIATION (3 - 2).
The subject of this course is optimal estimation and Kalman filtering with extensions to sensor fusion and data association. Main topics include the theory of optimal and recursive estimation in linear (Kalman filter) and nonlinear (extended Kalman filter) systems, with applications to target tracking. Topics directly related to applications such as basic properties of sensors, target tracking models, multihypothesis data association algorithms, reduced order probabilistic models and heuristic techniques will also be discussed. Examples and projects will be drawn from radar, EW, and USW systems. PREREQUISITES: EC2010, EC2320, MA3046.

EC3320 OPTIMAL CONTROL SYSTEMS (3 - 2).
This course addresses the problem of designing control systems which meet given optimization criteria. The student is exposed to the development of the theory, from dynamic programming to the calculus of variation, and learns how to apply it in control engineering. PREREQUISITES: EC2300, EC2320.

EC3400 DIGITAL SIGNAL PROCESSING (3 - 1).
The foundations of one and two-dimensional digital signal processing techniques are developed. Topics include fast Fourier transform (FFT) algorithms (1-D and 2-D), block convolution, the use of DFT and FFT to evaluate convolution (1-D and 2-D), elements of multirate signal processing and rate conversion, and design methods for 1-D nonrecursive and recursive digital filters. Computer-aided design techniques are emphasized. Introduction to time-frequency representation through the short-time Fourier transform and wavelet transforms. The algorithms introduced have direct applications in sonar and radar signal processing, IR sensor arrays, modern navy weapon systems, and also in voice and data communications. PREREQUISITE: EC2410.

EC3410 DISCRETE-TIME RANDOM SIGNALS (3 - 1).
Fundamentals of discrete-time random processes are developed from a probabilistic and statistical point of view for digital signal processing, control, and communications. Topics covered are random vectors and description of discrete-time random signals, sampling of continuous-time random signals, statistical averages and second moment analysis, linear transformations, and fundamentals of estimation theory. Subject matter also includes FIR optimal (Wiener) filtering, and an introduction to linear prediction. PREREQUISITES: EC2410 (may be taken concurrently), EC2010, and MA3046.

EC3420 STATISTICAL DIGITAL SIGNAL PROCESSING (3 - 1).
Modern naval systems are highly dependent on advanced statistical signal processing techniques. Modern methods of digital signal processing are developed in this course from a statistical point of view. Methods are developed for processing random signals through statistical data analysis and modeling. Topics include the IIR Wiener filter and the scalar form of the Kalman filter, linear prediction, MA, AR, and ARMA signal modeling, lattice structures, and an introduction to modern methods of spectrum estimation. PREREQUISITE: EC3410.

EC3450 FUNDAMENTALS OF OCEAN ACOUSTICS (4 - 0).
Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality relationships, etc., that are used to model and solve real world problems concerning the propagation of sound in the ocean. Topics include, for example, reflection and transmission coefficients, ocean waveguide pulse-propagation models based on normal mode and full-wave theory, the WKB approximation, three-dimensional ray acoustics, and the parabolic equation approximation. PREREQUISITES: Undergraduate calculus and physics.

EC3500 ANALYSIS OF RANDOM SIGNALS (4 - 0).
Fundamental concepts and useful tools for analyzing non-deterministic signals and noise in military communication, control, and signal processing systems are developed. Topics include properties of random processes, correlation functions, energy and spectral densities, linear systems and mean square estimation, noise models and special processes. PREREQUISITES: EC2500 (may be taken concurrently) and EC2010, or consent of instructor.

EC3510 COMMUNICATIONS ENGINEERING (3 - 1).
The influence of noise and interference on the design and selection of hardware in practical communication transmitters and receivers is analyzed. Specific topics include link budget analysis and signal-to-noise ratio calculations, receiver noise performance for various modulation schemes, bandwidth trade-offs, and hardware parameters. Examples of military communications systems are included. PREREQUISITES: EC2220 and EC3500.

EC3550 FIBER OPTIC SYSTEMS (3 - 1).
An introduction to the components and to the concepts of designing fiber optic communications systems for military applications. Includes fiber properties and parameters, fiber fabrication and testing, LED and injection laser sources, pin photodiodes and avalanche photodiode detectors, receiver design considerations, connector and splice techniques, and system design incorporating analysis and trade-offs. Data distribution techniques are also studied. PREREQUISITES: EC2220, EC2500, and EC2600.

EC3600 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (3 - 2).
The principles of electromagnetic radiation are applied to antenna engineering, scattering, and propagation. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. PREREQUISITE: EC2610 or equivalent.

EC3610 MICROWAVE ENGINEERING (3 - 2).
This course provides an overview of the circuits and devices used in microwave radar communication and electronic warfare systems. The course covers network analysis using scattering parameters, transmission media, selected circuits, electron tubes, solid state devices, and monolithic integrated circuits. Circuits and devices are studied in the laboratory using both hardware and computer simulation. PREREQUISITE: EC2610.

EC3630 RADIOWAVE PROPAGATION (3 - 0).
This course treats the effects of the earth and its atmosphere on electromagnetic waves in the frequency range up to about 300 GHz. Topics covered include ground waves, sky waves, meteor burst, scatter, ducting reflection, refraction, diffraction, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Antenna parameters are covered briefly. PREREQUISITE: EC3600 or consent of instructor.

EC3650 COMPUTATIONAL ELECTROMAGNETIC MODELING TECHNIQUES (4 - 1).
This is a “hands-on” course on numerical solution of static, time-harmonic, and transient electromagnetic field problems of the type encountered in radar and electronic warfare. One numerical technique for each of the two broad categories of integral and differential techniques is taught: Method of Moments (MOM) for static and time-harmonic field problems and Finite Differences (FD) for static, time-harmonic, and transient electromagnetic field problems. Applications include planar transmission lines, radiation and scattering by thin wires, waveguide and cavity modes, and transient scattering by perfectly conducting objects of simple shape. Students write their own computer codes to implement the techniques taught in class, using a high level programming environment such as MATLAB or MATHCAD. Commercial and “in house” numerical electromagnetic codes are introduced in the laboratory. PREREQUISITE: EC3600 or consent of instructor.

EC3700 INTRODUCTION TO JOINT SERVICES ELECTRONIC WARFARE (3 - 2).
The fundamental electronic warfare analysis course for Electrical Engineering majors. The course considers the sensors and associated weapon systems in use by the Army, Air Force, Navy, and Marines. Also, electronic warfare in joint theater, electronic warfare receiving systems, communications electronics, signal and telemetry intelligence systems, artillery, directed energy, and laser weapon systems. Active, passive, IR, and dual-mode seeker technologies are also discussed. PREREQUISITES: EC2010, EC2320, EC2500, EC2610.

EC3750 SIGINT SYSTEMS (3 - 2).
Introduction to National Signals Intelligence (SIGINT) systems with focus on tasking, exploitation, collection, processing, and dissemination of products derived by special SIGINT systems. This course focuses on applying numerical and analytical techniques to exploit realistic navigation, communications, radar, telemetry, and other threat target sets critical to national security. A thorough review of fundamentals in radar and communications to include the utilization of spread spectrum by these systems will be discussed. The analysis of systems is presented for SIGINT operations or measurements such as: encoding/decoding, multiplexing, demultiplexing, modulation/demodulation, signal-to-noise ratio, bit-error rate, bandwidth efficiency, power budget, and polarization. PREREQUISITES: EC2500 or EO3513 or consent of instructor; U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

EC3800 MICROPROCESSOR BASED SYSTEM DESIGN (3 - 2).
Advanced microprocessor system concepts are studied. Microprocessor systems are widely used for embedded control in military systems as well as for stand-alone computers. Topics covered are CPU operation and timing, address decoding, typical LSI support chips, exception processing, design of static and dynamic memory systems, worst-case timing analysis, bus arbitration, and direct memory access controllers. The laboratory consists of a design project integrating hardware and software using a state-of-the-art development system. PREREQUISITES: EC2820 and EC2840.

EC3820 COMPUTER SYSTEMS (3 - 1).
The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software, and firmware. General features of operating systems are studied as well as specific features of an existing system. The elements of a multiprogramming system are introduced. PREREQUISITE: EC2840.

EC3830 DIGITAL COMPUTER DESIGN METHODOLOGY (3 - 2).
A design and project-oriented course covering basic principles, theories and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential elements of classical switching theory with a thorough understanding of modern design aids. Current military and commercial systems are used as design examples. PREREQUISITE: EC2820.

EC3840 INTRODUCTION TO COMPUTER ARCHITECTURE (3 - 2).
Introduction to computer organization. Fundamental principles of computer design and cost/performance. Instruction set design and usage. Processor design and implementation, including the data path and the control unit. Computer design, including buses, the memory hierarchy and the input/output subsystem. Factors affecting performance and performance measurement/evaluation. The effects of embedded military applications on computer architecture. PREREQUISITES: EC2820 and EC2840.

EC3850 COMPUTER COMMUNICATIONS METHODS (3 - 1).
The course objective is to develop an understanding of computer communications networks with emphasis on the requirements of military environments and the US Navy’s combat platforms. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput, and cost analysis. The layered network architectures, such as the International Standards Organization (ISO) model and GOSIP consisting of the physical, data link, network, transport, session, presentation, and application layers, are covered. The techniques and protocols used in these layers are discussed. Local area networking technologies such as Ethernet, ring, FDDI and satellite link, and wide area technologies such as X.25 public packet switching are covered. DoD’s protocol suite is introduced. Some distributed applications are presented. PREREQUISITE: EC2010 and EC2500.

EC3910 ,20,...,90 SPECIAL TOPICS IN ELECTRICAL ENGINEERING (V - V).
Courses on special topics in Electrical Engineering are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EC4000 FUTURE ENGINEERING PRACTICE (3 - 0).
This course discusses the fundamental concepts and practices of electrical engineering history, especially computer simulations (including AI), so that students can see trends and make some guesses as to their future. It primarily concentrates on students and their problems in learning new things as technology and careers continue to progress. The course, to some extent, adapts itself to the interests of the students enrolled, but much is a survey of the fundamentals of engineering theory and practice and projections into the future. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC4010 PRINCIPLES OF SYSTEMS ENGINEERING (3 - 2).
Introduction to systems engineering concepts and methods for the design and integration of complex defense systems, with emphasis on electrical engineering applications. Familiarity with the systems engineering process is developed through case studies of representative defense systems and a group design project which includes determination of system requirements from mission needs and operational requirements. Digital simulation models, including those in current use by DoD, are used to determine engineering and performance tradeoffs. PREREQUISITES: Four quarters in an NPS engineering curriculum or equivalent.

EC4130 ADVANCED ELECTRICAL MACHINERY SYSTEMS (4 - 2).
Advanced analysis of detailed and reduced-order representations of shipboard electrical machinery and power electronic drives. This course will include extensions to 3-phase machine and network connections, constant flux and current source control, extensive simulation examples including saturation and open-phase conditions, comprehensive investigation of linearized and reduced-order machine and drive representations, the modeling and control of a dc link system, and the fundamentals of induction machine vector control. PREREQUISITE: EC3130.

EC4150 ADVANCED SOLID STATE POWER CONVERSION (4 - 1).
Design and analysis of modern power electronic drives with particular emphasis on electric drives for present and future ship propulsion systems and variable frequency/variable speed power converters for advanced shipboard electric power distribution. Electrical and mechanical systems compatibility and electrical system interfacing topics are addressed. This course begins by examining the non-ideal aspects of power semiconductor switches and other components. In addition, dynamic performance of power electronic circuits is explored. The course includes some more advanced topics like resonant converters and active power line conditioners. PREREQUISITES: EC3150 and electrical machine theory, or consent of instructor.

EC4210 ELECTRO-OPTIC SYSTEMS ENGINEERING (3 - 0).
Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest. PREREQUISITE: EC3210.

EC4220 INTRODUCTION TO ANALOG VLSI (3 - 1).
Modern active circuit design topologies; analog and sample data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications. PREREQUISITES: EC2400 and EC3200.

EC4300 ADVANCED TOPICS IN MODERN CONTROL SYSTEMS (3 - 1).
Advanced topics and current developments in control systems are presented in this course. The list of special topics includes (but is not limited to) robotics systems, autonomous vehicles, design by robust techniques. PREREQUISITE: Consent of instructor.

EC4320 DESIGN OF ROBUST CONTROL SYSTEMS (3 - 2).
This course presents advanced topics on control system design. Major emphasis is on robust techniques in order to account for uncertainties on the systems to be controlled. Several applications show the trade-offs in several applications, such as missile and/or underwater vehicles control design. Advanced concepts on H2 and H-infinity will be introduced as part of the course. PREREQUISITES: EC3310, EC3320.

EC4330 NAVIGATION, MISSILE, AND AVIONICS SYSTEMS (Classified) (2 - 2).
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, radar laser, and acoustic sensors; inertial platforms; gyros and accelerometers; Loran, Omega, GPS, INS guidance ,fire control and tracking systems. PREREQUISITES: EC3310, U.S. citizenship and SECRET clearance.

EC4340 NAVIGATION, MISSILE, AND AVIONICS SYSTEMS FOR INTERNATIONAL STUDENTS (2 - 2).
This course covers essentially the same material as EC4330, but with deletion of detailed analysis of specific systems. This course is intended for officers who do not have U.S. citizenship. PREREQUISITE: EC3310.

EC4350 NONLINEAR CONTROL SYSTEMS (3 - 2).
This course presents techniques for automatic control of nonlinear systems with application to current military and robotic systems. Main topics include the analysis and design of nonlinear systems with phase plane and describing function methods, Lyapunov and sliding mode control techniques. Accuracy limit cycles, jump resonances, relay servos, and discontinuous systems will also be considered. PREREQUISITES: EC2300, EC2320.

EC4360 ADAPTIVE CONTROL SYSTEMS (3 - 2).
This course addresses the problem of control systems which can self-adjust to changes in the operating conditions. Typical examples are autopilots for large ships which have to adapt to changes in load and/or sea conditions. Several techniques are presented, ranging from classical adaptive linear models to more modern techniques based on neural networks. PREREQUISITES: EC3310, EC3320.

EC4400 ADVANCED TOPICS IN SIGNAL PROCESSING (3 - 0).
Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest. PREREQUISITE: EC3420 or consent of instructor.

EC4410 SPEECH SIGNAL PROCESSING (3 - 1).
This course covers methods of digital signal processing as they are applied to speech communication for transmission, encryption, and recognition. The production and perception mechanisms are discussed. Topics include speech modeling analysis, synthesis, coding (including LPC), and speech and speaker recognition. The techniques introduced here are also applied to sonar signal processing, voice controlled remote security and access, voice operated aircraft control, and others areas. PREREQUISITES: EC3400 and EC3420 or consent of instructor.

EC4420 MODERN SPECTRAL ANALYSIS (3 - 1).
Spectral estimation is the key to passive sonar detection, tracking, and identification. It also plays a dominant role in radar/sonar signature evaluation and in a majority of signal processing applications as they apply to the weapons technology of DOD. Classical and modern spectral estimation are developed from their basic ideas and compared in terms of performance and implementation. Topics covered are Fourier-based, model-based and eigenspace-based estimators, as well as Capon's method and Prony's method. Nonstationary spectral estimation schemes are discussed, in particular the Wigner-Ville distribution and the instantaneous power spectrum. Array processing is discussed from classical, model-based and eigenspace-based perspectives. Additional topics are cepstral analysis, higher order spectral estimators, and coherency. PREREQUISITES: EC3400 and EC3420.

EC4450 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 critical to naval operations. Topics from complex aperture theory, array theory, and signal processing are covered. This course supports the undersea warfare and engineering acoustics curricula and others. PREREQUISITES: EC3450 or PH3400 or PH3452 and either EC3410 or EC3500 or EO3402.

EC4460 ARTIFICIAL NEURAL NETWORKS (3 - 1).
The basic theory and practice of artificial neural networks and their applications in electrical engineering are presented. Modeling of biological neurons as processing elements, their organization into a network of interconnected artificial neurons, and some basic laws of learning are discussed. Details of learning algorithms, such as LMS, back propagation, self-organizing map, adaptive resonance theory and simulated annealing, are presented. Emphasis is placed on problems related to pattern recognition and classification, control systems, optimization, and data compression. Course projects address DoD specific applications, such as radar/sonar target recognition and classification using image or acoustic data. Genetic algorithms and fuzzy logic are introduced. PREREQUISITE: EC3410 or EC3500 and knowledge of simple electronic and logic circuits.

EC4470 ADAPTIVE SIGNAL PROCESSING (3 - 1).
Introduction to the theory of adaptive signal processing for random sequences. Topics covered include: review of Wiener filters and one-step forward linear prediction-error filters; one-step backward linear prediction-error filters; analysis and synthesis lattice prediction-error filters; adaptive tapped-delay-line filters using steepest descent, least-mean-squares (LMS) and recursive least-squares (RLS) algorithms; and adaptive lattice filters. PREREQUISITES: EC3400 and EC3420.

EC4480 IMAGE PROCESSING AND RECOGNITION (3 - 2).
This course provides image processing background for understanding modern military applications such as long range target selection, medium range identification, and short range guidance of new weapons systems. Subjects include image sampling and quantization, image representation, enhancement, transformation, encoding, and data compression. Predictive coding, transform coding, and interframe coding techniques are also introduced. Some effort is directed toward image compression techniques particularly suited for multimedia video conferencing. The course contains a series of experiments using special peripherals and computers. PREREQUISITE: EC3400.

EC4490 OCEAN ACOUSTIC TOMOGRAPHY (EC/OC4490) (3 - 0).
An introduction to ocean acoustic tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of ocean acoustic tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITE: EC2410 or OC3260 or PH4453 or equivalent. Also offered as OC4490.

EC4500 ADVANCED TOPICS IN COMMUNICATIONS (3 - 0).
Topics and current developments in communications relevant to advanced naval and other military applications. Offered on an occasional basis with the topics determined by the instructor. PREREQUISITE: Consent of instructor.

EC4510 CELLULAR COMMUNCATIONS (3 - 0).
This course presents the fundamentals of cellular communications. Cellular architectures, propagation models, modulation formats, diversity techniques, equalization, error control, multiple access techniques, networking, and standards such as AMPS, N-AMPS, IS-54, GSM, and IS-95 are covered. PREREQUISITE: EC3510.

EC4550 DIGITAL COMMUNICATIONS (4 - 0).
This course presents some of the advantages and limitations of modern military M-ary digital communications systems. M-ary modulation formats, matched filter receivers, probability of error calculations, non-coherent receivers, carrier synchronization, symbol synchronization, telephone line modems, wideband modems, bandwith and signal energy, diversity combining, and Rayleigh fading channels are covered. Examples of current operational and proposed military space and earth links are treated. PREREQUISITE: EC3510.

EC4560 COMMUNICATIONS ECCM (3 - 2).
Methods of reducing the effects of jamming on military radio communications systems are considered. Direct sequence spread spectrum systems and frequency-hopped spread spectrum systems are examined with regard to their LPI, LPD, and AJ capabilities. Time hopping and hybrid systems are also considered. Coarse and fine synchronization problems and techniques are presented. PREREQUISITE: EC3510.

EC4570 SIGNAL DETECTION AND ESTIMATION (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). Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE), and maximum a posteriori estimators are introduced. Integral equations and the Karhunen-Loeve expansion are introduced. The estimator-correlator structure is derived. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations. This course provides students the necessary foundation to undertake research in military radar and sonar systems. PREREQUISITE: EC3410 or EC3500.

EC4580 CODING AND INFORMATION THEORY (4 - 0).
Digital military communication systems often employ error control coding to improve the effectiveness against noise, fading, and jamming. This course together with EC4560 provides students the necessary foundations for understanding the principles of such systems. Topics include concepts of information measure for discrete and continuous signals; fundamental theorems relating to coding and channel capacity; coding methods for error control in digital communications systems, convolutional, and block codes. Applications of the theory to real systems are discussed. PREREQUISITES: EC3410 or EC3500.

EC4590 COMMUNICATIONS SATELLITE SYSTEMS ENGINEERING (3 - 0).
Communication satellite systems including the satellite and user terminals. Subjects include orbital mechanics, satellite description, earth terminals, detailed link analysis, frequency division multiple access, time division multiple access, demand assignment, random multiple access, and spread spectrum multiple access. Various military satellite communications systems are introduced. PREREQUISITE: EC3510.

EC4600 ADVANCED TOPICS IN ELECTROMAGNETICS (3 - 0).
Selected advanced topics in electromagnetics that are not currently covered in regular courses offerings, and relevant to naval and other military applications. Topics may include, but are not limited to, computational electromagnetics, scattering and radiation, propagation, and new device and antenna concepts. PREREQUISITE: EC3600 or consent of instructor.

EC4610 RADAR SYSTEMS (Unclassified) (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, moving target indicator (MTI) and pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross-section of targets. PREREQUISITES: EC3410 or EC3500, EC3600, and either EC3610 or EC3630.

EC4630 RADAR CROSS SECTION PREDICTION AND REDUCTION (3 - 0).
This course covers the design and engineering aspects of stealth and its impact on platform and sensor design. Signature prediction methods in the radar, infrared (IR), and laser frequency bands are discussed. Radar cross section (RCS) analysis methods include geometrical optics and diffraction theory, physical optics and the physical theory of diffraction, and numerical solutions to integral and differential equations. Prediction methods for IR and laser cross sections (LCS) are also introduced. Signature reduction by shaping, materials selection, and active and passive cancellation are applied to each frequency regime. The measurement of these cross sections is also covered. PREREQUISITE: EC3600 or consent of instructor.

EC4640 AIRBORNE RADAR SYSTEMS (3 - 0).
The main objective of the course is to discuss concepts and digital signal processing techniques involved in modern airborne radars, which detect targets in presence of large ground clutter and other interferences. Radar waveform (or modes) are treated as continuous wave (CW), high pulse repetition frequency (HPRF), medium pulse repetition frequency (MPRF), and low pulse repetition frequency (LPRF). Practical implementation and the signal processing associated with each mode will be elaborated. Advantages and limitations of each mode shall be discussed. Military applications of these modes will be discussed in the existing airborne and surface based radar systems. Concepts and algorithms are covered for digital pulse compression, MTI clutter cancellation, Doppler processing, constant false alarm rate (CFAR) detection, ambiguity resolution, synthetic array radar (SAR) processing and other associated techniques and algorithms. PREREQUISITE: EC4610 or equivalent.

EC4650 ADVANCED ELECTROMAGNETICS (3 - 0).
An introduction is provided to advanced mathematical and numerical techniques of importance in the design and analysis of electromagnetic devices. Applications are considered for radar scattering, low observables, broad-band antennas, surface wave propagation, and microwave techniques. PREREQUISITE: EC3600 or consent of instructor.

EC4660 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS ON COMMUNICATION SYSTEM PERFORMANCE (3 - 2).
This course covers the effects of the electromagnetic environment on the performance of VLF-UHF land based and shipboard communications systems with emphasis on SIGINT applications. Methods of evaluating system performance in the presence of electromagnetic interference (EMI) are discussed. Newly developed techniques that overcome shortcomings of classical EMI test procedures of locating and eliminating sources of EMI in order to improve system performance are demonstrated in the laboratory. Current research in non-classical propagation and antenna effects are covered. Computational tools for evaluating these effects are demonstrated. Students participate in a project by applying the test procedures and computer tools to a current military system or sub-system, gaining an appreciation for the impact of the EM environment on operational systems. PREREQUISITE: EC3650 or consent of instructor.

EC4680 RADAR ELECTRONIC WARFARE TECHNIQUES AND SYSTEMS (3 - 3).
Radar electronic countermeasures and counter-countermeasures are considered in detail. Digital RF memories and directed energy weapons are also considered. Detailed sensor models are reviewed to solve analytically the effectiveness of various countermeasures. PREREQUISITES: EC4610 or EO3678, U.S. citizenship, and SECRET clearance.

EC4690 RADAR ELECTRONIC WARFARE TECHNIQUES AND SYSTEMS FOR INTERNATIONAL STUDENTS (3 - 3).
This course covers essentially the same material as EC4680. This course is intended for students who do not have U.S. citizenship. PREREQUISITE: EC4610 or EO3678.

EC4700 ADVANCED TOPICS IN INFORMATION WARFARE (3 - 0).
Special advanced topics in electronic warfare not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include electronic warfare, signals intelligence, psychological operations, deception techniques, physical destruction and operations security. PREREQUISITE: EC3700 or consent of instructor.

EC4750 SIGINT SYSTEMS II (3 - 4).
Detailed problems and principles of Signals Intelligence (SIGINT) are presented. Several SIGINT scenarios are studied in class, and students select one for a team project. The scenarios taught are based on SIGINT needs from the National Security Agency (the scenarios are highly classified). The selected SIGINT scenario will require a conceptual design or realignment of national SIGINT systems to satisfy the operational commander's SIGINT needs. PREREQUISITES: EC3750 or consent of instructor, U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

EC4800 ADVANCED TOPICS IN COMPUTER ENGINEERING (3 - 0).
Advanced topics and current developments in computer architecture including such subjects as: graphics and multimedia processors relevant to military applications and workstations; computer structures for artificial intelligence and large data bases; supercomputers and massively parallel architectures; advanced logic design, hardware/software co-design, and multiple-valued logic. PREREQUISITE: Consent of instructor.

EC4810 FAULT TOLERANT COMPUTING (3 - 2).
Introduction to fault-tolerant computing. The causes and effects of computer, digital system, and software failure. The fundamental concepts and techniques for the design and implementation of fault- tolerant computers, testing digital systems, and software. Modeling, simulation, and evaluation of fault-tolerant systems. Military and space applications of fault-tolerant computing. PREREQUISITES: EC3820 and EC3840.

EC4820 ADVANCED COMPUTER ARCHITECTURE (3 - 1).
A study of advances in computer architecture including computer description languages and memory system issues. High performance computers: pipeline supercomputers, array processors, multiprocessors. Data flow architectures and architectures for military applications. PREREQUISITES: EC3820, EC3840.

EC4830 DIGITAL COMPUTER DESIGN (3 - 1).
This course presents digital system design techniques that can be used in tactical embedded systems. It involves a study of the architecture of and the design process for digital computer systems. Topics covered include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, and design of systems using standards and custom VLSI devices. Modern computer-aided design tools are emphasized. Laboratory project is the design of a digital computer. PREREQUISITES: EC3800 and EC3830.

EC4840 ADVANCED MICROPROCESSORS (3 - 1).
Advanced topics and current developments in high-end microprocessor architecture and implementation; RISC vs. CISC; superscaler design; cache coherency; multimedia processors; bus and memory interfaces; military applications. PREREQUISITE: EC3840.

EC4850 HIGH SPEED NETWORKING (3 - 2).
The course objective is to develop an understanding of the emerging trends and technologies that enable deployment of high-speed global networks for tactical use. Coverage includes characterization of the networking requirements of multimedia DoD applications, ATM/SONET-based Gigabit network architectures, Gigabit LAN protocols, internal TCP/IP and their viability in future high-speed internets, multicast protocols, and principles of mobile internet working including the DoD Common Data Link (CDL) and its interface to the terrestrial internet. The emphasis will be on network and transport layer functionality and evaluation of the bit rates visible to the end-users for a given network architecture specification. Network architectures and protocols will be evaluated in terms of the requirements of future command and control applications. PREREQUISITE: EC3850 or consent of instructor.

EC4870 VLSI SYSTEMS DESIGN (3 - 2).
Introduction to the design and implementation of Complementary Metal Oxide Semiconductor (CMOS) Very Large Scale Integration (VLSI) digital Integrated Circuits (ICs). Topics covered include the specification of the high-level functional design, implementation, and simulation of low level cells, floor planning and the assembly of low-level cells into the high-level design using hierarchial place-and-route techniques, circuit extraction and simulation for functional

verification and timing analysis, and the principles of CMOS IC fabrication. Applications of VLSI ICs in military systems are also covered. The course is centered around laboratory projects where student groups design, implement, simulate, and submit for fabrications, a full custom CMOS, VLSI IC. IC functionality is selected by each student group. PREREQUISITES: EC3800 and EC3830.

EC4900 TOPICS FOR INDIVIDUAL STUDY IN ELECTRICAL ENGINEERING (V - V).
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.

EC4910 ,20,...,90 ADVANCED SPECIAL TOPICS IN ELECTRICAL ENGINEERING (V - V).
Courses on advanced special topics in Electrical Engineering are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EO2102 INTRODUCTION TO CIRCUIT AND POWER SYSTEM ANALYSIS (4 - 2).
An introduction to the fundemental tools of circuit analysis including Kirchhoff's current and voltage laws, series-parallel resistance combinations, voltage and current dividers, superposition, Thevenin and Norton equivalent circuits, source transformations and nodal and mesh analysis. The students are then exposed to frequency domain phasor techniques for analyzing ac circuits. An introduction to power calculations and three-phase systems is next presented. The remainder of the course focuses on the basic operational characteristics of power system components such as transformers, synchronous machines, induction machines, dc machines and power converters. PREREQUISITES: MA1043 and MA2121 (may be concurrent) and ME2440 or equivalent.

EO2402 INTRODUCTION TO LINEAR SYSTEMS (4 - 1).
A course in the rudiments of linear systems for naval officers in the ASW, EW, and other curricula. Principles of discrete and continuous-time systems. Topics include difference equations, discrete and continuous convolution, correlation, transfer functions, and system diagrams. Transform applications in communication and control systems. PREREQUISITE: Ability to program in a higher level language.

EO2413 INTRODUCTION TO COMMUNICATIONS SYSTEMS ENGINEERING (4 - 2).
A first course in communications systems for the C4I, Space Systems Operations, and Information Technology 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, signals bandwith, communications channels and amplitude, frequency, and phase modulation. PREREQUISITE: MA1117 or equivalent.

EO2652 FIELDS, WAVES, AND ELECTROMAGNETIC ENGINEERING (4 - 1).
This course covers electromagnetic field theory and engineering applications. Static electric and magnetic field theory is developed and Maxwell's equations are presented. Applications include plane wave propagation, analysis and design of transmission lines, waveguides, resonators, and high frequency components. Labs provide practical experience with microwave instruments, components, and measurement techniques. The objective of the course is to provide a foundation for subsequent study of microwave engineering, antennas, scattering, and radiowave propagation for application in the areas of communications, radar, and electronic warfare. PREREQUISITES: MA2138 and PH1322, or consent of instructor.

EO3402 SIGNALS AND NOISE (3 - 1).
A course in the rudiments of modern signal processing for naval officers in non-electrical engineering curricula. Topics include signal processing in the frequency domain using the DFT and FFT, random signals, their description and processing. Applications to signal detection, demodulation, filtering, beamforming, target tracking, and other relevant naval and military operations. PREREQUISITES: EO2402 and OS2103 or equivalent.

EO3512 COMMUNICATIONS AND COUNTERMEASURES (3 - 2).
This course, intended primarily for students in the EW curriculum, is concerned with the transmission of bit streams in a military environment including ECM. The fundamental parameters of a radio system are reviewed. The processes involved in digitizing voice and video are presented. Conventional carrier modulation methods are considered. Modern digital modulation techniques are studied. Spread spectrum methods of frequency hopping and direct sequence are developed. The effects of jamming are considered in all the topics treated. PREREQUISITES: EO3402, EO3602 or equivalent.

EO3513 COMMUNICATIONS SYSTEMS ENGINEERING (4 - 2).
The second course in communications systems engineering for the C4I, Space Systems Operations, Information Technology Management, and other operational curricula. Coverage begins with a review of Fourier methods and covers analog and digital communications systems. Specific topics include amplitude modulation, angle modulation, the sampling theorem; spectral representation of pulse and digital signals; pulse and digital modulations; baseband coding forms; frequency and time-division multiplexing. PREREQUISITE: EO2413.

EO3523 COMMUNICATIONS SYSTEMS ANALYSIS (4 - 2).
The final course in communications systems for the Information Technology Management, Joint C4I and Space Systems Operations curricula with emphasis on the relative performance of communications systems and analysis of trade-offs available in system design. Specific topics include comparative performance of analog and digital modulation types in the presence of noise; antenna characteristics; propagation effects on signal transmission; and end-to-end path calculations for wire/coax, optical fiber and RF systems. Partially satisfies Educational Skill Requirements (ESR's) for an applied, systems-level understanding of analog and digital communications systems and technologies. PREREQUISITE: EO3513.

EO3535 SPACECRAFT COMMUNICATIONS ENGINEERING (3 - 2).
This course examines basic spacecraft communication engineering. Satellite and ground station components, link budget analysis, multiple access techniques, digital modulation techniques, forward error correction coding, and spread spectrum techniques are covered. PREREQUISITE: EC2500 or EO3523.

EO3602 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (4 - 2).
The principles of electromagnetic radiation are applied to antenna engineering, scattering, and propagation. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. This course is intended for students not in the 590 curriculum. PREREQUISITE: EO2652 or equivalent.

EO3678 PRINCIPLES OF RADAR SYSTEMS (4 - 2).
This course presents radar systems for the Avionics curriculum with emphasis on airborne radars. Topics include pulse radar basics, radar range equation, probability of detection and maximum target detection range calculations, coherent radars such as continuous wave (CW), moving target indicator (MTI) and pulse Doppler radars, low pulse repetition frequency (PRF), medium PRF, and high PRF modes of airborne radars and their applications in airborne surveillance and fighter aircraft radars, principles of synthetic aperture radar, tracking techniques, such as conical scan, monopulse and track while scan. PREREQUISITES: EO3402, EO3602.

EO3816 COMPUTER ARCHITECTURE FOR MILITARY APPLICATIONS (3 - 0).
The course objective is to develop an understanding of the fundamental concepts in modern computer architectures as they relate to the computations required in signal processing for military applications. Uniprocessor and parallel processor architectures are studied with emphasis on their use rather than design. Emphasis is laid on the determination of computation and communication bandwidth requirements of typical signal processing algorithms used in military environments and identification of possible performance bottlenecks in various single and multiple processor systems. PREREQUISITE: Ability to program in a high level language.

EO3911 ,21,...91 INTERDISCIPLINARY STUDIES IN ELECTRICAL & COMPUTER ENGINEERING (V - V).
Courses on special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EO4011 SYSTEMS ENGINEERING FOR ACQUISITION MANAGERS (3 - 1).
An introduction to the discipline of system engineering and how it is applied over the life cycle of a product. Topics include: the system approach and system design process; translation of mission needs and operational requirements into system technical requirements; the role of performance analysis and tradeoffs in conceptual system design; functional decomposition of systems requirements into element and equipment requirements; designing for reliability, survivability, readiness, maintainability, and supportability; the role of test and development, production, and operational documentation; the role of system engineering in the DoD acquisition cycle and project management. Intended for acquisition management students. PREREQUISITES: MN3301 and OS3006 or consent of instructor.

EO4612 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 electronically steerable array radars. Electromagnetic compatibility problems involving radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross-section of targets. PREREQUISITE: EO3602 (may be taken concurrently) or consent of instructor.

EO4622 INFORMATION WARFARE SYSTEMS (3 - 2).
This course covers electronic warfare in that portion of the electromagnetic spectrum through the millimeter wavelength region. Electronic denial and deceptive countermeasure against fuses, communications, and various radar detection and tracking systems are discussed. Equations for required jammer gain and power output are developed. The characteristics of passive countermeasures are discussed. Other topics include anti-radiation missiles, counter-countermeasure circuits, target masking and modification, signal intercept, signal identification and direction finding. Techniques are discussed in relation to U.S., allied, and former communist bloc systems. Laboratory work reinforces the classroom discussions. PREREQUISITES: EO4612, U.S. citizenship and SECRET clearance.

EO4903 C3 COUNTERMEASURES (Variable Credit) (V - 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.

EO4911 ,21,...,91 ADVANCED INTERDISCIPLINARY STUDIES IN ELECTRICAL & COMPUTER ENGINEERING (V - V).
Courses on advanced special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

ENGINEERING ACOUSTICS ACADEMIC COMMITTEE

Chairman:
Kevin B. Smith
Assistant Professor
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Room 114
(831) 656-2107
DSN 878-2107
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Academic Associate
Curricula 525/526/533/535
James V. Sanders
Associate Professor
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Steven R. Baker, Associate Professor, Department of Physics (1985); PhD, University of California at Los Angeles, 1985.

Monique P. Fargues, Associate Professor, Department of Electrical and Computer Engineering (1989); PhD, Virginia Polytechnic Institute and State University, 1988.

Ralph D. Hippenstiel, Associate Professor, Department of Electrical and Computer Engineering (1986); PhD, New Mexico State University, 1985.

Kevin B. Smith, Assistant Professor, Department of Physics (1995); PhD, University of Miami, 1991.

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics and signal processing applied to undersea warfare. Subjects covered include the generation, propagation and reception of sound in the ocean; military applications of underwater sound; and acoustic signal processing. These programs are designed specifically for students in the Combat Systems Sciences and Technology and the Undersea Warfare curricula, government employees in acoustics-related laboratories and systems commands, and international students.

The academic aspects of the MS program are the responsibility of an academic committee composed of representatives from the Departments of Physics and Electrical and Computer Engineering.

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS
The degree Master of Science in Engineering Acoustics will be awarded as an interdisciplinary program in accordance with the following degree requirements:

1) A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.

2) The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter hours of course work; at least 20 graduate quarter hours must be taken in acoustics and its applications. One 4000 level course from each of three of the following four areas must be included: wave propagation; transducer theory and design; sonar systems; and signal processing.

3) An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING
The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the degree Doctor of Philosophy or Doctor of Engineering. Areas of special strength in the departments are physical acoustics, underwater acoustics and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other Federal Government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctor's degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

INFORMATION SYSTEMS ACADEMIC GROUP

Chairman:

Dan C. Boger
Professor
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Room 201D
(831) 656-3671/2535 (Voice)
DSN 878-3671/2535
(831) 656-3679 (Fax)

Hemant K. Bhargava, Associate Professor of Information Technology (1989); PhD, University of Pennsylvania, 1989.

Dan C. Boger, Chair of Information Systems Academic Group and Professor (1979); PhD, University of California at Berkeley, 1979.

Douglas Brinkley, Lecturer in Information Systems (1998); MS, Naval Postgraduate School, 1990.

Rex A. Buddenberg, Lecturer in Information Systems (1993); MS, Naval Postgraduate School, 1986.

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

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

Barry A. Frew, Associate Professor of Information Systems (1984); MS, Naval Postgraduate School, 1984.

William J. Haga, Senior Lecturer in Management Information Systems (1988); PhD, University of Illinois, 1972.

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

Magdi N. Kamel, Associate Professor of Management Information Systems (1988); PhD, University of Pennsylvania, 1988.

Mark Nissen, Assistant Professor in Acquisition Management and Information Systems (1996); PhD, University of Southern California, 1996.

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

Kishore C. Sengupta, Associate Professor of Management Information Systems (1989); PhD, Case Western Reserve University, 1990.

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

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

The degree of Master of Science in Information Technology Management requires:

1) Completion or validation of core courses in each of the following disciplines:

   Information Systems
   Computer Science
   Electrical and Computer Engineering
   Systems Management

2) Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.

3) Completion of an acceptable thesis

4) Approval of the candidate's program by the Chair, Information Systems Academic Group.

INFORMATION SYSTEMS COURSE DESCRIPTIONS

IS0001 SEMINAR FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (NO CREDIT) (0 - 2).
Guest lectures. Thesis and research presentations.

IS0123 COMPUTER SKILLS DEVELOPMENT I (NO CREDIT) (Accelerated first 6 weeks of quarter.) (0 - 2).
An introduction to the use and operation of microcomputers with emphasis on hardware basics, the operating system, and word processing. Emphasis on applications in systems management. Graded on Pass/Fail only.

IS0810 THESIS RESEARCH FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (0 - 8).
Every student conducting thesis research will enroll in this course.

IS2000 INTRODUCTION TO INFORMATION TECHNOLOGY MANAGEMENT (3 - 1).
Provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager.

IS2010 INTRODUCTION TO INFORMATION TECHNOLOGY (1 - 2).
This course provides an overview of the technology used to implement modern information systems. Extensive use of hands-on laboratories and demonstrations provide students a thorough introduction to microcomputer architecture and design, the Internet and Web page development, local area network (LAN) operation and administration, databases, management information systems, and computer security. The strong emphasis on hardware and software technical issues in this course establishes the foundation necessary for studying IT management issues during the follow-on course, IS3185. PREREQUISITES: None.

IS3000 DISTRIBUTED COMPUTER SYSTEMS (4 - 1).
The technology, application and management of distributed computer systems. Specific topics include distributed processing, distributed data base management, communication facilities and protocols, economic and performance analysis, and managerial and organizational problems. PREREQUISITES: CS2970, CS3030, and

IS3020 SOFTWARE DESIGN (3 - 2).
The use of structured techniques in the design and implementation of software. Topics covered include selection of programming languages, design of modules and module interfaces, testing, and program documentation techniques. Use of software metrics for determining program size, complexity and quality. PREREQUISITES: CS2970, IS2000.

IS3100 ANALYSIS OF MICROCOMPUTERS AND MICROPROCESSORS (3 - 2).
A comparative analysis of popular microcomputers-hardware and software. Analyses will be made of the following elements: microcomputer architecture; microprocessors; bus systems; operating systems and applications. Comparisons will be made both within a vendor's product line and between vendors, with respect to characteristics, strengths, limitations applications and costs. Student written and oral reports on comparative analysis. Some assembly language will be required. PREREQUISITES: CS2970, CS3030, and IS2000.

IS3112 INFORMATION TECHNOLOGY MANAGEMENT IN DOD (4 - 1).
Consideration of DoD information technology systems and their management development of a framework for understanding and managing systems based on the Technical Architecture Framework In Information Management (TAFIM). Command and control. Command and control warfare. PREREQUISITES: SECRET clearance and fifth quarter standing in the ITM curriculum.

IS3170 ECONOMIC EVALUATION OF INFORMATION SYSTEMS I (4 - 0).
Microeconomics concepts, including demand and supply, cost, competition, interest rates, present values, decision analysis and asymmetric information. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, the value of information, problem solving and strategic thinking. Defense information systems applications are stressed. PREREQUISITES: MN2155, MA1117.

IS3171 ECONOMIC EVALUATION OF INFORMATION SYSTEMS II (4 - 1).
A major challenge to DoD information technology managers is assessing the payoff from the investment in information systems. Continuation of IS3170 focusing on the study of cost benefit (effectiveness) analysis and techniques for evaluating investments in information technology and managing information. PREREQUISITES: IS3170, MN2155, and OS3105.

IS3181 INTEGRATING AND LEVERAGING INFORMATION TECHNOLOGIES (3 - 0).
The attributes of information technology are studied in conjunction with the management aspects of developing and maintaining systems in support for DoN and the Joint Services. This course is heavily project and case study oriented. Mini-cases force the student to apply theory from reading to realistic DoN settings. These case studies will force tradeoff, resource allocation decisions, development of strategy for specific problems, etc. PREREQUISITE: MN0123.

IS3185 MANAGEMENT OF INFORMATION TECHNOLOGY (3 - 0).
This course focuses on management issues in the implementation and use of information systems to support the missions of military organizations. It provides management students with a framework to comprehend the organizational impacts of information technology (IT) that will serve them throughout their careers despite rapid and continuous changes in hardware and software. They will know (1) what an IT system can do for their organization, (2) potential problems raised by IT and (3) how to work effectively with chief information officers and IT technical professionals. Topics include IT opportunities and strategies, IT implementation issues, IT staffing and the transformational effects of IT upon an organization's strategy, culture and operations. PREREQUISITES: MN3105, IS0123 and IS2010.

IS3502 COMPUTER NETWORKS: WIDE AREA/LOCAL AREA (3 - 2).
Architecture, standard protocols, and technological advances in computer networks, with an emphasis on internet working and interoperability. Specific topics include open network architectures (OSI vs. DoD architecture), X.25, local area networks, TCP/IP, and a variety of distributed application services built on the client-server model. Students also gain an understanding of DDN (Defense Data Network), X.400-based DMS (Defense Message System), SDNS (Secure Data Network Service), and GOSIP (Government Open System Interconnection Profile). PREREQUISITES: CS2970, CS3030, IS2000, and OS3004.

IS3503 MICROCOMPUTER NETWORKS (3 - 2).
Theory, application, and operation of microcomputer networks. Students learn, evaluate, compare, and operate several contemporary microcomputer networks, such as IBM PC Net, IBM Token-Ring, Apple Computer Apple-Talk, 3 Comm Ethernet, mainframe emulations, and LAN internets. Students perform a variety of hands-on lab experiments on the SM department LANs to prepare them for future LAN management billets. The IEEE Local Area Network Standards will be addressed. PREREQUISITE: IS3502.

IS3504 MODERN NETWORK OPERATIONING SYSTEMS: PLANNING, TECHNOLOGY AND OPERATIONS (3 - 2).
This course focuses on the planning, design, installation, configuration and management of network operating systems used throughout DoD and private industry. Network operating systems are compared with single user operating systems to understand differences and similarities. Popular client/server and peer-to-peer systems are examined to provide a thorough understanding of the correct applications of each. Network labs provide in-depth analysis of such topics as file server configuration and administration, multi-level network security procedures and global file server synchronization processes. PREREQUISITE: Computer Networks: Wide Area/Local Area (IS3502). Security Classification: None.

IS4182 INFORMATION SYSTEMS MANAGEMENT (4 - 0).
Capstone course for the ITM curriculum. Based on information technology playing a vital role throughout the Department of Defense. Broad range of management, economic, behavioral, and technical matters associated with the development and operation of effective information systems. Its primary focus is on the strategic and policy issues facing DoD management. Topics covered include IS functions and operations, systems development methodologies, the IS infrastructure and architecture, IS planning, process reengineering, and technology assessment. PREREQUISITE: Status as student in the final quarter of the ITM curriculum.

IS4183 APPLICATIONS OF DATABASE MANAGEMENT SYSTEMS (4 - 1).
Applications-oriented introduction to database management systems technology. Survey of current database systems and approaches to database technology. Technical and administrative considerations involved in a database design and implementation project are considered. Students will be expected to design and implement an applications system using a database management package. PREREQUISITES: CS2970, CS3030, OS3004. IS4200 taken concurrently.

IS4184 INFORMATION RESOURCE MANAGEMENT IN DON/DOD (4 - 0).
This course is concerned with understanding the major aspects of information resource management (IRM) and how it is conducted in DoD and DoN. Special attention will be paid to database administration and information engineering. Examples of IRM and DBA practice will be presented via case studies and by speakers with relevant expertise from the Navy, DoD, and private sector. PREREQUISITES: IS3112, IS4183, IS4200, and IS4300.

IS4185 DECISION SUPPORT SYSTEMS (4 - 1).
Principles for designing, implementing, and using computer systems that support a variety of decision making situations. Surveys or analytical techniques for decision-making in complex environments, involving single or multiple criteria made under certainty and uncertainty. The latest computer-based systems, and exemplary applications in DoD, that support or involve the use of these formal methods are covered. Group project requiring the design and implementation of a decision support system for a specific problem. PREREQUISITES: IS2000, IS4200, IS4183, MN2155, MN3105, OS3004 and OS3105.

IS4186 KNOWLEDGE-BASED SYSTEMS AND ARTIFICIAL INTELLIGENCE (4 - 1).
Principles, applications and limitations of knowledge-based systems, including expert systems, as problem-solving tools. Fundamental techniques, commonly employed in designing such systems, from the field of artificial intelligence. Specific topics include knowledge representation, automated reasoning, inference and search techniques, knowledge acquisition, and expert systems architectures. Hands-on experimentation and implementation of prototype systems. Students are expected to have a strong foundation in mathematical and analytical techniques. PREREQUISITES: IS2000, IS3171, IS4185, OS3105.

IS4187 INFORMATION NETWORKING & DISTRIBUTED DECISION TECHNOLOGIES (3 - 2).
Information technologies used for developing specialized applications on enterprise-wide or global information networks such as the World Wide Web. Focal topics include methods and applications of information networking; distributed libraries of computational and decision technologies; and management of large-scale applications. Applications involving remote execution of interactive decision technologies and the organization of a large collection of such applications into a distributed digital library. Examines applications and their implementation using emerging technologies and development of applications that are scalable and maintainable. Other topics include architectures and protocols for information networks, client-server computing, electronic commerce, pricing of information products and security. PREREQUISITE: IS3171, IS3502, IS4185, and IS4502 taken concurrently.

IS4188 COORDINATION AND COLLABORATIVE SYSTEMS (4 - 1).
The nature of work in most task domains is collaborative. The efficacy with which groups coordinate their activities is an important determinant of collaborative work. This course examines different approaches to defining and studying coordination and the use of information technology to support coordination. Various technologies that are collectively labeled as groupware will be presented. Design principles underlying the construction of groupware will be studied, and different types of groupware will be used. Students work in teams to implement projects highlighting specific aspects of coordination. PREREQUISITE: Decision Support Systems (IS4185) or equivalent. Security classification: None.

IS4200 SYSTEM ANALYSIS AND DESIGN (4 - 2).
Computer-based system development, including the following concepts, methodologies, tools, and techniques for: information systems requirements analysis, technical and economic feasibility studies, systems costing and data communications hardware and software trade-off evaluations and specifications, conversion, and testing. PREREQUISITES: CS2970, CS3030, IS2000, IS3170, MN3105, OS3105, OS3004.

IS4300 SOFTWARE ENGINEERING AND MANAGEMENT (3 - 2).
The objective of this course is to educate the student in areas of great concern to the Department of Defense in the fields of software engineering and management. The course examines both the technological tools of software production as well as the software engineering techniques for software project management. Software testing, metrics and reliability are also covered. DoD software standards and metrics programs are included. PREREQUISITES: CS3030, IS3020, IS3171, IS4200, OS3004.

IS4320 DATABASE AND INFORMATION RESOURCE MANAGEMENT FOR C4I (4 - 1).
Applications-oriented study of information systems, with a focus on database management. Survey of current techniques for designing and implementing database and decision support applications. Specific topics include the relational data model, use of SQL (structured query language) database administration, and the role of database and decision support tools in information management in the DoD. Students implement a prototype database or decision support system focusing on a C4I application. PREREQUISITE: A software design course.

IS4502 TELECOMMUNICATIONS NETWORK (3 - 2).
Evaluation and analysis of technological advances, market dynamics, and regulatory trends in the telecommunication industry. Understanding of current and future telecommunication services, applicable standards, and underlying motivations. Topics to be covered include PSTN (Public Switched Telephone Network), Intelligent Network, T1/T3 Networking, ISDN, Broadband Switching Services, and PCS (Personal Communication Services). Understanding of the Department of Defense's new telecommunication architecture, DISN (Defense Information Systems Network), which will serve as an integrated infrastructure for the command and control functions on a global scale. PREREQUISITE: IS3502.

IS4503 INTERNET TO SEA (2 - 2).
Internet capabilities will radically change maritime military operations study of the technological issues involved in bringing Internet capabilities to the maritime environment. Technological issues include network protocols, security, and commercial infrastructure. Use of commercial capabilities for military communications. Policy and planning issues. PREREQUISITE: IS4502. Security Classification: Unclassified.

IS4601 RESEARCH METHODS FOR INFORMATION TECHNOLOGY EVALUATION (4 - 0).
This course surveys current issues and techniques in empirical assessment of the effectiveness of information systems. Topics include the logic of scientific inquiry, the current state of research information systems, the framing of research problems, the nature of measures, scale construction, sampling, hypothesis testing, measures of association, experimental designs, issues in data collection techniques, level of data, reliability and validity of measures, and research report writing. PREREQUISITE: OS3105. Security Classification: Unclassified.

IS4800 DIRECTED STUDY IN ADVANCED INFORMATION SYSTEMS (Variable hours.) (V - V).
Directed study in advanced topics in information systems of mutual interest to student and a faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only.

IS4925 SEMINAR IN INFORMATION SYSTEMS (V - V).
Study of a variety of topics of current interest in information systems to be determined by the instructor. PREREQUISITES: A background of information systems and permission of the instructor.

INFORMATION WARFARE ACADEMIC GROUP

(Information Warfare - Curriculum 595 and Electronic Warfare - Curriculum 596)

John Arquilla, Associate Professor (IW, X3450)
Dan C. Boger, Chairman & Professor Joint C3 Academic Group (CC, X3671)
Ray Buettner, LCDR, U.S. Navy, Military Instructor (IW, X3387)
George Conner, Senior Lecturer & Assistant Provost, JWAP (OR, X3306)
Alfred Cooper, Professor (PH, X2452)
Dan Devlin, COL, U.S. Army, Commandant, Defense Language Institute
Vicente Garcia, NSA Chair and Visiting Associate Professor (EC, X2148 or X2235)
Don Gaver, Distinguished Professor (OR, X2605)
Wayne Hughes, Senior Lecturer (OR, x2484)
Cynthia Irvine, Assistant Professor (CS, X2461)
David Jenn, Associate Professor (EC, X2254)
Carl R. Jones, Professor (IS, X2995)
Michael Mullady, LtCol, U.S. Air Force, IW/EW Curriculum Officer (37, x2772)
Phil Pace, Associate Professor (EC, X3286)
James R. Powell, CAPT, U.S. Navy, Chair of Information Warfare, Chair of Tactical Analysis and Lecturer (IW, X2203)
Curt Schleher, Professor (IW, X3767)
Timothy Shimeall, Associate Professor (CS, x2509)
Alan Washburn, Professor (OR, X3127)

Chairman:
Dan C. Boger
Professor
Code IW, Root Hall
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Information Warfare Chair:
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Chair of Tactical Analysis and Lecturer
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Academic Associate Curriculum 595
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Academic Associate Curriculum 596:
David Jenn
Associate Professor
Code EC/Jn, Spanagel Hall
Room 414
(831) 656-2254/2082
DSN 878-2254/2082

The Information Warfare Academic Group is an interdisciplinary group of faculty representing various academic disciplines. The Group has administrative responsibility for the academic content of the Information and Electronic Warfare curricula. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Computer Science, Command, Control and Communications, Electrical and Computer Engineering, Mathematics, Operations Research and Physics. Thesis topics for students in this area of study are approved by the group and the thesis is approved by the chairman.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The degree Master in Science in Systems Engineering will be awarded at the completion of a multidisciplinary program in Curricula 595 and 596.

The Master of Science in Systems Engineering requires a minimum of 45 quarter hours of graduate-level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included.

An approved sequence of at least three courses constituting advanced specialization in one area must be included.

In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.

INFORMATION WARFARE COURSE DESCRIPTIONS

IW0002 SEMINAR (NO CREDIT) (0 - 1).
Special lectures and discussion of matters related to the IW program. PREREQUISITE: SECRET clearance.

IW0810 THESIS RESEARCH/GROUP PROJECT (0 - 8).
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.

IW3101 PRINCIPLES OF INFORMATION OPERATIONS (4 - 1).
This course provides a survey of Information Operations (IO) along the time line of peace, to conflict, and back to cessation of hostilities. Students study the methods and elements which contribute to successful Information Operations including: Psychological operations and deception, Operational security, information assurance, and infrastructure protection, Electronic attack/protect/support, Physical attack/destruction in support of IO, Military-civilian relationship, Human cognition and decision making, Command and control structures, Legal issues, Computer and network attack, Systems engineering concepts (including modeling and simulation), Sensor and signals intelligence support to IO. PREREQUISITE: None. Security classification: SECRET.

IW4000 APPLICATIONS OF SPACE AND INFORMATION WARFARE (4 - 0).
Review of weapons and sensor systems associated with Space and Information Warfare. Overview of space science to include space environment, orbital mechanics, propulsion and launch vehicles, spacecraft subsystems, periods of vulnerability and launch windows. Current SEW doctrine and fleet tactics are discussed in conjunction with briefs on current military threats. PREREQUISITES: EO4622, consent of instructor and TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

IW4001 IW/C2W PLANNING AND ASSESSMENT (4 - 2).
Organization theory, command and control concepts and models, C4I systems concepts, command and control performance and effectiveness measurement, nodal and vulnerability analysis, C2W/IW planning and execution process. PREREQUISITES: CS3030, IS3502, CS3600, OS3104, OS3003, IW2000, IW3001, PH3802.

IW4500 INFORMATION WARFARE SYSTEMS ENGINEERING (3 - 3).
This course is taken concurrently with EC4010 as the application of those concepts to Information Warfare. The project teams will develop an Information Warfare system from requirements determination through and including preliminary design. The five pillars of Information Warfare will be used in the design process, including information security considerations. Lectures will refine IW concepts. PREREQUISITES: IW4001, EC4010 concurrently.

IW4990 SEMINARS ON SIGNAL INTELLIGENCE (SIGINT) (1 - 0).
Course will consist of eleven 50-minute seminars on Signals Intelligence (SIGINT). The seminars will provide students with overview of national intelligence collection systems and missions focusing on technical, operational and political issues. Course is available to students from all curricula at NPS who have proper security clearance. The course will be graded as pass/fail. PREREQUISITE: None, but SCI security clearance required.

DEPARTMENT OF MATHEMATICS

Carlos Borges, Associate Professor and Associate Chair for Research (1991)*; PhD, University of California, Davis, 1990.

David Canright, Associate Professor (1988); PhD, University of California at Berkeley, 1987.

Donald Alfred Danielson, Professor (1985); PhD, Harvard University, 1968.

Fariba Fahroo, Assistant Professor (1992); PhD, Brown University, 1991.

Richard Franke, Professor and Associate Chair for Labs and Computing (1970); PhD, University of Utah, 1970.

Harold M. Fredricksen, Professor (1980); PhD, University of Southern California, 1968.

Christopher Frenzen, Associate Professor (1989); PhD, University of Washington, 1982.

William Gragg, Professor (1987); PhD, University of California at Los Angeles, 1964.

Toke Jayachandran, Professor (1967); PhD, Case Institute of Technology, 1967.

Wei Kang, Assistant Professor (1994); PhD, University of California at Davis, 1991.

Bard Mansager, Senior Lecturer (1991); MA, University of California, San Diego, 1979.

Michael A. Morgan, Chairman and Professor (1979); PhD, University of California at Berkeley, 1976.

Beny Neta, Professor, Associate Chair for Instruction and Academic Associate (1985); PhD, Carnegie-Mellon University, 1977.

Guillermo Owen, Professor (1983); PhD, Princeton University, 1962.

Craig Rasmussen, Associate Professor (1991); PhD, University of Colorado at Denver, 1990.

Ira Bert Russak, Associate Professor (1972); PhD, University of California at Los Angeles, 1967.

Clyde Scandrett, Associate Professor (1987); PhD, Northwestern University, 1985.

Arthur Schoenstadt, Professor (1970); PhD, Rensselaer Polytechnic Institute, 1968.

Maurice Dean Weir, Professor Emeritus (1969); DA, Carnegie-Mellon University, 1970.

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

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As well as the Master of Science and Ph.D. programs in Applied Mathematics, 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 1000-3000 level courses.

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 be qualified by background for a Bachelor of Science degree with a major in mathematics or with a strong mathematical orientation in physical science or engineering.

A program that leads to the 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:

1) The program must be approved by the Chairman of the Department of Mathematics and the Academic Associate.

2) The program must include at least fifteen hours at the 4000 level, with at least twelve hours in 4000 level mathematics courses.

3) The program must contain at least nine hours in an approved sequence of application courses from within the Mathematics Department, or outside the department.

4) An acceptable thesis is normally required and is credited as the equivalent of nine hours of 3000 level mathematics courses. A student receiving a dual masters and writing a thesis in another department may petition the Chairman of the Mathematics Department to substitute 2 or 3 approved courses for the thesis. The thesis, however, must contain a strong mathematical content.

5) Courses in the following areas are specifically required in any program; some of these courses may be used to satisfy part (or all) of the mathematics sequence requirement in item (3) above:

   a. Real Analysis (a two-course sequence) and Modern Applied Algebra;
   b. Ordinary and Partial Differential Equations;
   c. Numerical Analysis;
   d. Probability and Statistics;
   e. Linear Algebra (a two-course sequence);
   f. Mathematical Modeling Processes.

In addition to the core courses required in item (3), the program allows the student to select an applied subspecialty option from the following list: applied mathematics, numerical analysis and computation, discrete mathematics, operations research, theoretical mathematics, and intelligence.

DOCTOR OF PHILOSOPHY

The Department of Mathematics offers the degree Doctor of Philosophy in Applied Mathematics. Areas of specialization will be determined by the department on a case by case basis. Requirements for the degree include course work followed by an examination in both major and minor fields of study, and research culminating in an approved dissertation. It may be possible for the dissertation research to be conducted off-campus in the candidate's sponsoring organization.

Entrance into the program will ordinarily require a master's degree, although exceptionally well-prepared students with a bachelor's degree in mathematics may be admitted. A preliminary examination may be required to show evidence of acceptability as a doctoral student. Prospective students should contact the Chairman of the Mathematics Department or the Academic Associate for further guidance.

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.

Credit will be given for only one of a pair of substantially equivalent courses (e.g. MA3232 and MA3243).

MATHEMATICS COURSE DESCRIPTIONS

MAR117 REFRESHER: SINGLE VARIABLE CALCULUS (NO CREDIT) (Meets last 6 weeks of quarter.) (3 - 3).
Single variable calculus review.

MAR118 REFRESHER: MULTIVARIABLE CALCULUS (NO CREDIT) (Meets last 6 weeks of quarter.) (3 - 3).
Multivariable calculus review.

MAR125 INTRODUCTION TO FINITE MATHEMATICS (NO CREDIT) (Meets last 6 weeks of quarter.) (3 - 0).
An introduction to the elements of set theory and mathematical reasoning. Topics covered include: symbolic logic (propositional calculus, truth tables, predicates, and quantifiers); methods of proof (direct and indirect proof, mathematical induction, case analysis and counter examples); sets and set operations; relations and functions.

MAR142 REFRESHER: MATRIX ALGEBRA (NO CREDIT) (Meets last six weeks of quarter.) (2 - 0).
The fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to mxn systems of linear algebraic equations using Gaussian elimination and the LU decomposition (without pivoting). Determinants, properties of determinants, and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

MA1010 ALGEBRA AND TRIGONOMETRY (5 - 0).
Real number system, complex numbers, exponents and radicals, algebraic expressions and operations, linear and quadratic equations, inequalities, functions and graphs, polynomials and their zeros, rational functions, exponential and logarithmic functions, systems of equations, matrices, trigonometry and unit circles, trigonometric identities and functions. PREREQUISITE: None.

MA1025 FINITE MATHEMATICS FOR OPERATIONS RESEARCH (4 - 0).
An introductory course in logic and elementary discrete mathematics to be taken by students in Operations Research, Mathematics, and Computer Science. Considerable emphasis is placed on propositional and predicate logic and on techniques of proof in mathematics. Mathematical topics include sets, functions, and relations. Coverage of combinatories includes an introduction to permutations, combinations, the pigeon-hole principle, and the principle of inclusion/exclusion. No previous experience with this material is assumed. PREREQUISITE: None.

MA1042 MATRIX ALGEBRA (Also offered in the Six Week Refresher as MAR142.) (2 - 0).
The fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to mxn systems of linear algebraic equations using Gaussian elimination and the LU decomposition (without pivoting). Determinants, properties of determinants, and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA1043 INTENSIVE MATRIX ALGEBRA (2 - 0).
The fundamental algebra of vectors and matrices including addition, multiplication, and multiplication by a constant. Block operations with vectors and matrices. Algorithms for computing the LU (Gauss) factorization of an nxm matrix, with pivoting. Matrix representation of systems of linear equations and their solution via the LU factorization. The four fundamental subspaces. Basic properties of determinants. Matrix inverses. Introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem. COREQUISITE: EC1010.

MA1117 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; anti-derivatives, integrals and the fundamental theorem of calculus; definite integrals, areas, lengths of curves and physical applications; special methods of integration, including a two hour problem solving laboratory. PREREQUISITE: Precalculus mathematics.

MA1118 MULTI-VARIABLE CALCULUS (5 - 2).
Vector algebra and calculus, directional derivative, gradient, polar coordinates and parametric equations, functions of several independent variables, limits, continuity, partial derivatives, chain rule, maxima and minima, double and triple integrals, cylindrical and spherical coordinate systems; infinite series, convergence tests, and Taylor series; including a problem session and a computer laboratory. PREREQUISITE: MA1117 or MAR117.

MA2049 VECTOR ANALYSIS WITH APPLICATIONS (3 - 0).
Review of vector algebra. Bold and index notation. The calculus of vector fields; directional derivative, gradient, divergence, curl; potential fields; Green's, Stokes', and the divergence integral theorems. Applications in engineering and physics. PREREQUISITES: MA1118 and MAR142 or MA1042.

MA2051 VECTORS AND COMPLEX VARIABLES (4 - 1).
Review of vector algebra. The calculus of vector fields; gradient, divergence and curl. Potential fields. Green's, Stokes' and the Divergence theorems. Introduction to complex functions. Differentiability and the Cauchy-Riemann equations. Cauchy's integral theorem and Cauchy's integral formula. Taylor and Laurent series. Residues. PREREQUISITES: MA1118 (or MAR118) and MA1043.

MA2121 DIFFERENTIAL EQUATIONS (4 - 0).
Ordinary differential equations: linear and nonlinear (first order) equations, homogeneous and non-homogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms. Applications include radioactive decay, elementary mechanics, mechanical and electrical oscillators, forced oscillations and resonance. PREREQUISITES: MA1118 and MA1042 concurrently.

MA2138 MULTIVARIABLE CALCULUS AND VECTOR ANALYSIS (5 - 0).
Course develops several mathematical tools for the calculus of several variables and of vector-valued functions. Infinite series and Taylor series representations; basic vector operations, vector functions of one variable; scalar functions of several variables, partial derivatives, directional derivatives, gradients; double and triple integrals with applications, line integrals with applications; divergence and curl, Green's, Stokes' and Gauss' theorems. Designed for UW and IW/EW students. No credit for both MA1118 and MA2138. PREREQUISITE: MA1117.

MA2139 INTRODUCTION TO DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (5 - 0).
This course develops mathematical tools from vector calculus and ordinary differential equations. Vector calculus topics covered include: vector fields; line and surface integrals; gradient, divergence, and curl; Green's Theorem, the Divergence Theorem, and Stokes' Theorem; and, applications to the theory of electricity and magnetism. Topics from ordinary differential equations (ODEs) include: classification and general solutions of ODEs; solution of first- and second-order homogeneous and non-homogeneous ODEs; power series solutions of ODEs; Laplace transforms; systems of finite order ODEs; and, applications to oscillations and resonance. PREREQUISITES: MA1042 and MA1118.

MA2300 MATHEMATICS FOR MANAGEMENT (5 - 0).
Mathematical basis for modern managerial tools and techniques. Elements of functions and algebra; differential calculus of single- and multi-variable functions; integration (antidifferentiation) of single-variable functions. Applications of the derivative to rates of change, curve sketching, and optimization, including the method of Lagrange multipliers. PREREQUISITE: College algebra.

MA3001 INCREMENTED DIRECTED STUDY (Variable 1-0 or 2-0.) (V - 0).
Provides the opportunity for a student who is enrolled in a 3000 level mathematics course to pursue the course material and its applications in greater depth by directed study to the extent of one additional hour beyond the normal course credit. PREREQUISITE: Enrollment in a 3000 level mathematics course and consent of instructor.

MA3025 LOGIC AND DISCRETE MATHEMATICS (5 - 1).
MA3025 provides a rigorous foundation in logic and elementary discrete mathematics to students of mathematics and computer science. Topics from logic include modeling English propositions, propositional calculus, quantification, and elementary predicate calculus. Additional mathematical topics include elements of set theory, mathematical induction, relations and functions, and elements of number theory. PREREQUISITE: MAR125 or MA1025.

MA3026 DISCRETE MATHEMATICS WITH APPLICATIONS (5 - 0).
Graphs, trees, matchings and network flows. Introduction to combinatorial problems and counting techniques. Recurrence relations. Combinatorial circuits and introduction to finite state machines. PREREQUISITE: MA3025.

MA3030 INTRODUCTION TO COMBINATORICS AND ITS APPLICATIONS (4 - 1).
MA3030 provides a thorough grounding in elementary combinatorics and its applications to computer science and discrete probability theory to students of computer science who concurrently take MA3025, Logic and Discrete Mathematics. Topics from combinatories include fundamental counting rules, binomial and multinomial theorems, the pigeonhole and inclusion/exclusion principles, and homogeneous recurrence relations. Elementary discrete probability is covered, up to the expectation of a discrete random variable. COREQUISITE: MA3025.

MA3042 LINEAR ALGEBRA (4 - 0).
Finite-dimensional vector spaces, linear dependence, basis and dimension, change of basis. Linear transformations and similarity. Scalar product, inner product spaces. Orthogonal subspaces and least squares. LU (with pivoting), Cholesky, and QR factorizations. Eigenvalues/eigenvectors, diagonalization. Hermitian matrices, quadratic forms, definite matrices. Vector and matrix norms, orthogonal transformations, condition numbers. PREREQUISITES: MA1118 taken concurrently, MA1042.

MA3046 MATRIX ANALYSIS (4 - 1).
Linear algebra from a constructive point of view, important for applications. Gauss and Cholesky factorizations. Orthogonalization, linear least squares problems and the fundamental theorem of linear algebra. Hermitian eigen problems and singular value decompositions. General eigen problems. Structured and inverse problems from signal analysis and control. PREREQUISITE: MA1043, familiarity with MATLAB.

MA3110 INTERMEDIATE ANALYSIS (3 - 0).
Multi-variable calculus integrated with linear algebra. Functions of several variables, continuous transformations, Jacobians, chain rule, implicit function theorem, inverse function theorem, extreme, optimization and Lagrange multiplier technique. Applications in Operations Research. PREREQUISITE: MA1118, MA3042.

MA3132 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS (4 - 0).
Solution of boundary value problems by separation of variables; Sturm-Liouville problems; Fourier and Bessel series solutions, Fourier transforms; classification of second-order equations; applications, method of characteristics. Applications to engineering and physical science. Satisfies the ESR in differential equations for the Applied Mathematics program. PREREQUISITE: MA2121 and vector analysis.

MA3139 FOURIER ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS (4 - 0).
Fourier series; solution of the one and two-dimensional wave equations, D'Alembert's solution, frequency and time domain interpretations; Fourier integral transforms and applications to ordinary and partial differential equations and linear systems; Convolution theorems. Course covers basic material essential for signal processing, filtering, transmission, waveguides, and other related problems. Applications include spectral analysis of electronic signals, e.g. radar or sonar. Designed for UW and EW/IW students. PREREQUISITES: Vector analysis and MA2121.

MA3185 TENSOR ANALYSIS (3 - 0).
Definition and algebra of tensors. Dyadic representation in Cartesian and general components. Calculus of tensor fields in curvilinear coordinates. Derivation and application of the basic equations of heat conduction, rigid body mechanics, elasticity, fluid mechanics, electromagnetism, Newtonian and Einsteinian orbital mechanics. PREREQUISITE: MA2049.

MA3232 NUMERICAL ANALYSIS (4 - 1).
Provides the basic numerical tools for understanding more advanced numerical methods. Topics for the course include: Source and Analysis of Computational Error, Solution of Nonlinear Equations, Interpolation, Numerical Integration and Differentiation, Numerical Solution of Ordinary and Partial Differential Equations, Iterative Methods in Numerical Linear Algebra and the Eigenvalue Problem. PREREQUISITES: MA2121, MA3132 and ability to program in a high level language such as Fortran, C, or MATLAB. Credit cannot be obtained for both MA3232 and MA3243.

MA3243 NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (4 - 1).
Course designed to familiarize the student with some analytical techniques as well as classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning some of the applicable algorithms, the student will be required to do some programming. Topics covered include: Implicit, Explicit, and Semi-Implicit Methods in the solution of Elliptic and Parabolic PDE's, iterative methods for solving Elliptic PDE's (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDE's. PREREQUISITES: MA2121 and the ability to program in a high level language such as Fortran, C, or MATLAB.

MA3261 BASIC PARALLEL COMPUTATION (3 - 0).
The course has two goals: First to introduce some fundamental issues such as shared vs. distributed memory, connection topologies, communication algorithms, speedup, efficiency, storage requirements, granularity, pipelining, problem scaling, useful paradigms for algorithm development. Second, to develop working proficiency by designing, implementing and evaluating the performance of several parallel algorithms. These include, but are not limited to numerical quadrature, matrix computations, sorting, network analysis, and dynamic programming. PREREQUISITES: MA1118 or MA3025 and ability to program in a high-level language.

MA3301 LINEAR PROGRAMMING (Same as OA3201.) (4 - 1).
Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. PREREQUISITES: MA3042, MA3110 and OA3200.

MA3393 TOPICS IN APPLIED MATHEMATICS (Variable hours 1-0 to 4-0.) (V - 0).
A selection of topics in applied mathematics. The course content varies and the credit varies. This course is intended to reflect study for the beginning graduate student in an area for which no formal course is taught. Credit for this course may be granted more than one time to an individual student. PREREQUISITE: Consent of instructor.

MA3400 MATHEMATICAL MODELING PROCESSES (4 - 0).
Practice model construction while demonstrating the utility and universality of mathematics. Topics include modeling using graphical analysis, the model building process, modeling using proportionality, analysis of data, modeling using dimensional analysis, dynamical models, optimization of models and simulation. Models investigated include the nuclear arms race, drag force on a submarine, optimization of inventory levels, and fuel consumption. PREREQUISITE: MA1118 or consent of instructor.

MA3560 MODERN APPLIED ALGEBRA (3 - 0).
The techniques and tools of abstract algebra. The emphasis is on group theory: classification, subgroups, conjugates, isomorphism, direct products, homomorphism, and factor groups. The course concludes with a brief look at the theory of rings and fields, especially finite fields. Applications may vary, but typically are drawn from topics of interest to DoN/DoD. These include error correcting codes, reliable and secure communications and cryptography. Satisfies the algebra ESR. PREREQUISITE: MA3025.

MA3605 FUNDAMENTALS OF ANALYSIS I (3 - 0).
The real number system and the usual topology of the real line; properties of continuous functions; differentiation. Functions of bounded variation and theory of Riemann-Stieltjes integration, convergence theorems for sequence and series of functions. Satisfies the analysis ESR for the Applied Mathematics program. PREREQUISITE: MA3110 or consent of instructor.

MA3606 FUNDAMENTALS OF ANALYSIS II (3 - 0).
Continuation of MA3605. PREREQUISITE: MA3605.

MA3610 TOPOLOGY, FRACTALS, AND CHAOTIC DYNAMICS (3 - 0).
An introductory course on chaotic dynamics systems and fractals. Topics covered include: flows on the line, bifurcations, linear systems, phase plane, limit cycles, the Lorenz equations, fractals, and one-dimensional maps. Applications include population growth, laser threshold, the pendulum, relaxation oscillations, and synchronized chaos. PREREQUISITE: MA1118 and MA2121.

MA3675 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE I (3 - 0).
Selected topics from the theory of functions of a complex variable; complex functions, power series, Laurent series. Singularities of complex functions; contour integration and residues; zeros of analytic functions, factors of and infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. Applications include interference effects in optics and problems from heat flow and fluid flow. PREREQUISITE: MA1118.

MA3676 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II (3 - 0).
Continuation of MA3675. PREREQUISITE: MA3675.

MA3730 THEORY OF NUMERICAL COMPUTATION (3 - 0).
Analysis of computational methods used for the solution of problems from the areas of algebraic equations, polynomial approximation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. PREREQUISITES: MA2121.

MA4026 COMBINATORIAL MATHEMATICS (4 - 0).
Advanced techniques in enumerative combinatorics and an introduction to combinatorial structures. Topics include generating functions, recurrence relations, elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications in probability, game theory, network design, coding theory, and experimental design. PREREQUISITE: MA3025.

MA4027 GRAPH THEORY AND APPLICATIONS (4 - 0).
Advanced topics in the theory of graphs and digraphs. Topics include graph coloring, Eulerian and Hamiltonian graphs, perfect graphs, matching and covering, tournaments, and networks. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications to coding theory, searching and sorting, resource allocation, and network design. PREREQUISITE: MA3025.

MA4101 INCREMENTED DIRECTED STUDY (Variable hours 1-0 or 2-0.) (V - 0).
Provides the opportunity for the student enrolled in a 4000 level mathematics course to pursue the subject under faculty supervision to greater depth. One extra credit is assigned beyond the normal course credit. PREREQUISITES: Enrollment in a 4000 level math course and consent of instructor.

MA4103 THESIS TOPICS SEMINAR (3 - 0).
Explores in depth discrete dynamical systems and the thesis topics of students enrolled in the Applied Mathematics degree program. Fulfills the ESR to provide students with the experience of organizing and presenting applied mathematical ideas to students and faculty, including a classroom environment. PREREQUISITE: Consent of instructor. Graded on a Pass/Fail basis only.

MA4230 NUMERICAL FUNCTIONAL ANALYSIS (3 - 0).
Linear functionals, Riesz representation theorem, Hilbert spaces, Sobolev spaces, interpolation and approximation in Hilbert spaces, nonlinear operators, Newton's method. PREREQUISITES: MA3232, MA4635.

MA4237 ADVANCED TOPICS IN NUMERICAL ANALYSIS (Variable credit, usually 4-0.) (V - 0).
The subject matter will vary according to the abilities and interest of those enrolled. Applications of the subject matter to DoD/DoN are discussed. PREREQUISITE: Consent of instructor.

MA4242 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3 - 1).
Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. PREREQUISITE: MA3232.

MA4243 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3 - 1).
Finite difference methods for parabolic, elliptic, and hyperbolic equations, multi-grid methods; convergence and stability, error estimation and control, numerical solution of finite difference equations, applications. PREREQUISITES: MA3132, MA3232, MA4230 suggested.

MA4245 MATHEMATICAL FOUNDATIONS OF FINITE ELEMENTS (3 - 1).
Variational formulation of boundary value problems, finite element and boundary element approximations, types of elements, stability, eigenvalue problems. PREREQUISITES: MA3132, MA3232.

MA4248 COMPUTATIONAL LINEAR ALGEBRA (4 - 1).
Development of algorithms for matrix computations. Rounding errors and introduction to stability analysis. Stable algorithms for solving systems of linear equations, linear least squares problems and eigen problems. Iterative methods for linear systems. Structured problems from applications in various disciplines. PREREQUISITES: MA3046, or consent of instructor, advanced MATLAB programming.

MA4251 APPLIED APPROXIMATION THEORY (3 - 1).
Univariate and tensor product spline approximation, interpolation in Hilbert spaces, scattered data approximation, applications. PREREQUISITES: MA3232, MA4230.

MA4261 DISTRIBUTED SCIENTIFIC COMPUTING (3 - 2).
General principles of parallel computing, parallel techniques and algorithms, solution of systems of linear equations, eigenvalues and singular value decomposition, domain decomposition and application (e.g., satellite orbit determination and shallow water fluid flow). PREREQUISITES: MA3042 or MA3046, MA3132, and MA3232.

MA4301 NONLINEAR PROGRAMMING (Course taught by OR staff, same as OA4201.) (4 - 0).
Introduction to modern optimization techniques, Karesh-Kuhn-Tucker necessary and sufficient conditions for optimality, quadratic and separable programming, basic gradient search algorithms and penalty function methods. Applications to weapons assignment, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITES: OA3201 and MA3110.

MA4302 DESIGN OF EXPERIMENTS (Course taught by OR staff, same as OA4101.) (3 - 1).
Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments, traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. PREREQUISITE: OA3103 or equivalent.

MA4303 REGRESSION ANALYSIS (Course taught by OR staff, same as OA4102.) (4 - 0).
Construction, analysis and testing of regression models. An in-depth study of regression and its application in operations research, economics and the social sciences. PREREQUISITES: OA3102, OA3103 and OA3104.

MA4304 TIME SERIES ANALYSIS (Course taught by OR staff, same as OA4308.) (4 - 0).
Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. PREREQUISITES: OA3104 and OA3301.

MA4311 CALCULUS OF VARIATIONS (3 - 0).
Euler equation, Weierstrass condition, Legendre condition, numerical procedures for determining solutions, gradient method, Newton method, Transversability condition, Rayleigh Ritz method, conjugate points. Concepts are related to geometric principles whenever possible. PREREQUISITE: MA2121 (programming experience desirable).

MA4312 TOPICS IN CALCULUS OF VARIATIONS (3 - 0).
Topics covering extensions of concepts presented in MA4311. PREREQUISITE: MA4311 and computer programming.

MA4321 STABILITY, BIFURCATION AND CHAOS (3 - 0).
Differential equations and dynamical systems, equilibrium of autonomous systems, stability, Liapunov's method, examples of chaos, local bifurcations of vector fields and maps, chaotic dynamical systems. PREREQUISITE: MA3610.

MA4322 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS I (3 - 0).
Linear operators, generalized functions and Hilbert spaces; solutions of partial differential equations by Green's functions and eigen functions; variational techniques; Fredholm and Volterra integral equations; asymptotic methods and perturbations. Applications to wave propagation, optimization, fluid dynamics, and numerical methods. PREREQUISITES: MA3042 and MA3132; MA3232 strongly recommended.

MA4323 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS II (3 - 0).
Continuation of MA4322. PREREQUISITE: MA4322.

MA4332 PARTIAL DIFFERENTIAL EQUATIONS (3 - 0).
Diffusion, wave and Laplace equations. Classification of second order equations, discontinuities and signal propagation, transform methods, Green's functions, first order equations and characteristics. PREREQUISITE: MA3132.

MA4335 LINEAR AND NONLINEAR WAVES (3 - 0).
Analysis of the two main classes of wave motion, hyperbolic waves and linear dispersive waves. Topics covered include: kinematic waves, shock waves, shock structure and shock fitting, Burger's equation, the wave equation, linear dispersive waves, wave patterns and water waves. PREREQUISITE: MA3132.

MA4340 ADVANCED MATHEMATICAL MODELING (3 - 0).
A course intended to bring advanced mathematical methods to bear on the modeling and study of physical problems. Topics to be discussed include: simple dynamic models, the phase plane, stable and unstable motion, wave motion, bifurcation, catastrophe and chaos. PREREQUISITES: MA3132 and MA3400.

MA4362 ASTRODYNAMICS (3 - 0).
Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. PREREQUISITE: SS2500 or equivalent.

MA4370 THEORY OF PLATES AND SHELLS (3 - 0).
Foundations of the mathematical theory of thin plates and shells. Analytical and numerical solution techniques. Applications to structures used by the military. PREREQUISITES: MA3132.

MA4372 INTEGRAL TRANSFORMS (3 - 0).
The Laplace, Fourier and Hankel transforms and their inversions; Asymptotic behavior. Applications to problems in engineering and physics. PREREQUISITES: MA3132, MA3675.

MA4377 ASYMPTOTIC AND PERTURBATION METHODS I (3 - 0).
Advanced course in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. PREREQUISITE: MA3132.

MA4378 ASYMPTOTIC AND PERTURBATION METHODS II (3 - 0).
Continuation of MA4377. PREREQUISITE: MA4377.

MA4391 ANALYTICAL METHODS FOR FLUID DYNAMICS (4 - 0).
The basic fluid dynamic equations will be derived, and a variety of analytical methods will be applied to problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. PREREQUISITE: MA3132 or MA3139.

MA4392 NUMERICAL METHODS FOR FLUID DYNAMICS (4 - 0).
Numerical methods exclusively will be applied to fluid dynamics problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. PREREQUISITE: MA3232 and MA4391.

MA4393 TOPICS IN APPLIED MATHEMATICS (3 - 0).
A selection of topics in applied mathematics. The course content varies but applications of interest to the DoN/DoD will be discussed. Credit may be granted for taking this course more than once. PREREQUISITE: Consent of instructor.

MA4560 CODING AND INFORMATION THEORY (4 - 0).
Mathematical analysis of the codes used over communication channels is made. Techniques developed for efficient, reliable and secure communication are stressed. Effects of noise on information transmission are analyzed and techniques to combat their effects are developed. Linear codes, finite fields, single and multiple error-correcting codes are discussed. Codes have numerous applications for communication in the military, and these will be addressed. PREREQUISITE: MA3560.

MA4565 ADVANCED MODERN ALGEBRA (3 - 0).
A continuation of MA3560. Rings, ring homomorphism, integral domains and euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, Field extension and Galois theory. PREREQUISITE: MA3560.

MA4570 CRYPTOGRAPHY (4 - 0).
The methods of secret communication are addressed. Some simple cryptosystems are described and classical techniques of substitution and transposition are considered. The public-key cryptosystems, RSA, Discrete Logarithm and other schemes are introduced. Applications of cryptography and cryptanalysis. PREREQUISITE: MA3560.

MA4593 TOPICS IN ALGEBRA (3 - 0).
A selection of topics in algebra. Content of the course varies. Credit for taking the course more than once is allowed. Students may select a topic of interest to the DoN/DoD, so the course can support the ESR's in a variety of curricula. PREREQUISITE: MA3560 or consent of instructor.

MA4595 MATHEMATICAL FOUNDATIONS OF FAST SIGNAL PROCESSING ALGORITHMS (3 - 0).
Advanced transform algorithms for signal processing. Generalized Cooley-Tukey, Rader prime factor, and Winograd FFT algorithms. Polynomial rings, the Chinese Remainder theorem for polynomials, quotient fields, and reduced multiplication convolution algorithms. Application to hardware and software design for signal processing systems. PREREQUISITES: EC3400 and MA3042, or consent of instructor.

MA4620 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS (3 - 0).
Introduction to the modern theory of ordinary differential equations. Systems of equations. Theoretical and constructive methods of solutions. PREREQUISITES: MA2121 and MA3042.

MA4635 FUNCTIONS OF REAL VARIABLES I (3 - 0).
Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesgue measure and integration theory, convergence theorems and Lp spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesgue decomposition and product measure; Daniell integrals and integral representation of linear functionals. PREREQUISITE: MA3606.

MA4636 FUNCTIONS OF REAL VARIABLES II (3 - 0).
Continuation of MA4635. PREREQUISITE: MA4635.

MA4675 COMPLEX ANALYSIS (3 - 0).
A continuation of MA3675, MA3676. Differential equations in the complex plane, transform methods, the Wiener-Hopf method, integral equations, discrete Fourier analysis. PREREQUISITES: MA3675, MA3676.

MA4693 TOPICS IN ANALYSIS (3 - 0).
A selection of topics in analysis. Content of the course varies. Students will be allowed credit for taking the course more than once. PREREQUISITE: Consent of instructor.

MO designated courses are intended for students in operational curricula only. They do not satisfy the mathematics course requirements for accredited engineering curricula, nor do they satisfy the prerequisites for any of the MA designated courses.

MO1248 SELECTED TOPICS IN APPLIED MATHEMATICS FOR C4I, SPACE SYSTEMS OPERATIONS AND INFORMATION TECHNOLOGY MANAGEMENT (4 - 1).
A survey of selected calculus and post-calculus topics - infinite sequences and series; Fourier series and Fourier integral transforms; matrix algebra and determinants. (This course may not be taken for credit by students in an engineering or science degree program). PREREQUISITE: MA1117.

MO1901 MATHEMATICS FOR ISSO (3 - 0).
A brief survey of selected calculus and post-calculus topics - single variable derivatives and integrals, infinite series and sequences, complex numbers, and Fourier series and transforms. (This course may not be taken for credit by students in an engineering or science degree program nor may it be used as a prerequisite for any other mathematics course.) PREREQUISITE: None.

MO1902 MATHEMATICS FOR ISSO SPACE SYSTEMS OPERATIONS SPECIALIZATION (2 - 0).
This course is taken concurrently with MO1901 (3-0). The course is a brief survey of the following topics: Matrix Algebra, Ordinary Linear Differential Equations, selected numerical analysis topics and an introduction to MATLAB. (This course may not be taken for credit by students in an engineering or science degree program nor may it be used as a prerequisite for any other mathematics course.) PREREQUISITE: None.

MO1995 MATHEMATICS FOR SCIENTISTS AND ENGINEERS I (5 - 0).
This course is taken concurrently with MA1996 (5 - 0). Descriptions of all topics in both courses are provided in this course description but half of these topics are taught in MA1996 (5 - 0). Precalculus review, complex numbers and algebra, complex plane, DeMovire's Theorem, matrix algebra, LU decomposition, Cramer's rule, eigenvalues and eigenvectors. Limits and rates of change, derivatives, rules of differentiation, extreme values, indefinite integrals, vectors in the plane, definite integrals, applications and modeling physical problems, special functions, vectors in space, partial derivatives multiple integrals, integration in vector fields, extreme values, power series, first and second-order ordinary differential equations with applications. This course was designed for the METOC and Combat Systems curricula. PREREQUISITE: Precalculus mathematics.

MO1996 MATHEMATICS FOR SCIENTISTS AND ENGINEERS II (5 - 0).
This course is taken concurrently with MA1995 (5 - 0). Descriptions of topics in this course are given in the course description for MA1995 (5 - 0). This course was designed for the METOC and Combat Systems curricula. PREREQ-UISITE: Precalculus mathematics.

MO3197 DIFFERENTIAL EQUATIONS AND FOURIER ANALYSIS (5 - 0).
Nonhomogenous ODEs: variation of parameters, undetermined coefficients, linear systems of ODEs, series solutions, introduction to Laplace transforms. PDEs: classification, separation of variables for the Laplace, wave, and diffusion equations, Sturm-Liouville theory, Fourier series and Fourier transform methods. PREREQUISITES: MA1995, MA1996.

DEPARTMENT OF MECHANICAL ENGINEERING

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Charles N. Calvano, Professor (1991)*; Ocean Engineer, Massachusetts Institute of Technology, 1970.

Morris R. Driels, Professor (1989); PhD, City University of London, 1973.

Indranath Dutta, Associate Professor (1988); PhD, University of Texas, Austin, 1988.

Alan G. Fox, Professor (1989); PhD, University of Birmingham, United Kingdom, 1982.

Ashok Gopinath, Assistant Professor (1994); PhD, University of California, Los Angeles, 1992.

Joshua H. Gordis, Associate Professor (1992); PhD, Rensselaer Polytechnique Institute, 1990.

Anthony J. Healey, Professor (1986); PhD, Sheffield University, United Kingdom, 1966.

Matthew D. Kelleher, Professor (1967); PhD, University of Notre Dame, 1966.

Young W. Kwon, Associate Professor and Associate Chair (1990); PhD, Rice University, 1985.

Paul J. Marto, Distinguished Professor Emeritus (1965); ScD, Massachusetts Institute of Technology, 1965.

Terry R. McNelley, Chairman and Professor (1976); PhD, Stanford University, 1973.

Sarath K. Menon, Research Associate Professor (1994); PhD, Carnegie Mellon University, 1985.

Knox T. Millsaps, Jr., Associate Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

F. Kevin Owen, Senior Lecturer (1995); D. Phil., University of Oxford, 1969.

Fotis A. Papoulias, Associate Professor (1988), PhD, University of Michigan, 1987.

Paul F. Pucci, Professor Emeritus (1956) PhD, Stanford University, 1955.

Jon D. Raggett, Lecturer (1992); PhD, Princeton University, 1971.

David Salinas, Associate Professor Emeritus (1970); PhD, University of California, Los Angeles, 1968.

Turgut Sarpkaya, Distinguished Professor (1967); PhD, University of Iowa, 1954.

Young S. Shin, Professor and Associate Chair (1981); PhD, Case Western Reserve University, 1971.

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

The department of Mechanical Engineering provides a strong academic program which spans the disciplines of the thermal-fluid sciences, structural mechanics, dynamic systems and control, materials science and engineering and total ship systems engineering. These disciplines are blended together with a strong emphasis on naval engineering applications such as may be experienced on surface vessels and in submarines.

Programs leading to the degree Master of Science in Mechanical Engineering are accredited at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council.

Any program leading to award of a degree must be approved by the Chairman of the Department of Mechanical Engineering at least two quarters before completion. In general, approved programs will require more than minimum degree requirements in order to conform to the needs and objectives of the United States Navy.

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

A candidate shall have completed work equivalent to the Bachelor of Science requirements of this department. Candidates who have not majored in Mechanical Engineering, or who have experienced a significant lapse in continuity with previous academic work, initially will take undergraduate courses in mechanical engineering and mathematics in preparation for their graduate program.

The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. Because the Naval Postgraduate School accepts students with a wide variety of educational backgrounds, programs are uniquely tailored to provide a firm foundation in the principles of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements below.

In addition to the stated credit hour requirements, a student seeking the Master of Science in Mechanical Engineering must demonstrate competence in a broad spectrum of the fundamental core disciplines of Mechanical Engineering. These are: fluid mechanics; thermal science; solid mechanics; vibrations; dynamic systems and controls; designs; and materials engineering. This may be accomplished by successfully completing six of the following seven courses: ME3150 Heat Transfer; ME3201 Intermediate Fluid Mechanics; ME3521 Mechanical Vibrations; ME3611 Mechanics of Solids II; ME3711 Design of Machine Elements; ME3801 Classical Control of Naval Engineering Systems; MS3202 Properties, Performance and Failure of Engineering Materials. Alternatively, competence in any of these areas may be satisfied by validation of equivalent course work, to an acceptable level, from another institution.

The Master of Science degree in Mechanical Engineering requires at least 32 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 12 of which must be at the 4000 level. In addition, at least 8 quarter hours of graduate credit must be earned outside of Mechanical Engineering and Materials Science. Officers specializing in Materials Science must have their selection of electives approved by the Chairman.

An acceptable thesis is required for the Master of Science in Mechanical Engineering degree. An acceptable thesis for the degree of Mechanical Engineer may also be accepted as meeting the thesis requirement for the master's degree. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering).

The program must include at least 36 quarter hours of graduate work in the disciplines of engineering, science and mathematics. At least 20 of these hours must be in Mechanical Engineering and Materials Science. The program must include at least 12 quarter hours at the 4000 level, 8 of which must be in 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.

Non-thesis option for students in the 571 Reactors/Mechanical Engineering Curriculum. Entrance into this program, leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering), is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES) and who have an academic profile code (APC) of 121 or better. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors (SEA-08).

The program includes the following BRES courses: BRES 200 Mathematics; BRES 340 Applied Structural Mechanics; BRES 350 Heat Transfer and Fluid Flows; BRES 360 Reactor Dynamics, Control and Safeguards. The foregoing are equivalent to 16 credit hours of ME3XXX level courses. In addition, the BRES 370 Reactor and Power Plant Design Project and report must be successfully completed. In addition, the program must include 20 hours of graduate level (ME4XXX) level NPS courses in a program approved by the Chairman of Mechanical Engineering.

MASTER OF SCIENCE IN MATERIALS SCIENCE AND ENGINEERING

Students with acceptable backgrounds in science or engineering may enter a program leading to the degree Master of Science in Materials Science and Engineering. The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering and the faculty member designated to represent the Materials program. At a minimum, the approved curriculum must satisfy the requirements listed below.

The program must include at least 32 quarter hours of graduate work in Materials Science, at least 16 of which must be at the 4000 level. In addition, at least 8 quarter hours of graduate credit must be earned outside of Materials Science and Engineering.

An acceptable thesis is required for the Master of Science in Materials Science and Engineering degree. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MECHANICAL ENGINEER

A graduate student with a superior academic record (with a graduate QPR of 3.70 or better) may apply to enter a program leading to the degree Mechanical Engineer. A candidate is normally selected after completion of his first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer degree requires at least 60 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 30 of which must be at the 4000 level. In addition, at least 12 quarter hours of graduate level credits must be earned outside of Mechanical Engineering and Materials Science.

An acceptable thesis is required for the Mechanical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the Department of Mechanical Engineering.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer Degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that may address system design issues are welcome.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Mechanical Engineering has an active program leading to the degrees of Doctor of Philosophy and Doctor of Engineering. Areas of particular strength in the department are hydrodynamics, viscous flows, heat transfer, materials science, dynamics and control, vibrations and finite element analysis and computer aided design.

Entrance into the doctoral program may be requested by officers currently enrolled who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The department also accepts officer students selected in the Navy-wide doctoral study program, qualified international officers, and civilian students selected from the employees of the United States Federal Government.

An applicant to the Ph.D. program who is not already at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

Every applicant who is accepted for the doctoral program will initially be enrolled in the Mechanical Engineering Program under a special option which satisfies the broad departmental requirements for the Engineer's degree and which includes research work. As soon as feasible, the student must identify a faculty advisor to supervise research and to help initially in the formulation of a plan for advanced study. As early as practicable thereafter, a doctoral committee shall be appointed to oversee that student's individual doctoral program as provided in the school-wide requirements for the doctor's degree. Joint programs with other departments are possible. A noteworthy feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installations of the Federal Government. The degree requirements are as outlined in the general school requirements for the doctor's degree.

LABORATORIES

The Mechanical Engineering Laboratories are designed as complements to the educational mission and research interests of the department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes equipment and facilities for the investigation of problems in engineering mechanics; a completely equipped materials science laboratory, including advanced scanning electron microscopes, an Auger microprobe, a transmission electron microscope and X-ray diffractometers; an oscillating water tunnel, a unique underwater towing tank and a low turbulence water channel; a vibration analysis laboratory; a fluid power controls laboratory; a robotics and real-time control laboratory; facilities for experimentation with low velocity air flows; equipment for instruction in thermal transport phenomena; a laser doppler velocimeter; nuclear radiation detection equipment and an interactive CAD/CAE computer graphics laboratory. Experimentation is further enhanced by a broad selection of analog and digital data acquisition and processing equipment and instrumentation.

MECHANICAL ENGINEERING COURSE DESCRIPTIONS

ME0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

ME0951 SEMINARS (NO CREDIT) (0 - 1).
Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government or industrial activities.

ME1000 PREPARATION FOR PROFESSIONAL ENGINEERS REGISTRATION (3 - 0).
The course will cover the topics from the 8-hour Professional Examination given by the State of California for Professional Engineer. Discussion will involve applicable engineering techniques, including design and analysis of mechanical systems and components. PREREQUISITES: Prior passage of EIT Exam or consent of instructor. Graded on Pass/Fail basis only.

ME2001 INTRODUCTION TO ENGINEERING (3 - 0).
The origins of engineering. The role of mathematics and the physical sciences in engineering. Definition of an engineering problem, including its formulation, assumptions and method of attack. Engineering analysis. The engineering design process using the context of Naval ships and systems. Engineering communications, including graphics. This course is intended for students with a non-engineering background. PREREQUISITE: MA1117 (may be taken concurrently).

ME2101 ENGINEERING THERMODYNAMICS (4 - 2).
A comprehensive coverage of the fundamental concepts of classical thermodynamics, with insight toward microscopic phenomena. The laws of thermodynamics. Equations of state. Thermodynamic properties of substances. Entropy, irreversibility and availability. Cycle analysis, gas-vapor mixtures, combustion. PREREQUISITE: MA1118.

ME2201 INTRODUCTION TO FLUID MECHANICS (3 - 2).
Properties of fluids, hydrostatics and stability of floating and submerged bodies. Fluid flow concepts and basic equations in steady flows: mass, momentum, and energy considerations. Dimensional analysis and dynamic similitude. Viscous effects and fluid resistance. Drag and separated flow over simple bluff bodies. PREREQUISITE: ME2502.

ME2440 THE DIGITAL COMPUTER AS AN ENGINEERING TOOL (3 - 2).
Introduction to high-level programming languages including FORTRAN and MATLAB, Unix, VMS, operating system usage. Development of computer programs, subroutine organization, input and output. Application of programming techniques to the solution of selected problems in Mechanical Engineering. The laboratory includes introduction to the computing facilities at the school with emphasis on those unique to the Mechanical Engineering Department; familiarization with available software for solution of engineering problems; and various programming exercises. PREREQUISITES: MA1118, ME2101, ME2501 (all may be taken concurrently).

ME2501 STATICS (3 - 0).
Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. PREREQUISITE: MA1118 (may be taken concurrently).

ME2502 DYNAMICS (4 - 1).
Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear and space curvilinear motion. Newton's laws, work and energy, impulse and momentum, and impact. Plane motion of rigid bodies and introduction to gyroscopic motion. PREREQUISITE: ME2501.

ME2503 ENGINEERING STATICS AND DYNAMICS (5 - 0).
Forces and moments, equilibrium equations, statically indeterminate objects, trusses, methods of joints and sections, centroids, composites, rectilinear and plane curvilinear motion, absolute and relative motion, work and energy, virtual work, impulse and momentum, impact, system of particles, rigid body motion, moving frame, plane motion, fixed-axis rotation. PREREQUISITE: MA1118 (may be concurrent).

ME2601 MECHANICS OF SOLIDS I (4 - 1).
Stress-strain. Plane stress and plane strain, principal stresses, maximum shear stress, thermal stress, Mohr's circle, axial loading, indeterminate members, pressure vessels, elastic torsion, indeterminate torsion, shear moment diagram, elastic bending, beam deflection, combined loading, theory of failure. Supporting laboratory work. PREREQUISITES: ME2503 and MA1118 or equivalent.

ME2801 INTRODUCTION TO ENGINEERING SYSTEM DYNAMICS (3 - 2).
Generalized system modeling principles and reduction to mathematical forms. Analogies between electrical, mechanical, fluid, and thermal systems. Response of first and second order systems, characteristics, transient response. Introduction to feedback. PREREQUISITES: ME2502 and MA2121.

ME3150 HEAT TRANSFER (4 - 1).
Introduction to the various modes of heat transfer and their engineering applications. Steady and unsteady conduction involving the use of thermal circuit analogs, analytical, and numerical techniques. Introduction to conservation of mass, momentum and energy. External and internal forced convection fundamentals and correlation. External natural convection. Boiling. Condensation. Heat exchange analysis. Thermal radiation. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3201 APPLIED FLUID MECHANICS (4 - 1).
Steady one-dimensional compressible flow. Fundamentals of ideal-fluid flow, potential function, stream function. Analysis of viscous flows, velocity distribution in laminar and turbulent flows, introduction to the elements of the Navier-Stokes equations, solution of classical viscious laminar flow problems. Applications to Naval Engineering. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3220 STEAM POWER, REFRIGERATION, AND TURBOMACHINERY (3 - 2).
The conventional Rankine cycle steam plant, including superheat, reheat, and regenerative cycles. Boiler, condenser, and feed-water heater description. Thermodynamics of refrigeration systems, Fundamentals of turbomachinery: energy and momentum equations, dimensional analysis, and velocity diagrams. Blade design and work determination from blade shape. Application to pumps, fans, compressors, and turbines. PREREQUISITES: ME2101 and ME2201.

ME3240 MARINE POWER AND PROPULSION (4 - 2).
Fluid mechanics and thermodynamics of power propulsion systems for naval applications with a primary emphasis on platforms and weapons. Energy flow, efficiencies and performance definitions. Effects of propulsion parameters on vehicle performance including speed and range. Thermodynamics of gas power cycles, including spark ignition (Otto), compression ignition (Diesel) and gas turbine (Brayton). Steam cycles. Complex cycles including intercolling, regeneration and combined cycles. Cycle optimization. Aerothermodynamics of gas turbine components. Inlets and exhausts, compressors, turbines, combustors and augmentors. Analysis and design of axial, radial and mixed flow machines. Euler Equations and velocity triangles. Stage performance. Degree of reaction and diffusion factor. Casacade turning and losses. Non dimensional scaling of turbomachines including corrected speed and mass flow, work, flow and power flow coefficients. Meanline stage design. Fuels. Chemistry and thermodynamics of equilibrium combustion. Emissions. Gas turbine structures and vibrations. Modes and forcing of blade and rotors. Campbell diagrams. Engine vehicle integration. Propeller characteristics and matching. The course includes laboratories on gas turbines, diesels and turbomachinery.

ME3410 MECHANICAL ENGINEERING INSTRUMENTATION AND MEASUREMENT LAB (2 - 4).
Introduction to measurement systems, statistical analysis of data, error analysis, uncertainty analysis, manipulation of data including electrical readout and processing, data acquisition fundamentals and Fourier decomposition and dynamic signals. Measurements of temperature, pressure , velocity, flow rates. Energy balances, surface temperature visualization, flow visualization. Measurement of motion using accelerometers and encoders. Measurement of strain and force. Operational amplifiers, analog computers, filters. PREREQUISITES: ME2601, ME2801, ME3150, ME3521 (ME3150 and ME3521 may be taken concurrently).

ME3440 ENGINEERING ANALYSIS (4 - 0).
Rigorous formulation of engineering problems arising in a variety of disciplines. Approximate methods of solution. Finite difference methods. Introduction to finite element methods. PREREQUISITES: ME2201, ME2440, ME2502, and ME2601.

ME3450 COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING (3 - 2)
The course introduces students to the basic methods of numerical modeling for typical physical problems encountered in solid mechanics and the thermal/fluid sciences. Problems that can be solved analytically will be chosen initially and solutions will be obtained by appropriate discrete methods. Basic concepts in numerical methods, such as convergence, stability and accuracy, will be introduced. Various computational tools will then be applied to more complex problems, with emphasis on finite element and finite difference methods, finite volume techniques, boundary element methods and gridless Lagrangian methods. Methods of modeling convective non-linearities, such as upwind differencing and the Simpler method, will be introduced. Discussion and structural mechanics, internal and external fluid flows, and conduction and convection heat transfer. Steady state, transient and eigenvalue problems will be addressed. PREREQUISITES: ME2440, ME3150, ME3201,ME3601, MA2440.

ME3521 MECHANICAL VIBRATION (3 - 2).
Free and forced vibration of discrete linear systems. Vibration isolation and suppression. Vibration of bars, shafts, and beams. Supporting laboratory work. PREREQUISITES: ME2502, ME2601; MA2121 or equivalent (may be taken concurrently).

ME3611 MECHANICS OF SOLIDS II (4 - 0).
Differential equations of bars, shafts and beams with Macauley functions. Unsymmetric bending. Curved beams. Shear flow in thin walled sections. Shear center. Torsion of thin walled open sections. Thick walled cylinders. Energy including Castigliano and unit dummy load methods for displacements. Statically indeterminate systems including beams, frames, trusses, arches and combined structures. PREREQUISITE: ME2601.

ME3711 DESIGN OF MACHINE ELEMENTS (4 - 1).
Design of representative machine elements with consideration given to materials selection, tolerances, stress concentrations, fatigue, factors of safety, reliability, and maintainability. Typical elements to be designed include fasteners, columns, shafts, journal bearings, spur and helical gears, and clutches and brakes. In addition to traditional design using factors of safety against failure, particular emphasis is placed on design for specified reliability using probabilistic design methods. PREREQUISITE: ME2601.

ME3801 CLASSICAL CONTROL OF NAVAL ENGINEERING SYSTEMS (3 - 2).
Classical control design for linear systems with single-input, single-output design requirements. Transient response analysis, steady state error analysis. Routh, root locus and frequency response stability methods. Phase lead/lag and multimode compensation techniques. The course includes a laboratory. PREREQUISITE: ME2801.

ME4160 APPLICATIONS OF HEAT TRANSFER (4 - 0).
Applications of heat transfer principles to engineering systems. Design topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. PREREQUISITE: ME3150.

ME4161 CONDUCTION HEAT TRANSFER (4 - 0).
Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. PREREQUISITE: ME3150.

ME4162 CONVECTION HEAT TRANSFER (4 - 0).
Fundamental principles of forced and free convection. Laminar and turbulent duct flows and external flows. Dimensionless correlations. Heat transfer during phase changes. Heat exchanger analysis with Mechanical Engineering applications. PREREQUISITES: ME3150, ME3201.

ME4163 RADIATION HEAT TRANSFER (4 - 0).
Basic laws and definitions. Radiation properties of surfaces. Radiant interchange among diffusely emitting and reflecting surfaces. Applications and solutions of the equations of radiant interchange. Radiant interchange through participating media. Combined conduction and radiation. PREREQUISITE: ME3150.

ME4202 COMPRESSIBLE FLOW (3 - 0).
Review of simple one-dimensional flow. Generalized one-dimensional flow. Two-dimensional and axisymmetric flows. Subsonic flow with small perturbations. Mach lines. Methods of characteristics. Prandtl-Meyer expansion waves. Oblique shocks. Unsteady, one-dimensional flow. Introduction to compressible boundary layer. PREREQUISITE: ME3201 or equivalent compressible flow coverage.

ME4211 APPLIED HYDRODYNAMICS (4 - 0).
Fundamental principles of hydrodynamics. Brief review of the equations of motion and types of fluid motion. Standard potential flows: source, sink, doublet, and vortex motion. Flow about two-dimensional bodies. Flow about axisymmetric bodies. Added mass of various bodies and the added-mass moment of inertia. Complex variables approach to flow about two-dimensional bodies. Conformal transformations. Flow about hydro and aerofoils. Special topics such as dynamic response of submerged bodies, hydroelastic oscillations, etc. Course emphasizes the use of various numerical techniques and the relationship between the predictions of hydrodynamics and viscous flow methods. PREREQUISITE: ME3201.

ME4220 VISCOUS FLOW (4 - 0).
Development of continuity and Navier-Stokes equations. Exact solutions of steady and unsteady viscous flow problems. Development of the boundary-layer equations. Similarity variables, numerical and integral techniques. Separation, boundary-layer control. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications, and numerical models and CFD. PREREQUISITE: ME3201 and instructor’s permission.

ME4240 ADVANCED TOPICS IN FLUID DYNAMICS (4 - 0).
Topics selected in accordance with the current interests of the students and faculty. Examples include fluid-structure interactions, cable strumming, wave forces on structures, free-streamline analysis of jets, wakes, and cavities with emphasis on computational fluid dynamics. PREREQUISITES: ME4220 and ME4211.

ME4420 MARINE GAS TURBINES (4 - 0).
Thermodynamic analyses of gas turbine cycles, including airbreathing and closed cycle engines. Internal aerodynamics of compressor and turbine design. Combustor and source heat exchanger design. Materials considerations. Operational controls and instrumentation. Lubrication and fuels systems. Inlet, exhaust, and silencing systems. Propulsion of surface effect, hydrofoil, and conventional surface ships. Installation arrangements. Waste heat recovery systems and combined cycles (COGAS, CODOG). Auxiliary power generation. Repair and maintenance. PREREQUISITE: ME3240.

ME4522 SHIPBOARD VIBRATION AND NOISE (4 - 0).
Mechanical impedance, transfer matrices and their application to transmission of vibratory motion from machinery sources to hull plating. Acoustic signal generation at the hull-fluid interface. Characteristics of viscoelastic materials and their use in vibration isolation. Multi-isolator mounts. Study of accordian and flexural vibration of ship hulls using one-dimensional finite element modeling. Military vibration specifications. Use of vibration measurements for machinery condition monitoring. PREREQUISITE: ME3521.

ME4525 NAVAL SHIP SHOCK DESIGN AND ANALYSIS (4 - 0).
Characteristics of underwater explosion phenomena, including the shock wave, bubble behavior and bubble pulse loading, and bulk cavitation. Surface ship/submarine bodily response to shock loading. Application of shock spectra to component design. Dynamic Design Analysis Method (DDAM) and applications to shipboard equipment design. Fluid-Structure Interaction (FSI) analysis, including Doubly Asymptotic Approximation (DAA) and surface ship FSI. Current design requirements for shipboard equipment. PREREQUISITE: ME3521 or equivalent.

ME4550 RANDOM VIBRATIONS AND SPECTRAL ANALYSIS (3 - 2).
Engineering application of spectral analysis techniques to characterize system responses under a random vibration environment. Characteristics of physical random data and physical system responses. Application of probability concepts to random data and response analysis. Correlation and spectral density functions. Transmission of random vibration. System responses to single/multiple random excitations. Failure due to random vibration. Supporting laboratory work. PREREQUISITE: ME3521 or equivalent.

ME4612 ADVANCED MECHANICS OF SOLIDS (4 - 0).
Selected topics from advanced mechanics of materials and elasticity. Stress and strain tensors. Governing equations such as equations of equilibrium, constitutive equations, kinematic equations and compatibility equations. Two-dimensional elasticity problems in rectangular and polar coordinate systems. Airy stress function and semi-inverse technique. Energy methods with approximate solution techniques including Rayleigh-Ritz method. Buckling of imperfect columns. Introduction to plate and shell bending theory. PREREQUISITE: ME3611.

ME4613 FINITE ELEMENT METHODS (4 - 0).
Introduction to the fundamental concepts of the finite element method. Weighted residual methods and weak formulation. Element discretization concept and shape functions. Generation of element matrices and vectors, and their assembly into the matrix equation. Application of boundary and initial conditions. Isoparametric elements and numerical integration techniques. Computer programming and application to engineering problems such as boundary value, initial value and eigenvalue problems. PREREQUISITES: ME3611; ME3440 or equivalent or consent of the instructor.

ME4620 THEORY OF CONTINUOUS MEDIA (4 - 0).
Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. PREREQUISITES: ME3201 and ME3611.

ME4731 ENGINEERING DESIGN OPTIMIZATION (4 - 0).
Application of automated numerical optimization techniques to design of engineering systems. Algorithms for solution of nonlinear constrained design problems. Familiarization with available design optimization programs. State-of-the-art applications. Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques. PREREQUISITES: ME2440, ME3150, ME3201, ME3611.

ME4811 MULTIVARIABLE CONTROL OF SHIP SYSTEMS (3 - 2).
Multivariable analysis and control concepts for MIMO systems. State Observers. Disturbances and tracking systems. Linear Optimal Control. The linear Quadratic Gaussian compensator. Introduction to non-linear system analysis. Limit cycle behavior. PREREQUISITE: ME3801.

ME4812 FLUID POWER CONTROL (3 - 2).
Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements, valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability. PREREQUISITE: ME3801.

ME4821 ADVANCED DYNAMICS (3 - 2).
Newtonian mechanics: kinematics and dynamics of three dimensional motion of complex systems using Newton-Euler's method, analytical mechanics, generalized coordinates, virtual work, Lagrange's equations, calculus of variations, Hamilton's principle. PREREQUISITE: ME3521.

ME4823 DYNAMICS OF MARINE VEHICLES (4 - 0).
Development of the nonlinear equations of motion in ship-fixed coordinates. Linear forms. Elements of pathkeeping and stability for ships and submersibles. Maneuverability. Motions in waves. Added mass and damping. Statistical description of the seaway. Seakeeping consideration in ship design. PREREQUISITE: ME3201.

ME4825 MARINE PROPULSION CONTROL (3 - 2).
Introduction to dynamic propulsion systems modeling and analysis methods. Control design specifications and design strategies. Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems. Case studies of current Naval propulsion control systems. PREREQUISITES: ME3801, ME3240 (may be taken concurrently), and MA3132.

ME4902 ADVANCED STUDY IN MECHANICAL ENGINEERING (Variable hours 1-0 to 6-0.) (V - 0).
Directed advanced study in Mechanical Engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May be repeated for credit with a different topic. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

MS2201 INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING (3 - 2).
This is a first course in Materials Science and Engineering and emphasizes the basic principles of microstructure-property relationships in materials of engineering and Naval relevance. Topics include crystalline structure and bonding, defects, thermodynamics and kinetics of reactions in solids, deformation, strengthening mechanisms and heat treatment. Students will acquire a working vocabulary and conceptual understanding necessary for advance study and for communication with materials experts. PREREQUISITES: Undergraduate courses in calculus, physics and chemistry.

MS3202 PROPERTIES, PERFORMANCE & FAILURE OF ENGINEERING MATERIALS (3 - 2).
The purpose of this course is to advance the students' understanding of the fundamentals of materials science, while putting that understanding in the context of the behavior of materials in engineering applications. Contemporary developments in engineering materials such as composites, ceramics and polymers are considered, as well as traditional engineering alloys such as steels and aluminum alloys. Performance and failure histories of materials in service will be studied, as well as conventional textbook subjects. Examples pertinent to Naval, Aero and Combat Systems Science are emphasized. Topics include mechanical properties, fracture, fatigue, failure analysis and corrosion. PREREQUISITE: MS2201 or equivalent or consent of instructor.

MS3214 INTERMEDIATE MATERIALS SCIENCE AND ENGINEERING (4 - 0).
The purpose of this course is to provide a bridge between the introductory courses in materials science, MS2201 and MS3202, and the 4000-level elective courses in materials science. The emphasis is on a deepening of understanding of basic principles which govern the behavior of solid materials. Principles of physical metallurgy and the physics of materials will be considered in detail. Topics include thermodynamics of solids, electronic structure of alloys, lattice stability, phase equilibria, diffusion, dislocation theory, deformation mechanisms and an introduction to the kinetics of phase transformations. The course is intended to show how the application of basic principles leads to clearer understanding and control of the behavior and properties of contemporary materials. PREREQUISITES: MS2201 and MS3202 or equivalent or consent of instructor.

MS3304 CORROSION AND MARINE ENVIRONMENTAL DETERIORATION (3 - 2).
The fundamentals of corrosion science and the practice of corrosion engineering are discussed. The objectives include an appreciation of the varied causes, mechanisms and effects of corrosion. Fundamental topics such as basic electrochemistry, polarization and passivity are covered. A primary goal of the course is the development of skill in the recognition and prevention of a wide variety of types of corrosion. Standard methods of corrosion control are discussed, including cathodic protection, coatings, alloy selection and inhibitors. PREREQUISITE: MS2201 or equivalent or consent of instructor.

MS3505 MATERIALS SELECTION FOR MILITARY APPLICATIONS (4 - 0).
This course deals in depth with selection of the optimum material for a given application. Consideration is also given to evolution of new applications for existing materials, and to materials development for new and old applications. A variety of application areas are covered, including marine structures, aerospace applications, nuclear reactors, electronics, high temperature cryogenic services, and others. Sources of information, methodology, and basic rationale for materials selection decisions are presented. Emphasis is put on the variation in properties of a given material with processing history, and on variation of properties in service. PREREQUISITE: MS2201, MS3202 or consent of instructor.

MS3606 INTRODUCTION TO WELDING AND JOINING METALLURGY (3 - 2).
Welding and joining are presented from the point of view of metallurgy. Topics include the nature and applications of welding and joining processes; the welding thermal cycle; metallurgical effects of the welding thermal cycle; welding and joining of steels, aluminum alloys, stainless steels and heat-resistant alloys. Also, weldment inspection and quality assurance are introduced. PREREQUISITE: MS2201 and MS3202 or consent of the instructor.

MS4215 PHASE TRANSFORMATIONS (3 - 2).
The mechanisms and kinetics of structural changes in solid materials are considered in detail. A wide variety of transformation mechanisms are studied, including solidification, recrystallization, precipitation and martensitic transformation. The basic principles which govern these reactions are developed, including principles of nucleation and growth, diffusion and lattice distortion. The relevance of various transformations to practical heat treatment, thermomechanical processing, and technological advances is discussed. Microstructural recognition and methods of monitoring phase transformations are included. Changes in properties which result from phase transformations are given limited attention. PREREQUISITE: MS3214 or equivalent or consent of instructor.

MS4312 CHARACTERIZATION OF ADVANCED MATERIALS (3 - 2).
This course is structured to provide an insight into the various tools available for advanced physical examination of engineering materials. Topics covered include X-ray diffraction and optical, scanning, transmission and scanning transmission electron microscopies. PREREQUISITE: MS3202 or consent of instructor.

MS4811 MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS (4 - 0).
The response of structural materials to stress is discussed, including elastic and plastic deformation and fracture. Topics include elastic response and the modules of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application to materials development is also considered. PREREQUISITE: MS3202, and MS3214 or consent of the instructor.

MS4822 THE ENGINEERING AND SCIENCE OF COMPOSITE MATERIALS (4 - 0).
This course focuses on the structure-property correlation in composites utilizing a multi-disciplinary approach, covering the areas of materials science and engineering and solid mechanics. Emphasis is given to the theoretical constitutive behavior at the micro- and macro-levels, as well as on how such behavior can be altered by processing and service variables. The course is divided into three broad parts: (1) Theoretical predictions of composite properties; (2) Materials issues (including processing) complicating accurate performance prediction; and (3) Thermomechanical behavior in actual service conditions. PREREQUISITES: ME3611, MS3202 or equivalent.

MS4902 SPECIAL TOPICS IN MATERIALS SCIENCE (Variable 1-0 to 6-0.) (V - 0).
Directed advanced study in materials science on a subject of mutual interest to student and staff member after the student has taken most of his or her electives. May be repeated for credit with a different topic. PREREQUISITE: Permission of Department Chairman. Graded on Pass/Fail basis only.

TS3000 ELECTRICAL POWER ENGINEERING (3 - 2).
An overview of the principles, concepts and trade-offs which form the foundation for shipboard electric power systems. The composition of electrical power systems for present and future Navy vessels is presented. Theory necessary to understand interactions among shipboard electric power system components is discussed. The interactions between the electric power system and the various types of loads is introduced. PREREQUISITE: EC2270.

TS3001 FUNDAMENTAL PRINCIPLES OF NAVAL ARCHITECTURE (3 - 2).
The geometry, hydrostatics and hydrodynamics of monohull and other floating and submerged bodies; Froude similarity; wave and skin friction resistance; powering determination. Longitudinal and transverse stability of floating bodies. Hull girder strength. Introduction to seakeeping and passive survivability principles. PREREQUISITES: ME2201, ME2601.

TS3002 PRINCIPLES OF SHIP DESIGN AND CASE STUDIES (3 - 2).
Systems engineering in the design of complex systems; systems architecture and interface engineering and the Navy design environment. The systems development process, including need identification, requirements, feasibility determination, risk reduction, contract and detailed design. The iterative, multilevel ship design process, with affordability as a fundamental feature; modern ship design and construction methods, systems engineering techniques and tools. Case studies, ship design trends, design exercises and illustrative. PREREQUISITE: TS3001.

TS3003 NAVAL COMBAT SYSTEM ELEMENTS (3 - 2).
This course will cover combat system detection and engagement elements. This includes radar, ESM, active and passive sonar, infrared, warheads, guns, missiles, torpedoes, fire control and countermeasures. The emphasis will be on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, and their interfaces with the rest of the combat system. Details on specific elements and systems will be limited to those needed to illustrate basic principles and interactions affecting systems engineering. PREREQUISITES: ME2502, EC2170 or equivalent.

TS4000 NAVAL COMBAT SYSTEM ENGINEERING (3 - 2).
Covers the definition and integration of Naval combat systems. The emphasis will be on how the various detection, engagement, and control elements interact with each other and on how to combine them into an efficient and survivable combat system. Also addressed will be topside arrangements, signature reduction, readiness assessment, embedded training, and support system interfaces. PREREQUISITES: TS3000, TS3003.

TS4001 INTEGRATION OF NAVAL ENGINEERING SYSTEMS (3 - 2).
A system-oriented approach to integrating the principles of Naval Architecture and Marine Engineering in the design of ship subsystems. Lectures and projects exploring engineering design tools and analysis methods to meet specified systems requirements are used. Projects on hull, mechanical and electrical ship systems design are emphasized. The impact of systems design on other systems and subsystems and on the ship, including affordability, military effectiveness and survivability at the whole ship level are considered. PREREQUISITES: TS3000, TS3002.

TS4002 SHIP DESIGN INTEGRATION (2 - 4).
The ship-impact of requirements/cost/performance tradeoffs within technical and acquisition constraints. Conversion of broad military requirements to mission-based ship requirements and specific tasks resulting from those requirements. Exploration of alternative methods of satisfying requirements, leading to combat systems (payload) definition. Conduct of feasibility studies to investigate whole-ship alternatives which meet requirements. Selection of a best design approach. Design considerations for unusual ship types and an assessment of future Navy ship and combat systems needs and trends. PREREQUISITES: TS4001 and TS4000. SECRET clearance.

TS4003 TOTAL SHIP SYSTEMS ENGINEERING (2 - 4).
The design of a Naval vessel as a single engineering system satisfying mission requirements, with emphasis on affordability and survivability. The interaction and interfacing of various subsystems such as hull, propulsion, and combat systems will be explored through a joint ship “preliminary design” project to produce a balanced ship design based on the alternative chosen from feasibility studies conducted in TS4002. Concepts of design optimization within constraints. PREREQUISITE: TS4002. SECRET clearance.

DEPARTMENT OF METEOROLOGY

Lester E. Carr, Research Associate Professor (1992)*; PhD, Naval Postgraduate School, 1989.

Chih-Pei Chang, Professor (1972); PhD, University of Washington, 1972.

Kenneth L. Davidson, Professor and Associate Chair for Research (1970); PhD, University of Michigan, 1970.

Philip A. Durkee, Professor (1984); PhD, Colorado State University, 1984.

Russell L. Elsberry, Distinguished Professor (1968); PhD, Colorado State University, 1968.

Peter S. Guest, Research Associate Professor (1992); PhD, Naval Postgraduate School, 1992.

George W. Haltiner, Distinguished Professor Emeritus (1946); PhD, University of Wisconsin, 1948.

Robert L. Haney, Professor and Associate Chair for Curricular Matters (1970); PhD, University of California at Los Angeles, 1971.

Patrick A. Harr, Research Associate Professor (1989); MS Colorado State University, 1978; Ph.D. Naval Postgraduate School, 1993.

Randy T. Humiston, LCDR, U.S. Navy, Instructor (1998); MS, Naval Postgraduate School, 1992.

Bao-Fong Jeng, Research Assistant (1993); MS, National Taiwan University, 1986.

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Haflidi H. Jonnson, Research Assistant Professor (1996); PhD, State University of New York at Albany , 1988.

Douglas Miller, Research Assistant Professor (1997); PhD, Purdue University, 1996.

James T. Murphree, Senior Lecturer (1991); PhD, University of California at Davis, 1989.

Wendell A. Nuss, Associate Professor (1986); PhD, University of Washington, 1986.

Robert J. Renard, Distinguished Professor Emeritus (1952); PhD, Florida State University, 1970.

Elizabeth A. Ritchie, Research Assistant Professor (1997); PhD, Iowa State University, 1988.

Supachai (Pom) Sirayanone, Research Associate Professor (1993); PhD, Iowa State University, 1988.

Willem van der Bijl, Professor Emeritus (1961); PhD State University, Utrecht, 1952.

Qing Wang, Assistant Professor (1995); PhD, Pennsylvania State University, 1993.

Carlyle H. Wash, Chairman and Professor (1980); PhD, University of Wisconsin, 1978.

Roger T. Williams, Professor (1968); PhD, University of California at Los Angeles, 1963.

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

The Department of Meteorology's history dates back to the 1940s when it was part of the Postgraduate Department at the Naval Academy. The department's academic function is interdisciplinary in nature in that it supports separate Master of Science Degree programs: Meteorology, Meteorology and Physical Oceanography, and Oceanography; and, provides courses for the Space Systems, Undersea Warfare, Information/Electronic Warfare, and Joint Command, Control, Communications, Computers and Intelligence (C4I) curricula. Offerings in the Special Operations and Joint Warfare Analysis are under development.

Department academic strengths include air/ocean dynamics and numerical modeling and prediction, structure and dynamics of the atmospheric boundary layer, satellite remote sensing and its applications and synoptic meteorology, including analysis and prediction in tropical, midlatitude, and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has 22 faculty (9 tenure track, 9 non-tenure track, 1 military, and 3 emeritus), with graduate student participation as research-team members through the M.S. thesis and Ph.D. dissertation process. The current areas of research concentration encompass numerical and analytic air/ocean modeling and prediction, tropical meteorology (including monsoon circulations and tropical cyclone forecasting), coastal meteorology and oceanography, climate dynamics, marine boundary layer studies with emphasis on air/sea interactions and electromagnetic/optic propagation, remote sensing/satellite meteorology and a wide range of synoptic studies (e.g., regional studies, maritime cyclogenesis, short range forecasting, and numerical-model verification). The Ph.D. program in the department is active with Navy Officers, Air Force Officers, DoD civilians and international officers among its recent graduates.

DEPARTMENT REQUIREMENTS FOR DEGREES

MASTER OF SCIENCE IN METEOROLOGY

Entrance to a program leading to a Master of Science degree in Meteorology requires a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics.

The degree Master of Science in Meteorology requires completion of:

1) Necessary prerequisite courses in mathematics (through partial differential equations) and meteorology,

2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology,

3) An approved selection of graduate elective courses,

4) An acceptable thesis.

The total number of quarter hours in (2) and (3) above must be at least 36. These 36 hours must include 18 quarter hours at the 4000 level in courses other than directed study.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis, and various courses in meteorology and/or oceanography which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree of Master of Science in Meteorology and Physical Oceanography requires completion of:

1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology, and physical oceanography,

2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology and oceanography,

3) An approved selection of graduate elective courses in meteorology and oceanography,

4) An acceptable thesis on a topic approved by the department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of meteorology and oceanography.

DUAL DEGREE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

The Meteorology and Oceanography Departments have adopted a policy to not recommend the award of dual Master's degrees in Meteorology and Physical Oceanography.

DOCTOR OF PHILOSOPHY

The Ph.D. program is offered in the Department of Meteorology in the following areas of study: numerical weather prediction, geophysical fluid dynamics, boundary-layer meteorology, analysis of atmospheric systems and tropical meteorology.

The requirements for the degree are grouped into three categories: course work, research in conjunction with an approved dissertation and examination in both the major and, if elected, a minor field. The minor field is usually in physical oceanography, mathematics or physics.

The Department of Meteorology also may require a preliminary examination to show evidence of acceptability as a doctoral student.

Prospective students should consult with the Chairman of the Department of Meteorology for further guidance regarding doctoral programs.

LABORATORIES

As described below, the Department is served by four major laboratory facilities: An interactive computer lab, a synoptic meteorology lab, a meteorological measurements lab, and a tactical applications lab.

The Interactive Digital Environmental Analysis (IDEA) Laboratory, which is shared with Oceanography, provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology and oceanography programs. The laboratory consists of 32 image analysis and graphics workstations and more than 600 gigabytes of disk storage. The laboratory accesses real-time GOES, NOAA, Navy (FNMOC), and DMSP data for use in instruction and research.

The department has developed a modern Synoptic Analysis and Forecasting Laboratory which receives environmental products and observations for instruction on the preparation of real-time weather analyses and forecasts. Fleet Numerical Meteorology and Oceanography Center weather analysis and forecast products are received via the Navy Joint METOC Viewer and National Weather Service analyses and forecasts are received via PC-based DIFAX facsimile systems and UNIDATA internet distribution. Current weather observations and radar are accessible through the MIDDS system. The unique combination of Navy and civilian weather observations and products available in the lab provide students with the opportunity to examine and forecast the weather over the entire globe.

The Marine Atmospheric Measurements Laboratory utilizes in-situ and remote sensing instrumentation systems for both teaching and research. Instrumentation includes: A 405 MHz and 915 MHz Doppler radar wind profiler with radio acoustic sounding system (RASS); rawinsonde systems with GPS and LORAN navigational aids; a laser ceilometer; and a fully instrumented surface weather station. Access to other instrumentation (measuring turbulent fluxes, aerosols, etc.), measuring platforms (research vessel, buoys, and remotely piloted aircraft) and data from a variety of networked local measurement sites enables the laboratory to provide near “real-time” data from the coastal region.

The department also has a Joint Tactical Laboratory designed to assist students in applying and testing in an operational setting the oceanographic and meteorological principles learned in the classroom. The Joint Tactical Laboratory is a classified lab equipped with the same receiver units used aboard aircraft carriers, permitting real-time access and manipulation of environmental data and satellite imagery. The Joint Tactical Laboratory also has eight computer workstations that run the full suite of Geophysical Fleet Mission Planning Library (GFMPL) programs used by Navy oceanographers to facilitate analysis and forecasting in support of fleet operations. The lab supports classified research projects, and theses, in addition to classroom instruction.

METEOROLOGY COURSE DESCRIPTIONS

MRR210 REFRESHER, INTRODUCTION TO METEOROLOGY/LAB (NO CREDIT) (Meets last six weeks of quarter.) (4 - 2).
An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small- and large-scale motions, air masses fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Additionally, laboratory periods are included to illustrate lecture material, including surface and airways communication codes, pressure and streamline/ isotach analyses, introduction to mid-latitude and tropical analyses by the Navy Operational Global Atmospheric Prediction System (NOGAPS) over oceanic regions, plus satellite interpretation.

MR0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

MR0999 SEMINAR IN METEOROLOGY (NO CREDIT) (2 - 0).
Students present results of thesis or other approved research investigation. PREREQUISITE: Concurrent preparation of thesis or other acceptable research paper.

MR2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (2 - 2).
Introduction to MATLAB and FORTRAN and UNIX environments, as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

MR2200 INTRODUCTION TO METEOROLOGY (4 - 0).
A introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small-and large-scale motions, air masses, fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. PREREQUISITE: Department approval.

MR2210 INTRODUCTION TO METEOROLOGY/LABORATORY (4 - 2).
Same course as MR2200 plus laboratory periods illustrating lecture material, including Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis over oceanic areas, plus satellite imagery interpretation. PRE-REQUISITE: Department approval.

MR2262 ELEMENTS OF WEATHER FORECASTING (1 - 2).
Survey of subjective and objective methods of atmospheric prognosis. Weather briefings illustrate applications of forecasting principles and use of satellite imagery. PREREQUISITES: MR3222, MR3230 or consent of instructor.

MR2416 METEOROLOGY FOR ELECTRONIC WARFARE (2 - 0).
A survey of environmental factors affecting the propagation and attenuation of electromagnetic waves. Synoptic and climatological conditions associated with anomalous refraction are studied. Ionospheric phenomena associated with longer wavelength (Hf) propagation. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. PREREQUISITES: Differential and integral calculus. (May be taken concurrently).

MR2520 SURVEY OF AIR-OCEAN REMOTE SENSING (3 - 0).
Overview of systems for remote sensing of the atmosphere and oceans from space, and operational applications. PREREQUISITES: Undergraduate physics and calculus, or consent of instructor.

MR3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3 - 2).
Basic probability and statistics, in the air-ocean science context with emphasis on techniques of statistical data analysis. Histograms, boxplots, empirical distributions and associated characteristics such as moments and percentiles. Structure of a probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

MR3150 ANALYSIS OF AIR/OCEAN TIME SERIES (3 - 2).
Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data networks. Laboratory work involves analysis of actual atmospheric and oceanic time series using principles developed in class. PREREQUISITES: A probability and statistics course.

MR3212 POLAR METEOROLOGY/OCEANOGRAPHY (4 - 0).
Operational aspects of arctic and antarctic meteorology. Polar oceanography. Sea-ice; amount, its seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. PREREQUISITES: OC3240, MR3222 or consent of instructor.

MR3220 METEOROLOGICAL ANALYSIS (4 - 0).
Techniques of evaluation, interpretation and analysis of pressure, wind, temperature and moisture data, including weather satellite observations, with emphasis on the low and middle troposphere. Synoptic models of extratropical vortices, waves and frontal systems, with emphasis on three dimensional space structure and time continuity, including isentropic surfaces and vertical cross-section analysis. Introduction to analysis in the troposphere and low stratosphere including daily exposure to Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis, and satellite imagery interpretation. PREREQUISITES: MR3420 or MR3480, MR/OC3321.

MR3222 METEOROLOGICAL ANALYSIS/LABORATORY (4 - 3).
Same as MR3220 plus laboratory sessions in the IDEA lab, on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposphere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analyses. PREREQUISITES: MR3420 or MR3480, MR/OC3321.

MR3230 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY (4 - 0).
Development and application of conceptual models of the evolution of various tropospheric and stratospheric circulation systems. Extratropical cyclones, jet streams and fronts are examined through application of dynamical concepts with particular emphasis on aspects associated with the marine environment. PREREQUISITES: MR3222, MR4322 (may be concurrent).

MR3234 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY/LABORATORY (4 - 4).
Same as MR3230 plus laboratory sessions utilizing the IDEA Lab to facilitate the physical understanding of dynamical relationships inherent to the conceptual models of the various weather systems. Exercises utilize various case studies including material from recent marine cyclogenesis field experiments. PREREQUISITES: MR3222, MR4322, (may be taken concurrently).

MR3240 RADAR METEOROLOGY (3 - 0).
Principles of radar meteorology. Topics covered include radar systems, meteorological radar equation, doppler radar basics, propagation, attenuation, precipitation and velocity estimation, and characteristic echoes. PREREQUISITES: MR3222 and MR3522.

MR3250 TROPICAL METEOROLOGY (3 - 0).
Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, the intertropical convergence zone; structure, development and motion of tropical cyclones; monsoon circulations. Emphasis on analysis and energetics. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be taken concurrently).

MR3252 TROPICAL METEOROLOGY/LABORATORY (3 - 4).
Same as MR3250 plus laboratory sessions on analysis of tropical systems emphasizing streamline and isotach analysis and incorporating aircraft and satellite observations. Exercises stress tropical cyclone regimes. Satellite imagery is used as an analysis tool and also in forecasting tropical cyclone intensity. A track forecasting exercise provides an exposure to the use of various dynamic, climatological and statistical forecast models. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be taken concurrently).

MR3260 OPERATIONAL ATMOSPHERIC PREDICTION (3 - 0).
Subjective and objective methods of atmospheric prognosis and techniques for forecasting operationally-important weather elements from surface to 100 mb. Interpretation, use and systematic errors of computer-generated products. Weather satellite briefs and applications of forecasting principles to current situations. PREREQUISITES: MR3230, or MR3234; MR/OC4323 may be taken concurrently.

MR3262 OPERATIONAL ATMOSPHERIC PREDICTION/LABORATORY (3 - 5).
Same as MR3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations, and Fleet Numerical Oceanography Center and National Meteorological Center products. PREREQUISITES: MR3230 or MR3234; MR/OC4323 may be taken concurrently.

MR3321 AIR-OCEAN FLUID DYNAMICS (4 - 0).
A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluids are derived from fundamental physical laws. Topics include: the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. PREREQUISITES: Multivarialbe calculus and vectors; ordinary differential equations (may be taken concurrently).

MR3419 ASSESSMENT OF ATMOSPHERIC FACTORS IN EM/EO PROPAGATION (2 - 1).
The course addresses atmospheric parameters and their distribution that affect propagation of electromagnetic and Electro-optical (EM/EO) waves and describes their assessment with in situ and satellite borne sensors. It relates propagation phenomena to wavelength-dependent controlling atmospheric influences. Students receive demonstrations of obtaining web-site available atmospheric descriptions. There are demonstrations and exercises with computer based assessment codes that relate EM/EO propagation to measured and predicted atmospheric properties: PROPHET (HF), AREPS (UHF VHF-SHF), EOTDA&NOVAM (IR). Discussions will occur on display/distribution of global atmospheric and oceanic conditions supporting specific operational systems. Satellite sensor retrieval procedures will be described and demonstrated. PREREQUISITES: Curricula. Calculus based physics and math through multivariable calculus. Enrollment in International Electronic Warfare and Electronics/Communication. SECURITY CLASSIFICATION: None.

MR3420 ATMOSPHERIC THERMODYNAMICS (3 - 0).
The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air processes; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. PREREQUISITE: Multivariable calculus.

MR3421 CLOUD PHYSICS (3 - 0).
Basic principles of cloud and precipitation physics and application to cloud formation and optical properties. PREREQUISITE: MR3420 or MR3480.

MR3445 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: OC3230 and MR3420, MR/OC3150 or consent of instructor.

MR3455 MEASUREMENT SYSTEMS FOR THE MARINE AND COASTAL ATMOSPHERIC BOUNDARY LAYER (2 - 2).
The course treats a broad spectrum of measurement techniques for atmospheric dynamic and thermodynamic variables. Laboratory sessions provide hands-on experience with various state-of-the-art sensing systems, including NPS's Doppler Radar Wind Profiler. Topics include sensor static and dynamic characteristics; calibration; in situ measurements of wind, pressure, temperature, humidity, aerosols and radiation on the surface, on balloon-borne sounding systems and on aircraft; and surface-based remote sensing systems, including wind profilers, SODAR and LIDAR. PREREQUISITES: MR3150 and MR3222 or consent of the instructor.

MR3480 ATMOSPHERIC THERMODYNAMICS AND RADIATIVE PROCESSES (4 - 1).
The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air process; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Basic radiative transfer including absorption and scattering by atmospheric constituents; solar and terrestrial radiative heating; radiative energy budgets; climate change; radiative effects of clouds and aerosols; optical phenomena. PREREQUISITE: Single variable calculus.

MR3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4 - 0).
Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic properties. PREREQUISITES: Undergraduate physics and differential/integral calculus, ordinary differential equations and MR3480, or consent of instructor.

MR3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/LABORATORY (SS3525 is used for non Air-Ocean students.) (4 - 2).
Same as MR3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as MR3520.

MR3540 RADIATIVE PROCESSES IN THE ATMOSPHERE (3 - 0).
Applications of radiation theory to atmospheric energy budgets, general circulation and anthropogenic climate changes. Radiational imbalance at the surface leading to heat fluxes and temperature changes in atmosphere and earth. Upper atmosphere phenomena (ozonosphere and ionosphere). Radiative effects of clouds and aerosols, and optical phenomena. PREREQUISITES: MR3420, MR3520 or MR3522.

MR3570 OPERATIONAL OCEANOGRAPHY AND METEOROLOGY (2 - 4).
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea and post-cruise analysis. PREREQUISITES: OC3240, MR3220, or consent of instructor.

MR4240 COASTAL METEOROLOGY (3 - 1).
Mesoscale circulations of the coastal atmosphere are examined from theoretical, observational, and model perspectives. Thermally-driven circulations, orographically-driven circulations and mesoscale circulations due to the interaction of synoptic-scale weather systems with coastlines are studied to develop useful conceptual models of coastal meteorological phenomena. PREREQUISITES: MR4322, MR3234 taken concurrently or consent of instructor.

MR4241 MESOSCALE METEOROLOGY (3 - 0).
Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesoscale convective systems, tornadoes, etc., and their relation to the synoptic-scale environment. Applications to short-range and local-area forecasting utilizing satellite and numerical-model products relevant to mesoscale weather phenomena. PREREQUISITES: MR3230, MR4322 with consent of instructor.

MR4242 ADVANCED TROPICAL METEOROLOGY (3 - 0).
Theories and observations of tropical motion systems. Equatorial wave theory; stratospheric biennial oscillation; tropical intraseasonal oscillations; monsoon circulations; tropospheric biennial oscillation; El Nino and Southern Oscillation; other climate variations. Tropical cyclone dynamics; influence of environmental flow on formation and motion; advanced models and forecasting of tropical motion. Emphases among these topics will depend on the interest of the students. PREREQUISITE: MR3252 or consent of instructor.

MR4250 ATMOSPHERIC GENERAL CIRCULATION (3 - 0).
The observed circulation. Zonal mean and eddy motions. Balances of momentum, heat and moisture. Energetics. Maintenance of circulation. Zonally asymmetric circulations. Other selected topics of the general circulation of the atmosphere. PREREQUISITE: MR4322 and consent of instructor.

MR4322 DYNAMIC METEOROLOGY (4 - 0).
Pressure coordinates, quasi-geostrophic scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. PREREQUISITES: MR3420, MR/OC3321, calculus and ordinary differential equations.

MR4323 NUMERICAL AIR AND OCEAN MODELING (4 - 2).
Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving hyperbolic, parabolic and elliptic equations, linear and nonlinear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. PREREQUISITES: MR4322, OC4211, partial differential equation, MA3232 desirable.

MR4324 ADVANCED NUMERICAL WEATHER PREDICTION (3 - 0).
Initialization, boundary conditions; sensible, latent and radiative heat transfer; simulation of sub-grid scale processes such as convection and friction; spectral methods and finite element models; general circulation models. PREREQUISITE: MR/OC4323 or consent of instructor.

MR4331 ADVANCED GEOPHYSICAL FLUID DYNAMICS I (3 - 0).
Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. PREREQUISITE: Consent of instructor.

MR4332 ADVANCED GEOPHYSICAL FLUID DYNAMICS II (3 - 0).
Normal mode and baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves; symmetric instability. PREREQUISITE: Consent of instructor.

MR4413 AIR-SEA INTERACTION (4 - 0).
Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer and bulk formula for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers in air-sea interaction. PREREQUISITE: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

MR4414 ADVANCED AIR/SEA INTERACTION (3 - 0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

MR4415 ATMOSPHERIC TURBULENCE (3 - 0).
Approaches for defining the structure of the turbulent atmospheric boundary layer. Review of statistical descriptions of atmospheric turbulence; averaging, moments, joint moments, spectral representation. Equations for turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra; Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. PREREQUISITE: MR/OC3150 or consent of instructor.

MR4416 ATMOSPHERIC FACTORS IN ELECTROMAGNETIC AND OPTICAL PROPAGATION (3 - 0).
Principles of microwave and optical wave propagation in the atmosphere. Effects of surface and boundary layers on propagation: refraction, scattering, attenuation, ducting, etc. Addresses existing environmental effects assessment models. PREREQUISITE: MR/OC4413 or MR4415 (may be taken concurrently).

MR4520 TOPICS IN SATELLITE REMOTE SENSING (3 - 0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

MR4800 ADVANCED TOPICS IN METEOROLOGY (Variable credit 1-0 to 4-0.) (V - 0).
Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of Department Chairman and instructor.

MR4900 DIRECTED STUDY IN METEOROLOGY (Variable credit 1-0 to 4-0.) (V - 0).
Directed study of selected areas of meteorology to meet the needs of the individual student. PREREQUISITE: Consent of Department Chairman and instructor. Graded on Pass/Fail basis only.

MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES) ACADEMIC GROUP

Chairman & Academic Associate MOVES:
Michael Zyda
Professor
Code MOVES/Mz, Spanagel Hall
Room 252
(831) 656-2305
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The Naval Postgraduate School MOVES Academic Group is an interdisciplinary department dedicated to education and research in all areas of modeling, virtual environments and simulation. The focus of the group is on strong academic fundamentals with emphasis on application to Department of Defense and Department of Navy problems.

The MOVES Academic Group has an associated curriculum leading towards a MS in MOVES and a Ph.D. program. The MOVES Academic Group also has a research center dedicated to mid-term and long-term, fundamental research in modeling, virtual environments and simulation.

MOVES EXECUTIVE COMMITTEE

Don Brutzman, Assistant Professor, Brutzman@nps.navy.mil. Large-scale virtual environments, virtual reality transfer protocol (vrtp), virtual reality modeling language (VRML).

Rudy Darken, Assistant Professor, darken@cs.nps.navy.mil. Virtual environments, human-computer interaction, virtual environments for training, human factors. Immersive displays.

Tom Lucas, TWLucas@nps.navy.mil.. High resolution combat modeling.

Robert B. McGhee, Professor, McGhee@cs.nps.navy.mil. Human modeling, motion tracking, robotics, artificial intelligence.

Neil Rowe, Associate Professor, rowe@cs.nps.navy.mil. Modeling of plan-based actions of intelligent agents in a simulation. automatic updating of terrain databases from aerial photographs.

MOVES GROUP FACULTY

Eric Bachmann, Lecturer, Bachmann@cs.nps.navy.mil. Real time measurement of human body segment motion for realistic human animation in the networked virtual environment.

Wolfgang Baer, Research Assistant. Tactical battlefield simulation, high resolution terrain database creation from battlefield measurements, operational test instrumentation, real time image generation.

Dan Boger, Professor and Division Dean Computer and Information and Operations, Boger@cs.nps.navy.mil.

Gordon Bradley, Professor, GBradley@nps.navy.mil. Web-based combat modeling.

Mitch Brown, Lecturer, MBrown@nps.navy.mil.

Michael Capps, Research Assistant, Capps@cs.nps.navy.mil. Large-scale, networked 3D virtual environments. Area of interest management.

Peter Chu, Associate Professor, Chu@nps.navy.mil. Environment modeling.

George Conner, Senior Lecturer and Assistant Provost. Tactical and campaign analysis. Theater Missile Defense attack operations using a knowledge base of search and detection theory.

John Falby, Senior Lecturer, falby@cs.nps.navy.mil. Programming languages, animation, virtual environments for training.

Don Gaver, Distinguished Professor, DGaver@nps.navy.mil. Dynamic and stochastic state-space modeling with emphasis on representing the effect of information (IW/IO); theater and campaign-level modeling and inferences therefrom; decision-making in Test and Evaluation.

Debra Hensgen, Associate Professor, Hensgen@cs.nps.navy.mil. Software architectures that support QoS negotiation and allocation of heterogeneous computing resources (distributed OS's and RMS's).

Tom Hoivik, Senior Lecturer, THHoivki@nps.navy.mil. Simulation based acquisition, virtual prototyping, M&S in test and evaluation (e.g. Model-Test-Model) and war gaming.

Cynthia Irvine, Assistant Professor, Irvine@cs.nps.navy.mil. Computer security, information warfare.

Pat Jacobs, Professor, PJacobs@nps.navy.mil. Stochastic modelling, simulation and data analysis.

Mitchell Kerman, LT, U.S. Navy, MCKerman@nps.navy.mil. Battle simulation and analysis in virtual environment, real-world modeling in virtual environments, human/computer interaction.

Taylor Kidd, Associate Professor, Kidd@cs.nps.navy.mil. Distributed computing. Managing uncertainty in distributed environments through statistics, filtering and estimation theory.

William K. Krebs, Assistant Professor, wkrebs@nps.navy.mil. Human factors with a specialization in visual perception. dual band electro-optic sensor arrays, evaluation of image compression algorithms, virtual environment adaptation effects, computational models of visual processing, and military retention.

Ted Lewis, Professor. Distributed and parallel Java multimedia.

Don McGregor, McGredo@cs.nps.navy.mil. Large-scale-networked virtual environments.

Barry Peterson, Peterson@cs.nps.navy.mil. Human factors of virtual environments.

Frank Petho, CAPT, U.S. Navy, Chair of National Security Affairs and Assistant Professor, FPetho@nps.navy.mil. Human factors, psychophysics, measurement and scaling, methodological design, evaluative research.

Peter Purdue, Professor and Division Dean of Operational and Applied Sciences, PPurdue@nps.navy.mil.

James Taylor, Professor, JTaylor@nps.navy.mil. Modeling and simulation of combat and operations other than war, hierarchy-of-models approaches, urban warfare, joint warfare, information warfare, Lanchester-type models of warfare including stochastic representation of terrain effects, estimation of loss rates, JWARS applications.

Geoffrey Xie, Assistant Professor, Xie@cs.nps.navy.mil. Wide area networks and multimedia systems.

Xiaoping Yun, Associate Professor, Yun@nps.navy.mil. Robotics, inertia navigation and motion tracking, physics-based modeling and simulation, wireless communications, control systems.

Michael Zyda, Chair and Professor, zyda@nps.navy.mil, large-scale virtual environment network software architectures. Computer graphics. Computer-generated characters.

MOVES GROUP AFFILIATED FACULTY

Arnie Buss, Visiting Assistant Professor. Discrete event simulation, distributed simulation, component architectures.

Gordon Schacher, Professor, GSchacher@nps.navy.mil.

Bard Mansager, Senior Lecturer, Bardman@math.nps.navy.mil. Combat modeling.

Al Washburn, Professor, AWashburn@nps.navy.mil. Methods for evaluating information, particularly making cost/effectiveness tradeoffs involving other kinds of military force.

Lyn Whitaker, Associate Professor, LWhitaker@nps.navy.mil. Reliability, survival analysis, categorical data analysis, isotonic regression.

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION

The degree Master of Science in Modeling, Virtual Environments and Simulation is awarded upon satisfactory completion of a program, approved by the Chairman of the Modeling, Virtual Environments and Simulation Academic Group, which satisfies, as a minimum, the following degree requirements:

a. At least 40 quarter hours of graduate-level work, of which at least 12 quarter hours must be at the 4000 level.

b. Completion of an approved sequence of courses constituting specialization in an area of Modeling, Virtual Environments and Simulation.

c. Completion of an acceptable thesis in addition to the required course work.

DOCTOR OF PHILOSOPHY IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION

The Academic Group in Modeling, Virtual Environments, and Simulation (MOVES) has a program leading to the degree Doctor of Philosophy. Areas of special strength in the Group are networked virtual environments; adaptable software agents; human factors in virtual environments; physically-based modeling for virtual environments; modeling human and organizational behavior; discrete-event systems modeling; and data and model visualization. Further information about the program is provided at Web site http://www.moves.nps.navy.mil/PhD.html. The degree requirements are substantially the same as the general school requirements for the doctor's degree.

CURRICULUM SPONSORS

Sponsors define the Educational Skill Requirements for the MOVES curriculum through a biennial curriculum review. Our main sponsor is US Navy Modeling & Simulation Management Office (N6M). Naval officers graduating from MOVES receive the xx99-P code.

Co-sponsors of the MOVES curriculum include:

US Army Modeling and Simulation Office (AMSO).

US Army Simulation, Training & Instrumentation Command (STRICOM) - FA-53 and FA-54 communities.

US Army National Simulation Center - FA-57 community.

US Marine Corps Combat Developments Center, Office of Science & Innovation.

MOVES co-sponsors are coordinated through N6M. To become a co-sponsor, contact the MOVES Chair (currently zyda@nps.navy.mil) and N6M1 (currently George Phillips, Phillips.George@hq.navy.mil).

THE MOVES RESEARCH CENTER

Introduction and Background

The Naval Postgraduate School, in conjunction with N6M, has established a new degree program, the Modeling, Virtual Environments and Simulation (MOVES) curriculum. That new degree program produces officers that are capable of filling xx99-P coded billets upon graduation. The degree program is roughly half computer science and half operations analysis, with the goal of educating officers to gain an understanding of the mathematics and technology behind modern modeling and simulation systems.

The Need for Research Support

Students moving through the eight quarter MOVES curriculum select a thesis topic in conjunction with their thesis advisor beginning in the third quarter of their program. The selected topic is most often a thesis that partially satisfies a DoD funded research contract. Faculty at NPS write reimbursable contracts to coincide with their personal research interests and the interests of the funding sponsor. This support insures their currency in Naval modeling and simulation programs as well as in their disciplines. Also thesis students need military relevant topics for research.

The MOVES curriculum sponsor, N6M, needs to have a capability to utilize NPS MOVES students and faculty to study N6M's mid-term and long-term modeling and simulation problems, providing an opportunity for mutual collaboration. Many faculty research capabilities and interests line up with N6M requirements and funding, making such collaboration natural.

The MOVES Academic Group, the MOVES Research Center
MOVES is a new curriculum at the Naval Postgraduate School, utilizing the courses of the Computer Science and Operations Research Departments in the quarters of offering. This approach was taken to insure the program could get off the ground despite an era of reduced funding. The number of MOVES students is increasing. NPS has recognizes the importance of the program and that a formal academic group must be established, the MOVES Academic Group. Currently, almost thirty faculty have requested joint appointments or main appointments with this group. This academic group will be the organizing entity for the MOVES Research Center.

Each year N6M and NPS will propose research that it feels will be of mutual benefit to the programs of both organizations. Funding from N6M will be utilized for faculty salaries, student and faculty travel, and hardware/software requirements of internally reviewed research proposals.

As part of their funded research efforts, NPS faculty will provide annual technical review services to Navy and DoD M&S master plans. Senior faculty will be provided as Board of Visitor Members for these reviews, with faculty specialization closely matched to the topic of review. Quarterly student and faculty briefs will be provided to N6M, either in Monterey or at N6M, augmented by video teleconferencing via the MBone (multicast backbone). MOVES faculty will help connect N6M to the Defense Research and Engineering Network (DREN) for work on networked virtual environment and simulation systems. Additionally, faculty will advise N6M on the newly formed M&S subspecialty regarding billets, manning and effectiveness and will participate in annual billet reviews. Some of the funding will be utilized to develop and offer MOVES-specific courses on special topics.

The MOVES Academic Group Faculty Research Capabilities
Current work by students and faculty of the MOVES Academic Group includes:

The design of the large-scale virtual environment (LSVE) network software architecture, web-based interoperability, cross-platform VE toolkits.

Rapid 3D virtual environment construction.

Spatial sound for the improvement of performance and training in the virtual environment.

Virtual environment evaluation for its utility in training. Fidelity requirements for wayfinding in the virtual environment.

Software architectures for computer-generated virtual environment characters and semi-automated forces. Modeling of plan-based actions for intelligent agents in a simulation. Autonomous behavior for simulated humans and real or simulated military vehicles.

The Department of Defense's High Level Architecture for virtual environment interoperability. Runtime interface (RTI) and next-generation RTI.

Human body tracking technologies to provide a natural and immersive interface to networked virtual environments. Articulated body kinematics and dynamics. Inertial motion tracking, locomotion devices, human modeling in the VE. Application areas include damage control training, ship walkthroughs, search and rescue training, hostage extraction training and warfighting in urban areas.

Dynamic and stochastic state-space modeling with emphasis on representing the effect of information (IW/IO); theater and campaign-level modeling and inferences therefrom; decision-making in Test and Evaluation.

Methods for evaluating information, particularly making cost/effectiveness tradeoffs involving other kinds of military force.

Human factors, psychophysics, measurement and scaling, methodological design, evaluative research.

Java cross platform interoperability and corresponding Java multimedia technology for component-based modeling and simulation systems. Parallel and distributed processing techniques for speeding up Java multimedia applications for real-time modeling and simulation systems.

False color target identification techniques and evaluations for natural and virtual environments. Image fidelity requirements for target identification under conditions of image compression.

Tactical and campaign analysis. Theater Missile Defense attack operations using a knowledge base of search and detection theory. Operational - level simulations that are capable of insertion of system-level objects. Realistic baseline scenarios for various classification level simulations. Experiment-level analysis methodologies that yield valid system-level testing. Means for determining the military value from simulation output.

Immersive ship walkthrough, tactical visualization of the ocean environment, immersive information visualization for C4I and IW.

The development of real time systems to reduce tactical battlefield sensor data to terrain databases and produce battlefield decision aid products from such data. Database generation from battlefield measurements, photogrammetry, real time perspective view generation from large terrain arrays, live-virtual interaction in operational weapons testing, and parallel processing.

The use of simulation models for analysis. Methodologies for component-based simulation modeling. Component architectures for real-time map-based planning.

High resolution combat models and in particular Army models (Janus, JTS, JCATS). Modeling to capture the force-on-force effects of new technologies on the battlefield. Naval problems including Mine Countermeasures and the Advanced Amphibious Assault Vehicle (AAAV).

The effective application of DoD computational resources on a “point of need” basis. Combining databases, computers and software of an ashore facility to field problems.

High level aggregate models for the feasibility and structure of network centric warfare and naval fires, including levels of system representation, decision processes, operations, concepts, information structures, organizations, human factors, system performance and vulnerability.

MODELING, VIRTUAL ENVIRONMENTS & SIMULATION COURSE DESCRIPTIONS

MV2920 INTRODUCTORY TOPICS IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (V - V).
Designed to support introductory subject matter of special interest, dependent upon faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture/lab oriented or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Variable hours 2-4 to 4-1.

MV3800 DIRECTED STUDY IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (0 - V).
Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in depth subjects not fully covered in formal class work. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only. Variable hours 0-2 to 0-8.

MV3920 TOPICS IN MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (V - V).
Designed to support subject matter of special interest, dependent upon faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. PREREQUISITE: Consent of instructor. Variable hours 2-4 to 4-1.

MV4001 HUMAN FACTORS OF VIRTUAL ENVIRONMENTS (3 -2).
This course focuses on human factors issues in virtual environments (VEs). While the similarities of VEs to the real world can often make VE interfaces intuitive and easy to use, the differences between VEs and the real world can often be the cause of serious performance problems and physical inability to effectively use a system. The design of effective VE systems depends on an understanding of humans and their interaction with their environment. Only then, can a VE system hope to achieve reasonable performance levels and acceptability. This course will survey the VE literature on issues of human performance, perception, cognition, multimodal interfaces, locomotion, wayfinding, object selection and manipulation, visualization, simulator sickness, and performance differences between individuals. Students will be required to write a research paper on a selected topic and will participate in an empirical laboratory analysis of a VE system.

MV4002 TRAINING IN VIRTUAL ENVIRONMENTS (3 - 2).
This course focuses on training issues in virtual environments (VEs). VEs have often been considered to be general purpose trainers. However, systems are often built without an understanding of how to build a trainer that can verify that it improves subsequent performance without forming bad habits or other reverse training artifacts. This course will first investigate VE training systems from a theoretical perspective, focusing on learning, memory, and cognition. From this framework, actual training systems will be studied with the focus being on an actual study of training transfer of a real training system. Students will be required to participate in a training transfer study and to formally present their results in written form.

MV4030 MODELING AND SIMULATION IN OCEAN ENVIRONMENTS (3 - 2).
This course focuses on modeling and simulation (M&S) issues in ocean environments. While virtual environments (VEs) serve as M&S tools, the design of effective VE systems needs realistic physical environments. This course will cover the basic physics of ocean environments, visualization of the ocean from satellites, visualization of the ocean from Navy METOC model output, METOC information flow in M&S, the impact of the environment on human behavior, and physically-based modeling. PREREQUISITES: MA1118, CS3472.

MV4204 COMPUTER GRAPHICS USING VRML (3 - 2).
An introduction to the principles of hardware and software used for computer-generated 3D graphics via the World Wide Web. The focus of the course is authoring interactive 3D scenes and a major design project. The course is intended for MOVES and Computer Science students working in visual simulation, or students in other majors interested in the basics of 3D modeling and rendering. PREREQUISITE: CS2971, CS2973 or equivalent.

MV4655/OA4655 INTRODUCTION TO JOINT COMBAT MODELING (4 - 0).
This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision-making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, introduction to aggregated force on force modeling (including the basic Lanchester model and some of its derivatives), sensing algorithms, simulation entity decision-making, simulating C4ISR processes, terrain and movement algorithms, verification, validation, and accreditation (VV&A), stochastic versus deterministic representa-

tions, hierarchies of models, and variable resolution modeling. The primary course objective is for you to understand the enduring fundamentals of how combat models are built and used to support decision-making. This will be done, in part, through several small projects that will require you to design, implement, and analyze models. PREREQUISITES: Probability & Statistics (through OA3103), familiarity with a programming language (Java recommended), Stochastic Models (OA3301), Calculus, concurrent instruction in computer simulation (e.g., OA3302).

MV4800 DIRECTED STUDY IN ADVANCED MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (0 - V).
Advanced group studies in modeling, virtual environments and simulation on a subject of mutual interest to students and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only. Variable hours 0-2 to 0-8.

MV4900 RESEARCH SEMINAR IN MODELING, VIRTUAL ENVIRONMENTS & SIMULATION (0 - 2).
This course will examine the current and planned research of Modeling, Virtual Environments & Simulation (MOVES) faculty in multiple fields of study. The course is designed to support MOVES students in the selection of an emphasis track and an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. PREREQUISITE: none. Graded Pass/Fail basis only.

MV4910 ADVANCED READINGS IN ADVANCED MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (0 - V).
Directed readings in modeling, virtual environments and simulation 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. Variable hours 0-2 to 0-8. Can be taken pass/fail or graded.

MV4920 ADVANCED TOPICS IN ADVANCED MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (V - V).
Designed to support advanced group study of subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Variable hours 2-4 to 4-1.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

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Donald Abenheim, Associate Professor (1985)*; PhD, Stanford University, 1985.

Sherman Wesley Blandin, Jr., Professor Emeritus (1968); PhD, University of Santa Clara, 1977.

Glen Browder, Distinguished Visiting Professor (1997); PhD, Emory University, 1971

R. Mitchell Brown, III, Lecturer (1989); MA, Naval Postgraduate School, 1980; MBA, Wharton, 1976.

Thomas C. Bruneau, Professor and Academic Associate for International Security and Civil Military Relations (1987); PhD, University of California at Berkeley, 1970.

Mary P. Callahan, Assistant Professor (1995); PhD, Cornell University, 1995.

Ralph Norman Channell, Senior Lecturer (1987); MA, Boston University, 1964.

Emmanuel Chavasse-Fretaz, Captain, French Navy (1998); Visiting Military Faculty

Dana P. Eyre, Assistant Professor (1991); PhD, Stanford University, 1997.

Ahmad Ghoreishi, Lecturer (1994); PhD, University of Colorado, 1965.

Boyd Francis Huff, Professor Emeritus (1958); PhD, University of California at Berkeley, 1955.

Terry D. Johnson, Lecturer (1993); MA, Georgetown University, 1979.

Frank B. Kelly, Captain, U.S. Navy (1996); Senior Military Instructor and Intelligence Program Coordinator; MA, Naval Postgraduate School, 1977.

Peter Lavoy, Assistant Professor and Academic Associate for Strategic Studies (1993); PhD, University of California at Berkeley, 1995.

Letitia Lawson, Visiting Assistant Professor (1996); PhD, University of California at Davis, 1995.

Robert Edward Looney, Professor and Associate Chair for Instruction (1979); PhD, University of California at Davis, 1969.

Ralph Harry Magnus, Associate Professor (1976); PhD, University of California at Berkeley, 1971

Edwin R. Micewski, Colonel, Austrian Armed Forces (1998); Visiting Military Faculty.

Rodney Kennedy Minott, Senior Lecturer (1990); PhD, Stanford University, 1960.

Daniel Moran, Associate Professor and Academic Associate for Regional Security Studies (1994); PhD, Stanford University, 1982.

Maria Moyano-Rasmussen, Associate Professor (1993); PhD, Yale University, 1990.

Edward Allan Olsen, Professor (1980); PhD, The American University, 1974.

Michael D. Palatas, Commander, U.S. Navy (1997); CNO (N-3/5) Chair of Strategic Planning; MPA, Harvard University, 1990; MA, Naval War College, 1995.

Bertrand M. Patenaude, Lecturer (1992); PhD, Stanford University, 1987.

Frank Petho, Captain, U.S. Navy, Chairman and Assistant Professor (1991); PhD, University of Vermont, 1979.

Douglas Porch, Professor (1996); PhD, Cambridge, 1972.

Lois J. Roberts, Lecturer (1993); PhD, University of California at Los Angeles, 1970.

Glenn Edward Robinson, Associate Professor (1991); PhD, University of California at Berkeley, 1992.

Tjarck Gralf Roessler, Colonel (GS), German Army (1996); MA, University of Freiburg, 1976.

Denny C. Roy, Visiting Assistant Professor (1998); PhD, University of Chicago, 1991.

Kamil T. Said, Senior Lecturer (1975); MA, San Jose State College, 1967.

Gross Scruggs Jr., Admiral Bobby R. Inman Intelligence Chair (1997); MS, National Defense University, 1995.

Paul N. Stockton, Associate Professor and Director, Center for Civil Military Relations (1990); PhD, Harvard University, 1986.

Frank Michael Teti, Associate Professor (1966); PhD, Syracuse University, 1966.

Scott D. Tollefson, Senior Lecturer (1997); PhD, Johns Hopkins University SAIS, 1991.

Mikhail Tsypkin, Associate Professor (1987); PhD, Harvard University, 1985.

James J. Wirtz, Associate Professor and Associate Chair for Research (1990); PhD, Columbia University, 1989.

David Scott Yost, Professor (1979); PhD, University of Southern California, 1976.

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

The Department of National Security Affairs supports programs of study in four major curricula, supporting nine different fields. The four major curricula are Strategic Studies, Regional Security Studies, Resource Planning and Management for International Defense, and Civil-Military Relations and International Security.

REGIONAL SECURITY STUDIES: The Regional Security Studies curriculum is subdivided into five major fields, as follows:

- Middle East, Central Asia, and Sub-Saharan Africa
- Far East, Southeast Asia and the Pacific
- Latin America
- Europe and Russia
- Regional Intelligence

Programs of study range from 12 to 18 months. All the fields within Regional Security Studies focus on security and defense issues in one of the above-listed regions or, in the case of the Regional Intelligence field, combine specialized intelligence courses with a course of study in one or more regions of the world. Regional Security Studies supports all Service Foreign Area Officer Programs, in which context graduate study will often be supplemented by, and coordinated with, language study at the Army's Defense Language Institute, also located in Monterey. In the case of students enrolling in 12-month programs, language study, combined with successful completion of a written comprehensive examination, may substitute for a Master's Thesis.

The Regional Intelligence field with Regional Security Studies focuses on area-specific knowledge from an intelligence perspective. It provides a graduate-level understanding of those political, military, cultural and economic characteristics of a given geographic region that are of greatest concern to intelligence professionals within any of the armed forces, or relevant federal agencies. It is designed to meet the intelligence requirements of the Unified Commands, and to satisfy the educational skill requirements of the 824 subspecialty. This sub-field includes among its requirements courses leading to a Joint Professional Military Education Phase I qualification.

STRATEGIC STUDIES: The Strategic Studies program is 18 months long and includes courses in conventional and nuclear strategic planning, international political economy, quantitative methods, international law and organizations, terrorism, and joint warfare. The program emphasizes long-term global trends in political-military affairs, and provides students with a comprehensive understanding of the political, economic, social, cultural, and technical factors that shape the domestic and international security environment, and the formulation of U.S. national security policy and military strategy. Graduates are prepared to think critically and imaginatively about U.S. strategic interests, develop strategic concepts for the present and future, and to articulate their ideas to the highest levels of the DoD and related governmental departments and agencies.

RESOURCE PLANNING FOR INTERNATIONAL DEFENSE (RePMID): The RePMID program is offered by the National Security Affairs and Systems Management Departments, and is intended for officers and civilian employees in defense agencies of allied countries and emerging democracies. The RePMID program focuses on economic analyses; management of financial, material, and human resources; domestic and international political institutions; civil-military relations; and international law.

INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS: The curriculum in International Security and Civil-Military Relations is tailored to the needs of U.S. and international students, both civilian and military, from around the world. The core of the program is a set of courses designed to analyze the key issues in contemporary civil-military relations, international security, and defense policymaking systems. The program also emphasizes comparative study, political analysis, international law and issues in coalition operations (including peacekeeping). Students may write a Master's thesis, or elect instead to participate in a Research Seminar, followed by a written comprehensive examination tailored to their particular course of study. Graduates of this program will be well prepared to participate in the policy-making process of their own countries, as well as to teach others what they have learned.

COURSE WORK: All curricula in National Security Affairs are interdisciplinary in character, and include courses in international relations, comparative politics, international and military history, and economics, as well as specialized courses grounded in traditional academic disciplines, and tailored to the unique intellectual requirements of a military career, and the demands of the sub-specialty system. Collectively, course offerings in the department define and explore the military, political, social, economic, and technological forces that shape the international security environment, with particular attention to their impact upon the strategic interests of the United States and its friends, allies, and partners around the world. All programs include significant electives, and it is expected that students will be actively engaged in developing and planning a course of study tailored to their personal strengths and interests, while satisfying the Educational Skill Requirements of the curricular sponsors. Given the dynamic nature of subjects the department faculty studies, specific course offerings inevitably vary somewhat from year to year.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

1) At least 44 units of approved graduate study in National Security Affairs, including four departmental core courses (NS 3000, 3023, 3024, 3252), and at least 16 units of course work at the 4000 level;

2) The completion of an approved sequence of required and elective courses pertinent to one of the curricula described above;

3) Successful completion of a Master's thesis (or, in specified cases, of a written comprehensive examination);

4) Language proficiency, as required for some Regional Security Studies students, which may in some cases substitute for a thesis.

NATIONAL SECURITY AFFAIRS COURSE DESCRIPTIONS

NS0001 SEMINAR (NO CREDIT) (0 - 1).
Distinguished lecturer series. Lectures discuss matters and issues related to joint intelligence. Attendance is required by students every quarter. PREREQUISITE: TS/SCI clearance.

NS0810 THESIS RESEARCH (0 - 8).
Students conducting thesis research will enroll in this course.

NS0811 PREPARATION FOR COMPREHENSIVE EXAMINATION (NO CREDIT) (0 - 0).
Students preparing for comprehensive examinations will enroll in this course.

NS0855 EXPERIENCE TOUR (0 - 0).
Thesis research assignment to the National Maritime Intelligence Center (NMIC) and other Washington area intelligence organizations, for selected students in Track 1 and Track 3A of the Intelligence curriculum. PREREQUISITE: Approval of Academic Associate for Intelligence. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS3000 WAR IN THE MODERN WORLD (4 - 0).
This course provides an introduction to war as a political and social phenomenon, and as a force in the international system. Major themes include; the development of leading ideas about war; the mutual interactions of politics, society, and warfare; the impact of military doctrine on warfighting; allocation of resources and coordination of effort among land, sea, and air forces; national strategic cultures, and their implications for strategic practice. PREREQUISITE: None. CLASSIFICATION: None.

NS3011 POLICY ANALYSIS AND RESEARCH METHODS (4 - 2).
Survey of the methods and techniques used in social scientific inquiry. Topics include policy research design, measurement, sampling, and generation of data using survey research, scaling techniques, interviewing, content analysis, analysis of elites, event data analysis, and bibliographic research techniques. The course emphasizes hypothesis testing, using both statistical methods and the method of structured, focused comparison of case studies. Special focus is placed on applying the principles and methods of social science to the general problem of indications and warning. Laboratory experience includes extensive use of the equipment and software in the NSA computer lab. PREREQUISITE: None. CLASSIFICATION: None.

NS3012 FORECASTING AND GAMING METHODS FOR STRATEGIC PLANNERS (4 - 2).
Survey of concepts and methods employed in forecasting, wargaming, and simulation that are available for use by military planners and strategists. Includes historical development and recent forecasting, analytical gaming, and modeling, and simulation techniques applicable to national security planning. Examines a variety of forecasting and gaming methodologies including the Integrated Theater Engagement Model, the Army's JANUS system, and others. Emphasis is on current and potential uses in the development of strategy, plans and policy. PREREQUISITE: NS3011. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3020 THE OPERATIONAL LEVEL OF WAR (4 - 0).
This course provides a theoretical and historical introduction to the operational level of war, with emphasis on the conduct of joint and combined operations by American and other armed forces in the modern era. Topics include: the application of military theory and "principles of war" at the operational level; campaign planning; the operational art; decision-making at the operational level; the theoretical and practical relationship between operations, strategy, and tactics; the role of war aims and strategic objectives in shaping military operations; the interaction between military operations and war-time diplomacy; escalation, de-escalation, and war termination as operational problems. PREREQUISITE: None. CLASSIFICATION: None.

NS3023 INTRODUCTION TO COMPARATIVE POLITICS (4 - 0).
This course is designed to introduce students to the major intellectual approaches to the study of comparative politics. Readings will be drawn from major theorists and leading schools of thought. Students will confront the central questions on the nature of economic, political, and cultural development. PREREQUISITE: None. CLASSIFICATION: None.

NS3024 INTRODUCTION TO INTERNATIONAL RELATIONS (4 - 0).
This course provides an overview of the prominent theories of international relations. It surveys explanations based on decision-making, organizational behavior, domestic politics, international regimes and international systems, especially in terms of the insights they offer into the conduct of international relations in the post-Cold War world. PREREQUISITE: None. CLASSIFICATION: None.

NS3025 INTRODUCTION TO CIVIL-MILITARY RELATIONS (4 - 0).
This course introduces students to the basic concepts and issues in civil-military relations. It offers a historical and comparative analysis of different patterns of military participation in politics, defense policy making and national development. The course also introduces alternative models for structuring civil-military relations, and examines the problems associated with the models adopted by the United States and other nations. PREREQUISITE: None. CLASSIFICATION: None.

NS3030 AMERICAN NATIONAL SECURITY POLICY (4 - 0).
An institutional and functional analysis of the national and international factors which shape U.S. defense policy. Attention is focused on two major areas: (1) the decision-making process, including the legislative-executive budgetary process, as well as the influence of bureaucratic politics and interest group participation upon defense decisions; and (2) the problems of strategic choice, including security assistance, threat analysis, net assessment, deterrence theory, and limited war. PREREQUISITE: None. CLASSIFICATION: None.

NS3036 THE MILITARY AND POLITICS IN THE DEVELOPING WORLD (4 - 0).
This course examines the diverse political roles played by the military and paramilitary establishments of the developing world. Particular attention is given to the character of Third World civil-military relations and the pressures, motivations, and consequences of military coups against the established political order. The course examines the different classes of military involvement, the relationship between national political culture and military roles, and the varying methods of influence open to the armed forces. The course will conclude with an examination of different types of military governments, the consequences of military rule for national stability, problems inherent in the transition to civilian rule, and the consolidation of democratic regimes. Case studies are drawn from Africa, Latin America, the Middle East, and the Far East with the intention of identifying common and regional patterns in the character of civil-military relations in the developing world. PREREQUISITE: NS3023 or consent of instructor. CLASSIFICATION: None.

NS3037 THE ROLE OF CONGRESS IN U.S. NATIONAL SECURITY POLICY (4 - 0).
Survey of the roles, processes and orientations of the U.S. Congress in making national security policy. The course examines the powers and responsibilities granted to Congress by the Constitution, how the role of Congress has changed over time and the way the role may evolve in the future. Specific topics include the budget process, War Powers, security assistance and the problems of executive-legislative coordination in foreign and military policy making. PREREQUISITE: None. CLASSIFICATION: None.

NS3038 INTERNATIONAL NAVAL POWER AND POLICY (4 - 0).
This course examines the role of international maritime power in peace, crisis and war. It reviews the evolution of the post-World War II global balance of naval power, the roles, missions and capabilities of the principal regional navies (e.g., Japan, India, China, Western Europe, Brazil, and Argentina), and the impact of technological innovation on regional maritime strategies, threats and risks. Specific threat capabilities covered include the proliferation of underwater threat systems (e.g., submarines, mines) and precision-guided weapons. The course focuses on regional, non-superpower naval developments, and their implications for U.S. maritime policy and strategy. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3040 THE POLITICS OF GLOBAL ECONOMIC RELATIONS (4 - 0).
Examination of the world economy. Focuses on implications for the United States of changes in the world trading and financial systems. Topics covered include trade patterns, economic integration, trade blocs, new international economic order, and international economic organizations. PREREQUISITE: None. CLASSIFICATION: None.

NS3041 COMPARATIVE ECONOMIC SYSTEMS (4 - 0).
An examination of the economic systems and development problems in developing countries, including post-communist states. The course focuses on the political and ideological bases of economic organizations, and the nature of basic economic problems in these regions. Special attention is given to the socio-economic strategies and tactics used in the management of the economy, and institutions and techniques of decision making. Attention is also given to problems of economic stabilization in the developing world. PREREQUISITE: NS3040. CLASSIFICATION: None.

NS3079 DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Credit 1-0 to 4-0.) (V - 0).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS3152 JOINT WARFARE: THREAT ASSESSMENT (4 - 0).
This course concentrates on identifying the key warfare issues for successful accomplishment of the U.S. Navy's missions. The evolution of threats in examined in the context of present and future U.S. Strategy. PREREQUISITE: U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3154 JOINT INTELLIGENCE AND MILITARY COMMAND (4 - 0).
This course provides an overview of intelligence and related C4I requirements and issues affecting the planning and conduct of joint and combined operations. The Intelligence Community and C4I structure is studied with emphasis on students knowing the process and application of intelligence and C4I capabilities to support military Commands during Joint and combined operations at all levels of war. The organization and functions of the various elements of the national intelligence community are considered. Includes an introduction to systems and organizations supporting the collection, analysis, production, and dissemination of intelligence to support decision makers. The course is intended for the non-intelligence specialist to make them aware of national intelligence organizations and their capabilities in acquiring necessary intelligence support for joint commanders. This course covers various learning objectives specified by the CJCS to meet Phase One PJE criteria. PREREQUISITE: NS3252 (may be taken concurrently). U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3155 INTELLIGENCE AND DEMOCRACY (4 - 0).
This course examines how civilian authorities in emerging democracies can establish strong, effective controls over their intelligence agencies, and minimize the risk that these agencies will undermine democratic governance. The course begins by examining the potential problems that intelligence agencies can pose to the process of democratization. Next,, students will analyze the mechanisms used by the United States, the United Kingdom, France and other long-established democracies to maintain control over their intelligence organizations. These instruments of control include use of the power of the purse, structural and organizational arrangements, legislative oversight, and other mechanisms. Students will also examine the recent efforts by democracies in Latin America, Central Europe and the former Soviet Union to establish their own democratic controls over intelligence and the challenges that such nations will face in the future. PREREQUISITE: None. CLASSIFICATION: Unclassified.

NS3159 PRINCIPLES OF JOINT OPERATIONAL INTELLIGENCE (4 - 0).
This course examines the problems encountered by an intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under joint and naval operational conditions. Lectures are provided on the joint intelligence organization with emphasis on the operational aspects of warfighting, on the theory and modern history of operational intelligence, on intelligence in support of battle and amphibious group operations, on support to joint and naval operations from national and theater level assets, and on the Copernicus and C2WC concepts. Students are required to prepare and present current intelligence briefings and staff intelligence studies emphasizing joint threat analysis and assessments, and the direction of joint collection assets. Readings are from classified material and from selected literature. This course covers various learning objectives specified by the CJCS to meet Phase One PJE criteria. PREREQUISITE: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS3160 HUMAN INTELLIGENCE (4 - 0).
This course familiarize students with the concepts, principles, and methodology of Human Intelligence collection. Additionally students will comprehend the capabilities and limitations of various collectors and programs, learn the organizational architecture and understand the collection management process of Human Intelligence. This course is a requirement for all students in the Regional Intelligence Track of the Joint Intelligence Curriculum. PREREQUISITE: Student must be a US citizen holding a TOP SECRET clearance with eligibility for access to Sensitive Compartmented Information. CLASSIFICATION: TOP SECRET (SCI).

NS3171 JOINT INTELLIGENCE DATA SYSTEMS AND CONNECTIVITY (4 - 2).
This course explores the principles and concepts involved in the use of data systems for joint intelligence support. Systems examined include those used in support of joint intelligence operations afloat and ashore with attention to those used for expeditionary warfare and in the Joint Intelligence Centers. Emphasis is on understanding these systems as assets for operational intelligence officers in joint operations. Lectures will be provided on the general structure of computers, LAN's, and communications links as they apply to joint intelligence data systems, on joint and naval systems ashore and afloat, and on systems connectivity. Students will be given the opportunity during lab sessions to conduct "hands on" experiments with a modern UNIX based micro workstation and with the new Joint Deployable Intelligence Support System (JDISS). PREREQUISITES: Open to students in the 825 curriculum and to intelligence specialists. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. NS3159 or permission of instructor required. CLASSIFICATION: TOP SECRET (SCI).

NS3225 CIVIL-MILITARY RELATIONS AND DEFENSE BUDGETING (4 - 0).
This course provides a detailed analysis of the budget process used by the United States and other democracies to allocate defense resources. Students will become familiar with the planning, programming and budgeting system (PPBS) and other budgeting models and techniques. Students will also examine the sources of civil-military conflict in defense budgeting, and analyze different structures to resolve those conflicts. PREREQUISITE: Permission of instructor. CLASSIFICATION: None.

NS3230 STRATEGIC PLANNING AND THE MILITARY (4 - 1).
Introduction to strategic planning approaches and methods inherent to national security policy formulation and specifically, military defense planning. Includes long range strategic planning, scenario building and forecasting of macro-trends affecting defense policies and capabilities, and the military dimensions of those factors. Theory and process meet through case study/analysis of U.S. defense planning practices and the evolution of the Joint Strategic Planning System (JSPS), including the changing roles of the Joint Staff, Unified CINC and Component, Joint Task Force, and Service staffs following passage of the Goldwater-Nichols Act and post-Cold War international security developments. This course covers various learning objectives specified by the CJCS to meet Phase One Program for Joint Education (PJE) criteria. PREREQUISITE: NS3000, NS3154, NS3159, NS3152 may be taken concurrently. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS3250 THE ECONOMICS OF U.S. DEFENSE POLICY (4 - 0).
An examination of the manner in which economic constraints affect the defense allocation process in the United States. Emphasis is placed on the macroeconomic environment in which the budget process is undertaken. Topics include: factors affecting defense expenditures, budgeting for defense, the impact of defense spending on the economy, manpower, and the structure, conduct and performance of defense industries. PREREQUISITE: NS3040 or permission of the instructor. CLASSIFICATION: None.

NS3252 JOINT AND MARITIME STRATEGY (4 - 0).
This course provides students with a graduate level understanding of defense strategy in general, and joint and maritime strategy in particular. Major themes include: the development of strategic theory in modern times and its influence on contemporary military organization, force planning, and operations; the roles and missions of land, sea, aerospace and special operation forces; joint organization and doctrine; the interaction between military strategy, foreign policy, and alliance systems; the impact of technological developments on warfare; domestic policy-making processes affecting the armed forces of the United States; joint planning for acquisitions (PPBS) and operations; current defense reform and reorganization issues. Primary strategic planning documents are introduced and discussed. Required for all U.S. officer students at NPS. This course covers various learning objectives specified by CJCS Phase One Program for Joint Education (PJE) criteria. PREREQUISITE: None. CLASSIFICATION: None.

NS3280 NUCLEAR STRATEGY AND NATIONAL SECURITY (4 - 0).
This course surveys the history of U.S. nuclear weapons policies and explores deterrence and arms control theories. The course also evaluates the challenges posed by the proliferation of weapons of mass destruction and advanced delivery systems. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3300 HISTORY AND CULTURES OF THE MIDDLE EAST (4 - 0).
Introduction to the basic geography, culture, society, economy, and religions of the major ethnic and linguistic groups in the Middle East. The course will introduce students to important events and developments, such as the changing concepts of politics in Islam; the evolving sociological bases of states and societies in the Middle East; and the early impact of Europe on the Middle East, first through trade and then through colonialism. PREREQUISITE: None. CLASSIFICATION: None.

NS3310 GOVERNMENT AND POLITICS IN THE MIDDLE EAST (4 - 0).
This introductory course is designed to familiarize students with the politics of the contemporary Middle East. The course will cover such topics as the various types of political systems found in the Middle East, the political economy of development, and ethno-nationalist and Islamicist political movements. PREREQUISITE: None. CLASSIFICATION: None.

NS3320 UNITED STATES INTERESTS AND POLICIES IN THE MIDDLE EAST (4 - 0).
The course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on a variety of issues that have occupied American interests, such as: the Arab-Israeli conflict, the security of oil resources, revolutionary change, regional conflicts, and international rivalry of external powers. PREREQUISITE: None. CLASSIFICATION: None.

NS3360 TOPICS IN MIDDLE EASTERN POLITICS (4 - 0).
This course will examine various topics of central importance in contemporary Middle Eastern politics. These include, for example, nationalism and the state in the Middle East, the politics of Islamicist movements, and the politics of oil. PREREQUISITE: None. CLASSIFICATION: None.

NS3361 TOPICS IN MIDDLE EASTERN SECURITY (4 - 0).
This course will examine topics of central importance to contemporary Middle Eastern security. It will focus on security issues in at least one of the following: the Maghreb, Israel, the Northern Tier, and the Arabian Peninsula and the adjacent areas. PREREQUISITE: None. CLASSIFICATION: None.

NS3400 GOVERNMENT AND POLITICS IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4 - 0).
An examination of the role of domestic politics in Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy. PREREQUISITE: None. CLASSIFICATION: None.

NS3401 ETHNO-NATIONALISM IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4 - 0).
This course introduces the students to the states and societies of Russia, Ukraine, Belarus, Latvia, Lithuania, Moldova, Georgia, Azerbaijan, Armenia, Kazakhstan, Uzbekistan, Turkmenistan, and Kirgiztan. It also serves as a basic introduction to the broader study of ethnicity and nationalism. PREREQUISITE: None. CLASSIFICATION: None.

NS3410 RUSSIA, EASTERN EUROPE AND CENTRAL ASIA IN WORLD AFFAIRS (4 - 0).
This course is concerned with the international conduct and security policies of Russia, the other countries of Eastern Europe, and Central Asia. It examines their major geopolitical, historical, demographic, and economic influences. PREREQUISITE: None. CLASSIFICATION: None.

NS3450 MILITARY STRATEGY IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4 - 0).
The course examines the international factors that condition military strategy and doctrine in Russia, Eastern Europe, and Central Asia. It focuses on contemporary strategic concepts and strategy: conventional warfighting capabilities, strategy for nuclear war, roles played by the fleets in military strategy, threat and net assessment, and arms control. Emphasis is on the strategic and operational levels of warfare. PREREQUISITE: NS3252. CLASSIFICATION: None.

NS3460 GOVERNMENT AND SECURITY IN EASTERN EUROPE (4 - 0).
This course examines the countries of east central Europe that fell in the Soviet sphere of influence after World War II. It is concerned in particular with the complex relationship of Marxism and nationalism, the nature of communist revolution from abroad, revolutions against communist states including Hungary in 1956 and Poland in 1980, and the present situation of the Central European states in the transition from communism to democracy. PREREQUISITE: None. CLASSIFICATION: None.

NS3501 HISTORY AND CULTURES OF LATIN AMERICA (4 - 0).
This introductory course examines the heritage of Latin America from pre-Columbian Indian traditions and Iberian colonial patterns, through the independence movements of the early 19th century, and the global economic relationships that re-oriented the region toward Northwestern Europe and the United States. PREREQUISITE: None. CLASSIFICATION: None.

NS3510 GOVERNMENT AND POLITICS IN LATIN AMERICA (4 - 0).
This introductory course is designed to familiarize students with the politics of contemporary Latin America. The course will cover such topics as the various types of political systems found in Latin America, the political economy of development and the issue of regime transition. PREREQUISITE: None. Classification: None.

NS3520 LATIN AMERICA INTERNATIONAL RELATIONS AND SECURITY (4 - 0).
This course surveys the international relations of Latin American nations. It analyzes the relations of Latin America with the United States and other nations, both within and outside of the region. Attention is given to political, security, economic, and cultural issues. PREREQUISITE: None. CLASSIFICATION: None.

NS3600 HISTORY AND CULTURES OF EAST ASIA (4 - 0).
This course addresses the historical development of the peoples of East, South, and Southeast Asia. It emphasizes their economic, political, and military development through the late 19th century. PREREQUISITE: None. CLASSIFICATION: None.

NS3601 VALUES AND BELIEF SYSTEMS OF ASIA (4 - 0).
An introduction to the values and belief systems that have shaped the civilizations of East, South, and Southeast Asia. This course addresses the development and practices of Hinduism, Buddhism, Confucianism, Islam, Shintoism and other belief systems, and the ways they influenced traditional and modern Asia. PREREQUISITE: None. CLASSIFICATION: None.

NS3620 ASIA AND THE MODERN WORLD (4 - 0).
An analysis of major national and international developments within Asia, and between Asia and the non-Asian world from the mid-19th century to the late mid-20th century. Includes an examination of U.S. relations with Asia. PREREQUISITE: None. CLASSIFICATION: None.

NS3661 GOVERNMENT AND SECURITY IN CHINA (4 - 0).
An examination of the rise of the Chinese Communist Party and the establishment of the Communist state; its domestic achievements and problems; the special problem of Taiwan; changing foreign policies and the current role of the People's Republic of China in world affairs. Includes an examination of U.S. relations with China. PREREQUISITE: None. CLASSIFICATION: None.

NS3662 GOVERNMENT AND SECURITY IN JAPAN (4 - 0).
An examination of Japan in the contemporary world, focusing on Japan's political dynamics, economic evolution, social transformation, the National Self Defense Forces and alternatives for ensuring national security. Includes an examination of U.S. relations with Japan. PREREQUISITE: None. CLASSIFICATION: None.

NS3663 GOVERNMENT AND SECURITY IN KOREA (4 - 0).
An examination of the division of the Korean nation into two states; the aftermath of the Korean war; domestic political, economic and social problems of North Korea and South Korea; the prospects for reunification; the military balance and the changing strategic environment; and the relations of Pyongyang and Seoul with their key allies. Includes an examination of U.S. relations with Korea. PREREQUISITE: None. CLASSIFICATION: None.

NS3667 GOVERNMENT AND SECURITY IN SOUTH ASIA, SOUTHEAST ASIA, AND OCEANIC REGIONS (4 - 0).
This course examines domestic issues and foreign relations among the states in the region of South Asia, Southeast Asia, Australia, New Zealand and Melanesia. Analyzes the importance of the Indian Ocean and Southwestern Pacific ocean area, and the strategic interests of the major powers, including the United States. PREREQUISITE: None. CLASSIFICATION: None.

NS3700 HISTORY OF MODERN EUROPE (4 - 0).
Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present. PREREQUISITE: None. CLASSIFICATION: None.

NS3710 GOVERNMENT AND SECURITY IN WESTERN EUROPE (4 - 0).
Survey and analysis of government and security issues in contemporary Western Europe. The course emphasizes the political systems and security policies of Britain, France, Italy, and Germany. PREREQUISITE: None. CLASSIFICATION: None.

NS3720 EUROPEAN SECURITY INSTITUTIONS (4 - 0).
Survey and analysis of the main international institutions dealing with European security, including the North Atlantic Treaty Organization (NATO), the Conference on Security and Cooperation in Europe (CSCE), the Western European Union (WEU), and the European Community (EC). The survey will include selected challenges facing each organization, particularly NATO, and their relation to specific European countries and to U.S. foreign and defense policy. PREREQUISITE: NS3252 or permission of the instructor. CLASSIFICATION: None.

NS3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4 - 0).
This course provides an overview of insurgency and counter-insurgency. It reviews the theoretical literature and offers an operational focus, by examining the alternative models of insurgency provided by the doctrine of “people’s war,” “foco theory,” and the urban guerrilla. It also examines the roots and development of U.S. counterinsurgency doctrine, the difference between the “hearts and minds” and systems prescriptions of counterinsurgency, and alternative British, French, and Soviet concepts of counterinsurgency. Four special topics are also analyzed: the role of terror in revolutionary warfare, the relationship between narcotics and insurgency, the questions of guerrillas in power, and a comparison of U.S. counterinsurgency strategy in Vietnam and El Salvador with that currently pursued elsewhere. The course concludes with an examination of the future of guerrilla warfare. PREREQUISITE: NS3023 or permission of instructor. CLASSIFICATION: None.

NS3801 INTERNATIONAL TERRORISM (4 - 0).
This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. PREREQUISITE: NS3023 or permission of the instructor. CLASSIFICATION: None.

NS3900 INTERNATIONAL LAW AND ORGANIZATIONS (4 - 0).
An introduction to the principles of international law including origins, sources, sovereignty, states, territory, jurisdiction, persons, treaties, settlement of disputes and the Law of the Sea. The course also traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various forms of multi-national and transnational organizations. PREREQUISITE: None. CLASSIFICATION: None.

NS3902 MODERN REVOLUTION (4 - 0).
A study of a general framework and historical cases of modern revolution. Examines the most important revolutions of modern times, including the testing of the methods of systematic analysis. PREREQUISITE: None. CLASSIFICATION: None.

NS4030 SPECIAL TOPICS IN NATIONAL SECURITY POLICY (4 - 0).
This course will focus on special topics in national security policy. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4031 SPECIAL TOPICS IN INTERNATIONAL SECURITY AFFAIRS (4 - 0).
This course will focus on current topics in international security affairs. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4032 SPECIAL TOPICS IN INTERNATIONAL RELATIONS (4 - 0).
This course will focus on current topics in the broader international system. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4033 SPECIAL TOPICS IN U.S. FOREIGN POLICY (4 - 0).
This seminar focuses on contemporary topics in U.S. foreign policy. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded paper research paper is required. PREREQUISITE: Permission of instructor. CLASSIFICATION: None.

NS4034 SPECIAL TOPICS IN AMERICAN GOVERNMENT (4 - 0).
This course will focus on special topics in American government. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4035 SPECIAL TOPICS IN JOINT INTELLIGENCE (4 - 0).
This seminar will focus on contemporary topics involving joint intelligence and related areas. The list of issues to be analyzed for the seminar is announced one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. PREREQUISITE: Permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4079 ADVANCED DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit, from 1-0 to 4-0.) (V - 0).
Format and content vary. Normally involves extensive individual research under direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. PREREQUISITE: Permission of the instructor. CLASSIFICATION: None.

NS4080 RESEARCH COLLOQUIUM (2 - 0).
A research colloquium in which NSA/Intelligence/Speciation Operations students present the main findings from their master's thesis research for critical analysis and discussion. PREREQUISITE: None. CLASSIFICATION: None. GRADING: Pass/Fail.

NS4152 JOINT WARFARE: INTELLIGENCE ANALYSIS (4 - 0).
Advanced seminar on intelligence support to military commanders and national-level officials. Using case studies, the course examines concepts of individual and organizational decision-making, factors in threat analysis, and issues in intelligence activities. PREREQUISITE: NS3159 or permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4159 SEMINAR IN JOINT INTELLIGENCE SUPPORT TO CRISIS OPERATIONS (4 - 0).
This course examines problems encountered by an intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under joint and naval operational conditions. Lectures are provided on advanced aspects of operational intelligence in support of joint and naval warfare including strategic nuclear, counterinsurgency, operational deception, and wargaming. Students study and critique classified case studies from recent joint operations. The course culminates in a joint operational intelligence to include use of the Joint Deployable Intelligence Support System (JDISS). Course readings are from classified material, selected literature, and statements by leading intelligence officials. The course is conducted at the TOP SECRET SCI level. PREREQUISITE: Open to students in the 825 curriculum and to intelligence specialists. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. NS3159 and NS3171, or permission of instructor required. CLASSIFICATION: TOP SECRET (SCI).

NS4160 FOREIGN INTELLIGENCE SERVICES (4 - 0).
This course examines selected foreign intelligence services. It emphasizes their organization, missions, and functions. This course is intended for students in the Joint Intelligence Curriculum and others upon permission of the instructor. PREREQUISITE: NS3160 or permission of the instructor. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4200 SEMINAR IN THE NATIONAL INTEREST (4 - 0).
An advanced study of the underlying assumptions and objectives of American security and foreign policy. The core of the course is an in-depth analysis of approaches to understanding the American national interest in the international context. Students are required to write a major seminar paper on American national interest in a specific country or region. PREREQUISITES: NS3252 and NS3030. CLASSIFICATION: None.

NS4225 CIVIL-MILITARY RELATIONS AND TRANSITIONS TO DEMOCRACY (4 - 0).
A seminar which reviews selected cases of transitions from authoritarian rule in the post-1945 period. The course compares the various roles played by the military and other actors in these transitions, examines the participation of the military in the consolidation of democracy and the problem of democratic consolidation. Students will also examine different theories and concepts of democratic transition and consolidation. PREREQUISITE: NS3025 or permission of instructor. CLASSIFICATION: None.

NS4230 SEMINAR IN JOINT STRATEGIC PLANNING (4 - 0).
Advanced study in the concept and methods of strategic planning and analysis, particularly with respect to Department of the Navy and other services, the Joint Chiefs of Staff, the Office of the Secretary of Defense, the Department of State, the National Security Council, White House, and the Congress. This course covers various learning objectives specified by the CJCS to meet Phase One Professional Joint Education (PJE) criteria. PREREQUISITES: NS3030 and NS3230 or permission of the instructor. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS4235 SEMINAR ON DIPLOMACY AND STRATEGY OF COALITION WARFARE AND OPERATIONS OTHER THAN WAR (4 - 0).
This seminar examines the problems of military alliances in the post-cold war era, and the civil-military relation issues raised by defense cooperation, including operations other than war. PREREQUISITE: NS4225 or permission of instructor. CLASSIFICATION: None.

NS4240 SEMINAR IN REGIONAL SECURITY PLANNING PROBLEMS (4 - 0).
This seminar, which is the national security policy capstone course in the Resource Planning for Management and International Defense (RePMID) curriculum, provides advanced study of regional and inter-regional security problems which are likely to confront emerging democracies in the immediate and mid-range future. Potential roles of individual countries and coalitions are explored to develop new and innovative strategies for dealing with both common and unique security problems in diverse regions. Through the course readings, students critically analyze the implications of the most likely future security environment challenges and opportunities for each region. PREREQUISITE: Completion of previous RePMID courses, or consent of instructor. CLASSIFICATION: None.

NS4250 SEMINAR IN SECURITY ASSISTANCE AND ARMS TRANSFER (4 - 0).
An analysis of the patterns, purposes and effects of cross-national security assistance, including arms sales and the transfer of technology. Special topics include: factors dominating the arms transfer policies of the major powers; the design, execution and evaluation of security assistance programs. PREREQUISITE: NS3030. CLASSIFICATION: None.

NS4251 SEMINAR IN NET ASSESSMENT (4 - 0).
The seminar examines the methodology of comparative threat analysis (net assessment), including: security policies, forces, the RMA, and capabilities of the world's military superpowers. The course introduces the student to original source material. PREREQUISITES: NS3230, NS3252, NS3280, and NS3450. U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4253 TECHNOLOGY AND STRATEGIC PLANNING (4 - 0).
This course is intended to develop an understanding of the interrelationship of technology and strategic planning. Issues include technological risk, affordability, institutional impediments to innovation, and a strategy for long range technology investments. PREREQUISITE: NS3030, or NS3230, or NS3252, or permission of the instructor. U.S. citizen holding a SECRET clearance. CLASSIFICATION: SECRET.

NS4261 SURVEY OF STRATEGIC STUDIES (4 - 0).
Survey of the classical and contemporary literature on strategic thinking: national objectives and strategic alternatives; deterrence, counterforce, arms control, counter insurgency; components and rules of the international strategic system; and arms competitions, nuclear proliferation, and terrorism. PREREQUISITE: NS3030 or permission of the instructor. CLASSIFICATION: None.

NS4280 SEMINAR IN NUCLEAR STRATEGY (4 - 0).
A follow-up course to NS3280 that examines selected issues in nuclear strategy, the proliferation of weapons of mass destruction, and deterrence. In addition to theoretical issues of deterrence, this course will specifically investigate the role and importance of nuclear force planning and strategy formulation in deterrence, stability, and foreign policy implementation. PREREQUISITE: NS3280. U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI. CLASSIFICATION: TOP SECRET (SCI).

NS4300 SEMINAR IN MIDDLE EASTERN POLITICS (4 - 0).
A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. PREREQUISITE: NS3300 or permission of the instructor. CLASSIFICATION: None.

NS4310 SEMINAR IN MIDDLE EASTERN SECURITY ISSUES (4 - 0).
A research seminar on security issues in the contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. PREREQUISITE: NS3310 or permission of the instructor. CLASSIFICATION: None.

NS4410 SEMINAR IN SECURITY ISSUES IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4 - 0).
This advanced seminar addresses the security problems of the successor states to the former Soviet Union, focusing on the military, the security environment, political culture, Russian and non-Russian nationalism, and the relationship between domestic and foreign policies. PREREQUISITE: NS3400 or NS3410, or NS3450, or permission of the instructor. CLASSIFICATION: None.

NS4510 SEMINAR IN LATIN AMERICA GOVERNMENT AND POLITICS (4 - 0).
An advanced seminar on Latin American politics in government. The topics analyzed include those of most current relevance including political transitions, the changing role of different political movements and institutions, and the prospects for economic growth and political stability. PREREQUISITE: NS3510 or NS3520, or permission of the instructor. CLASSIFICATION: None.

NS4560 SEMINAR IN LATIN AMERICAN SECURITY ISSUES (4 - 0).
A research seminar on security issues in contemporary Latin America. Students conduct and present original research on selected issues concerning Latin American security. PREREQUISITE: NS3510 or NS3520, or permission of the instructor. CLASSIFICATION: None.

NS4660 SEMINAR IN ASIA IN WORLD AFFAIRS (4 - 0).
Advanced study of Asia's contemporary economic, security, diplomatic, and cultural roles in world affairs, with special emphasis upon the policy interaction of China, Japan, India and other key states with the United States, Russia, Europe and the developing world. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor. CLASSIFICATION: None.

NS4690 SEMINAR IN INTERNATIONAL SECURITY ISSUES OF ASIA (4 - 0).
Advanced study of Asian security issues with special emphasis on the balance of forces, regional and external alliances, prospects for conflict, and Asian concepts of security and strategy. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor. CLASSIFICATION: None.

NS4710 SEMINAR IN EUROPEAN POLITICS (4 - 0).
A research seminar on politics in contemporary Europe. Students conduct and present original research on selected issues concerning European politics, with an emphasis on defense and security problems. PREREQUISITE: NS3710 or permission of the instructor. CLASSIFICATION: None.

NS4720 SEMINAR IN EUROPEAN SECURITY ISSUES (4 - 0).
A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. PREREQUISITE: NS3720 or permission of the instructor. CLASSIFICATION: None.

NS4880 SEMINAR IN LEGAL AND MILITARY RESPONSES TO POLITICAL VIOLENCE (4 - 0).
The course will first review the variety of legal and military policy options open to any state that confronts political violence, with particular attention to short versus long term consequences of different policy options. It then analyzes a few individual cases (the British in Ulster, violence in Spain) in depth, in order to assess how different policy options combine or cancel each other. PREREQUISITE: NS3036 or permission of instructor. CLASSIFICATION: None.

NS4900 SEMINAR IN INTERNATIONAL NEGOTIATIONS (4 - 0).
Advanced study in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security. PREREQUISITE: NS3900 or permission of the instructor. CLASSIFICATION: None.

NS4902 SEMINAR IN MODERN REVOLUTION (4 - 0).
A research seminar on modern revolution. Students conduct and present original research on selected issues concerning modern revolution. PREREQUISITE: NS3902 or permission of the instructor. CLASSIFICATION: None.

DEPARTMENT OF OCEANOGRAPHY

Mary Louise Batteen, Associate Professor and Associate Chair for Academic Affairs (1985)*; PhD, Oregon State University, 1984.

Robert Hathaway Bourke, Professor (1971); PhD, Oregon State University, 1972.

Ching-Sang Chiu, Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Associate Professor (1986); PhD, University of Chicago, 1985.

James R. Clynch, Research Professor (1990); PhD, Brown University, 1974.

Curtis Allan Collins, Professor (1987); PhD, Oregon State University, 1967.

Edith L. Gallagher, Research Assistant Professor (1999); PhD, University of California, San Diego, 1996.

Newell Garfield, III, Research Assistant Professor (1989); PhD, University of Rhode Island, 1989.

Roland William Garwood, Chairman and Professor, (1976); PhD, University of Washington, 1976.

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Eugene Clinton Haderlie, Distinguished Professor Emeritus (1965); PhD, University of California at Berkeley, 1950.

Ramsey Harcourt, Research Assistant Professor (1999); PhD, University of California, Santa Cruz, 1999.

Thomas H.C. Herbers, Associate Professor (1993); PhD, University of California, San Diego, 1990.

Henry Jones, Military Instructor (1996); MS, Naval Postgraduate School, 1986.

Glenn Harold Jung, Professor Emeritus (1958); PhD, Texas A & M University, 1955.

Dale Fredrick Leipper, Professor Emeritus (1968); PhD, Scripps Institution of Oceanography, 1950.

Ly Ngoc Le, Research Associate Professor (1993); PhD, State Hydromet Institute, St. Petersburg, 1976.

Wieslaw Maslowski, Research Assistant Professor (1994); PhD, University of Alaska-Fairbanks, 1994.

Julie McClean, Research Assistant Professor (1993); PhD, Old Dominion University, 1993.

William O'Reilly, Research Assistant Professor (1996); PhD, University of California, San Diego, 1991.

Jeffrey Dean Paduan, Associate Professor (1991); PhD, Oregon State University, 1987.

Robert George Paquette, Professor Emeritus (1971); PhD, University of Washington, 1941.

Pierre Marie Poulain, Assistant Professor (1995); PhD, University of California, San Diego, 1989.

Steven R. Ramp, Research Professor (1998); PhD, University of Rhode Island, 1986.

Leslie K. Rosenfeld, Research Associate Professor (1989); PhD, Woods Hole Oceanographic Institution, 1987.

Albert Julius Semtner, Jr., Professor (1986); PhD, Princeton University, 1973.

Timothy Peter Stanton, Research Associate Professor (1978); MS, University of Auckland, 1977.

Warren Charles Thompson, Professor Emeritus (1953); PhD, Texas A & M University, 1953.

Edward Bennett Thornton, Distinguished Professor and Associate Chairman for Research, (1969); PhD, University of Florida, 1970.

Robin T. Tokmakian, Research Assistant Professor (1997); PhD, Naval Postgraduate School, 1997.

Eugene Dewees Traganza, Professor Emeritus (1970); PhD, University of Miami, 1966.

Stevens Parrington Tucker, Professor Emeritus (1968); PhD, Oregon State University, 1972.

Joseph John von Schwind, Professor Emeritus (1967); PhD, Texas A & M University, 1968.

Jack B. Wickham, Professor Emeritus (1951); MS, Scripps Institution of Oceanography, 1949.

James H. Wilson, Research Professor (1992); PhD, The Pennsylvania State University, 1974.

Yuxia Zhang, Research Assistant Professor (1994); PhD, Texas A&M University, 1994.

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

The Oceanography Department primarily supports curricula sponsored by the Oceanographer of the Navy: #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography.

The department focuses on Physical Oceanography, Acoustical Oceanography, Numerical Modeling, and Nearshore and Coastal Oceanography.

Topics include ocean dynamics, numerical ocean prediction and simulation, satellite remote sensing of the ocean, air-sea interaction, polar oceanography, upper ocean dynamics and thermodynamics, near-shore processes, mesoscale dynamics, coastal ocean circulation and environmental acoustics. The department also provides core courses for Undersea Warfare and the Space Systems curricula.

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

Entrance to a program leading to the degree Master of Science in Physical Oceanography requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The degree Master of Science in Physical Oceanography requires:

1) Completion of at least eight physical oceanography graduate courses with at least four courses in the OC4000 series. The entire sequence of courses selected must be approved by the Department of Oceanography. Significant educational experience at sea on a research vessel is required for the degree. (OC3570 satisfies this requirement).

2) Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics, or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography, which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree Master of Science in Meteorology and Physical Oceanography requires:

1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography.

2) The sequence of core courses in meteorology and oceanography in the fields of dynamical, numerical and physical and synoptic meteorology and oceanography.

3) An approved selection of graduate elective courses in meteorology and oceanography.

4) A significant educational experience at sea on a research vessel.

5) An acceptable thesis on a topic approved by either department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of Meteorology and Physical Oceanography.

DOCTOR OF PHILOSOPHY
Department of Oceanography admission requirements for the degree Doctor of Philosophy include:

1) A master's degree (or the equivalent) in one of the physical sciences, mathematics, or engineering or,

2) A bachelor's degree with a high QPR or,

3) A highly successful first graduate year in a Master's program, with clear evidence of research ability.

The Ph.D. Program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics and nearshore oceanography among others. An applicant to the Ph.D. program who is not already at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

OCEANOGRAPHIC LABORATORIES
NPS is a member of UNOLS (University National Oceanography Laboratory System), CENCAL (Central California Cooperative) and MBCORC (Monterey Bay Cresent Ocean Research Consortium). UNOLS operates the Nation's academic oceanographic research fleet, while CENCAL promotes and coordinates research vessel operations between several academic institutions in Central California. The nearby Moss Landing Marine Laboratory operates the NSF-owned, 135-foot R/V POINT SUR for the benefit of CENCAL. Through sponsorship of the Oceanographer of the Navy, NPS is a major user of the R/V POINT SUR, primarily for instructional purposes.

A moored-equipment laboratory provides for instruction in the practical design, deployment and recovery of state-of-the-art oceanographic instrumentation. Real-time observations of currents, temperature, salinity and sound speed structure in a variety of oceanic regimes are analyzed, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

NPS is also a member of UCAR (University Corporation for Atmosphere Research), which serves some of the computational and other research facility needs of the oceanographic community. Together with the Meteorology Department, the Oceanography Department operates the Interactive Digital Experimental Analysis Laboratory (IDEA) that is equipped with several workstations for the analysis of satellite images or other digital fields, e.g., numerical model output. In addition, the Department operates a Graphics Laboratory with 12 networked workstations for simulation and analysis of oceanographic data. This laboratory is connected to the Idea lab expanding the capabilities of this lab for instructional purposes.

NPS has recently acquired the former PT SUR SOSUS underwater acoustic array. Acoustic signals can now be brought into the classroom in real time to demonstrate signal processing, ambient noise and beam forming techniques.

The Department is organized around thematic laboratories, each containing faculty, staff and student offices, computing facilities and special laboratory equipment. Thematic laboratories exist for Oceanic Planetary Boundary Layer, Polar, Nearshore, Acoustics, Coastal Modeling, Electronics and Calibration, Global Modeling, MC & G, Naval Ocean Analysis and Prediction, Ocean Turbulence, Ocean Waves, Radar and Drifter, Tactical Environmental Support, and Rapid Environmental Assessment.

OCEANOGRAPHY COURSE DESCRIPTIONS

OC0810 THESIS RESEARCH (0 - 8).
Every student conducting research in Oceanography will enroll in this course.

OC0999 THESIS SEMINARS (NO CREDIT) (2 - 0).
Students in the various oceanography curricula present their thesis research. PREREQUISITE: Preparation of a thesis.

OC2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (2 - 2).
Introduction to the programming languages, operating systems, and computing facilities which METOC students use in MR and OC courses. Laboratory assignments are elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

OC3030 OCEANOGRAPHIC COMPUTING AND DATA DISPLAY (1 - 2).
Course emphasizes the use of the computer as a tool in oceanography problem-solving. Use of various software packages for graphics, scientific visualization, statistics and numerical computation. PREREQUISITES: OC/MR2020, OC3240 or MR/OC3522, or the consent of the instructor. Graded: Pass/Fail.

OC3120 BIOGEOCHEMICAL PROCESSES IN THE OCEAN (4 - 3).
Basic biological, geological, and chemical processes in the ocean. Bioacoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean.

OC3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3 - 2).
Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation, and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

OC3150 ANALYSIS OF AIR OCEAN TIME SERIES (3 - 2).
Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cross-spectrum. Optimal design of air-ocean data network. Laboratory work involves analysis of actual atmospheric and ocean time series using principles developed in class. PREREQUISITE: A probability and statistics course.

OC3210 POLAR OCEANOGRAPHY (3 - 0).
Covers the ice characteristics and physical oceanography of polar seas. Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models, and remote sensing of ice/snow covered surfaces. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes, and underwater acoustics. Discuss naval and research operations in polar warfare. PREREQUISITE: OC3240.

OC3212 POLAR METEOROLOGY/OCEANOGRAPHY (4 - 0).
Operational aspects of Arctic and Antarctic meteorology, including polar lows, boundary layer and marginal ice zone influences. Polar oceanography. Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes. PREREQUISITE: MR3222 and OC3240 or consent of instructor.

OC3230 DESCRIPTIVE PHYSICAL OCEANOGRAPHY (3 - 1).
Physical properties of seawater. Processes influencing the distribution of heat, salt and density in the ocean. Static stability in the ocean. Circulation and water masses in the ocean. Laboratory work involves collection and analysis of actual data using principles developed in class.

OC3231 DESCRIPTIVE REGIONAL OCEANOGRAPHY (4 - 0).
Overview of basic concepts. Water masses and regional circulation including littoral regions and marginal seas. Recent developments dealing with ocean circulation, sea level, climate, El Nino, ocean resources and pollution, and modern observational techniques. PREREQUISITE: OC3230 or the equivalent.

OC3240 OCEAN DYNAMICS I (4 - 2).
Application of dynamic concepts of ocean circulation, including conservation of mass, momentum and energy. Oceanic currents without friction: inertial and geostrophic flows. Frictional currents: Reynolds equations, Ekman and wind-driven flows. Vorticity balance: Sverdrup transport, potential vorticity, topographic steering, western intensification and Rossby waves. Thermohaline effects and thermocline theory. PREREQUISITES: OC3230 and OC3321 or the equivalent.

OC3260 SOUND IN THE OCEAN (4 - 0).
The fundamentals of ocean acoustics including the acoustic wave equation, ray theory, acoustic arrays and filters, ambient noise, scattering, absorption, an introduction to normal mode theory, and sonar equations. PREREQUISITES: OC3230, partial differential equations or equivalent.

OC3266 OPERATIONAL ACOUSTIC FORECASTING (3 - 2).
Course emphasizes tactical use of the environment as a force multiplier in acoustic USW. Tactical guides involving ducts, fronts, eddies and bottom structure are examined in ange-dependent propagation loss models. Emerging tactics using LFA, VLF and Fixed Distributed systems and non-acoustic methods are reviewed. PREREQUISITES: OC3260, SECRET clearance, U.S. citizenship.

OC3321 AIR-OCEAN FLUID DYNAMICS (4 - 0).
A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluid are derived from fundamental physical laws. Topics include the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. PREREQUISITES: Multi-variable calculus, vectors, and ordinary differential equations (may be taken concurrently).

OC3325 MARINE GEOPHYSICS (3 - 0).
Theory and methods of marine geophysics surveys, and emphasis on gravity, magnetism, seismic and acoustic wave propagation; geophysical anomalies associated with major sea floor features; marine geodesy. PREREQUISITE: OC3120 (may be taken concurrently).

OC3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2 - 2).
Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC3230 and MR3420, MR/OC3150 or consent of instructor.

OC3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4 - 0).
Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry, and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic variability. PREREQUISITES: Undergraduate physics and differential/integral calculus; ordinary differential equations and MR3480 or consent of instructor.

OC3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/LABORATORY (4 - 2).
Same as OC3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as OC3520.

OC3570 OPERATIONAL OCEANOGRAPHY AND METEOROLOGY (2 - 4).
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in-situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea, and post-cruise analysis. PREREQUISITES: OC3240, MR3220, or consent of instructor.

OC3750 NAVAL ASTRONOMY AND PRECISE TIME (2 - 0).
Positional astronomy. Coordinate systems. Solar system dynamics. Astrometry (measurements of positions and motion of stars). Time, earth rotation and atomic clocks. Naval applications of astronomy. Overview of astrophysics and cosmology. PREREQUISITES: College physics and calculus.

OC3902 FUNDAMENTALS OF MAPPING, CHARTING AND GEODESY (3 - 2).
Basics of map/chart generation and scientific basis for their accuracy and precision. Ellipsoids, latitudes, longitudes, datums, datum transformations, map projections, geoid and heights. Map/chart generation process including satellite surveying. Use of map/charts with modern navigation systems, including GPS. Digital map characteristics. PREREQUISITES: Vector analysis, probability and statistics or consent of instructor.

OC3903 ELECTRONIC SURVEYING AND NAVIGATION (3 - 0).
Introduction to the theory and practice of electronic navigation including principles of electronics, geometry, and error propagation. Covers ground-based and satellite systems. The global positioning system is covered in detail. PREREQUISITE: Consent of instructor.

OC4211 OCEAN DYNAMICS II (4 - 0).
Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. PREREQUISITES: Partial differential equations and OC3240.

OC4212 TIDES (4 - 0).
Development of the theory of tides including the tide-producing forces, equilibrium tides, and the dynamic theory of tides; harmonic analysis and prediction of tides; tidal datum planes and their relationship with geodetic datum planes, short-term and secular changes in sea level. PREREQUISITE: OC4211.

OC4213 NEARSHORE AND WAVE PROCESSES (3 - 1).
Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. PREREQUISITE: OC4211 or consent of instructor.

OC4220 COASTAL CIRCULATION (4 - 1).
Coastal ocean physical processes. Dynamics and models of coastal ocean circulations driven by wind, thermohaline, tidal, boundary currents, and ocean eddy forces. Recent papers on coastal ocean circulation. Laboratory sessions on computing properties of tides, coastal trapped waves and wind-driven motions over the shelf and slope. PREREQUISITE: OC4211 (may be taken concurrently).

OC4230 PHYSICAL OCEANOGRAPHY OF MONTEREY BAY (3 - 0).
Monterey Bay will be used as a case study for various processes affecting the physical oceanography of coastal environments. Topics to include coastal upwelling, flow in and around submarine canyons, internal waves, air-sea interactions, and tides and seiches. Historical, recent, and ongoing studies in and around the bay will be considered. PREREQUISITE: OC3240 or consent of instructor.

OC4250 GENERAL CIRCULATION OF THE ATMOSPHERE AND OCEANS (3 - 0).
Selected topics on the general circulation of the atmosphere (e.g. heat, momentum and moisture fluxes; energetics) and ocean (e.g. linear and non-linear theories of the wind-driven ocean circulation); coupled ocean-atmosphere general circulation models. PREREQUISITE: Consent of instructor.

OC4262 THEORIES & MODELS IN UNDERWATER ACOUSTICS (3 - 0).
Development of the underlying theories and algorithms of ray, normal mode, and parabolic equation acoustic models for both range independent and dependent environments. Examination of the strengths and weaknesses of and similarities between the various models. PREREQUISITES: OC3260 and partial differential equations or equivalent.

OC4267 OCEAN ACOUSTIC PREDICTION (4 - 0).
Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection and scattering from the sea surface and bottom as they affect sound propagation in the ocean. Synoptic prediction techniques for ambient noise and transmission loss are reviewed. Environmental data input and computational approximations for acoustic models are evaluated against observed signal fluctuations and transmission loss. The course is designed for the Air-Ocean Science, Operational Oceanography, and USW Curricula. PREREQUISITES: OC3230 and OC3260 or equivalent.

OC4323 NUMERICAL AIR AND OCEAN MODELING (4 - 2).
Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic equations, linear and non-linear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. PREREQUISITES: MR4322, or OC4211, partial differential equations; numerical analysis desirable.

OC4324 ADVANCED NUMERICAL OCEAN MODELING (3 - 0).
Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer guasi-geotrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. PREREQUISITE: MR/OC4323.

OC4331 MESOSCALE OCEAN VARIABILITY (4 - 0).
Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics for observations, theories and models. PREREQUISITE: OC4211 or equivalent.

OC4335 NAVAL OCEAN ANALYSIS AND PREDICTION (3 - 2).
Advanced knowledge of the U.S. Navy ocean analysis and prediction systems, including the Naval Ocean Modeling Program (NOMP), naval ocean data systems, atmospheric forcing systems, data assimilation systems, Optimal Thermal Interpolation System (OTIS), Thermal Ocean Prediction Systems (TOPS), the global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS), Polar Ice Prediction System (PIPS), and global wave prediction system (WAM). PREREQUISITES: OC4211 and MR/OC4323 (may be taken concurrently).

OC4413 AIR/SEA INTERACTION (4 - 0).
Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. PREREQUISITES: MR/OC3150, and OC3240 or MR3240 or consent of instructor.

OC4414 ADVANCED AIR/SEA INTERACTION (3 - 0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4415 OCEAN TURBULENCE (3 - 0).
Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4490 OCEAN ACOUSTIC TOMOGRAPHY (Same as EC4490.) (3 - 0).
An introduction to Ocean Tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of Ocean Acoustic Tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITES: OC3260 or EC3450 or PH4453 or equivalent; linear algebra, partial differential equations or equivalent.

OC4520 TOPICS IN SATELLITE REMOTE SENSING (3 - 0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

OC4610 WAVE AND SURF FORECASTING (2 - 2).
Theory and prediction of wind-generated ocean waves. Spectral transformation of waves from deep to shallow water. Prediction of surf and wave related influences on operations. PREREQUISITES: OC3150, OC4211.

OC4800 ADVANCED COURSES IN OCEANOGRAPHY (Variable hours 1-0 to 4-0.) (V - 0).
Advanced courses in various aspects of oceanography. Typically these are advanced topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of the Department Chairman and instructor.

OC4900 DIRECTED STUDY IN OCEANOGRAPHY (V - 0).
Independent study of advanced topics in oceanography. PREREQUISITE: Consent of the Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF OPERATIONS RESEARCH

Chairman:
Richard E. Rosenthal (OR/Rl)
Professor
Glasgow Hall
Room 239
(831) 656-2381
DSN 878-2381

Associate Chairmen:

Operations
Ronald L. Brown (OR/Br)
Professor
Glasgow Hall
Room 210
(831) 656-3489
DSN 878-3489

Research
Gerald G. Brown (OR/Bw)
Professor
Glasgow Hall
Room 208
(831) 656-2140
DSN 878-2140

Instruction
David Olwell (OR/Ol)
Associate Professor
Glasgow Hall
Room 225
(831) 656-2281
DSN 878-2281

Timothy Patrick Anderson, LCDR, U.S. Navy (1997); MS, Naval Postgraduate School, 1994.

Matthew Boensel, CDR, U.S.Navy, Military Instructor (1999); MS, Naval Postgraduate School, 1988.

Dan Calvin Boger, Dean of Computer and Information Sciences and Operations, Chairman of Command, Control, Communications, Computers & Intelligence (C4I) Academic Group and Computer Science, and Professor (1979); PhD, University of California at Berkeley, 1979.

Gordon Hoover Bradley, Professor (1973); PhD, Northwestern University, 1967.

Gerald Gerard Brown, Professor and Associate Chair for Operations and Research (1973); PhD, University of California at Los Angeles, 1974.

Arnold Herbert Buss, Visiting Associate Professor, (1994); PhD, Cornell University, 1987.

Samuel Edward Buttrey, Assistant Professor (1996); PhD, University of California at Berkeley, 1996.

George Conner, Senior Lecturer and Assistant Provost, (1991); MS, Naval Postgraduate School, 1982.

Robert F. Dell, Associate Professor (1990); PhD, State University of New York at Buffalo, 1990.

James Norfleet Eagle, II, Professor and Chairman of Undersea Warfare Academic Group (1982); PhD, Stanford University, 1975.

James Daniel Esary, Professor Emeritus (1970); PhD, University of California at Berkeley, 1957.

Robert Neagle Forrest, Professor Emeritus (1964); PhD, University of Oregon, 1959.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Thomas Eugene Halwachs, Lecturer and Associate Provost for Computer Information Services (1988); MS, Naval Postgraduate School, 1976.

Gilbert Thoreau Howard, Associate Professor and Director of Academic Planning (1967); PhD, Johns Hopkins University, 1967.

Wayne Philo Hughes, Jr., Senior Lecturer (1979); MS, Naval Postgraduate School, 1964.

Patricia Anne Jacobs, Professor (1978); PhD, Northwestern University, 1973.

William Glenn Kemple, Associate Professor (1990); PhD, University of California at Riverside, 1985.

Mitchell Craig Kerman, LT, U.S. Navy (1997); MS, Naval Postgraduate School, 1997.

Robert Anthony Koyak, Assistant Professor (1998); PhD, University of California at Berkeley, 1985.

William Krebs, Assistant Professor (1996); PhD, University of Louisville, KY (1992).

Harold Joseph Larson, Professor (1962); PhD, Iowa State University, 1960.

Siriphong Lawphongpanich, Associate Professor (1987); PhD, University of Florida, 1983.

Peter Adrian Walter Lewis, Distinguished Professor (1971); PhD, University of London, 1964.

Glenn Frank Lindsay, Professor Emeritus (1965); PhD, Ohio State University, 1966.

Douglas John Mackinnon, LCDR, U.S. Navy (1998); MS, Naval Postgraduate School, 1992.

Kevin Maher, CDR, U.S. Navy (1997); MS, Naval Postgraduate School, 1993.

Kneale Thomas Marshall, Distinguished Professor (1968); PhD, University of California at Berkeley, 1966.

Alan Wayne McMasters, Professor Emeritus (1965); PhD, University of California at Berkeley, 1966.

Paul Robert Milch, Professor (1963); PhD, Stanford University, 1966.

David Olwell, Associate Professor (1998); PhD, University of Minnesota, 1996.

Joel R. Parker, LTC, U.S. Army, Military Instructor (1999); MS, Naval Postgraduate School (1990).

Samuel Howard Parry, Professor (1964); PhD, Ohio State University, 1971.

Frank Petho, CAPT, U.S. Navy, Chairman of National Security Affairs and Assistant Professor (1991); PhD, University of Vermont, 1979.

James R. Powell, CAPT, U.S. Navy, Chair of Information Warfare, Chair of Tactical Analysis and Military Instructor (1996); MSSE, Naval Postgraduate School (1984).

Peter Purdue, Professor and Dean of Operational and Applied Sciences (1986); PhD, Purdue University, 1972.

Robert Richard Read, Professor (1961); PhD, University of California at Berkeley, 1957.

Richard Edwin Rosenthal, Chairman and Professor (1985); PhD, Georgia Institute of Technology, 1975.

David Alan Schrady, Distinguished Professor (1965); PhD, Case Institute of Technology, 1965.

Rex Hawkins Shudde, Professor Emeritus (1962); PhD, U.C. Berkeley, 1956.

Michael Graham Sovereign, Professor (1970); PhD, Purdue University, 1965.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

Alan Robert Washburn, Professor and Associate Chair for Instruction (1970); PhD, Carnegie Institute of Technology, 1965.

Lyn R. Whitaker, Associate Professor (1988); PhD, University of California, Davis 1985.

Roger Kevin Wood, Associate Professor (1982); PhD, University of California at Berkeley, 1982.

Peter William Zehna, Professor Emeritus (1961); PhD, Stanford University, 1959.

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

The Operations Research Department was founded in 1961 primarily to service students in the OA (360) Curriculum. Graduates of that curriculum receive the Master of Science in Operations Research degree as do graduates of the Operational Logistics (361) Curriculum. The department consists of approximately forty faculty located in Glasgow Hall. The department operates several laboratories including the Human Systems Integration Lab located in Glasgow Hall and the Wargaming Lab in Ingersoll Hall.

In addition to being the primary department for the 360 and 361 curricula, the Operations Research Department also provides an extensive sequence of service courses for students in other curricula and is charged with teaching all probability and statistics courses at NPS. Nearly half of the department's teaching effort is devoted to these courses.

Active research areas within the department include statistics, stochastic processes, mathematical programming, human factors, wargaming, combat models, logistic systems, C4I systems, IW/EW and USW models, modeling and simulation.

MASTER OF SCIENCE IN APPLIED SCIENCE

Students with acceptable academic backgrounds may enter a program leading to a degree in Applied Science with a major in Operations Research. The program of each student seeking this degree must contain a minimum of 20 quarter hours in operations research at the graduate level, including work at the 4000 level. Additionally, the program must contain a minimum of 12 graduate quarter hours in an approved sequence of courses outside the Department of Operations Research. A total minimum of 12 quarter hours at the 4000 level plus an acceptable thesis is required. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The Department Chairman's approval is required for all programs leading to this degree. Applications to include this degree in dual master's programs will not be approved.

MASTER OF SCIENCE IN OPERATIONS RESEARCH

The degree Master of Science in Operations Research requires that:

1. A candidate shall previously have satisfied the requirements for the degree Bachelor of Science in Operations Research or the equivalent.

2. Completion of a minimum of 40 quarter hours of graduate level courses with:

   a. At least 20 quarter hours of 4000 level courses, of which at least 16 are OA.
   b. An elective sequence approved by the Department of Operations Research.

3. Submission of an acceptable thesis on a subject previously approved by the Department of Operations Research.

DOCTOR OF PHILOSOPHY IN OPERATIONS RESEARCH

The department offers the Ph.D. degree in Operations Research. The program begins with advanced course work guided by the student's doctoral committee and leading to qualifying examinations in mathematical programming, statistics and stochastic processes, as well as completion of a minor field of study outside of operations research. The primary emphasis then shifts to the student's research program culminating in the Ph.D. dissertation.

An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases the student must fulfill the general school requirements for the doctor's degree. Residency for this program generally requires two to three years beyond completion of a master's degree.

OPERATIONS RESEARCH COURSE DESCRIPTIONS

OAR100 INTRODUCTION TO COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH (NO CREDIT) (Meets first 6 weeks of quarter.) (2 - 2).
Introduction to the Naval Postgraduate School computer laboratories and software. Windows operating system, files, internet, editing, word processing, spreadsheets, data analysis and presentation graphics.

OAR200 INTRODUCTION TO VISUAL BASIC FOR OPERATIONS RESEARCH (NO CREDIT) (Meets last 6 weeks of quarter.) (2 - 2).
A first course in computer programming using Visual Basic as a high level programming language. Primary emphasis will be on the planning, structuring, and debugging of computer programs for solving Operations Research problems.

OA0001 SEMINAR FOR OPERATIONS ANALYSIS STUDENTS (NO CREDIT) (0 - 2).
Guest lecturers. Review of experience tours. Thesis and research presentations.

OA0810 THESIS RESEARCH FOR OPERATIONS ANALYSIS & LOGISTICS STUDENTS (0 - 8).
Every student conducting thesis research will enroll in this course.

OA2200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH (4 - 1).
An introductory course in Java with an emphasis on software design and on computational methods particularly appropriate to Operations Research. Assigned projects include computations for simulation, graph and network algorithms, and Operations Research models. The laboratory has weekly programming assignments.

OA2600 INTRODUCTION TO OPERATIONS ANALYSIS (4 - 0).
A first course in Operations Analysis, covering its origins in World War II to current practice. Introduces concepts, tools and methods of analysis, with tactical examples. Emphasis is on measuring combat effectiveness and developing better tactics. PREREQUISITE: None.

OA2900 WORKSHOP IN OPERATIONS RESEARCH / SYSTEMS ANALYSIS (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Department approval. Graded on Pass/Fail basis only.

OA2910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background in operations research.

OA3101 PROBABILITY (4 - 1).
Introduction to data entry, manipulation, graphing using spreadsheets and statistical packages. Graphical and tabular methods in descriptive statistics, measures of location and variability. Probability axioms, counting techniques, conditional probability. Discrete and continuous probability distributions: binomial, hypergeometric, negative binomial, Poisson, normal, exponential, gamma, and others. Joint probability distributions, conditional distributions and conditional expectation, linear functions. Random samples, probability plots. PREREQUISITES: Knowledge of single-variable calculus (concurrently), Taylor series expansions (concurrently), MA1118 (may be taken concurrently).

OA3102 STATISTICS (4 - 2).
Point estimation, method of moments, maximum likelihood, least squares. Confidence intervals, tests of hypotheses for one and two sample problems. Analysis of variance, multiple comparisons, interaction, simple design cases. Goodness of fit and contingency tables, sign tests, Wilcoxon-Mann-Whitney test. PREREQUISITES: OA3101, MA1118, MA3110 (taken concurrently).

OA3103 DATA ANALYSIS (4 - 1).
Techniques for analyzing, summarizing and comparing sets of real data with several variables. Computations are done in a statistical package and a common spreadsheet program. Model building and verification, graphical methods of exploration. Least squares regression, logistic and Poisson regression, introduction to categorical data analysis, principal components and/or classification. PREREQUISITES: OA3101 and OA3102.

OA3105 NONPARAMETRIC STATISTICS (4 - 0).
Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one sample tests, two sample tests and tests for independence based on ranks and scores; nonparametric analysis of variance and regression. Applications will illustrate the techniques. PREREQUISITE: A course in statistical inference.

OA3201 LINEAR PROGRAMMING (Same as MA3301.) (4 - 0).
Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. PREREQUISITES: MA3042, MA3110, and OA3200.

OA3301 STOCHASTIC MODELS I (4 - 0).
Course objectives are to provide an introduction to stochastic modeling. Topics include the homogeneous Poisson process and its generalizations and discrete and continuous time Markov chains and their applications in modeling random phenomena in civilian and military problems. PREREQUISITE: OA3101 or consent of instructor.

OA3302 OA SYSTEM SIMULATION (4 - 0).
Discrete event digital simulation methodology. Monte Carlo techniques, use of simulation languages. Variance reduction techniques, design of simulation experiments and analysis of results. PREREQUISITES: OA3200 or equivalent, OA3103 or equivalent, OA3301.

OA3401 HUMAN FACTORS IN SYSTEM DESIGN I (3 - 1).
Provide the foundation to understand, explain, and predict human behavior. Students will be able to recognize and conceptually organize a behavioral sciences problem. Students will develop techniques in understanding how to ask a question, methodological procedures for collecting data, analyzing data, and interpreting results. Laboratory exercises will provide laboratory based demonstrations of psychological phenomena that give students a clear, “hands-on” picture of human strengths and limitations in the military workplace.

OA3402 HUMAN PERFORMANCE MEASUREMENT II (3 - 0).
The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man’s motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3501 INVENTORY I (4 - 0).
A study of deterministic and approximate stochastic inventory models. Deterministic economic lot size models with infinite production rate, constraints, quantity discounts. An approximate lot size-reorder point model with stochastic demand. An approximate stochastic periodic review model. Single period stochastic models. Applications to Navy supply systems. PREREQUISITE: OA3101 or consent of instructor.

OA3601 COMBAT MODELS AND GAMES (4 - 0).
This course provides a discussion of measures of effectiveness and a quantitative introduction to dynamic programming, target coverage models, Kalman filters, Lanchester Systems, and two-person zero-sum games. PREREQUISITES: MA3110, OA3102.

OA3602 SEARCH THEORY AND DETECTION (4 - 0).
Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking and trailing. PREREQUISITE: OA3301.

OA3610 INTRODUCTION TO NAVAL LOGISTICS (4 - 0).
Presentation of the fundamental purposes, history and components of the naval logistics system. Logistics is introduced as a command function necessary for sustaining combat operations. This concept is developed by looking at logistics resources and processes, unit and battle-group logistics, in-theater support, strategic lift, and CONUS/ system support. PREREQUISITES: SECRET clearance and approval of instructor.

OA3900 WORKSHOP IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OA3910 SELECTED TOPICS IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research. Consent of instructor.

OA4101 DESIGN OF EXPERIMENTS (Same as MA4302.) (3 - 1).
Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments, traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. PREREQUISITE: OA3103 or equivalent.

OA4102 REGRESSION ANALYSIS (Same as MA4303.) (4 - 0).
Construction, analysis and testing of regression models. An in-depth study of regression and its application in operations research, economics and the social sciences. PREREQUISITES: OA3102, OA3103.

OA4103 ADVANCED PROBABILITY (3 - 0).
Probability spaces, random variables as measurable functions, expectation using the Lebesque-Stieltjes integral and abstract integration. Modes of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. PREREQUISITE: MA3605 or departmental approval.

OA4104 ADVANCED STATISTICS (3 - 0).
Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher and Kullback information, asymptotic methods, sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. PREREQUISITE: OA3103 and consent of instructor.

OA4106 ADVANCED DATA ANALYSIS (3 - 1).
The course features the blending of sophisticated statistical software and data from recent DoD applications. The manipulation of multivariate data and statistical graphics are emphasized. Methodologies presented can include survival analysis, classification and discrimination, categorical data analysis, and sample survey methods. PREREQUISITE: OA3103.

OA4201 NONLINEAR PROGRAMMING. (Same as MA4301.) (4 - 0).
Convex sets, convex functions, and conditions for local and global optimality. Elements and convergence of algorithms for solving constrained and unconstrained optimization problems. Introduction to algebraic modeling languages. Many applications of integer and nonlinear programming to military and civilian problems, such as weapons assignments, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITE: OA3201.

OA4202 NETWORK FLOWS AND GRAPHS (4 - 0).
Introduction to formulation and solution of problems involving networks, such as maximum flow, shortest route, minimum cost flows, and PERT/CPM. Elements of graph theory, data structure, algorithms, and computational complexity. Applications to production and inventory, routing, scheduling, network interdiction, and personnel management. PREREQUISITE: OA3201.

OA4203 MATHEMATICAL PROGRAMMING (4 - 0).
Advanced topics in linear programming, large scale systems, the decomposition principle, additional algorithms, bounded variable techniques, linear fractional programming, formulation and solution procedures for problems in integer variables. Applications to capital budgeting, large scale distribution systems, weapon systems allocation and others. PREREQUISITE: OA3201.

OA4204 GAMES OF STRATEGY (4 - 0).
Mathematical models of conflict situations, emphasizing the theory of decision making against a completely opposed enemy. Topics include matrix games, Blotto games, stochastic games, and the Shapley value. Applications to combat, resource allocation, cost sharing, etc. PREREQUISITES: OA3201 and OA3101 or consent of instructor.

OA4205 ADVANCED NONLINEAR PROGRAMMING (4 - 0).
Continuation of OA4201. Advanced topics in non-linear programming including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in non-linear programming. PREREQUISITE: OA4201.

OA4206 DYNAMIC PROGRAMMING AND OPTIMAL CONTROL (4 - 0).
The basic theory, including Bellman's equation and the Maximum Principle. Applications to tactical and economic problems. PREREQUISITE: OA3201.

OA4301 STOCHASTIC MODELS II (3 - 2).
Course objectives are to teach methods of stochastic modeling beyond those taught in OA3301 and to give students an opportunity to apply these tools to real world problems. Suitably selected projects that entail data collection and analysis are undertaken, with emphasis on problem formulation, choice of appropriate assumptions and attainment of practical results. Topics include renewal processes, and further topics in queuing, illustrated by several military and industrial applications. PREREQUISITES: OA3103, OA3301, OA3302.

OA4302 RELIABILITY AND WEAPONS SYSTEM EFFECTIVENESS MEASUREMENT (4 - 0).
Component and system reliability functions and other reliability descriptors of system effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. PREREQUISITE: OA3301.

OA4303 SAMPLE INSPECTION AND QUALITY ASSURANCE (4 - 0).
Attribute and variables sampling plans. MILSTD sampling plans with modifications. Multi-level continuous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. PREREQUISITE: OA3101 or consent of instructor.

OA4304 DECISION THEORY (3 - 0).
This course provides an introduction to modern theory and methods for decision making in both single and multiple person situations. Bayesian methods are emphasized in the single person case, including decision trees, Bayesian networks and influence diagrams. Multi-person situations covered include two-person-zero-sum games, voting, Nash bargaining, and the Shapley value. Applications mainly to military problems. PREREQUISITES: OA3101, OA3201.

OA4305 STOCHASTIC MODELS III (4 - 0).
Lecture topics include, non-stationary behavior of Markov processes, point process models, regenerative processes, Markovian queuing network models, and non-Markovian systems. Applications to include reliability, computer system modeling, combat modeling and manpower systems. Students are given exercises entailing data analysis, formulation of probability models, and application of models to answer specific questions concerning particular phenomenon. PREREQUISITES: OA3103, OA3301, OA4301.

OA4308 TIME SERIES ANALYSIS (Same as MA4304.) (4 - 0).
Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. PREREQUISITES: OA3103, OA3301.

OA4321 DECISION SUPPORT SYSTEMS (3 - 1).
An introduction to the topic; includes an overview of organizational decision making, discussion of OR techniques integral to DDS, relationships to artificial intelligence and expert systems, specialized computer languages, and non-traditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. PREREQUISITES: OA3101 and OA3200 or consent of instructor.

OA4333 SIMULATION METHODOLOGY (4 - 0).
Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on interests of students and Instructor. PREREQUISITE: OA3302.

OA4401 HUMAN PERFORMANCE EVALUATION (4 - 0).
This course provides the methods, theories and applications of classical and modern psychophysics. Investigate the fundamental processes of human vision. Overview of the other sensory processes. Investigate sensory perceptual deficits associated with simulators, virtual environments, and other man-machine devices. Laboratory exercises will provide students an opportunity to test psychophysical methodologies that pertain to the military workplace.

OA4402 SKILLED OPERATOR PERFORMANCE (3 - 2).
First part of the course is devoted to an examination of the theoretical foundations of skilled performance. The second half of the course is devoted to the study of the acquisition, development and prediction of skilled operator performance in the operational setting. PREREQUISITE: OA3401.

OA4403 SPECIAL TOPICS IN HUMAN PERFORMANCE (3 - 0).
A study of current topics and advances in human factors research and application. The course will have a different topic each time it is offered depending on the interests of the faculty, needs of the students, or availability of visiting professors. Typical course topics could include Visual Perception, Cognitive Modeling, or Training and Simulation. PREREQUISITE: OA3401.

OA4501 SEMINAR IN SUPPLY SYSTEMS (4 - 0).
A survey of the supply system for the U.S. Navy. Topics include inventory models at all levels for consumables and repairables, budget formulation and execution, provisioning and allowance lists, planned program requirements, transaction item reporting and current topics of research such as stock migration, and material distribution studies. PREREQUISITE: OA3501.

OA4600 INFORMATION IN WARFARE (4 - 0).
Quantitative approaches to measuring and assessing the value of information in warfare, with emphasis on tradeoffs between information and firepower. Major components are on information as precision (Bayesian filtering, data association and fusion), and information as a guide to decision making (decision theory, Markow policies, optimization). PREREQUISITES: OA3102, OA3201, OA3301.

OA4601 MODELS FOR DECISION MAKING (4 - 0).
The objective is to be able to formulate and analyze operational and executive decision problems, where a lack of clear problem definition and data, sequential timing of decisions, uncertainty, and conflicting objectives, are all normal features of such problems. Understanding and applying influence diagrams and decision trees form the core part of the course. Emphasis is on building models and determining data requirements. Specific areas include the use of policy space analysis in sensitivity analysis, the value of perfect information in evaluating the worth of a forecast, measuring outputs, and resolving decision conflicts that result from multiple output measures. PREREQUISITES: OA3101 or OS2103.

OA4602 JOINT CAMPAIGN ANALYSIS (4 - 0).
The development, use and state-of-the-art of campaign analysis in actual procurement and operations planning. Emphasis is on formulating the problem, choosing assumptions, structuring the analysis, and measuring effectiveness. Interpreting and communicating results in speech and writing is an important part of the course. In the last three weeks the students conduct a broad gauge, quick reaction campaign analysis as team members. PREREQUISITES: A course in basic probability theory, a course in quantitative decision making, working knowledge of computer war game construction and application, and four years of military field assignments.

OA4603 TEST AND EVALUATION (4 - 0).
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: OA3103.

OA4604 WAR GAMING ANALYSIS (4 - 0).
Analysis of problems in the design, construction and application of manual, computer and interactive gaming. Emphasis is on gaming as a means of evaluating Naval Warfare tactics. Current naval/joint facilities will be used. PREREQUISITES: OA3302, SECRET clearance and U.S. citizenship.

OA4605 OPERATIONS RESEARCH PROBLEMS IN NAVAL WARFARE (3 - 0).
Analysis of fleet exercises. Changes in tactics and force disposition arising from the introduction of nuclear weapons and missiles. Relationship of air defense to strike capability and USW. Current radar, sonar, communications and ECM problems. PREREQUISITES: OA4604, OA4655.

OA4607 TACTICAL DECISION MAKING (4 - 0).
This course deals with computer-aided decision making. Topics include the human-computer interface, the construction of effective graphics, verification/validation, and theoretical frameworks for competitive and non-competitive decision making. Kalman filters are introduced as an important fusion and tracking tool. The primary classroom application areas are information fusion, search/track and mine warfare. A project is required. PREREQUISITES: OS2103 - OS3604 or OA3101 - 3. Working knowledge of a programming language such as MATLAB, C++, Java, or Visual Basic.

OA4608 FOREIGN MILITARY OPERATIONS RESEARCH (4 - 0).
This course considers military operations research (OR) of foreign countries that are of current concern to DoD. Because many of these have been military clients of the former Soviet Union, the course will take Soviet military O/R as a point of departure for study. Asymmetries between Soviet and American military O/R are emphasized. Exploitation of such information is discussed. Course content will change as concerns change. Topics have included: Soviet military O/R textbooks, use of combat models in automated systems of troop control (Soviet C3), Soviet combat models, network models for planning and control of combat operations, target-engagement models, models for reconnaissance/intelligence processes, modelling of deception, automated artillery fire planning, strategic models. English translations of major Soviet works on military O/R will be supplied. PREREQUISITES: OA4655, SECRET clearance and U.S. citizenship.

OA4610 MOBILIZATION (4 - 0).
Introduction to the military and civilian systems for mobilization, linear programming and simulation formulations of strategic mobility and munitions scheduling. Planning and controls of the logistics systems, including planning factors and joint operations planning. Integration of mobilization with Navy operational logistics.

OA4611 JOINT AND COMBINED LOGISTICS (4 - 0).
Presentation of the role of logistics and logisticians in war planning and strategy development with emphasis on jointness. Introduction to JCS, Unified and Navy command and staff strictures and participation in deliberate and crisis action planning process. Emphasis on the transition to war, mobilization, strategic lift, and the weapon system acquisition process as related to logistics planning. PREREQUISITES: OA3610, MN4376, SECRET CLEARANCE and approval of instructor.

OA4612 LOGISTICS MODELS (4 - 0).
Mathematical modeling of most of the processes in unit/battle group or battle force logistics. Computation of fuel consumption, underway replenishment scheduling, shuttle ship requirements, measures of effectiveness, formations and their supportability, sustainability, engagement models and ordnance prediction, and implementation of such models in microprocessor-based logistics decision aids. Also ordnance programming models. Only for U.S. students enrolled in curricula 360 or 361 only. PREREQUISITE: Consent of instructor.

OA4655/MV4655 INTRODUCTION TO JOINT COMBAT MODELING (4 - 0).
This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision-making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, introduction to aggregated force on force modeling (including the basic Lanchester model and some of its derivatives), sensing algorithms, simulation entity decision-making, simulating C4ISR processes, terrain and movement algorithms, verification, validation, and accreditation (VV&A), stochastic versus deterministic representations, hierarchies of models, and variable resolution modeling. The primary course objective is for you to understand the enduring fundamentals of how combat models are built and used to support decision-making. This will be done, in part, through several small projects that will require you to design, implement, and analyze models. PREREQUISTES: Probability & Statistics (through OA3103), familiarity with a programming language (Java recommended), Stochastic Models (OA3301), Calculus, concurrent instruction in computer simulation (e.g., OA3302).

OA4656 ADVANCED COMBAT MODELING (4 - 1).
Advanced concepts in modeling both large scale and high resolution Joint Combat Operations. Topics include: Distributed and virtual simulation, logistics, weapons of mass destruction, countermobility, minefields, operations other than war, C4ISR, and stochastic and deterministic analytic models of combat. Additional material in aggregate attrition and land warfare models is also presented. PREREQUISITE: OA4655.

OA4701 ECONOMETRICS (4 - 0).
Construction and testing of econometric models, analysis of economic time series, and the use of multivariate statistical analysis in the study of economic behavior. PREREQUISITE: OA3103.

OA4702 COST ESTIMATION (4 - 0).
Advanced study in the methods and practice of systems analysis with emphasis on cost analysis; cost models and methods for total program structures and single projects; relationship of effectiveness models and measures to cost analysis; public capital budgeting of interrelated projects; detailed examples from current federal practices. PREREQUISITE: OA3103.

OA4703 DEFENSE EXPENDITURE AND POLICY ANALYSIS (4 - 0).
A presentation of the major components of defense budgeting and policy formulation from the standpoint of the three major institutions involved, the agency, executive and congress. The use of quantitative models of institutional behavior is emphasized when examining both individual institutions and the interaction between them. PREREQUISITE: OA3103.

OA4704 O/R TECHNIQUES IN MANPOWER MODELING (4 - 0).
The most frequently applied manpower models are studied including Markov chain and renewal models using grade and/or length of service categories. Statistical techniques to estimate relevant attrition and promotion rates from cohort and census data are also included in the course to provide both longitudinal and cross-sectional views of personnel systems. Career aspects are analyzed with respect to attrition, promotion opportunity and time to promotion in hierarchical systems with or without promotion zones. Examples emphasize the personnel systems of the military services. PREREQUISITES: OA3201, OA3301, and OA3103.

OA4910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research and departmental approval.

OA4930 READINGS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0.) (V - 0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OS2101 ANALYSIS OF EXPERIMENTAL DATA (4 - 0).
Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representation. Populations and sampling. Principle of least squares, estimation of mean and standard deviation. Curve fitting and regression, propagation of errors. Confidence intervals, tests and contingency tables. Elementary ANOVA. Relevant probabilistic concepts introduced as needed.

OS2103 APPLIED PROBABILITY FOR SYSTEMS TECHNOLOGY (4 - 1).
A first course in probability for students in operational curricula. Topics include probability laws and calculation methods, discrete and continuous random variables, common probability distributions, introduction to modeling, expectation, variance, covariance, and rudiments of discrete time processes. Emphasis is on understanding uncertainty and developing computational skills in probability. PREREQUISITES: Single variable differentiation and integration at MA1118 level.

OS3002 OPERATIONS RESEARCH FOR NAVAL INTELLIGENCE (4 - 0).
This course provides an introduction to the approach and methods of operations research, with special emphasis on military applications of interest to intelligence. It focuses on the mathematical modeling of combat operations and considers intelligence aspects. Students develop basic skills in such modeling. Topics include: operational definitions, measurement of combat effectiveness, model validation/verification, and models versus modeling. Also included are modeling of processes of target acquisition, fire assessment (kill probabilities and target coverage), tactical decision making, and games.

OS3003 OPERATIONS RESEARCH FOR INFORMATION WARFARE (4 - 0).
This course deals with applications of quantitative models to operational electronic warfare problems, with the underlying idea being to make decisions by optimizing some measure of effectiveness (MOE). Topics covered include ESM, ECM/ECCM, strike warfare, ASMD, and cost- effectiveness tradeoffs. PREREQUISITES: Calculus and OS2103.

OS3004 OPERATIONS RESEARCH FOR COMPUTER SYSTEMS MANAGERS (4 - 1).
A one-quarter survey of operations research techniques of particular interest to students in computer systems management. Topics covered include optimization, network flow models, simulation, queuing, forecasting techniques, Markov chains, decision analysis, reliability, and project management techniques. Spreadsheet models and analysis tools are an integral part of the course. PREREQUISITES: MA2300, OS3101.

OS3006 OPERATIONS RESEARCH FOR MANAGEMENT (4 - 0).
A survey of problem solving techniques for operations research. Topics include decision theory, linear programming, models, project scheduling, inventory, queuing and simulation. PREREQUISITES: MA2300, OS3101 or OS3105.

OS3008 ANALYTICAL PLANNING METHODOLOGY (4 - 0).
A one-quarter survey of operations research techniques of particular interest to students in the C4I curriculum, with emphasis on model formation. Topics include linear and nonlinear programming, integer programming, networks, shop flow and project scheduling, decision analysis, queuing and simulation. PREREQUISITE: MA2300.

OS3101 STATISTICAL ANALYSIS FOR MANAGEMENT (4 - 1).
A specialized course covering the basic methods of probability and statistics with emphasis on managerial applications. The course includes applications of probability models, statistical inference and regression analysis. Computation for these applications are carried out on a computer, using commercial software packages. Topics in probability include the binomial, geometric, Poisson and normal distributions, risk and expected value. Parametric statistical techniques include significance testing and confidence intervals, together with point estimation of model parameters. Regression analysis includes simple linear regression and multiple regression, with estimation of parameters and tests of hypothesis and confidence intervals for regression coefficients and the variance of the error term. PREREQUISITE: College algebra.

OS3104 STATISTICS FOR SCIENCE AND ENGINEERING (4 - 0).
Acquaint the engineering student with the techniques of statistical data analysis with examples from quality control, life testing, reliability and sampling inspection. Histograms and empirical distributions and random variables are introduced along with their probability distributions and associated characteristics such as moments and percentiles. Following a brief introduction to decision making, standard tests of hypotheses and confidence intervals for both one and two parameter situations are treated. Regression analysis is related to least squares estimation and associated tests of hypotheses and confidence intervals are treated. PREREQUISITE: Calculus.

OS3105 STATISTICS FOR TECHNICAL MANAGEMENT (4 - 1).
The first of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Skills in numerical computation are developed in laboratory periods through the use of MINITAB. Emphasis in the lectures is placed on modeling problems and interpreting results. Those aspects of probability structure that are germane to distributions such as the binomial and normal. Standard topics of statistical inference for one and two variables are introduced in the settings of both hypothesis testing and confidence interval estimation. PREREQUISITE: Calculus.

OS3302 QUALITY ASSURANCE AND RELIABILITY (4 - 0).
A technical treatment of quality assurance discipline with attention to its corresponding programmatic and managerial elements. Survey of current trends and policies in total quality management and system design, development production and logistic support. Reliability modeling, testing, growth, estimation and assessment, manufacturing qualification, process control management and improvement, quality control charts. Survey of selected current DoD instructions, handbooks and manuals. PREREQUISITES: A course in Statistics, OS3101, OS3105 or equivalent.

OS3303 COMPUTER SIMULATION (4 - 1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to USW problems. War gaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. PREREQUISITES: OS2103 and OS3604 or equivalent.

OS3401 HUMAN FACTORS ENGINEERING (3 - 0).
An introduction to human factors engineering for students in fields such as engineering. Designed to give the student an appreciation of man's capacities and limitations and how these can affect the optimum design of the man-machines system. Emphasis on integration of human factors into the system development cycle considering such topics as manpower/personnel costs, control and display design, human energy expenditure, physiological costs, and evaluation systems. PREREQUISITE: A previous course in probability and statistics.

OS3403 HUMAN FACTORS IN INFORMATION WARFARE (3 - 1).
This course will provide the student with the ability to evaluate and predict human performance in specified operational environments. The effects of stress factors such as noise, temperature, motion, work load, etc., on various aspects of human performance will be studied. Students will identify the control and display requirements or an EW system and design a workspace to accommodate an EW data reduction/analysis system. PREREQUISITE: OS3604.

OS3404 MAN-MACHINE INTERACTION (3 - 2).
An introduction to the man-machine interface problems in C3. Information, display and human communication requirements for effective C3. Applied orientation involving message handling systems, query languages, computer to computer communications, command and control applications programs, file transfer between host computers, etc. PREREQUISITE: Enrollment in the Joint C4I curriculum.

OS3601 SEARCH, DETECTION, AND LOCALIZATION MODELS (4 - 0).
An introduction to the decision problems associated with Navy detection systems. The relation of detection models to search and localization models, measures of effectiveness of search/detection systems, and the optimum allocation of search effort are discussed. This course is designed for the USW curriculum. PREREQUISITES: OS2103, OS3604, PH2401 or consent of instructor and SECRET clearance.

OS3603 SIMULATION AND WAR GAMING (3 - 1).
This course introduces students to systemic and interactive wargame simulation models. The students will understand and play two interactive wargames and will run an existing systemic combat model to conduct output and sensitivity analyses on the results. Basic topics include measures of effectiveness, Monte Carlo processes for generating simulation events, decision and utility models, high resolution versus aggregated combat models, scenario development and analysis objectives. PREREQUISITES: Basic probability, statistics, and Data Analysis - OS2103, OS3604 or equivalent, and a working knowledge of computer programming language.

OS3604 DECISION AND DATA ANALYSIS (4 - 0).
An introduction to statistics and data analysis for students in the operational curricula. Topics include point and interval estimation, hypotheses testing, analysis of variance, single and multiple regression, and categorical data analysis. Emphasis is placed on decision rules and in the analysis of data from operational environments. PREREQUISITE: OS2103 or equivalent.

OS3702 MANPOWER REQUIREMENTS DETERMINATION (4 - 0).
The objective is to enable the student to use some of the tools of industrial engineering in the determination of the quantity and quality of manpower required in military systems. Techniques include motion and time study, work sampling, predetermined time standards, work design and layout, materials handling, procedures review and process design. Applications for ship and squadron manning documents and SHORESTAMPS are included. PREREQUISITES: OS3006, or OA3201 and OA3301.

OS4601 TEST AND EVALUATION (4 - 0).
Designed for system technology students, this course examines problems associated with tests and evaluations of weapon systems and tactics. Included are concepts from experimental design, regression analysis. Realistic data sets and examples are discussed and analyzed. PREREQUISITE: Inferential statistics.

OS4602 TEST & EVALUATION MANAGEMENT (2 - 0).
Designed to cover Developmental, Operational and Joint Test and Evaluation, including planning concepts and procedures frequently used in test and evaluation programs. Taught from the perspective of the Program manager, Test Project Officer and Test Engineer. Actual military cases are used for examples. Topics include the role of Test and Evaluation in Systems Engineering and Acquisition Management, DT and OT test planning, introduction to test design, conduct of tests, live fire testing, modeling and simulation, human systems integration (HIS), reporting of test results, range and resource issues, and lessons learned. Student teams will write a detailed test plan. PREREQUISITE: MN3302.

OS4701 MANPOWER AND PERSONNEL MODELS (4 - 0).
The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements and validation. Application in the form of current military models are included. PREREQUISITE: OS3006.

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William Boniface Colson, Professor (1989); PhD, Stanford University, 1977.

Alfred William Madison Cooper, Professor (1957); PhD, The Queen's University of Belfast, 1961.

David Scott Davis, Associate Professor and Associate Chairman for Administration (1989); PhD, Purdue University, 1976.

Bruce C. Denardo, Associate Professor (1998), PhD, University of California at Los Angeles, 1990.

David Fried, Visiting Professor (1998); PhD, Rutgers University, 1962.

Robert Charles Harney, Associate Professor (1995), PhD, University of California at Davis, 1976.

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William L. Kruer, LLNL Chair for Laser Research (1998); PhD, Princeton University, 1969.

Andres Larraza, Associate Professor (1994); PhD, University of California at Los Angeles, 1987.

James H. Luscombe, Associate Professor (1994), PhD, University of Chicago, 1983.

William B. Maier II, Chairman and Senior Lecturer (1995); PhD, University of Chicago, 1965.

Xavier K. Maruyama, Professor (1987); PhD, Massachusetts Institute of Technology, 1971.

Thomas Muir, Mine Warfare Chair (1997); PhD, University of Texas, 1971.

Richard Christopher Olsen, Associate Professor (1987); PhD, University of California at San Diego, 1980.

James Vincent Sanders, Associate Professor, Associate Chair for Instruction and Academic Associate for Combat Systems (1961); PhD, Cornell University, 1961.

Gordon Everett Schacher, Professor (1964); PhD, Rutgers, 1961.

Mitchell Shipley, Instructor (1997); MS, Naval Postgraduate School, 1988.

Kevin B. Smith, Assistant Professor (1995); PhD, University of Miami, 1991.

Donald E. Spiel, Research Associate Professor (1985); MS, Naval Postgraduate School (1968).

Philip L. Walker, Research Associate Professor (1988); PhD, University of California Riverside (1976).

Donald Lee Walters, Professor (1983); PhD, Kansas State University, 1971.

Oscar Bryan Wilson, Professor Emeritus (1957); PhD, University of California at Los Angeles (1951).

Karlheinz Edgar Woehler, Professor Emeritus (1962); PhD, University of Munich, 1962.

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

Current expertise in the Department of Physics includes the following specializations:

SPECIALIZATIONS

1) Optical and Electromagnetic Signal Propagation, Detection and Sensor Systems.
2) Conventional and Nuclear Weapons and their Effects.
3) Underwater Acoustics.
4) Free-electra Laser Physics.
5) Physical Acoustics.
6) Solid State Physics.

All of these specializations are of relevance to modern and future weapons technologies. The faculty supports an ongoing research program in these areas and student thesis topics are available in all of them.

DEGREE REQUIREMENTS
The Department of Physics offers the Master of Science and the PhD degrees in Physics and in Applied Physics. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements.

MASTER OF SCIENCE IN PHYSICS
A candidate for the degree Master of Science in Physics must complete satisfactorily a program of study which includes a minimum of 30 quarter hours of physics courses (not including thesis) distributed among courses at the graduate (3000 or 4000) level; of these 30 hours at least 15 hours must be at the 4000 level. Upon approval of the Chairman of the Physics Department, a maximum of 4 hours of courses taken in another department may be applied toward satisfying the above requirements. In lieu of the preceding requirements, students who are qualified to pursue graduate courses in physics when they arrive at the Naval Postgraduate School may complete a minimum of 20 hours entirely of 4000 level physics courses. In addition, all students must satisfy the general Postgraduate School minimum requirements for the master's degree and present an acceptable thesis.

The following specific course requirements must be successfully completed for a student to earn the degree Master of Science in Physics:

1) PH3152: Mechanics of Physical Systems,
   PH3352: Electromagnetic Waves and Radiation
   PH3991: Theoretical Physics
   PH3782: Thermodynamics and Statistical Physics.
   PH4353: Topics in Advanced Electricity and Magnetism
   PH4984: Advanced Quantum Physics, or equivalents to the above courses.

2) In addition to the above, a graduate sequence containing at least two physics courses, at least one of which must be at the 4000 level.

All programs leading to the degree Master of Science in Physics must be approved by the Chairman of the Department of Physics.

MASTER OF SCIENCE IN APPLIED PHYSICS
To be awarded the degree Master of Science in Applied Physics, a student must complete a program which includes at least 20 quarter hours of Physics courses at the graduate level, including 12 at the 4000 level. The total graduate hours in Physics, Mathematics, and Engineering must be at least 32 including 20 at the 4000 level.

The program must include at least one graduate level course in each of the following areas: mechanics, electromagnetism, and quantum physics. In addition, the program must include a 4000 level Physics course from at least one of the following areas of physics: mechanics of continua, solid state physics, laser physics, nuclear physics, plasma physics, acoustics, or electromagnetic radiation.

In addition to the above required courses, a student's program must include an area of concentration containing a four-course sequence of graduate level courses, at least two at the 4000 level, in an area related to applied physics and approved by the Chairman of the Department of Physics. A list of courses and concentrations meeting the above requirements is available from the Chairman of the Physics Department.

All programs leading to the degree Master of Science in Applied Physics must satisfy the general Postgraduate School requirements for the Master's degree, must include a thesis advised or co-advised by a member of the Physics Department, and must be approved by the Chairman of the Department of Physics.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer Degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that may address system design issues are welcome.

DOCTOR OF PHILOSOPHY

The Department of Physics offers the PhD. degree in several areas of specialization which currently include acoustics, electro-optics, free electron lasers, space physics, theoretical physics, and nuclear physics.

Requirements for the degree may be grouped into three categories: courses, dissertation research, and examinations.

The required examinations are outlined under the general school requirements for the PhD. In particular, the Department requires a preliminary examination to show evidence of acceptability as a doctoral student. This examination may be taken before or after commencement of graduate studies at NPS.

The department offers two options for the PhD; major in Physics or major in Applied Physics. For the major in Physics, a minimum of 40 credit hours of physics courses at the 4000 level is required. The major in Applied Physics also requires 40 credit hours of 4000 level courses, but a portion of these hours may be taken in other departments in technical subjects related to physics.

A more detailed description of departmental requirements for the PhD is contained in the booklet "Doctoral Study in Physics or in Applied Physics at the Naval Postgraduate School."

An applicant to the PhD program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01B3, Naval Postgraduate School, Monterey, California 93943-5100.

PHYSICS LABORATORIES

The physics laboratories are equipped to carry on instruction and research work in acoustics atomic and molecular physics, electro-optics, spectroscopy, laser physics, computational physics, optical propagation, sensor physics and transient electrical discharges.

The Optical Physics and Sensors Laboratory uses imaging, spectroscopic and sensing systems from far infrared to ultraviolet wavelengths, including instrumentation for seagoing, airborne and ground-based measurements.

The Acoustics Laboratory equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in acoustics in air. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the Underwater Acoustics Laboratory, a scale-model of a shallow water waveguide for the study of environmentally adaptive sonar and high-speed digital acoustic communication. The Physical Acoustics Laboratories are equipped with a variety of modern data collection and processing equipment.

PHYSICS COURSE DESCRIPTIONS

PHR110 REFRESHER PHYSICS (NON CREDIT) (Meets last 6 weeks of quarter.) (5 - 3).
Selected topics from elementary physics for incoming students. Typical topics are kinematics, Newton's Laws of motion, work, energy, linear and angular momentum, basic concepts of fluid flow, temperature, heat, and the kinetic theory of gases. Vector algebra and some aspects of calculus are developed as needed and their use is emphasized. The two ninety-minute problem sessions are devoted to guided problem solving. PREREQUISITES: Previous college course in elementary physics and integral calculus. Refresher mathematics (calculus) is usually taken concurrently.

PH0499 ACOUSTICS COLLOQUIUM (NO CREDIT) (0 - 1).
Reports on current research, and study of recent research literature in conjunction with the student thesis. PREREQUISITE: A course in acoustics.

PH0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research will enroll in this course.

PH0999 PHYSICS COLLOQUIUM (NO CREDIT) (0 - 1).
Discussion of topics of current interest by NPS and outside guest speakers.

PH1001 FUNDAMENTALS OF PHYSICS I (4 - 2).
This calculus-based course is the first of two courses for students entering the Combat Systems Science and Technology Curriculum. The course meets for twelve hours per week for the first five and one-half weeks of the quarter. Topics covered are the fundamentals of calculus-based mechanics: Kinematics and dynamics of particles, statics of rigid bodies, work, energy, systems of particles, collisions, rotations of rigid bodies, angular momentum and torque, mechanical properties of solids, elasticity, harmonic motion, sound, fluids. Mathematical methods are reviewed as required. PREREQUISITES: Calculus with a passing grade.

PH1002 FUNDAMENTALS OF PHYSICS II (4 - 2).
This calculus-based course is the second of two courses for students entering the Combat Systems Science and Technology Curriculum. The course meets for twelve hours per week for the second five and one-half weeks of the quarter and covers electromagnetism: electric charge, electric and magnetic fields, forces on charges in fields, electric potential, Gauss' law, Ampere's law, Faraday's law, resistance, capacitance, inductance, DC circuits, magnetic properties of matter, transient currents in circuits, complex AC circuits analysis, Maxwell's equations. Mathematical methods are reviewed as required.

PH1121 PHYSICS I (4 - 2).
Particle kinematics, Newton's laws of motion, particle dynamics, work and energy, conservation of energy and momentum, systems of particles, rotational kinematics and dynamics including torque and angular momentum, gravitation, stress and strain in materials, simple harmonic motion, fluids. Laboratory exercises. PREREQUISITE: A course in calculus or concurrent registration in a calculus course and approval of the instructor.

PH1322 PHYSICS II (4 - 2).
Electric charge, Coulomb's Law, electric field, Gauss' Law, electrical potential and energy, current and resistance, EMF, capacitors and dielectrics, magnetic field, Faraday's Law, Ampere's law, Maxwell's equations, wave motion. Laboratory exercises. PREREQUISITE: PH1121 or approval of the instructor.

PH1623 PHYSICS III (4 - 2).
Geometrical and physical optics, thermodynamics and kinetic theory, sound, atoms and molecules, modern physics. Laboratory exercises. PREREQUISITES: PH1322 or approval of the instructor.

PH1992-1998 SPECIAL TOPICS IN ELEMENTARY PHYSICS (V - 0).
Study in one of the fields of elementary physics selected to meet the needs of students without sufficient undergraduate physics to meet the prerequisites of their curriculum. The course may be conducted either as a lecture course or as supervised reading. PREREQUISITE: Consent of the Department Chairman.

PH2001 PHYSICS THESIS OPPORTUNITIES (1 - 0).
This course is designed for students interested in choosing and pursuing a Master's thesis in physics. Members of the faculty of the Department of Physics having research projects suitable for Master's degree theses will give presentations on their projects. The course is given in the pass/fail mode. PREREQUISITE: At least 7 quarter-hours of physics courses.

PH2151 PARTICLE MECHANICS (4 - 1).
After a review of the fundamental concepts of kinematics and dynamics, this course concentrates on those two areas of dynamics of simple bodies which are most relevant to applications in Combat Systems: vibrations and projectile motion. Topics include: damped and driven oscillations, projectile motion with atmospheric friction, satellite orbits, and rotating coordinate systems. PREREQUISITES: PH1121 or equivalent; MA2121 or equivalent course in ordinary differential equations (may be taken concurrently).

PH2203 TOPICS IN BASIC PHYSICS: WAVES AND OPTICS (4 - 0).
A course to provide physical background to wave motion, acoustics, and optics for students in the Electronic Warfare and Information Warfare curricula, and to provide applications of analytical techniques to physical problems. Areas covered are harmonic motion differential equations, complex notation, damped vibration and resonance, wave motion (properties of waves, sound waves, optics), geometrical and wave optics. PREREQUISITE: MA2138.

PH2207 FUNDAMENTALS OF ELECTRO-OPTICS (4 - 0).
This course is designed to provide students in interdisciplinary curricula with specific prerequisite background for electro-optics courses in those curricula. Topics discussed include: matrix formulation of optics, catoptric and catadioptric systems, diffraction, behavior of Gaussian profile beams, Fourier optics and resolution, atmospheric transmission, atomic and molecular energy states, line shapes, band theory of semiconductors, the p-n junction, light emitting diodes, stimulated emission, and lasers. PREREQUISITES: MA3139 and PH2203 (or equivalent).

PH2351 ELECTROMAGNETISM (4 - 1).
Electrostatic fields in vacuum and dielectrics, electrostatic energy and capacitors. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Faraday's Law. Magnetic energy. Maxwell's Equations. Gauge transformations. The electromagnetic wave equation and plane waves. PREREQUISITES: PH1322 or equivalent, a course on multivariable calculus and a course on differential equations.

PH2401 INTRODUCTION TO THE SONAR EQUATIONS (3 - 0).
A discussion of each term of the sonar equations, with application to the detection, localization, and classification of underwater vehicles. Topics include ray acoustics, simple transmission loss models, tonals, spectrum and band levels, directivity index, array gain, doppler shift, and detection threshold. This course is intended primarily for students in the Undersea Warfare curriculum and is given in a "structured" PSI mode. PREREQUISITE: Precalculus mathematics.

PH2410 ANALOG ELECTRONICS AND SIGNAL CONDITIONING FOR ACOUSTICS (3 - 2).
Applications of simple integrated circuits to acoustical measurements including op-amp filters and amplifiers, voltage controlled oscillators, D-to-A, A-to-D, and frequency-to-voltage converters. Sources of noise (thermal and quantization) in electro-acoustic systems. Techniques of noise reduction in the frequency and time domains including signal integration and time averaging, digital and analog Fourier analysis, phase sensitive detection and time domain auto- and cross-correlation analysis. PREREQUISITES: SE2012 and EC2170.

PH2511 INTRODUCTION TO ORBITAL MECHANICS (4 - 0).
The gravitational two-body problem. Elliptic orbits and orbital elements. Orbital maneuvers and transfers. Time of flight. Ground track. Additional topics selected from the following: suborbital trajectories, hyperbolic trajectories, orbit determination from radar data, sun synchronous orbits, Molniya orbits and orbital perturbations. PREREQUISITES: A course in basic mechanics (including vectors) and a course in ordinary differential equations.

PH2514 INTRODUCTION TO THE SPACE ENVIRONMENT (4 - 0).
Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field, and the magnetosphere, radiation belts, structure and properties of the earth's upper atmosphere, ionosphere, implications of environmental factors for spacecraft design. PREREQUISITE: A course in basic electricity and magnetism.

PH2601 SURVEY OF MODERN PHYSICS (4 - 1).
This is a one-term course covering the fundamentals of modern physics with selected applications. Topics include special relativity, the wave-particle duality, the Schrodinger Equation, atoms and molecules, lasers, semiconductors, and superconductors. PREREQUISITE: PH1623.

PH2652 QUANTUM PHYSICS (4 - 1).
Thermal radiation, photons, matter waves, Bohr model of hydrogen, special relativity, Schroedinger's Equation applied to barriers, wells, harmonic oscillator, and the hydrogen atom. Spin and multi-electron. PREREQUISITE: PH2151 and partial differential equations.

PH2724 THERMODYNAMICS (4 - 0).
Equations of state; the concepts of temperature, heat and work; the first law of thermodynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. PREREQUISITES: PH1623 and a course in multivariable calculus.

PH3002 NON-ACOUSTIC SENSOR SYSTEMS (4 - 0).
This course covers the physical principles underlying the operation of a number of operational and proposed non-acoustic sensor systems. Geomagnetism, magnetometers and gradiometers, MAD signatures, optical and IR transmission in the atmosphere and in sea water. Image Converter, FLIR and radar systems for USW. Exotic detection schemes. PREREQUISITE: PH1322.

PH3052 PHYSICS OF SPACE AND AIRBORNE SENSOR SYSTEMS (4 - 0).
This inter-disciplinary course explores the physical principles underlying the sensor systems needed for satellites and tactical aircraft as well as limitations imposed by the atmosphere and operating environment on these systems and their communication links. Topics include: satellite orbits, the satellite environment, ionospheric interactions and atmospheric propagation, phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars, noise resources, thermal radiation, principles of semiconductor devices, optical and infrared imaging detector systems and their resolution limitations and bandwidth requirements. PREREQUISITE: EO2413 or equivalent .

PH3119 OSCILLATION AND WAVES (4 - 2).
An introductory course designed to present mechanics to students studying acoustics. Kinematics, dynamics, and work and energy consideration for the free, damped, and driven oscillators. The wave equation for transverse vibration of a string, ideal and realistic boundary conditions, and normal modes. Longitudinal and transverse waves in bars. Transverse waves on rectangular and circular membranes. Vibrations of plates. Laboratory periods include problem sessions and experiments on introduction to experimental techniques and handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal, and torsional waves on a bar. PREREQUISITE: PH3991 or equivalent.

PH3152 MECHANICS OF PHYSICAL SYSTEMS (4 - 0).
The dynamics of rockets. Rotating coordinate systems and coriolis acceleration. Hamilton's principle and the role of physical symmetry in dynamics. Velocity dependent potentials. The inertia tensor and the rotational dynamics of rigid bodies. Small oscillations and normal PREREQUISITE: PH2151.

PH3172 FLUID DYNAMICS OF WEAPONS (4 - 1).
This course is designed for the students in the Combat Systems Sciences and Technology Curriculum to provide the basic physical principles applicable to air-borne and water-borne missiles. Topics include: The stress tensor and the rate of deformation tensor. The general equations of continuity, momentum, and energy. Navier-Stokes equation for incompressible flow. Laminar boundary layers. Hydrodynamic stability and the turbulent boundary layer. Drag and lift in incompressible flow with application to torpedoes. Normal and oblique shock waves. Supersonic nozzles. Drag and lift of supersonic airfoils with application to missiles. PREREQUISITE: PH3152.

PH3204 ELECTRO-OPTIC SYSTEMS AND COUNTERMEASURES (3 - 2).
This course is designed to provide students in the Information Warfare curriculum with an understanding of the principles, and capabilities of military electro-optic and infrared systems and their countermeasures. Topics treated include: Target signatures and backgrounds, laser radiation characteristics, atmospheric extinction, refraction, turbulence, thermal blooming and breakdown, adaptive optics, thermal radiation, target signatures, background, reticles and other trackers. Infrared detector characteristics, CCD, CID and FLIR, IRST and staring sensors; sensor performance parameters. Laboratory work provides hands-on familiarity with modern infrared devices. PREREQUISITES: PH2203, EO2413, EO2652 and MA3139 or equivalent.

PH3252 ELECTRO-OPTICS (4 - 0).
This course treats the properties of electro-optic systems together with the basic physical principles involved. Topics included are: diffraction and Fourier transform methods; optical data processing; Fresnel equations, evanescent waves, film and fiber optics; Gaussian beams and laser resonators; molecular spectra, transition probability, line widths, and laser gain; specific lasers, Q-switching and mode locking; semi-conductors, junction diodes, photo detection, light emitting diodes and diode lasers. PREREQUISITES: PH2652, PH3352.

PH3292 APPLIED OPTICS (4 - 2).
An intermediate-level course in optics. Review of basic optical concepts: reflection, refraction, imaging systems, interference, polarization. Matrix methods of ray tracing and matrix-based analysis of optical systems. Introduction to aberrations. Birefringence, circular and elliptical polarization, optical activity, electro-optical modulators. Multiple-beam interference. Huygens-Fresnel principle, Fraunhofer diffraction, Fresnel diffraction. Introduction to Fourier optics. Basic coherence theory and its applications. PREREQUISITES: PH1623 and PH3352, or equivalents.

PH3352 ELECTROMAGNETIC WAVES AND RADIATION (4 - 0).
Propagation of uniform plane waves in free space, in dielectric media, in conducting media (with emphasis on sea water), and in the ionosphere. Reflection and refraction. Radiation and antennas. Principles of radar. Rectangular waveguides. PREREQUISITE: PH2351.

PH3360 ELECTROMAGNETIC WAVE PROPAGATION (4 - 1).
Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, in dielectrics and conductors, and in the ionosphere. Reflection and refraction at the interface between media. Guided waves. Radiation from a dipole. PREREQUISITES: MA2121 and a course in basic electricity and magnetism.

PH3410 OPTICAL FIBER SENSORS AND COMMUNICATION SYSTEMS (3 - 2).
Introduction to the physics, engineering, and applications of optical fibers, electro-optic sources, sensors, and communication systems. The course will cover communication system design including component specification, data rates, power budgets, and optical amplifiers. The course will also cover sensor design including interferometric and intensity based sensors, fiber optic hydrophones, gyroscopes, and displacement sensors. PREREQUISITE: PH3292 or equivalent.

PH3451 FUNDAMENTAL ACOUSTICS (4 - 2).
Development of, and solutions to, the acoustic wave equation in fluids; propagation of plane, spherical and cylindrical waves in fluids; sound pressure level, intensity, and specific acoustic impedance; normal and oblique incidence reflection and transmission from plane boundaries; transmission through a layer; image theory and surface interference; sound absorption and dispersion for classical and relaxing fluids; acoustic behavior of sources and arrays, acoustical reciprocity, continuous line source, plane circular piston, radiation impedance, and the steered line array; transducer properties, sensitivities, and calibration. Laboratory experiments include longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, three-element array, speed of sound in water, and absorption in gases. PREREQUISITES: PH3119 and PH3991 or equivalent.

PH3452 UNDERWATER ACOUSTICS (4 - 2).
This course is a continuation of PH3451. Lumped acoustic elements and the resonant bubble; introduction to simple transducers; normal modes in rectangular and cylindrical enclosures; steady-state response of acoustic waveguides of constant cross section, propagating evanescent modes, and group and phase speeds; transmission of sound in the ocean, the Eikonal Equation and necessary space conditions for ray theory, and refraction and ray diagrams; sound propagation in the mixed layer, the convergence zone, and the deep sound channel; passive sonar equation, ambient noise and doppler effect and bandwidth considerations; active sonar equations, target strength and reverberation. Laboratory experiments include Helmholtz resonators, normal modes in rectangular, cylindrical, and spherical enclosures, water-filled waveguide, noise analysis, impedance of a loudspeaker. PREREQUISITE: PH3451.

PH3458 NOISE, SHOCK AND VIBRATION CONTROL (4 - 2).
The application of the principles of acoustics and mechanics to the problems of controlling noise, vibration and mechanical shock. Topics include linear mechanical vibrations; introduction to vibrations of nonlinear systems; damping mechanisms; vibration and shock isolation; noise generation and control; effects of noise on man; application to problems of Naval interest such as ship quieting and industrial noise control. PREREQUISITE: A course in acoustics.

PH3479 PHYSICS OF UNDERWATER WEAPONS (4 - 0).
The basic physics of underwater weapons from launch through explosion are addressed using a modern acoustic torpedo to illustrate practical applications. Topics include initial inputs, water entry, power plants, propulsors, drag and drag reduction, stability and control, guidance, acoustic search, terminal homing, exploders, and explosions. PREREQUISITE: MA3139 or equivalent.

PH3513 INTERMEDIATE ORBITAL MECHANICS (Variable hours 2-0 to 4-0.) (V - 0).
Orbital perturbations due to various sources, such as atmospheric drag and lunar tidal effects. Interplanetary trajectories. Additional topics depending on hours assigned to course. PREREQUISITE: PH2511.

PH3516 ENVIRONMENTAL FACTORS IN SPACECRAFT DESIGN & OPERATIONS (3 - 0).
The environmental effects covered in this course include spacecraft charging, space radiation effects, natural and artificial space debris, and atmospheric effects. The nature of the physical interactions is emphasized. PREREQUISITE: PH2514.

PH3652 QUANTUM MECHANICS (4 - 1).
This course covers the fundamentals of quantum mechanics that are required for applications in combat systems technology. Wave-particle duality and the Schrodinger equation, bound states, scattering by simple barriers, WKB approximation, expectation values and operators, rotationally invariant potentials, hydrogen atom, quantum theory of angular momentum, spin, identical particles, Pauli exclusion principle, perturbation theory. PREREQUISITES: PH1623, PH3152, PH3991.

PH3653 FOUNDATIONS OF QUANTUM DEVICES (4 - 1).
Quantum statistics and identical particles; degenerate electron gas, solids, band theory of metals, insulators, and semiconductors; molecules and molecular spectra; semiconductor junctions and transistors; applications of quantum mechanical principles of radiating systems (e.g., lasers) and photon detectors; superconductivity and superconducting quantum interference devices (SQUIDs). PREREQUISITE: PH2652.

PH3782 THERMODYNAMICS AND STATISTICAL PHYSICS (4 - 0).
Entropy, temperature, Boltzmann factor and Gibbs factor are developed from a quantum point of view. Blackbody radiation, chemical potential, partition function, Gibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerate systems; Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. PREREQUISITES: PH2724 and PH3653.

PH3800 INTRO TO THE EFFECTS OF CONVENTIONAL AND UNCONVENTIONAL WEAPONS (4 - 0).
Dynamic behavior of ductile and brittle materials. Hugoniots. Target failure mechanisms; penetration at high velocities; shaped charges; nuclear, chemical, and biological weapons effects. PREREQUISITE: MS2201 or consent of instructor.

PH3802 WEAPONS, WEAPONS EFFECTS AND WEAPONEERING (4 - 0).
This course is designed primarily for students of the Information Warfare Curriculum (595). The course gives an introduction to the planning and targeting process of joint air operations, followed by discussion of the current types of warheads including nuclear warheads, basic principles governing the warhead target interaction. An introduction to the principles of “Weaponeering”, the estimate of target course concludes with concepts of directed energy weapons, lasers and high power microwave beams and their effects on target of interest. PREREQUISITES: Basic physics, MA1117/1118 or equivalent, U.S. citizenship and SECRET clearance.

PH3855 NUCLEAR PHYSICS (4 - 2).
This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the necessary underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes, and interaction of high energy particles with matter. The laboratory includes radiation detection techniques and statistics of counting. PREREQUISITES: PH3152, PH3352 and PH3653 or equivalent. (PH3653 may be concurrent.)

PH3921 NONLINEAR DYNAMICS, CHAOS, FRACTALS AND ALL THAT (Variable hours 2-0 to 3-0.) (V - 0).
The existence of chaotic dynamics has been discussed in the literature for many decades and is associated with names like Poincare, Birkhoff, Kolmogorov and others. However, it is only recently that the wide ranging impact of chaos has been recognized. The field is undergoing explosive growth and many applications have been made across a broad spectrum of scientific disciplines - ecology, economics, physics, chemistry, engineering, and fluid mechanics. Much effort is driven by the hope that it may be possible to find unifying principles that characterize and classify large classes of nonlinear complex systems. This course is an introduction into the concepts and the language used in this rapidly growing exciting field from a physicist’s point of view. PREREQUISITE: PH2151 or equivalent.

PH3991 THEORETICAL PHYSICS (4 - 0).
Discussion of heat flow, electromagnetic waves, elastic waves, and quantum mechanical waves; applications of orthogonal functions to electromagnetic multi poles, angular momentum in quantum mechanics, and to normal modes in acoustic and electromagnetic systems. PREREQUISITES: Basic physics, multivariable calculus, vector analysis, Fourier series, complex numbers, and ordinary differential equations.

PH3992-3998 SPECIAL TOPICS IN INTERMEDIATE PHYSICS (Variable hours 1-0 to 4-0.) (V - 0).
Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading in different topics. PREREQUISITES: A 2000 level course appropriate to the subject to be studied, and consent of the Department Chairman. The course may also be taken on a Pass/Fail basis provided the student has requested so at the time of enrollment.

PH4001 PHYSICS THESIS PRESENTATION (1 - 0).
This course provides students with the opportunity to develop the ability to deliver a briefing on a technical subject by presenting their thesis to other students and faculty. This course is required of all students working for a degree from the Physics Department and of all Combat Systems students not presenting their thesis in some other department. PREREQUISITE: At least two quarters of thesis research.

PH4054 PHYSICS OF DIRECTED ENERGY WEAPONS (4 - 0).
This course is an in-depth study into the beam weapon concepts. Topics covered are: relativistic electron beams, their equilibrium, propagation losses and stability; giant power accelerator concepts; target interaction; proton beams; neutral particle beams, their production and limitations; high power microwave beams; high energy laser beams, their production, atmospheric propagation and control and their interaction with targets. PREREQUISITES: PH2151 and PH3352 (or equivalents) and SECRET clearance.

PH4055 FREE ELECTRON LASER PHYSICS (3 - 0).
The physical principles describing free electron lasers are explained with applications to ship defense from sea-skimming missiles, and to new radiation sources for scientific research. Theory is applied to experimental facilities around the world. Topics include optical resonator design, general laser concepts, laser beam propagation, relativistic electron dynamics, phase-space analysis, and numerical simulation. PREREQUISITE: PH4353, E&M.

PH4056 RADIOFREQUENCY WEAPONS, HIGH POWER MICROWAVES, AND ULTRAWIDEBAND SYSTEMS (4 - 2).
This course outlines High Power Microwave (HPM) and RF weapons technology, design, and progress including sources, systems integration, and effects of these emerging capabilities. Definitions and terminology; calculations concerning the effects upon electronics such as burnout and upset; narrowband and wideband modulation; and RF radiation, propagation, and coupling will be presented. The generation of high power electromagnetic fields in compact sources, testing, EMI/EMC fratricide/suicide issues, and transition to employment as operational systems in a variety of applications will be described. Additionally, intelligence concerning the growing RF weapons threat will be analyzed with particular attention paid to asymmetrical threat aspects of these developments. PREREQUISITE: PH3352 or equivalent. SECRET/U.S. ONLY.

PH4162 MECHANICS OF CONTINUA (3 - 0).
The foundations of fluid mechanics presented in the tensor formulation. Scalars, vectors, and tensors; tensor differential and integral calculus; the stress tensor and rate of deformation tensor; principal values, deviators, and other invariants; fundamental laws: conservation of mass, linear momentum, angular momentum, and energy; constitutive equations; non-Newtonian fluids; Visco-Plastic materials. PREREQUISITE: PH3172 or equivalent.

PH4209 EO/IR SYSTEMS AND COUNTERMEASURES (3 - 2).
This unclassified course for students in interdisciplinary curricula treats the military applications of electro-optic systems, including IR and EO seekers and trackers, surveillance and missile warning systems, and laser rangers and designators. Scanning FLIR and IRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approaches will be discussed. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. PREREQUISITES: PH3208, MA3139.

PH4253 SENSORS, SIGNALS, AND SYSTEMS (4 - 2).
This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals in the EO/IR range. Topics included are: optical modulation, nonlinear optics, acousto-optics; atmospheric molecular absorption characteristics and mechanisms of detectors for optical and infrared radiation, noise in detectors, cooling systems; image intensifiers, television and FLIR systems; detecting, tracking and homing systems; signal sources, target signatures and backgrounds; laser target designators, laser radars, the range equation. The laboratory will include experiments related to this material as well as to that of the preceding course, PH3252. PREREQUISITES: PH3653, PH3292, and PH3352 or equivalent.

PH4254 THERMAL IMAGING AND SURVEILLANCE SYSTEMS (4 - 0).
This course is intended as a capstone course to follow the sequence PH3252 and PH4253, or the sequence PH2207 and PH3208. It will address the system analysis and technology of infrared imaging and search/track systems, including the derivation of system performance measures such a Minimum Detectable Temperature Difference, (MDT), and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display, and human operator characteristics. Performance Prediction codes and Tactical Decision aids (TDAs) will be analyzed for current Forward Looking Infra Red (FLIR) Systems, and comparable codes for IRSTs discussed. Criteria for target detection and transference of contrast will be compared. Integrated Focal Plane Array Technology will be explored for application to second generation FLIR and Staring Imager development. PREREQUISITE: PH3208 or PH4253 or consent of instructor.

PH4283 LASER PHYSICS (4 - 0).
The physics of lasers and laser radiation. Topics will include: spontaneous and stimulated emission, absorption, interaction of radiation with matter; line broadening mechanisms; optical and electrical pumping; gain; properties of laser beams; Gaussian beams; stable and unstable resonators; rate equations; output coupling; mode locking; short pulsing; specifics of solid state and gas laser systems; high energy and high power lasers; laser-surface interaction; air breakdown; laser supported detonation waves; laser isotope separation; and laser fusion. PREREQUISITE: PH4051or equivalent.

PH4353 TOPICS IN ADVANCED ELECTRICITY AND MAGNETISM (4 - 0).
Topics selected from: Electromagnetic radiation, including radiation from antennas and accelerating particles, and radiation scattering from charged particles. Additional topics may include Cerenkov radiation, free electron lasers, and the relativistic formulation of electrodynamics. PREREQUISITES: PH3152, PH3352 and PH3991.

PH4354 ADVANCED ELECTROMAGNETIC RADIATION (4 - 0).
Electromagnetic radiation from accelerating particles and antennas, including Yagi antennas and phased arrays. Radar sources such as klystrons. Radiation scattering, including Rayleigh scattering, Mie scattering and scattering from rough surfaces. Relativistic electrodynamics. PREREQUISITES: PH3352 and PH3991.

PH4371 CLASSICAL ELECTRODYNAMICS (3 - 0).
Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. PREREQUISITES: PH4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

PH4410 ADVANCED ACOUSTICS LABORATORY (1 - 6).
Advanced laboratory projects in acoustics. Through the performance of experiments drawn from diverse fields of acoustics, the student is introduced to the problems and opportunities of acoustics research. For each experiment the student is guided through the scientific literature on the subject, the construction of the equipment, the collection and analysis of the data, and the writing of a research report. PREREQUISITE: PH3451.

PH4453 SCATTERING AND FLUCTUATION OF SOUND IN THE OCEAN (4 - 0).
An advanced treatment of the effects of variations of the ocean and its boundaries on ocean noise and the scattering and fluctuation of sound. Topics include: multipole radiation fields and noise sources in the sea, coherence and incoherence, probability density functions, the Hemholtz integral and general scattering formalism, scattering from objects, correlations and frequency spectra of sound scattered from rough boundaries, fluctuations associated with variability in the medium. PREREQUISITE: PH3452 or consent of the instructor.

PH4454 SONAR TRANSDUCER THEORY AND DESIGN (4 - 2).
A treatment of the fundamental phenomena basic to the design of sonar transducers, specific examples of their application and design exercises. Topics include piezoelectric, magnetostrictive and hydromechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical navy transducers, and a design project. A field trip to visit one or more transducer manufacturers is normally scheduled during the course. PREREQUISITE: PH3452 (may be taken concurrently).

PH4455 SOUND PROPAGATION IN THE OCEAN (4 - 0).
An advanced treatment of the subject. Topics include: reflection of spherical waves from ocean boundaries; normal mode propagation of sound; inhomogeneous wave equation and the point source in cylindrical coordinates; shallow water channel with fluid and solid bottoms; the deep sound channel and the WKB approximation; range-dependent channels; adiabatic normal modes and the parabolic equation; multi-path propagation; application to Arctic ocean acoustics. PREREQUISITE: PH3452 or consent of instructor.

PH4459 SHOCK WAVES AND HIGH-INTENSITY SOUND (3 - 0).
Nonlinear oscillations and waves on strings; the nonlinear acoustic wave equation and its solution; the parametric array; the physics of shock waves in air and in water. PREREQUISITE: PH3451.

PH4515 PHYSICS OF THE SATELLITE ENVIRONMENT (3 - 2).
A graduate level treatment of the structure and properties of the near earth space environment and some aspects of solar physics. Topics (usually two per quarter) are chosen from: ionospheric composition, ionospheric radio wave propagation, structure of the magnetosphere, the geomagnetic field, solar structure and emissions, spacecraft/environment interactions. PREREQUISITES: PH2514 and a 3000 level course in electromagnetism. Some background in plasma physics is desirable.

PH4531 INTRODUCTION TO ASTROPHYSICS (4 - 0).
Introduction to theories of stellar structure, energy transport in stars, and stellar evolution; recent advances in solar physics; supernovae, pulsars, black holes, and the origin of the universe will be topics of discussion. PREREQUISITES: PH3152 and PH3352.

PH4653 QUANTUM DEVICES (4 - 1).
This course covers the essentials of solid-state physics necessary to understand the role played by semiconductor heterojunctions, multilayers and microstructures in modern quantum devices. Topics in the theory of bulk solid-state physics include crystal structures, diffraction from periodic structures, vibrational properties of lattices, energy band structure, theory of donor (acceptor) levels and equilibrium carrier statistics. We then cover semiconductor homojunctions and heterojunctions, quantum wells and the two-dimensional electron gas, and devices that incorporate these effects. PREREQUISITE: PH3652.

PH4661 PLASMA PHYSICS I (4 - 0).
Introduction to plasma physics; single particle dynamics (orbit theory), MHD fluid theory, electromagnetic waves, instability, diffusion, and breakdown in gases. PREREQUISITE: PH3352 or equivalent.

PH4662 PLASMA PHYSICS II (3 - 0).
A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma; classification of plasma instabilities; kinetic theory, the Boltzmann equation and the macroscopic-momentum transport equation; plasma oscillations and Landau damping; nonlinear effects, shock waves, radiations from plasma, sheath theory. PREREQUISITE: PH4661 or consent of instructor.

PH4750 SOLIDS AND RADIATION EFFECTS (4 - 0).
An introduction to solid state physics and radiation effects. Free electron theory, bands, semiconductors, and lattice structure are discussed. Radiation damage mechanisms, TREE, and hardening concepts are introduced. PREREQUISITE: PH4760.

PH4760 SOLID STATE PHYSICS (4 - 0).
Fundamental theory dealing with solids: crystals, binding energy, lattice vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semi-conductors and insulators, magnetism. PREREQUISITE: PH3653.

PH4771 STATISTICAL PHYSICS (3 - 0).
Kinetic theory and the Boltzmann theorem, configuration and phase space, the Liouville theorem, ensemble theory, microcanonical, canonical and grand canonical ensembles, quantum statistics; applications to molecules, Bose-Einstein gases, Fermi-Dirac liquids and irreversible processes. PREREQUISITE: PH3782.

PH4856 PHYSICS OF NUCLEAR WEAPONS (4 - 0).
This second course in the nuclear weapons effects graduate specialization sequence considers in-depth questions of weapon designs and their specific output environments which are created by the nuclear explosion. Topics are: principles affecting weapon yield efficiency; explosion phenomenology in various ambient environments, blast and shock, thermal radiation, X-rays and gamma rays, neutron fluxes, electromagnetic pulse, radioactive fallout models. PREREQUISITES: PH3855 and SECRET clearance.

PH4857 PHYSICS OF HIGH VELOCITY IMPACT PHENOMENA IN SOLIDS (4 - 0).
This course is designed for students of the Combat System Sciences and Technology Curriculum taking the Weapon Effects concentration. It gives a broad overview of the impact response of materials from the linear elastic through the nonlinear plastic and hydrodynamic deformation regimes. Emphasis is on thorough coverage of fundamentals and their application to the dynamic behavior of materials subject to intense short duration loading. Topics are stress waves in solids, limitations of elementary wave theory, elastic plastic stress waves, penetration and perforation, hypervelocity impact, material behavior at high strain rates, dynamic fracture, simulation computer models of high velocity impact. PREREQUISITES: MS2201, PH3171, PH3172.

PH4858 WEAPONS LETHALITY AND SURVIVABILITY (4 - 0).
This course will cover the principles and effectiveness of advanced conventional warheads and new armor concepts for a range of military applications. Topics will include kinetic energy penetration, shaped charges, fragmentation warheads, and selected directed energy weapons applications. Advanced armor concepts will include the use of ceramics and their behavior under high velocity impact and penetration and possible armor applications to ship protection. PREREQUISITES: PH4857 and SECRET clearance.

PH4911 SIMULATION OF PHYSICAL AND WEAPON SYSTEMS (3 - 2).
The role of computation physics in modern weapons development and combat simulations. The programming language is C within the UNIX operating systems. Applications emphasize physical principles of weapons development, and the use of graphics. Subject matter includes random number distributions, projectile and fragment dispersion, free electron laser simulation, molecular dynamics in solids, liquids and gases, wave propagation in various media, and numerical integration methods. PREREQUISITES: PH2151, PH2911, and PH3352.

PH4971 QUANTUM MECHANICS I (3 - 0).
Review of Lagrange's and Hamilton's equations of motion. Poisson brackets; general principles of non-relativistic quantum mechanics; stationary states. PREREQUISITES: PH3152, PH3653.

PH4972 QUANTUM MECHANICS II (3 - 0).
Addition of angular momenta; scattering theory; additional topics of interest to students and instructor. PREREQUISITE: PH4971.

PH4973 QUANTUM MECHANICS III (3 - 0).
General principles of relativistic quantum mechanics; properties and solutions of relativistic wave equations. PREREQUISITE: PH4972.

PH4984 ADVANCED QUANTUM PHYSICS (4 - 0).
Quantum mechanics in the Dirac format. Angular momentum, spin, spin resonance. Additional topics may include group theoretical applications to selection rules and crystal fields, variational principles, self-consistent fields in the many-electron atom, scattering theory, and polyatomic molecules. PREREQUISITES: PH3152 and PH3653.

PH4991 RELATIVITY AND COSMOLOGY (3 - 0).
Einstein's general theory of relativity; the three classical tests; the Schwarzchild singularity and black holes; cosmological models and their relations with observations; introduction to modern developments; gravitational waves, problems of quantum cosmology and superspace. PREREQUISITE: PH4371.

PH4992-4998 SPECIAL TOPICS IN ADVANCED PHYSICS (Variable hours 1-0 to 4-0.) (V - 0).
Study in one of the fields of advanced physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading. The course carries a letter grade and may be repeated in different topics. PREREQUISITES: A 3000 level course appropriate to the subject to be studied, and consent of the Department Chairman. It may also be taken on a Pass/Fail basis if the student has requested so at the time of enrollment.

SE2012 APPLIED PHYSICS LABORATORY I: FUNDAMENTALS (3 - 3).
An introduction to the analysis of experimental data and signals in the applied physics laboratory. Experimental uncertainties and error propagation in physical measurements; statistical mean and standard deviation; Gauss, Poisson, and binomial probability distributions, least-squares techniques; introduction to simple circuits; Ohm's and Kirchoff's laws; complex number and phasor representations of physical quantities; introduction to applied Fourier analysis. Laboratory exercises are based upon applications in mechanics, optics and signal processing. PREREQUISITES: Previous college courses in basic physics and mathematics.

SE2013 INTRODUCTORY APPLIED PHYSICS LABORATORY (4 - 3).
This course is an introduction to basic electronic test instrumentation and basic passive and active circuit components, with emphasis on extensive, practical hands-on exposure to laboratory hardware and devices. Included are the measurement and signal processing of analog signals and analog sensors/transducers as well as applied Fourier analysis and transfer functions. Operational amplifiers are introduced as building blocks of analog systems. Negative feedback amplifiers and op-amp applications are covered as well as positive feedback and oscillators. Some background in laboratory instrumentation and simple DC and AC circuit elements is assumed. PREREQUISITES: College-level basic physics and mathematics, plus simple electrical circuits (e.g. PH1322).

SE2014 INTERMEDIATE APPLIED PHYSICS LABORATORY (4 - 3).
This course is a continuation of the instrumentation and signal processing topics begun in SE2013. Included are controllable oscillators and RF modulation/demodulation techniques. Basic electrical noise sources and active filters are covered. The basics of elementary digital logic gates and ICs are covered, as well as an overview of some relevant microcomputer topics, such as digital encoding schemes, analog and digital interfacing, and serial communications and networking. At the discretion of the instructor, a hands-on class project, incorporating the course material, may be assigned. Typical projects are: in-air sonar systems, radio receivers and transmitters, and opto-electronic communications links.

SE2020 COMBAT SYSTEMS REQUIREMENTS AND DESIGN (1 - 0).
This course develops the requirements for and investigates the conceptual system design for combat systems of contemporary interest. The operational problem selected for detailed definition and solution are at the limits of today's technology and operational arts. Examples include defense against tactical ballistic missiles, zero-collateral-damage counter-battery combat systems, and shallow water antisubmarine and mine warfare robot based systems. The system project is introduced in the first quarter of the student's curriculum. Subsequent quarters involve seminars, guest lectures, and discrete problems and subprojects integrated into the courses of the curriculum. The project is brought to completion in a systems integration course (SE4021) taught in the third quarter before graduation. PREREQUISITE: Enrollment in the Combat Systems Sciences and Technology Curriculum or consent of the instructor.

SE3015 ADVANCED APPLIED PHYSICS LABORATORY (3 - 4).
Students are expected to integrate the material that they learned in the previous two courses (SE2013 and SE2014), along with some additional basic material on embedded microprocessors. A working introduction to control systems theory is provided and incorporated into an autonomous weapon system or "robot". With the exception of the formal material on control systems, the entire course is devoted to the project, with students split into competing teams, each developing independent hardware and software. At the end of the quarter, each team's system competes against the others' systems in a comprehensive contest that tests the students' assimilation of both the formal and the practical aspects of analog and digital instrumentation, sensor interfacing and system control. PREREQUISITES: SE2911 or other C/C++ programming course, plus SE2013 and SE2014.

SE3172 PHYSICS OF WEAPONS SYSTEMS: FLUID DYNAMICS OF WEAPONS, SHOCK WAVES, EXPLOSIONS (4 - 2).
This course provides the basic physical principles applicable to air-borne and water-borne missiles, as well as the fluid dynamics of shocks and explosions. Topics include: Elements of thermodynamics, ideal fluid flow, elementary viscous flows, similitude and scaling laws, laminar and turbulent boundary layers, underwater vehicles, classical airfoil theory, supersonic flow, drag and lift of supersonic airfoils with applications to missiles, fluid dynamics of combustion, underwater explosions. PREREQUISITES: PH2151 and PH3991.

SE3301 RADIATING SYSTEMS (4 - 0).
This course for students of Operations Research and other weapon system oriented non-engineering curricula discusses the physical principles exploited by information gathering systems with emphasis on general capabilities and limitations. After a general introduction to wave propagation, topics of discussion are electromagnetic waves, radar, electro-optics including lasers and underwater sound. These topics will be applied to specific systems such as missile guidance, sonobouys, and phased arrays as appropriate to the class and instructor. PREREQUISITE: MA1118 or equivalent may be taken concurrently, or by consent of instructor.

SE3400 SURVEY OF UNDERWATER ACOUSTICS (4 - 2).
The physics of the generation, propagation, and detection of sound in the ocean. Topics include the acoustic wave equation and its limitations in fluids; plane, cylindrical, and spherical waves; the ray approximation; reflection of planes waves from plane boundaries; radiation of sound from circular piston, continuous line source, and linear array; speed of sound and absorption in the ocean; active and passive sonar equations; transmission-loss and detection-threshold models; normal mode propagation in the ocean; the parabolic equation approximation. Laboratory experiments include surface interference, noise analysis, normal modes, and acoustic waveguides. PREREQUISITES: PH2151 and PH3991.

SE4006 TECHNICAL ASSESSMENT OF WEAPON SYSTEMS (4 - 0).
This course is designed to support the Intelligence Curriculum. Current technical trends in weapon system technologies which are expected to significantly affect warfare are investigated. Topics covered are: nuclear weapons and their effects, nuclear strategic balance, satellite orbits, directed energy weapon concepts (SDI), future weapon concepts. PREREQUISITES: SE3301 or equivalent, and SECRET clearance.

SE4021 COMBAT SYSTEM PROJECT INTEGRATION (4 - 0).
This course, a continuation of SE2020, integrates the results of the subsystem studies begun in SE2020 into the design of a combat system that solves an operational problem. (See SE2020 for the types of problems studied.) The resulting solution will address the threat and operational environment; the assignment of tasks to system components; the performance of the system in terms of its coverage, fire power, reaction time, and response to counter measures; and costs. The results are presented to an experienced external review group. PREREQUISITES: SE2020 or consent of the instructor. SECRET clearance required.

SE4022 COMBAT SYSTEMS CAPABILITIES (3 - 0).
An advanced study of the technical capabilities of current acquisition programs within DoD. The course will conduct an in-depth analysis of three or four major Combat Systems acquisition programs by first reviewing the technical background required of the program, analysis of the Mission-Need statement, review of the programs products to date and capped by a week of review with the program's technical manager. Topics of the course will be dictated by availability of technical managers. PREREQUISITES: SE2020, SE3172, SE3400, and SE4050 (or equivalents).

SE4050 PHYSICS OF ELECTROMAGETIC SENSOR SYSTEMS (4 - 2).
Introduction to the physics of active and passive electromagnetic detection systems. Basic radiometry. Introduction to radar: ranging, pulse rate and range ambiguity, Doppler measurements radar equation, target cross-sections, antenna beam patterns and phased arrays. Optoelectronic displays: CRTs, LEDs, LCDs, plasma displays. Introduction to lasers: transitions, population inversion, gain, resonators, longitudinal and transverse resonator modes, Q-switching, mode-locking, laser applications. Photodetection basics: noise and its characterization, photovoltaic, photoconductive and photoemissive detectors, image intesifiers, CCDs. Introduction to optical fibers and their applications. PREREQUISITES: PH3292, PH3352 and PH4653, or equivalents.

SE4858 NUCLEAR WARFARE ANALYSIS (4 - 0).
This final course in the nuclear weapons effects graduate specialization sequence deals with technical aspects of strategic and tactical nuclear war. Effects which nuclear weapons explosion environments have on various defense platforms and systems are considered together with methods of hardening to reduce system vulnerability in each of the effected areas: blast and shock, thermal radiation, transient effects on electronics. EMP, biological effects from contamination, atmospheric and ionospheric effects on communication, detection and surveillance systems. PREREQUISITES: PH3171, PH4856, and SECRET clearance.

SE4859 TECHNICAL ASPECTS OF WEAPON PROLIFERATION, CONTROL AND DISPOSAL (3 - 0).
This course is designed for students of the Combat Systems Sciences and Technology Curriculum taking the Weapon Effects concentration. The course address technical issues of detection of nuclear weapon materials, covert explosions, disposition of weapon grade material and nuclear reactor fuel, control and disposition of chemical and biological weapons, policy issues of arms proliferation and arms control. PREREQUISITE: Consent of instructor.

SE4860 ADVANCED WEAPON CONCEPTS (4 - 1).
This course serves as a final synthesis course in the Combat Systems Science and Technology Curriculum 533. It brings together many elements of the curriculum in a comprehensive overview of the components and underlying technologies of modern missile delivered warheads. After an introduction to modern high explosives and determination of velocities of explosively driven metal, a description of principles and design considerations for all types of modern warheads is given. This is followed by an analysis of the effects of the various warhead mechanisms on targets. The second half of the course is dedicated to a comprehensive overview of modern missile elements and their technologies. The course concludes with a summary of the tactical missile development process. PREREQUISITES: The course requires good comprehension of all aspects of mechanics (e.g. PH3152), electromagnetism (e.g. PH3352), modern optics (e.g. PH3292) and some fluid dynamics (e.g. SE3172).

SPACE SYSTEMS ACADEMIC GROUP

Chairman:
Rudolf Panholzer
Professor
Code SP, Bullard Hall
Room 205
(831) 656-2948
DSN 878-2948

The Space Systems Academic Group is an interdisciplinary association of faculty, chaired professors, and adjuncts representing eight separate academic disciplines. The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and the Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the Group as well as the following academic departments: Aeronautics and Astronautics, Electrical and Computer Engineering, Mathematics, Meteorology, Oceanography, Operations Research, Physics and Systems Management. Thesis topics for students in Space Systems Operations are approved by the group and the final thesis is approved by the group Chairman in addition to the academic department granting the degree (if any).

GROUP FACILITIES
To provide laboratory experience several facilities have been developed in cooperation with other academic departments.

1) Solar Simulation Facility
2) Flash X-Ray Facility
3) Electron Linear Accelerator
4) Navigational Satellite Receiver Laboratory
5) Small Satellite Test and Development Laboratory
6) Vibro-Acoustic Test and Measurement Facility
7) FLTSATCOM Laboratory
8) Special Compartmented Information Facility for Classified Research and Theses Work.
9) Spacecraft Environment Testing Laboratory
10) Spacecraft Attitude Dynamics and Control Laboratory
11) Smart Structures Laboratory
12) Space Warfare Computer Laboratory

DEGREE REQUIREMENTS
The Space Systems Engineering students earn a master's degree in one of the following academic departments: Aeronautics and Astronautics, Computer Science, Electrical and Computer Engineering, Mechanical Engineering, Physics or Mathematics. Refer to degree requirements for the listed departments.

The Space Systems Operations students are awarded the degree Master of Science in Space Systems Operations. A minimum of 45 quarter hours of graduate level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included. There is also a requirement of three courses constituting advanced study in an area of specialization and a six week experience tour. Each student is required to write a thesis which is space oriented. The study program must be approved by the Chairman of the Space Systems Academic Group.

SPACE SYSTEMS COURSE DESCRIPTIONS

SS0810 THESIS RESEARCH (0 - 8).
Every student conducting thesis research enrolls in this course.

SS2041 INTRODUCTION TO SPACE (4 - 1).
Introduction to space mission analysis and the missions that can be performed from space with emphasis on those providing support to the military. Topics usually covered are include: The process of space mission analysis and design, orbital mechanics, space policy and organization, space environment, reliable systems, and the space mission.

SS2500 ORBITAL MECHANICS (4 - 0).
Fundamentals: conic sections, coordinate systems and transformations, time. The two-body problem: Newton's laws and their solution, Kepler's equation. Orbital maneuvering. Orbit determination. Perturbations. Mission design.

SS3001 MILITARY APPLICATIONS OF SPACE (3 - 2).
Examination of the military functions which utilize space systems and the capabilities of current and future space systems with tactical or strategic applications. Tasking and use of space systems and ground support elements. Vulnerability considerations. Impact of current R&D programs. PREREQUISITES: Orbital mechanics, Fourier analysis, and TOP SECRET clearance with eligibility for SI/SAO, U.S. citizenship.

SS3035 MICROPROCESSORS FOR SPACE APPLICATIONS (3 - 2).
An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, I/O systems and interfacing, and operating systems. PREREQUISITE: EC2820.

SS3041 SPACE SYSTEMS AND OPERATIONS I (4 - 2).
Space systems mission analysis and design. Mission characterization, mission evaluation, requirements determination, cost analysis and estimating, cost and operational effectiveness analysis. PREREQUISITES: OS3604, SS2041; OS3008 (taken concurrently), SECRET clearance.

SS3051 SPACE SYSTEMS AND OPERATIONS II (Accelerated) (4 - 0).
Space systems mission analysis and design. Space systems concepts of operation and architectures. Information warfare and its relation to space systems. The role of space in command and control. Space history and space policy. PREREQUISITES: SS3041 and TOP SECRET clearance with eligibility for SI/SAO.

SS3525 AIR/OCEAN REMOTE SENSING FOR INTERDISCIPLINARY CURRICULA (3 - 2).
Principles of radiative transfer and satellite sensors, and methods used to measure the atmosphere and ocean; visual, infrared and microwave radiometry, and radar systems. Laboratory sessions illustrate lecture concepts using interactive displays of satellite data. Course designed for Space Systems Operations, Space Systems Engineering, Undersea Warfare, Underwater Acoustics and other interdisciplinary curricula. PREREQUISITES: Undergraduate physics, and differential/integral calculus and ordinary differential equations; or consent of instructor.

SS3900 SPECIAL TOPICS IN SPACE SYSTEMS (Variable hours 1-0 to 5-0.) (V - 0).
Directed study either experimental or theoretical in nature. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

SS4000 SPACE SYSTEMS SEMINARS AND FIELD TRIPS (0 - 1).
Seminars consist of lectures to provide perspective on Space Systems. Field trips expose the student to various space activities such as industry, NASA and DoD laboratories and commands.

SS4003 SPACECRAFT DESIGN STUDIES (Graded Pass/Fail) (0 - 1).
Students registered for SS4003 are typically those whose thesis is on some element of the PANSAT project. In SS4003 the systems-level aspect of the design is discussed. The format is a combination of oral presentation and discussion. The purpose of this class is to give students an appreciation of the "big picture" and to demonstrate how individual research efforts fit into the "grand scheme of things." The concurrent engineering design approach makes this class a simulation of design meetings held in a typical industrial environment. Faculty, SSAG engineering staff and students participate in the weekly meetings. PREREQUISITE: None.

SS4041 MILITARY SPACE SYSTEMS AND TECHNOLOGY I (3 - 2).
Space systems and technologies of interest to the military. Strategic and tactical imagery and SIGINT requirements. Space mission design to satisfy requirements. National systems, navigation systems, weather and communication systems. Geolocation techniques. Examples of space support to military operations. PREREQUISITES: SS3041 and SS3051 concurrent. TOP SECRET clearance with eligibility for SI/SAO.

SS4051 MILITARY SPACE SYSTEMS AND TECHNOLOGY II (3 - 2).
Space systems and technologies of interest to the military. SIGINT and imagery technologies. Geolocation techniques, payload design. Space control, theater ballistic missile defense. Launch vehicles. PREREQUISITES: SS3051 and SS4041. TOP SECRET clearance with eligibility for SI/SAO.

SS4900 ADVANCED STUDY IN SPACE SYSTEMS (Variable hours 1-0 to 5-0.) (V - 0).
Directed graduate study based on journal literature, experimental projects, or other sources. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

SPECIAL OPERATIONS ACADEMIC GROUP

Chairman:
Gordon H. McCormick
Associate Professor, Academic Associate
Code CC/Mc, Root Hall
Room 209
(831) 656-2933
DSN 878-2933

The Special Operations Academic Group is an interdisciplinary association of faculty, representing a wide range of academic and operational specialties. The program provides a focused course of instruction on the dynamics of asymetric warfare, sub-state conflict, terrorism, information operations, and other "high leverage" operations in U.S. defense and foreign policy. The core program also provides every student with a strong background in strategic analysis, international relations and comparative politics, organization theory, and formal analytical methods.

The student's program is built around a common set of core courses and a selected specialty track. The specialty track is chosen by the individual student, depending upon his or her interests and academic background. In selected cases, students are also able to develop a tailored area of specialization to satisfy a particular interest or requirement. Graduates are awarded a Master of Science in Defense Analysis, with their specialty track so specified. The program is 18 months.

While the Special Operations program in sponsored by USSOCOM, the curriculum actively solicits student participation from across the services, regardless of branch. International students are also encouraged to apply. Students are encouraged to enter the program in the Summer Quarter, permiting them to take best advantage of the Curriculum's sequenced course of instruction. This entry date, however, should not serve to deter the off-cycle student.

MASTER OF SCIENCE IN DEFENSE ANALYSIS

The degree Master of Science in Defense Analysis will be awarded in accordance with the following degree requirements:

1) This degree requires 45 quarter hours of graduate level work, of which 15 hours must represent courses at the 4000 level in at least two disciplines. Within the course program there must be a specialization sequence consisting of at least six courses.

2) In addition to the 45 hours of course credit, an acceptable thesis must be completed.

3) The program must be approved by the Chair of the Special Operations Group.

The Master of Science in *Defense Analysis* is currently offered with the following specialties:

- Irregular Warfare
- Information Operations
- Operations Analysis
- C4I Systems
- Combat Systems
- Financial Management
- National Security Affairs
- Aeronautics and Astronautics

Associated Faculty and Departments:

John Arquilla (Special Operations Academic Group)
Dan Boger (Command, Control and Communications)
Carlos Borges (Mathematics)
Jan Breemer (Undersea Warfare)
Wayne Hughes, Jr. (Operations Research)
Eric Jansen (Systems Management)
George Lober (Special Operations Academic Group)
Bard Mansager (Mathematics)
Xavier Maruyama (Physics)
Gordon H. McCormick (Special Operations Academic Group)
Doug Moses (Systems Management)
Guillermo Owen (Mathematics)
Glenn Robinson (National Security Affairs)
Anna Simons (Special Operations Academic Group)
David Tucker (Special Operations Academic Group)

Special Operations Chair: COL Joseph Andrade

Special Operations Fellows: COL Tom Gerblick
LtCol Randy O'Boyle

CORE COURSE OFFERINGS:

SO2410 Modeling for Special Operations I (4-0)
CC3111 C4I Mission and Organization (4-0)
SO3101 Warfare in the Information Age (4-0)
SO3102 Psychological Operations and Deception (4-0)
MN3121 Organizational Design for Special Operations (4-0)
SO3410 Modeling for Special Operations II (4-0)
SO3800 Theory and Practice of Social Revolution (4-0)
SO3801 International Terrorism (4-0)
SO3802 Seminar in Guerrilla Warfare (4-0)
SO3880 History of Special Operations (4-0)
SO3882 Deterrence, Compellance, & Crisis Management (4-0)
SO3900 Directed Studies in Special Operations and Low Intensity Conflict (4-0)
SO4101 Concepts in Information Operations *
SO4102 Special Information Operations *
SO4410 Models of Conflict (4-0)
SO4450 Analytical Methods (4-0) *
SO4500 Special Topics in Special Operations and Low Intensity Conflict (4-0)
OA4602 Joint Campaign Analysis (4-0)
SO4710 Critical Thinking and Ethical Decisionmaking *
SO4750 Anthropology of Conflict (4-0) *
SO4760 The Military Advisor (4-0) *
SO4820 Regional Seminar in Low-Intensity Conflict: Africa (4-0) *
SO4830 Regional Seminar in Low-Intensity Conflict: Middle East (4-0)
SO4840 Regional Seminar in Low-Intensity Conflict: Europe and the Transcaucasus (4-0)
SO4850 Regional Seminar in Low-Intensity Conflict: Latin America (4-0)
SO4860 Regional Seminar in Low-Intensity Conflict: Far East (4-0)
SO4900 Advanced Directed Studies in Special Operations and Low Intensity Conflict (4-0)

* New course

Course descriptions for the above courses may be found under the respective Academic Department or Group.

SPECIAL OPERATIONS COURSE DESCRIPTIONS

SO2410 MODELLING FOR SPECIAL OPERATIONS I (4 - 0).
This course introduces mathematical modeling processes and concepts. Deterministic models in a graphical setting will be emphasized, including experimental modeling, curve fitting, and optimization. Applications include arms race models, Lanchester combat models, exponential growth and decay models, the Logistic model for social diffusion, supply/demand economic models, and inventory models. The computer is used as a tool with emphasis on the MINITAB statistical package. PREREQUISITE: College algebra.

SO3101 WARFARE IN THE INFORMATION AGE (4 - 0).
Given that the emerging information age heralds stark changes in future military and security policy, this course begins with a survey of the literature on the current revolution in military affairs (RMA), as well as studies of similar periods earlier in history. While significant attention is focused upon information technologies, the principal emphasis in this course lies in an endeavor to understand the ways in which new technologies affect military strategy, doctrine, and organization. In particular, the rise of networked organizations, non-linear military operations, and the further blurring of the line between war and peace are examined.

SO3102 PSYCHOLOGICAL OPERATIONS AND DECEPTION (4 - 0).
This course surveys current theories of behavior, cognition and perceptual bias, linking them to applied military issues across the spectrum of conflict, from irregular to high-intensity warfare. The effects of increased information flows on the prospects for accurate assessments in crisis and war are also considered in detail. Case studies and experimentation complement the theoretical framework initially advanced, with the students working in teams during this portion of the course.

SO3410 MODELING FOR SPECIAL OPERATIONS II (4 - 0).
This course continues the mathematical modeling process and concepts introduced in SO2410. Models will now entail the use of probability to find solutions. Introductory probabilistic models will be discussed along with rudimentary statistical concepts needed to analyze data generated from those models. The course will also introduce simulation modeling using combat model such as Janus. Decision modeling includes decision making under both risk and uncertainty. Use of the MINITAB statistical package continues from SO2410. PREREQUISITE: SO2410.

SO3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4 - 0).
This course provides an overview of insurgency and counter-insurgency. It reviews the theoretical literature and offers an operational focus on social revolution by examining the alternative models of insurgency provided by the doctrine of “people’s war,” “foco theory”, and the urban guerrilla. The course goes on to examine the development of U.S. counterinsurgency doctrine, the difference between the “hearts and minds” and “systems” prescriptions of counterinsurgency, and alternative British, French, and Russian concepts of counterinsurgency.

SO3801 INTERNATIONAL TERRORISM (4 - 0).
This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response.

SO3802 SEMINAR IN GUERRILLA WARFARE (4 - 0).
Have you ever wanted to seize state power from below? Have you ever been responsible for keeping others from doing so? This reading seminar is designed to examine the strategy and operational art of sub-state conflict. It examines the problems of social mobilization; underground organization, command and control, and security; alternate strategies of internal war, and competing theories of counterinsurgency. These and related issues are examined analytically and historically. Comparative cases are discussed and evaluated. Throughout the course attention is also given to the manner in which such wars are conducted in the future.

SO3880 HISTORY OF SPECIAL OPERATIONS (4 - 0).
This course considers special operations in an historical context, with emphasis given to their impact upon war outcomes, the necessary conditions for their success, and the patterns of civil-military relations that emerge when elite forces are formed. Comparative analysis of a variety of national traditions in special operations and irregular warfare is undertaken, including the study of U.S., British, French, German, Russian and Israeli approaches to special operations.

SO3882 DETERRENCE, COMPELLANCE, AND CRISIS MANAGEMENT (4 - 0).
This course surveys current theories of deterrence and coercive diplomacy, relating them to a variety of applied problems in crisis management. Special attention is given to political psychological factors, crisis communication styles, extended deterrence and the implications of proliferation of weapons of mass destruction for conventional deterrence.

SO3900 DIRECTED STUDIES IN SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT (4 - 0).
Supervised study in selected areas of special operations and low intensity conflict to meet the needs of individual students. Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers, projects and/or examinations. PREREQUISITE: Permission of instructor.

SO4410 MODELS OF CONFLICT (4 - 0).
This course deals with the problems faced by a rational decision-maker, trying to maximize some payoff in a social setting. A distinction will be made between Type I behavior (optimization in a game against nature), Type II (optimization when faced with agents who react against the decision-maker's perceived behavior), Type III (optimizations against strategic agents), and Type IV (cooperation with other agents). Applications include arms race models, treaty inspections problems, monopolistic behavior, coalition formation, and pursuit games. The computer is used as a modeling tool. PREREQUISITES: SO2410 and SO3410.

SO4500 SPECIAL TOPICS IN SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT (4 - 0).
This course will focus on special topics in special operations and low intensity conflict. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITES: SO3801 and SO3802 or permission of instructor.

SO4830 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: MIDDLE EAST (4 - 0).
As part of the regional seminar series, this course examines political violence in the Middle East. The course focuses on the major systemic causes of violence in the Middle East at both the state and non-state levels. At the state level, sources of violence include the consolidation of state power in fragmented societies, survival strategies by weak states, and competition for scarce regional resources. Violence by non-state actors is also examined, including violence associated with Islamic Fundamentalism and Palestinian terrorism.

SO4840 REGIONAL SEMINAR IN LOW INTENSITY CONFLICT: EUROPE AND THE TRANSCAUCASUS (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in Europe and the Caucasus. The seminar reviews the theoretical literature on political violence and analyzes the recent history of European and Caucasus-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Europe and the Caucasus.

SO4850 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: LATIN AMERICA (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in Latin America. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Latin America.

SO4860 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT: FAR-EAST (4 - 0).
As part of the regional seminar series, this course examines low intensity conflict issues in the Far East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Asian-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Far East.

SO4900 ADVANCED DIRECTED STUDIES IN SPECIAL OPERATIONS LOW INTENSITY CONFLICT (4 - 0).
Supervised study in selected areas of special operations and low intensity conflict to meet the needs of individual students. Format and content may vary. Normally involves individual research under the direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. PREREQUISITE: Permission of instructor.

DEPARTMENT OF SYSTEMS MANAGEMENT

Chair:

Reuben T. Harris
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Associate Chairs:

Instruction
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Research
Shu S. Liao
Professor
Code SM/Lc, Ingersoll Hall
Room 321
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James A. Barber, Senior Lecturer in Military Leadership (1998); PhD, Stanford University, 1965.

Frank J. Barrett, Associate Professor of Organization and Management (1990); PhD, Case Western Reserve University, 1989.

Bob Barrios-Choplin, Research Assistant Professor of Management (1993); PhD, University of Texas, Austin, 1990.

Hemant K. Bhargava*, Associate Professor of Information Technology (1989); PhD, University of Pennsylvania, 1989.

Dan C. Boger, Chair for Command, Control and Communications Academic Group and Professor of Economics (1979); PhD, University of California at Berkeley, 1979.

Michael W. Boudreau, COL (Ret.) U.S. Army, Senior Lecturer in Acquisition and Logistics (1995); MBA, Santa Clara University, 1966.

Douglas Brinkley*, Director of Computer Support Services and Lecturer in Information Systems; MS, Naval Postgraduate School, 1990.

Rex A. Buddenberg*, Senior Lecturer in Information Systems (1993); MS, Naval Postgraduate School, 1986.

Tung X. Bui*, Professor of Management Information Systems (1984); PhD, New York University, 1984.

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

Michael D. Cook, Assistant Professor of Economics (1995); PhD, University of Maryland, 1995.

Alice Crawford, Senior Lecturer in Psychology (1988); MA, San Diego State University, 1973.

Jeffrey Cuskey, CDR, SC, U.S. Navy, Lecturer (1997); MS, Naval Postgraduate School, 1993.

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

Richard B. Doyle, Associate Professor of Public Budgeting (1990); PhD, University of Washington, 1984.

Donald R. Eaton, RADM (Ret.), U.S. Navy, Logistics Chair and Senior Lecturer in Logistics (1994); MS, George Washington University, 1980.

Leroy E. Edwards, Visiting Assistant Professor of Organization and Management (1993); EdD, University of San Francisco, 1989.

Mark J. Eitelberg, Professor of Public Policy (1982); PhD, New York University, 1979.

Richard S. Elster, Provost and Professor of Systems Management (1969); PhD, University of Minnesota, 1967.

James C. Emery*, Professor of Management Information Systems Emeritus (1993); PhD, Massachusetts Institute of Technology, 1965.

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

Roger D. Evered, Professor of Management (1979); PhD, University of California at Los Angeles, 1973.

Jane N. Feitler, Visiting Assistant Professor of Logistics and Transportation Management (1995); PhD, University of Maryland, 1995.

Julie D. Filizetti, Lecturer in Manpower Analysis (1994); MS, Naval Postgraduate School, 1991.

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

Dana P. French, CAPT (Ret.), U.S. Navy, Senior Lecturer in Management (1997); MS, Naval Postgraduate School, 1975.

Barry A. Frew*, Associate Professor of Information Systems (1984); MS, Naval Postgraduate School, 1984.

William R. Gates, Associate Professor of Economics (1988); PhD, Yale University, 1984.

Kevin R. Gue, Assistant Professor of Logistics Management (1995); PhD, Georgia Institute of Technology, 1995.

William J. Haga*, Senior Lecturer in Management Information Systems (1988); PhD, University of Illinois, 1972.

Reuben T. Harris, Chairman of Systems Management and Professor of Management (1978); PhD, Stanford University, 1975.

William D. Hatch II, CDR, U.S. Navy, Lecturer (1998); MS, Naval Postgraduate School, 1991.

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

Gregory G. Hildebrandt, Associate Professor of Economics (1989); PhD, Princeton University, 1976.

Ted Hleba, CDR, U.S. Navy, Lecturer (1998); MS, Naval Postgraduate School, 1995.

Susan P. Hocevar, Assistant Professor of Organization and Management (1990); PhD, University of Southern California, 1989.

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

Erik Jansen, Visiting Associate Professor of Organization and Management (1994); PhD, University of Southern California, 1987.

David E. Johnson, Senior Lecturer in Ethics (1997); PhD, University of Iowa, 1965.

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

Lawrence R. Jones, RADM George Wagner Professor of Financial Management (1987); PhD, University of California at Berkeley, 1977.

Magdi N. Kamel*, Associate Professor of Management Information Systems (1988); PhD, University of Pennsylvania, 1988.

Keebom Kang, Associate Professor of Logistics (1988); PhD, Purdue University, 1984.

Rakesh Lall, LT, MSC, U.S. Navy, Lecturer in Psychology (1997); PhD, Pacific Graduate School, 1994.

Steve Lamar,** CAPT (Ret.), U.S. Navy, Director, Institute for Defense Education and Analysis and Senior Lecturer in Health Care Management (1995); PhD, Case Western Reserve University, 1982.

David V. Lamm, Associate Professor of Acquisition and Contract Management (1978); DBA, The George Washington University, 1976.

Ira Lewis, Associate Professor of Transportation Management (1998); PhD, Arizona State University, 1992.

Shu S. Liao, Associate Chair for Research and Professor of Accounting (1977); PhD, University of Illinois, 1971.

David F. Matthews, COL (Ret.), U.S. Army, Senior Lecturer in Acquisition Management (1994); MA, Middle Tennessee State University, 1974.

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

Alan W. McMasters, Professor of Operations Research and Systems Management, Emeritus (1965); PhD, University of California at Berkeley, 1966.

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

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

John E. Mutty, CAPT (Ret.), U.S. Navy, RADM Peter C. Conrad Chair and Senior Lecturer in Financial Management (1995); MS, George Washington University, 1976.

Brad Naegle, LTC, U.S. Army, Lecturer (1997); MS, Naval Postgraduate School, 1994.

Mark Nissen*, Assistant Professor in Acquisition Management and Information Systems (1996); PhD, University of Southern California, 1996.

Walter E. Owen, Lecturer in Acquisition Management (1992); MS, Naval Postgraduate School, 1992.

Bruce Pawlowski, Lecturer in Installation Management (1996); MPA, Texas Christian University, 1975.

Philip Quast, VADM (Ret.), U.S. Navy, ADM Michael Boorda Chair of Management and Analysis and Senior Lecturer (1997); MS, Marymount University, 1984.

Benjamin J. Roberts,** Adjunct Research Associate of Management and Human Resource Development (1985); PhD, Pennsylvania State University, 1977.

Nancy C. Roberts, Professor of Strategic Management (1986); PhD, Stanford University, 1983.

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

Norman F. Schneidewind*, Professor of Information Sciences (1971); DBA, University of Southern California, 1966.

Kishore C. Sengupta*, Associate Professor of Management Information Systems (1989); PhD, Case Western Reserve University, 1990.

Cary A. Simon, Visiting Assistant Professor in Manpower Systems Analysis (1997); MS, Naval Postgraduate School, 1996.

David A. Smith, CDR, SC, U.S. Navy, Lecturer in Acquisition and Contracting (1996); MS, Naval Postgraduate School, 1990.

Keith F. Snider, Assistant Professor of Management (1993); PhD, Virginia Polytechnic Institute and State University, 1997.

Mark W. Stone, Lecturer in Acquisition and Contracting (1993); JD, Santa Clara University, 1988.

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

Gail Fann Thomas, Associate Chair for Instruction and Associate Professor of Management Communications (1989); EdD, Arizona State University, 1986.

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

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

Rodney E. Tudor, LTC, U.S. Army, Lecturer in Acquisition Management (1999); MA, Webster University, 1983.

Greg Walls, LTC, U.S. Army, Lecturer in Acquisition Management (1996); MS, Air Force Institute of Technology, 1989.

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

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

*Holds joint appointment with Information Systems Academic Group.
**Holds primary appointment with IDEA.
***The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

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

The other four degrees that are awarded by the department are the Master of Science in Resource Planning and Management for International Defense; the Master of Science in Leadership and Human Resource Development; the Master of Science in Contract Management; and the Master of Science in Program Management.

The Resource Planning and Management for International Defense (RePMID) curriculum is designed for students from allied countries and is jointly offered by the Department of Systems Management and National Security Affairs. The Leadership Education and Development program (LEAD) is currently taught at the U.S. Naval Academy in Annapolis. The Contract Management and Program Management curricula are currently offered to DoD civilians at designated off-site locations.

MASTER OF SCIENCE IN MANAGEMENT
The degree Master of Science in Management requires:

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

Accounting and Financial Management	6
Economics	6
Organization and Management	6
Quantitative Methods	8

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

3) Completion of an approved sequence of courses in the student's area of concentration.

4) Completion of an acceptable thesis.

5) Approval of the candidate's program by the Chair, Department of Systems Management.

MASTER OF SCIENCE IN INTERNATIONAL RESOURCE PLANNING AND MANAGEMENT
The degree Master of Science in International Resource Planning and Management requires:

1) Completion or validation of a minimum of credit hours, as indicated, in the following disciplines:

Accounting, Financial Management, and Economics	24
Organization and Management	20
Domestic and International Policy Studies	24

2) Completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.

3) Completion of an acceptable thesis, with at least one advisor from either the Department of Systems Management, or the Department of National Security Affairs.

4) Approval of the candidate's program by the Chair, Department of Systems Management or the Chair, Department of National Security Affairs.

MASTER OF SCIENCE IN LEADERSHIP AND HUMAN RESOURCE DEVELOPMENT
The degree Master of Science in Leadership and Human Resource Development requires:

1) Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.

2) Completion of an acceptable thesis, with at least one advisor from the Department of Systems Management.

3) Approval of the candidate's program by the Chair, Department of Systems Management.

MASTER OF SCIENCE IN CONTRACT MANAGEMENT
The degree Master of Science in Contract Management requires:

1) Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.

2) Completion of an acceptable thesis, with at least one advisor from the Department of Systems Management.

3) Approval of the candidate's program by the Chair, Department of Systems Management.

MASTER OF SCIENCE IN PROGRAM MANAGEMENT
The degree Master of Science in Program Management requires:

1) Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.

2) Completion of an acceptable thesis, with at least one advisor from the Department of Systems Management.

3) Approval of the candidate's program by the Chair, Department of Systems Management.

SYSTEMS MANAGEMENT COURSE DESCRIPTIONS

MN0001 SEMINAR FOR SYSTEMS MANAGEMENT STUDENTS (NO CREDIT) (0 - 2).
Guests lectures. Thesis and research presentations.

MN0123 COMPUTER SKILLS DEVELOPMENT (0 - 2).
An introduction to the use and operation of microcomputers including hardware basics, operating system, word processing, spreadsheets and graphics. Emphasis on applications in systems management. Graded on Pass/Fail only.

MN0163 THESIS WRITING WORKSHOP (0 - 1).
Guidelines for scientific writing for the thesis are given with examples and opportunities for practice. PREREQUISITES: MN3160 and MN3162.

MN0810 THESIS RESEARCH FOR SYSTEMS MANAGEMENT STUDENTS (0 - 8).
Every student conducting thesis research will enroll in this course.

MN0811 THESIS RESEARCH FOR NON-RESIDENT SYSTEMS MANAGEMENT STUDENTS (0 - 4).
Every student conducting thesis research in the Distance Learning Contract Management and Program Management degree programs will enroll in this course during six quarters of the curriculum, including the resident quarter.

MN2031 ECONOMIC DECISION MAKING (4 - 0).
A course in macroeconomics. Brief introduction to microeconomics—scarcity, production possibility curves, and supply and demand. Topics in macroeconomics include national income determination, inflation, unemployment, deficits, and the banking system. Also covered are the various schools of thought in macroeconomics: Keynesian, monetarist, rational expectations, and supply side. PREREQUISITE: MA2300 (concurrently) or equivalent.

MN2039 BASIC QUANTITATIVE METHODS IN ECONOMIC ANALYSIS (4 - 0).
This course simultaneously introduces economics and the mathematical basis required for advanced economic analysis. Math topics include algebra, graphs, differential calculus, including both single and multiple variable functions, and indefinite and definite integrals. Economics concepts include demand and supply, market equilibrium, marginal analysis and unconstrained and constrained optimization. PREREQUISITE: College algebra or permission of instructor.

MN2111 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES I (0 - 2).
An introduction to the major issues, theory, and practice of the military MPT system. Graded on a Pass/Fail basis only. PREREQUISITE: Permission of instructor.

MN2112 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES II (0 - 2).
Continuation of MN2111. Graded on a Pass/Fail basis only. PREREQUISITE: Permission of instructor.

MN2150 FINANCIAL ACCOUNTING (4 - 0).
Study of basic accounting models concepts and standards underlying financial report. Emphasis on the reporting of an organization's results of operations, financial position and cash flows. Specific topics include the accounting cycle, asset and liability valuation, income measurement, capital structure, and financial statement analysis. Includes discussion of financial reporting for Federal Government organizations.

MN2155 ACCOUNTING FOR MANAGEMENT (4 - 0).
Study of the fundamentals of financial and managerial accounting relevant to financial management. Introduction to financial accounting stressing accrual concepts and the content and analysis of financial statements. More in depth focus on management accounting topics, including costing techniques for products and programs, use of cost information for decision making, capital budgeting, and financial performance measures. Applications of managerial accounting tools to DoD situations. (May not be substituted for MN2150 and MN3161.)

MN2302 SEMINAR FOR ACQUISITION AND CONTRACTING STUDENTS (0 - 3).
This course brings both Government and defense industry contract managers into the academic forum for interaction with students. Visits to Government facilities and defense plants. Thesis and research presentations. Preparation for Certified Professional Contracts Manager (CPCM) certificate examinations. Graded on a Pass/Fail basis. PREREQUISITE: Permission of instructor.

MN2303 SEMINAR FOR PROGRAM MANAGEMENT STUDENTS (0 - 3).
This course brings both Government and defense industry acquisition/program managers into the academic forum for interaction with students. Guest lecturers include program executive officers, program managers, laboratory and field personnel, OSD officials, congressional members and staff personnel, and defense industry representatives. Visits to Government facilities and defense plants. Thesis and research presentations. Preparation for Program Manager Certification. Graded on a Pass/Fail basis. PREREQUISITE: Permission of instructor.

MN3001 ECONOMICS FOR DEFENSE MANAGERS (4 - 0).
This course develops the fundamental tools of microeconomics and macroeconomics and applies them to topics in the management and allocation of defense resources. Although fundamental economic principles are covered, the course stresses the applications of economic theory to defense issues and polices. Topics covered include: macroeconomic aspects of defense spending and budgeting; defense production functions; allocative efficiency in defense labor and capital markets; international economics and national security; and comparative systems.

MN3101 MODELS OF LEADERSHIP IN COMPLEX ORGANIZATIONS (2 - 0).
A broad range of leadership models is presented to demonstrate the evolution of approaches to the study of leadership and to provide a framework for subsequent leadership courses. These models range from trait approaches to current transformational concepts. Students will acquire a systems view of leadership in organizations and an approach to analyze the variables that influence leadership. PREREQUISITE: Undergraduate course in Naval Leadership and admission to graduate standing. The course demands critical reasoning and systematic thinking on an advanced level.

MN3102 MILITARY LEADERSHIP (2 - 0).
Models of leadership are studied in depth in the context of how they have been used by notable military leaders. Historical and future perspectives for military leadership are analyzed. Emphasis is on self-assessment and self-development as well as the develop of subordinate leaders. PREREQUISITE: MN3101.

MN3103 GROUP DYNAMICS AND TEAMBUILDING (2 - 0).
Human behavior in group settings and leadership in building cohesive teams are the focus of this course. Group structural characteristics, stages of team development, group problem solving and decision making are studied. PREREQUISITE: MN3129.

MN3104 MOTIVATION AND EMPOWERMENT (1 - 0).
The major cognitive and behavioral theories of motivation are examined from the perspectives of the leader and subordinates. A model of empowerment is introduced, and a framework of motivation research and applications is created. Case analysis is used to balance theory and application through cases that focus on a variety of Navy organizations. PREREQUISITE: MN3101.

MN3105 ORGANIZATION AND MANAGEMENT (4 - 0).
This course gives students a knowledge of key concepts from management theory, organization theory, organizational behavior and organizational development. Special emphasis is given to the ability to apply these concepts in an integrated fashion to management situations in DoD/DoN. Towards that end, the course makes extensive use of multiple theoretical frames, open-systems models, and DoD/DoN case studies.

MN3106 CONFLICT MANAGEMENT (1 - 0).
The impact of conflict in organizations is studied with emphasis on models of conflict management that offer students multiple conflict handling strategies. The relation of conflict to the leader's use of power and influence strategies is explored. An overview of negotiation literature is provided. Students practice using conflict management strategies and negotiation techniques. PREREQUISITE: MN3101.

MN3109 ETHICS AND MORAL DEVELOPMENT (3 - 0).
An examination of the major traditions in western ethical thinking. Application of these theories to moral dilemmas encountered in the profession of arms involving a critical exploration of the meaning and validity of arguments offered on various sides of current ethical controversies. Reading, discussing, and writing about military virtues and their place in the everyday life of the officer. PREREQUISITE: Undergraduate course in Naval Leadership and admission to graduate standing. This course demands critical reasoning and systematic thinking at an advanced level.

MN3111 PERSONNEL MANAGEMENT PROCESSES (4 - 0).
A broad coverage of human behavior in the work situation, with key emphasis on the issues of work in the Naval environment. Topical areas covered include selection, placement, training development, and evaluation of personnel; motivation, remuneration, morale, supervision, and working conditions in military organizations; job design and organization development within complex military bureaucracies; equipment design and man-machine interface, and the impact of technological programs within the military. PREREQUISITES: MN3105 and OS3101 (taken concurrently) or equivalent.

MN3112 COUNSELING (3 - 0).
The basic theory, principles, and techniques of counseling will be presented in this course. An emphasis will be placed on counseling in military settings. Students will learn and practice basic listening and therapeutic skills. PREREQUISITES: MN3104, MN3135 and MN3138.

MN3121 ORGANIZATIONAL DESIGN FOR SPECIAL OPERATIONS (4 - 0).
Principles of organizational design are critically examined and applied to special operations' missions and organizations. Focus is on the organizational level of analysis and includes such topics as organizational environments, key success factors, technology and information systems, configuration and structure, organizational learning, reward systems, and decision making. Case method is used to develop diagnostic skills and a systemic perspective. PREREQUISITE: Enrollment in the SOLIC curriculum or permission of instructor.

MN3123 MILITARY SOCIOLOGY (4 - 0).
An exploration of classical theories of sociology pertaining to civilian-military relations with modern applications to command and control problems. Sexism, racism, family dissolution, unionization, bureaucratic inertia, career patterns, professionalism and other topics are considered from the perspective of sociology and implications for the military are examined in depth. PREREQUISITE: MN3105.

MN3129 ORGANIZATION DESIGN (2 - 0).
Organizations are studied from a systems perspective in which the leader must analyze the internal and external components and their interrelationships to design the appropriate structural configuration for the organization. Organizational theory provides the foundation for this study of the structure and design of military organizations. Special emphasis is given to the ability to apply these concepts in an integrated manner to DoD/DoN management situations. PREREQUISITE: MN3101.

MN3135 EDUCATIONAL THEORY (3 - 0).
This class focuses on the range of educational theories and applications for the teaching-learning process. Students examine the areas of the cognitive, affective, and behavioral basis of human learning. The emphasis will be on obtaining a solid foundation for understanding and applying educational theory. The theoretical foundation will provide an understanding of DoD, DoN and USNA educational needs. PREREQUISITE: MN3104.

MN3137 INSTRUCTIONAL SYSTEMS DESIGN (1 - 0).
A system approach as applied to the design, development, delivery, implementation and evaluation of educational and training programs. Navy and Marine Corps models are examined. PREREQUISITE: MN3135.

MN3138 ADULT DEVELOPMENT (2 - 0).
Ways in which individuals differ in their development and the continuities seen among adults are studied. The effects those differences have on behavior is the focus of the course. Analysis of recent theory and empirical research data on adult development is conducted using an interdisciplinary perspective. Beginning with the transition to adulthood at age 18, the full range of adult years are examined with respect to physical, cognitive, social, and emotional development. Topic is grounded in implications for leading midshipmen and other officers. PREREQUISITE: MN3135.

MN3140 MICROECONOMIC THEORY (4 - 0).
This course reviews traditional microeconomics concepts, including demand, cost, perfect and imperfect competition public goods, externalities, and factor markets. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, problem solving and strategic thinking. Defense applications are stressed. PREREQUISITES: MA2300 or MN2039 and MN3001.

MN3154 FINANCIAL MANAGEMENT IN THE ARMED FORCES (4 - 0).
This course focuses on financial management practices and concepts in the DoD, with emphasis on the Department of the Navy. Topics include appropriations and legal aspects of appropriations; the Planning, Programming and Budgeting System (PPBS); budget formulation, review and execution; federal budget legislation; and accounting terminology and systems. Current financial management issues such as working capital funds, DFAS, non-appropriated funds and unit cost are reviewed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. PREREQUISITE: MN2155 or MN3161.

MN3155 FINANCIAL MANAGEMENT FOR ACQUISITION MANAGERS (2 - 0).
This course is a study of financial management practices and issues associated with Department of Defense (DoD) acquisition programs. The course has emphasis on (1) the DoD resource management process flow from initiation of a new acquisition program through execution of appropriated funds (procurement and research & development accounts) for that program, (2) the congressional approval and review process unique to Defense procurement, and (3) cost estimation, analysis and evaluation as tools for sound acquisition management. PREREQUISITES: MN2150 or MN2155 and MN3331 or MN3221 or permission of the instructor.

MN3160 METHODS OF INQUIRY (3 - 0).
Basic concepts and principles fundamental to inquiring systems, scientific reasoning, and research design are provided. The strengths and weaknesses of traditional research methods (e.g., experiments, surveys, field research) and inquiring system are examined. Methods appropriate for multi-disciplinary inquiry into complex, dynamic, and uncertain phenomena are addressed, as are action research strategies in organizational contexts. PREREQUISITE: MN3101.

MN3161 MANAGEMENT ACCOUNTING (4 - 0).
Introduction to the concepts and systems of cost determination. Attention is given to applying cost concepts and techniques of analysis in a military environment and relating them to Working Capital Funds, pertinent OMB Circulars and DoD Instruction on Economic Analysis. Topics covered include job costing systems, overhead accounting and allocation, standard costs for control, flexible budgeting, cost-volume-profit analysis, performance analysis, cost analysis for structured and unstructured decision-making, and long-term investment analysis. PREREQUISITE: MN2150.

MN3162 TOOLS OF INQUIRY (3 - 0).
Statistical methods used to explain and predict the organizational behavior of individuals and groups are developed. Particular emphases is given to developing skills in the use of regression analysis using PC software and applying the methods using DoD/DoN data. PREREQUISITE: MN3160.

MN3170 DOD POLICY AND RESOURCE ANALYSIS (4 - 0).
This seminar exposes students to the major elements shaping U.S. military policy foundation in the post Cold War environment. Significant problems confronting military decision-makers are reviewed and the decision-making processes and organizations used to address these problems are examined. Problems addressed include relating national security requirements to force structure, force development and management and resource allocation. PREREQUISITE: Experience as a naval or Marine Corps officer/knowledge of DoD fleet systems and admission to graduate standing.

MN3172 PUBLIC POLICY AND BUDGETING (4 - 0).
This course analyzes federal policy-making with emphasis on resource decision making for national defense. The roles of principal budget process participants are examined. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Students examine the DoN/DoD PPB process as it relates to budget planning and execution.

MN3221 PRINCIPLES OF ACQUISITION AND PROGRAM MANAGEMENT I (2 - 1).
This course introduces the fundamental principles of DoD systems acquisition and program management by examining acquisition policy issues; planning, programming, and budgeting processes; acquisition strategies; contractual decisions; and program management philosophies, issues and concepts. The aspects of planning, organizing, staffing, directing and controlling within the program structure will be examined. Key functional areas are explored including; research & development, test and evaluation, contracting, funding and budgeting, logistics support, systems engineering and legal issues.

MN3222 PRINCIPLES OF ACQUISITION AND PROGRAM MANAGEMENT II (3 - 2).
This course broadens the student's understanding of the principles of DoD systems acquisition and program management gained in MN3221 by examining program management characteristics and competencies, control policies and techniques, systems analysis methods, and functional area concerns. Techniques for interpersonal relationships will be examined in exercise settings. The course structure concentrates on the activities occurring during the major milestones and acquisition phases. Cases involving key planning documents, activities and phase exit criteria are examined. PREREQUISITE: MN3221 or permission of instructor.

MN3302 ADVANCED PROGRAM MANAGEMENT (2 - 0).
Builds on the student's experience in the acquisition workforce. Examines each of the major disciplines in the acquisition process and brings each student to a current and common understanding of the acquisition environment, process, requirements and management approaches. PREREQUISITE: DAWIA Level II Certification.

MN3303 PRINCIPLES OF ACQUISITION AND CONTRACT MANAGEMENT (4 - 0).
This course is an introduction to the principles of Government acquisition and contracting. It presents the fundamentals of the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement; the Federal acquisition and contracting processes, including requirements determination, acquisition strategies, Government contract law, ethics, contract types, contracting methods, and acquisition/contract management techniques. Emphasis is on the unique aspects of defense acquisition and contracting.

MN3304 CONTRACT PRICING AND NEGOTIATIONS (5 - 2).
This course involves the study and application of pricing theory and strategies, cost methods, defense cost and price analysis, cost principles, Cost Accounting Standards, and contract negotiations as used in DoD. Students develop and sharpen negotiating skills by participating in practical negotiation exercises with Defense corporations. PREREQUISITES: MN3140 and MN3303.

MN3309 ACQUISITION OF EMBEDDED WEAPON SYSTEMS SOFTWARE (4 - 1).
This course focuses on the key aspects of mission critical computer resources with particular emphasis on major weapon systems embedded software. The course analyzes software development, software risk management, software in the systems acquisition life cycle, software metrics, contracting methods for software, software test and evaluation, and software configuration management. Case studies, reports, software specifications and standards, and other similar documents/materials are used. The course addresses the underlying management principles involved in defense software acquisition. Significant software acquisition issues and problems are examined and solutions developed. PREREQUISITE: MN3331 or MN3222.

MN3312 CONTRACT LAW (4 - 1).
This course examines the legal structure within which Federal Government contracts with private industry are formulated and executed. The course addresses the unique aspects of Government contract law including such topics as agency authority, contract interpretation, disputes and remedies, Alternative Dispute Resolution (ADR), socio-economic laws, labor law, property, patent and data rights, conflicts of interest, protests, and ethics. Comparisons are made with the Uniform Commercial Code (UCC). Emphasis is on the use of Court and Armed Services Board of Contract Appeals (ASBCA) cases. PREREQUISITE: MN3303.

MN3315 ACQUISITION MANAGEMENT AND CONTRACT ADMINISTRATION (4 - 0).
This course focuses on the management functions and decision-making techniques involved in the award and administration of Best Value competitively negotiated contracts. The first phase of the course concentrates on the source selection phase of the acquisition process; specific topics include acquisition planning, market research, source selection planning, proposal development, solicitation management, source selection evaluation, contract award, and contractor debriefings. The second phase of the course emphasizes the performance phase of the acquisition process; specific topic areas include organizing for contract administration, transitioning to performance, quality management, subcontract management, financial management, performance monitoring, change management, and contract closeout. Emphasis is on the use of legal case studies and practical exercises.

MN3331 PRINCIPLES OF SYSTEMS ACQUISITION AND PROGRAM MANAGEMENT (5 - 1).
This course provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods, and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics include the evolution and current state of systems acquisition management; the system acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. PREREQUISITE: None.

MN3333 MANAGERIAL COMMUNICATION SKILLS IN THE DOD ENVIRONMENT (4 - 0).
This course provides DoD and International military officers and civilians with the communication strategies and skills needed to manage and lead in the dynamic DoD environment. Instruction focuses on writing informative and persuasive documents, giving succinct, easy-to-understand briefings, managing team communication processes, developing associates' communication competencies through various feedback roles and strategies, and listening analytically and empathetically. DoD cases, scenarios, and readings are used to analyze complex communication situations unique to the military.

MN3341 ADVANCED CONTRACTING PRINCIPLES (4 - 2).
This course builds on the student's knowledge and experience in contracting to address the more complex pre-award contracting issues in the acquisition environment including contracting methods, contract types, negotiation, source selection, contingency contracting, environmental contracting, contracting for services, R&D contracting and international procurement. Major issues regarding acquisition reform are addressed. Ethical issues throughout the contracting process are examined. Cases are used to illustrate methods for attacking contracting problems and challenges.

MN3342 ADVANCED CONTRACT MANAGEMENT (4 - 1).
This course builds on the student's knowledge and experience in contracting to address the more complex post-award contracting issues in the acquisition environment including disputes and appeals, claims, intellectual and technical data rights, post-award pricing and negotiations, terminations, contract modifications, traffic and transportation, value engineering, environmental contracting, contractor systems reviews, property administration, quality assurance, contract financing, alternative dispute resolution (ADR), labor relations, contractor performance monitoring and surveillance, contractor performance evaluation. PREREQUISITES: MN3341, MN3312.

MN3370 SEMINAR ON LEADERSHIP IN SUPPLY CHAIN MANAGEMENT (0 - 2).
Graduate-level seminar emphasizing current and emerging issues from a broad range of logistics and supply chain management subjects. Speakers from the Department of Defense, other government agencies, and industry. Graded on Pass/Fail basis. PREREQUISITE: Permission of instructor.

MN3371 CONTRACTS MANAGEMENT AND ADMINISTRATION (4 - 0).
This course is a study of procurement planning, negotiation, and contract administration, including the determination of need, basic contract law, methods of procurement and fundamentals of management techniques. Topics include procurement organizations, procurement by sealed bidding and competitive negotiation, source selection, pricing, types of contracts, negotiating techniques, structuring incentives, the terms and conditions of contracts, managing contract progress, total quality management, change control, cost and schedule control, contract termination, dispute situations, and international contracting issues.

MN3372 MATERIAL LOGISTICS (4 - 0).
An overview of material logistics emphasizing trade-off analysis and the total cost concept of logistics. Topics include forecasting, customer service level optimization, inventory management, transportation, warehousing, facilities location, and the potential trade-offs within and between all of these areas. The similarities and differences between commercial and DoD applications are developed throughout the course. PREREQUISITES: MA2300 (or equivalent) and OS3101.

MN3373 DOMESTIC TRANSPORTATION MANAGEMENT (4 - 0).
Analysis of domestic U.S. transportation systems from a managerial perspective with an emphasis on freight service. After introducing fundamental transportation concepts and an overview of urban and passenger transportation, the course focuses on an analysis of the individual freight modes followed by an examination of intermodel services. Topics include the overall logistics context of freight service; carrier and modal competition; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. Carrier and shipper decision perspectives are both developed in general and then related to the DoD as a provider and consumer of freight service. This course also introduces the student to both the commercial and defense transportation professional literature. PREREQUISITE: MN3140 (may be taken concurrently).

MN3374 PRODUCTION AND OPERATIONS MANAGEMENT (4 - 0).
Qualitative issues and quantitative techniques for managing DoD production and service operations. Qualitative issues covered include process design, operations strategy, and Just-In-Time techniques. Qualitative techniques include quality monitoring and measurement, forecasting, queueing, scheduling and aggregate planning. The context is DoD production and service activities, with special emphasis on DoD repair depot processes. PREREQUISITE: OS3006.

MN3375 MATERIALS HANDLING SYSTEMS DESIGN (4 - 0).
Principles and techniques for managing military material handling systems. Topics include warehousing, storage systems design, intra-facility material movement, and the role of information in distribution. Particular emphasis is placed on DLA automated warehousing systems and Navy shipboard operations. PREREQUISITE: OS3006.

MN3377 INVENTORY MANAGEMENT (4 - 0).
Fundamental models and qualitative techniques for managing DoD inventory systems. Covers demand-based and readiness-based inventory systems, including deterministic and stochastic inventory models, availability-based models, and multi-echelon techniques. Applications and case studies emphasize current problems in DoD and supply-chain solutions such as outsourcing, improved supplier relationships, and vendor-managed inventory. Highlights the distinctive nature of defense inventories and their effect on military readiness. PREREQUISITE: OS3006.

MN3384 PRINCIPLES OF ACQUISITION PRODUCTION AND QUALITY MANAGEMENT (5 - 1).
This course provides the student with an understanding of the principles and concepts of production and quality management in the acquisition environment. Topics include production/manufacturing techniques, tools, and technology; cost estimating methods; process oriented contract administration; production planning and control; progress payments; producibility issues; quality assurance and control; and contract negotiations in production/operations management. PREREQUISITE: MN3331 or MN3221 or permission of instructor.

MN3402 SEMINAR IN INSTALLATION MANAGEMENT I (0 - 2).
Introduces students to a variety of topics associated with the management of a complex military base installation. Graded on a pass/fail basis. PREREQUISITE: Permission of instructor.

MN3403 SEMINAR IN INSTALLATION MANAGEMENT II (0 - 2).
This is a continuation of MN3402 with the addition of guest lecturers. Graded on a pass/fail basis. PREREQUISITE: Permission of instructor.

MN3471 INSTALLATION MANAGEMENT IN THE ARMED FORCES (4 - 0).
Examines fundamental concepts of commanding and managing a typical base installation. Topics covered include: roles and mission, installation organizational structure, functions, duties and responsibilities of the organizational elements, personnel management, commercial activities and best sourcing, environmental management, facilities management, media and community relations, morale, welfare, recreation, retail, medical, dental, security, religious and emergency services, and munitions storage. PREREQUISITES: MN3402, MN3105, MN3161, MN3140, MN3172.

MN3610 MICROECONOMICS FOR OPERATIONS RESEARCH (4 - 0).
Basic concepts involved in the decision processes of individuals and groups faced with scarcity of resources. Topics include consumer theory and demand, producer theory and supply, market structures, optimization and efficiency, partial and general equilibrium analysis, welfare analysis, and optimal investment decision rules. Applications focus on DoD's roles as demander and supplier of resources. A required course for 360 and 361 curricula. PREREQUISITES: MA3110 and OA3201.

MN3760 MANPOWER ECONOMICS I (4 - 0).
An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. PREREQUISITES: MN3140, OS3101.

MN3801 TECHNOLOGY TRANSFER (4 - 0).
The study of dissemination and utilization of technology and associated problems, with emphasis on communications, sociology, and organizational factors. Course uses in-depth recent case studies to examine technology transfer issues of concern to the military. Also relies on guest speakers from military and private sector organizations. PREREQUISITE: MN3105 or permission of the instructor.

MN3805 TOTAL QUALITY LEADERSHIP AND THE MILITARY (2 - 0).
This course introduces the basic concepts and principles of Total Quality Leadership/Management and discusses their application to the military setting. The different service approaches and initiatives are reviewed, and examples and cases from a variety of military organizations are examined. Emphasis is placed on: the teachings of Dr. W. E. Deming, use of a systems perspective, process orientation and fact-based decision making to lead and manage a military organization, the difference between problem solving and process improvement, applying the scientific method and basic statistical and planning tools to process management and improvement, and how the concept of customer-supplier relationships translates into a military environment. PREREQUISITE: MN3105 or permission of the instructor.

MN3900 READINGS IN SYSTEMS MANAGEMENT (V - 0).
An individualized program of readings and study in some area of the systems management, designed to meet the student's special educational needs. PREREQUISITES: A background in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN3902 MPT COMPUTER SKILLS ENHANCEMENT (2 - 0).
An introduction to computer analysis of manpower data files. Topics include methods of file creation, storage, and transfer. Statistical concepts are applied using the SAS statistical software package. Taken currently with MN4110. PREREQUISITE: OS3101.

MN4080 RESEARCH COLLOQUIUM (2 - 0).
Meetings are held throughout the thesis research process to integrate course work with thesis progress and results. PREREQUISITE: Permission of instructor.

MN4101 LEADERSHIP IN THE MILITARY CULTURE (2 - 0).
This course focuses on the relationships between leaders and the aspects of their organizations that are moderated by culture: people, tasks, missions, goals, structure, and strategies. Assessment and implementation techniques are studied to enable leaders to achieve a desired culture state leading to positive organizational outcomes. PREREQUISITES: MN3101 and MN3102.

MN4103 INSTALLATION STRATEGIC MANAGEMENT (4 - 0).
Study and analysis of complex managerial events confronting Installation Commanders and produce optimal cost effective solutions. Throughout this course, the student will apply critical thinking to achieve tactical and strategic objectives through comprehensive integrated decision making. Area of study include: strategic planning, operational support, crisis management, strategic integrations with DoN and DoD organizations, and the effects of current legislative changes. PREREQUISITES: MN3105, MN4125, MN4145, MN4472.

MN4104 STRATEGIC MANAGEMENT ISSUES IN MILITARY ORGANIZATIONS (3 - 0).
Examination of strategic management from the perspective of leadership in military education and training organizations. This course explores strategic planning, policy formulation, and organizational adaptation with a dual emphasis on understanding the concepts as well as acquiring the ability to isolate and communicate concepts relevant to developing subordinates. PREREQUISITES: MN3101, MN3102, MN3103, MN3104, MN3129, and MN4101.

MN4105 STRATEGIC MANAGEMENT (4 - 0).
Study and analysis of complex managerial situations requiring comprehensive integrated decision making. Topics include operational and strategic planning, policy formulation, executive control, environmental adaptation and management of change. Case studies in both the public and private sectors are used. Particular attention is given to strategic management in the military context, and in the challenging DoD, DoN organizations. PREREQUISITE: Open only to students in the final quarter of a Systems Management curriculum, or Information Technology Management, or permission of instructor.

MN4106 MANPOWER/PERSONNEL POLICY ANALYSIS (4 - 0).
Study and analysis of military manpower/personnel policy alternatives with emphasis on identifying the trade-offs involved, the dynamic impact of major policy decisions and the short-term and long-term consequences of decisions. Review, use and evaluation of tools to aid in selecting policy alternatives. Analysis of issues in the DoD and military services. PREREQUISITES: MN3760, MN4111.

MN4110 MULTIVARIATE MANPOWER DATA ANALYSIS I (4 - 1).
An introduction to multivariate data analysis using the linear regression model. Topics include hypothesis testing, the organizations and analysis of large scale data bases, model specification issues, multicollinearity, dummy variables, forecasting, and estimation of binary choice models. Students apply techniques to Navy and DoD manpower databases developed at NPS. Taken concurrently with MN3902. PREREQUISITE: A course in statistics.

MN4111 MULTIVARIATE MANPOWER DATA ANALYSIS II (4 - 1).
An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include an introduction to study design and sampling theory, maximum likelihood estimation, techniques for analyzing limited dependent and qualitative data, selection bias, time series data, and simultaneous equations models. Students apply techniques to Navy and DoD manpower databases developed at NPS. PREREQUISITE: MN4110, or permission of instructor.

MN4112 PERSONNEL TESTING AND SELECTION (4 - 0).
Study of methods available for evaluating and predicting training and work performance in organizations like the Navy: employment interviewing, testing, life-history data, and rating scales, with some reference to job analysis and recruitment. Special emphasis on testing concepts and models particularly in relation to the computerization of the Armed Services Vocational Aptitude Battery, equal employment opportunity, and selection decisions based on cost benefit analysis. PREREQUISITE: MN4110 or equivalent with approval of instructor.

MN4113 MILITARY SOCIOLOGY/PSYCHOLOGY: LEADERSHIP DIMENSIONS (2 - 0).
Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting; with specific emphasis on leadership applications. Study of the military as a social institution, focusing on the internal organizations and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of psychological and sociological principles employed in a variety of research areas such as recruit screening and job classification, personnel adaptability and trainability, the military family, population representation, diversity, equal opportunity, personnel security, institutional versus occupational constructs, the military life course, and civil-military relations. Extensive use of representative cases in DoD and the U.S. armed forces as well as cases in the militaries of other nations. PREREQUISITES: MN3101 and MN3170.

MN4114 SOCIOLOGICAL AND PSYCHOLOGICAL PERSPECTIVES ON MILITARY SERVICE (4 - 0).
Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting. Study of the military as a social institution, focusing on the internal organization and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of the psychological principles employed in a variety of military areas such as health care, selection and job classification, human factors, organizational systems, personnel security, and performance appraisal. Emphasis on representative cases in DoD and the armed forces. PREREQUISITE: MN3105. Curriculum option for MSA (847) students, who are given priority enrollment.

MN4115 TRAINING FOUNDATIONS AND MANAGEMENT (4 - 0).
Analysis of issues in DoD training and education. Major course themes focus on understanding military education and training from a systems perspective; analyzing instructional program design, implementation, and technologies; and applying methods of needs analysis and program evaluation. Guest speakers, military publications, student cases, and discussion based on the experience of the instructor and the students are utilized to maintain the necessary focus on current military applications. PREREQUISITE: MN3105.

MN4117 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: MN3111.

MN4118 MODELING FOR DECISION SUPPORT IN MANPOWER SYSTEMS (3 - 2).
An introduction to applied manpower models and modeling techniques. Students will gain insight into how models are used by policy makers in the decision process and into the complexity of the military manpower system. Several models that are currently used by the Bureau of Naval Personnel and Headquarters USMC will be analyzed, including accession planning, sea-shore rotation policy, promotion planning and inventory projection models. Other topics covered include the manpower planning process, types of models, model evaluation and good modeling practices. PREREQUISITES: OS3101 or equivalent; OS3006; OS4701 (may be taken concurrently).

MN4119 SEMINAR IN MANPOWER ANALYSIS (Variable credit 1-0 to 4-0.) (V - 0).
Study of a variety of topics of current interest in military manpower analysis, to be determined by the instructor. PREREQUISITES: A background in manpower analysis and permission of instructor.

MN4120 MANAGING DIVERSITY (3 - 0).
This course is focused on creating awareness of diversity issues that surround constructions of race, gender, class, and culture and building skills to deal with these issues. This course addresses the question, “How can diversity become an organizational resource in the military and a force to increase productivity and innovation?” PREREQUISITES: MN3104 and MN3138.

MN4121 ORGANIZATION THEORY (4 - 0).
Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenomena from multiple perspectives, using theories of individual, group, and organizational behavior. Topics include organization design and culture, political analysis of organizations, management of change, open systems theory, and contingency theories. PREREQUISITE: MN3105.

MN4122 PLANNING AND CONTROL: MEASUREMENT AND EVALUATION (4 - 0).
Theory and techniques of the managerial functions of planning and control in both governmental and private sector organizations. Emphasis is placed on the effects of the planning and control structure on the behavior of human components of the system. Examples are drawn extensively from the governmental sector. Topics include the problems associated with the utilization of surrogates for measurement purposes, the analysis of the influence of assumptions, values, and objectives on the planning and control process, budgeting, forecasting, performance evaluation, and the reward structure. PREREQUISITE: MN4161.

MN4124 DEFENSE MANAGEMENT OF CHANGE (3 - 0).
Review and evaluation of techniques and strategies for planning and managing change efforts in complex social systems. This course emphasizes implementing change in military organizations in which leadership development is a key concern, for example, military education and training institutions. Examples are provided through course work to address the unique nature of managing change within the culture and structure of the military. PREREQUISITES: MN3103, MN3104, and MN3129.

MN4125 MANAGING PLANNED CHANGE IN COMPLEX ORGANIZATIONS (4 - 0).
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. Particular emphasis is placed on the DoD, DoN organizations and the special problems they have in bringing about change. PREREQUISITE: MN3105.

MN4127 SEMINAR IN ORGANIZATION BEHAVIOR (Variable credit 1-0 to 4-0.) (V - 0).
Study of a variety of topics of current interest in organization behavior, to be determined by the instructor. PREREQUISITES: A background in organization behavior and permission of instructor.

MN4129 PERFORMANCE ASSESSMENT (2 - 0).
Theory and methods of assessing the performance of individuals and organizations are studied. Applications are provided that use leadership-related data on midshipmen. Students use data to assess leadership potential of subordinates. PREREQUISITES: MN3160, MN3162 and MN4143

MN4143 DEFENSE MANPOWER AND PERSONNEL ANALYSIS (2 - 0).
This course applies the statistical tools developed in MN3162 in the analysis of DoD/DoN manpower and personnel issues. The focus is on officer personnel issues. Topics include officer accession programs, training, performance measurement, retention, promotion, the structure of career paths, and compensation systems. PREREQUISITES: MN3160 and MN3162.

MN4145 POLICY ANALYSIS (4 - 0).
The course continues MN3140. It introduces advanced microeconomics concepts, including cost benefit analysis, risk, strategic interactions and imperfect information. These concepts are used to analyze public policy issues, stressing defense-related resource allocation problems. These applications emphasize optimization, incentives, efficiency, problem solving and strategic thinking. PREREQUISITES: MN3140, MN3161, and OS3101 or equivalent.

MN4151 INTERNAL CONTROL AND AUDITING (2 - 0).
Study of the objectives and activities of internal control. Overview of audits of financial reports and records and of government operations, in accordance with Government Auditing Standards. Specific topics include the design and evaluation of internal controls, auditing standards, audit reports, audit evidence, and audit tests. PREREQUISITE: MN3161.

MN4152 CORPORATE FINANCIAL MANAGEMENT (4 - 0).
This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision making process encountered by commercial enterprises, with particular emphasis on risk analysis, valuation models, cost of capital determination, optimal capital structure, short term financing, long term financing, and working capital management. PREREQUISITE: MN3161.

MN4153 SEMINAR IN FINANCIAL MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
Study of a variety of emerging financial management topics that impact on the Navy's planning, programming, budgeting and operations. It includes discussion of new Congressional, Department of Defense and Department of the Navy financial management policies. Case studies emphasize current issues affecting the Navy and other DoD organizations.

MN4154 APPLIED ETHICS (4 - 0).
An examination of ethical issues in a managerial environment. Students will recognize ethical problems in the context of organizational activity and develop knowledge and skills for dealing with them from a moral point of view. Focus is on three aspects of managerial behavior and leadership: defining and maintaining an ethical framework for the organization, establishing a structure to ensure that organizational members act in ethically appropriate ways, and developing attitude, skill and knowledge to make decisions that are ethically sound.

MN4157 SEMINAR IN MANAGEMENT ACCOUNTING I (0 - 2).
Complements the financial management program by covering significant topics not otherwise included in the program. These topics are integrated into financial management as a whole. A strong emphasis is placed throughout on motivational and ethical considerations. Topics include federal income tax planning and accounting, special accounting treatment needed by partnerships, and consolidated financial statements.

MN4158 SEMINAR IN MANAGEMENT ACCOUNTING II (Continuation of MN4157.) (0 - 2).
Complements the financial management program by covering significant topics not otherwise included in the program. These topics are integrated into financial management as a whole. A strong emphasis is placed throughout on motivational and ethical considerations. Topics include foreign currency translation and transactions, fund accounting, branch office accounting, fiduciary accounting, the differences and responsibilities of external and internal auditing, and the design of accounting information systems.

MN4159 FINANCIAL REPORTING AND ANALYSIS (4 - 0).
Advanced study of accounting concepts underlying published financial reports. Emphasis is placed on the evaluation of financial reporting approaches and measures from the perspective of managers and users of financial information. Topics include accounting policies and standards; asset and liability recognition, measurement, amortization and valuation; alternative concepts of earnings; and the use of financial report information in financial analysis. Course project investigating financial reporting in DoD settings. PREREQUISITE: MN3161.

MN4161 MANAGEMENT CONTROL SYSTEMS (4 - 0).
Study of the design, implementation, and evaluation of management planning and control systems in Navy and Defense organizations with comparisons to large, complex private sector organizations. Specific topics include the need for planning and control, strategic planning, the resource allocation process, organization of the management control function, measurement of inputs and outputs, pricing government services programing, budgeting, reporting, and performance evaluation. PREREQUISITES: MN3105 and MN3161.

MN4162 STRATEGIC COST MANAGEMENT (4 - 0).
Examines cost accounting and cost management concepts and policies used to identify, measure, and report cost information for strategic decision making and long-term resource allocation. Includes the study of alternative cost allocation systems, activity-based management, benchmarking, target costing, and value chain analysis. Also covered are the Cost Accounting Standards used by the federal government for negotiated procurement contracts. PREREQUISITE: MN3161.

MN4163 DECISION, COST AND POLICY ANALYSIS (4 - 0).
Study of sophisticated analytical methods for various cost, policy and decision scenarios in DoD and other organizations. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are pertinent segments of DoD instructions in economic analysis, program evaluation, and risk management, relevant quantitative techniques for decision analysis, the conditions for successful applications, data needed for applications, and the use of computational aids for problem solving. PREREQUISTES: MN3161 and OS3101.

MN4301 CONTRACTING FOR MAJOR SYSTEMS (4 - 0).
This course is the study of the major defense contracting process, procedures, and practices. It focuses on the contracting process of the Service Systems Commands and the major defense acquisition process. Topics include contracting organizations for systems acquisition, systems acquisition process, business clearance process, source selection, multi-year procurement, pricing, and administration of major systems contracts. Related topics include funding, reliability/maintainability, logistics support, research and development, test and evaluation, and congressional activity. PREREQUISITE: MN3315.

MN4302 DEFENSE RESOURCE POLICY AND MANAGEMENT (V - 0).
National defense and Navy policy formulation and execution and its impact on the defense budget. Analysis of contemporary defense policy and management issues and their resource implications. Relationships between DoD, the Navy and other military departments, Congress, and the defense industry in the policy and resource decision making process. Textbook written specifically for this course by instructor: Reinventing the Pentagon. PREREQUISITE: MN3172.

MN4304 DEFENSE SYSTEMS CONTRACTING (2 - 0).
This course is the study of the DoD's major systems contracting policies, processes, procedures, and practices. A review of major systems acquisition and program management is provided but the primary focus is on the contracting process used to acquire Defense systems for the various Services. The topics covered include: acquisition environment, acquisition strategy, source selection, incentive contracting, risk management, competition, post-award systems contract administration, configuration management, warranties, industrial base, and ethics. PREREQUISITES: MN3331 or MN3222 and MN4473.

MN4305 DEFENSE TECHNOLOGY POLICY (4 - 0).
This seminar examines the problems of identifying and acquiring U.S. military technology in the post-cold war environment. Readings in the literature of defense technology, bureaucracy and economics explore changes in the defense technology base, developments in DoD technology policy and organization, including the defense laboratories, defense cooperation, foreign dependence, technology security, shifts in U.S. economic policy and assets and the evolution of global technological capabilities, especially in the Asia-Pacific region. PREREQUISITE: MN3172 or permission of instructor.

MN4306 RESEARCH & DEVELOPMENT CONTRACTING (2 - 0).
This course focuses on the issues and problems associated with contracting for research and development requirements. Additionally, methods for acquiring R&D, such as using Other Transactions (OT) authority and Federally Funded Research & Development Centers (FFRDCs) are explored. PREREQUISITE: MN4473 or permission of instructor.

MN4307 PROGRAM MANAGEMENT POLICY AND CONTROL (4 - 0).
This course provides the student with knowledge and understanding of major defense systems management control processes and tools, application of program management control systems; and the use of computer-based management information systems with emphasis on real world, practical systems for performance, cost and schedule control. Case studies involving program management problem solving and decision-making in the defense acquisition environment are used. PREREQUISITES: MN3331/or MN3302, MN3309, MN3371, OS4602, EO4011 and MN3384.

MN4308 FIELD CONTRACT MANAGEMENT (2 - 0).
Examines the Navy and other Service Field Contracting Systems for accomplishing procurement at the base, camp and post level. Emphasis is on (1) simplified acquisition procedures, (2) contracts for other than major systems, (3) services contracting, and (4) contracting for information technology resources. PREREQUISITE: MN4473 or permission of instructor.

MN4309 FACILITIES CONTRACTING (2 - 0).
This course is a concentrated analysis of facilities, construction and architecture-engineering contracting. It focuses on the contract formation and contract administration requirements in these areas with emphasis on problems faced in facilities management. Topics covered include cost estimating and analysis for construction, pre and post award contract actions, environmental remediation, base operating support contracts, contractor performance evaluation, leases and easements, A-76 public/private competitions, outsourcing, privatization, public/private ventures and base closure issues. PREREQUISITE: MN4473 or permission of instructor.

MN4310 LOGISTICS ENGINEERING (4 - 0).
The concept of integrated logistics support and its relationships with systems engineering in the design of military weapon systems. Operational requirements, system maintenance concept, functional analysis, life-cycle costs, logistics support analysis, systems design, test and evaluation, production, provisioning and resupply of spare and repair parts are discussed. Case studies include the F/A-18 Aviation Coordinated Allowance List (AVCAL) spare parts determination and various weapon system reliability/readiness tradeoffs. PREREQUISITE: OS3006 (taken concurrently).

MN4312 SIMULATION MODELING FOR MANAGERIAL DECISION MAKING (4 - 0).
Modeling and analysis of computer simulation for managerial decision making. Case studies of simulation applications to weapon, logistics, communications and production systems. PREREQUISITE: Introductory probability and statistics.

MN4333 MEDIA RELATIONS AND INTER-ORGANIZATIONAL COMMUNICATIONS (2 - 1).
This course examines strategies for developing, maintaining, and enhancing base-community relations as a means of forming partnerships with the community. Students will learn to make strategic media choices so as to develop effective media campaigns, interact effectively with the print and broadcast news media, and handle press conferences and similar media events. Particular attention is focused on anticipating and handling crisis communication. Specifically, students will learn to organize crisis management teams, develop crisis management plans, and create communication plans to manage information and public perception. PREREQUISITE: MN3333.

MN4371 ACQUISITION AND CONTRACTING POLICY (4 - 0).
This course uses case studies and current acquisition issues to analyze Government and business acquisition/contracting policies. Emphasis is on defense acquisition decision-making and policy formulation/execution. PREREQUISITE: MN4301 or MN4304 or MN4473.

MN4372 SEMINAR IN ACQUISITION AND CONTRACT MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
This seminar involves the study of a variety of topics of current interest in defense acquisition and contracting to be determined by the instructor. PREREQUISITE: A background in acquisition and permission of the instructor.

MN4373 INTERNATIONAL TRANSPORTATION MANAGEMENT (4 - 0).
Analysis of international transportation systems from a managerial perspective. Maritime economics and operations are emphasized as background for DoD/DoN sealift responsibilities and operations. As a first graduate course in transportation research, this course is also designed to introduce the student to transportation research methods through the current transportation research literature, with an emphasis on critical thinking in the application of fundamental transportation concepts. Topics include carriers and users of the systems; carrier and modal competition; intermodel options; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. PREREQUISITE: MN3373.

MN4376 DEFENSE TRANSPORTATION SYSTEM (4 - 0).
Study and analysis of the structure and environment of the Defense Transportation System. Topics include strategic planning systems for warfare (e. g., GCCS and JOPES), organizations providing transportation support for warfare (e.g., USTRANSCOM and TCCs), the strategic lift triad and trade-offs concerning their roles and capabilities, and studies and analyses of the Defense Transportation System (e.g., MRS). No commercial text is available, therefore readings are based upon an NPS-developed package. PREREQUISITES: An active SECRET clearance and MN4373 or permission of the instructor.

MN4377 TQM/TQL: PHILOSOPHY, THEORY, TOOLS (4 - 0).
Deming's 14 points (philosophy and basic theory). The 7 basic graphic tools (flow charts, cause and effects diagrams, Pareto charts, histograms, scatter diagrams, run charts and control charts), which help analyze generic processes. Advanced theories and techniques, designed to address quality issues of specific types, including SMED (Single minute exchange or die, or setup reduction), Poka-Yoke (mistake proofing), Synchronized Operations (also known as Just-In-Time), and Statistical Experimental Methods for off-line quality improvement such as Taguchi Methods, and Group Technology. Discussion of how methods developed predominantly in the manufacturing environment are used in services. PREREQUISITE: Any 3000 level course in probability and statistics.

MN4470 STRATEGIC PLANNING AND POLICY FOR THE LOGISTIC MANAGER (4 - 0).
The course explores and analyzes the concepts, processes and methods of strategic logistics planning and execution emphasizing proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life-cycle management of fielded systems. The course will examine and analyze key opportunities for maximum logistics influence in requirements development, contracting, test and evaluation, reliability and maintainability as well as financial management and communications. The course will feature logistics management relevance to service roles and missions. The course will employ lectures, guided discussions, case studies, role playing, panel discussions and lessons learned in the DoD acquisition environment. PREREQUISITE: MN4310 or Permission of instructor.

MN4472 BASE INSTALLATION ISSUES (4 - 0).
This course critically examines complex issues associated with base installation management. Students will analyze facility management issues ranging from defining resource requirements and budget planning to mission execution. Cases, student exercises, and selected readings will be used throughout the course. Students will also examine emergent issues in a fiscally constrained and politically sensitive environment. PREREQUISITE: MN3471.

MN4473 STRATEGIC ACQUISITION AND CONTRACT MANAGEMENT (4 - 1).
Tailored toward the students in the class, the course examines the unique contracting issues/problems encountered in a variety of organizational situations. Analysis, discussion and potential resolution of actual working problems is undertaken. A comprehensive written case study is the capstone effort in the course for each student. Students will be grouped into teams simulating product team (IPT) organization to address various issues germane to the students' organizations. PREREQUISITE: MN3342.

MN4474 ORGANIZATIONAL ANALYSIS (2 - 0).
This course concentrates on analysis of organizations from an open systems perspective. Focus is on tools and techniques for diagnosing managerial problems by analyzing structure, task requirements, technology, culture, and various organizational subsystems. The course emphasizes application in that students complete a course project requiring integrated application of the systems model in an analysis of their own organization. PREREQUISITE: MN3115.

MN4500 PRODUCTIVITY ANALYSIS (4 - 0).
Study of the theoretical and institutional foundations of the analysis of productivity measurement and enhancement programs in DoD. Emphasis is placed on methods of applying microeconomic and organizational effectiveness principles and concepts to the critical analysis of proposed and existing DoD productivity programs, as well as to the development of alternatives which have higher probabilities of effecting the desired increases in program effectiveness and efficiency. PREREQUISITES: MN3105 and MN3140.

MN4613 THEORY AND PRACTICE OF SYSTEMS ANALYSIS (4 - 0).
Systems analysis (cost-effectiveness analysis) formulated as capital investment decision models. Topics include the nature of opportunity costs, theory of the second best, the social discount rate, methods of risk assessment, modeling, and solution computation. Planning and control models emphasizing decentralization of the decision problem are also addressed. DoD cost effectiveness models are examined, and institutional procedures and processes of DoD, such as PPBS, FYDP, and DAB, are discussed. PREREQUISITE: MN3610.

MN4650 THE MILITARY HEALTH CARE DELIVERY SYSTEM AND ANALYSIS (4 - 0).
This course is designed to acquaint the student with the structure and operation of the Department of Defense's system for providing health care to those eligible under current regulations; to identify current problem areas; and, through application of systems analysis and management techniques, to address the possible solutions to these problems in a course project. PREREQUISITE: Permission of instructor.

MN4761 APPLIED MANPOWER ANALYSIS (4 - 0).
Application of theoretical models and quantitative techniques to Navy and DoD manpower, personnel, and training issues. Topics include manpower supply models, attrition and reenlistment models, manpower requirements determination, force structure analysis, manpower productivity, and compensation systems. Course uses specialized readings in DoD and Navy manpower. PREREQUISITES: MN3760 and MN4111.

MN4900 READINGS IN SYSTEMS MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
An individualized program of advanced readings and study in some area of Systems Management. PREREQUISITES: A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN4942 THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DEFENSE INDUSTRIES (4 - 0).
A study of selected defense industries' structures (e.g., seller concentration, product differentiation, barriers to entry, demand for products, and buyer concentration), conduct (e.g., pricing policy, product characteristics policy, and policies toward rivals and customers), and performance (e.g., efficiency, progress, and employment). The government as consumer and regulator. Typical industries include aerospace, computers, shipbuilding, and telecommunications. PREREQUISITE: MN3140 or equivalent.

MN4945 SEMINAR IN ECONOMICS (Variable hours 1-0 to 4-0.) (V - 0).
Study of a variety of topics of current interest in economics, to be determined by the instructor.

MN4970 SEMINAR IN SYSTEMS MANAGEMENT (Variable hours 1-0 to 4-0.) (V - 0).
Study of a variety of topics of general interest in the systems management, to be determined by the instructor. PREREQUISITES: A background in systems management and permission of instructor.

UNDERSEA WARFARE ACADEMIC GROUP

Chairman:
James Eagle
Professor
Code UW, Root Hall
Room 201
(831) 656-2654
DSN 878-2654

Steven Richard Baker, Associate Professor (1985)*; PhD University of California at Los Angeles, 1985.

Robert Barsanti, LCDR, U.S. Navy, Military Instructor (1997); BS, Polytechnical Institute of New York, 1982; MS, Naval Postgraduate School, 1996.

Robert Hathaway Bourke, Professor of Oceanography (1971); BS, Naval Academy, 1960; MS, Oregon State University, 1969; PhD, Oregon State University, 1972.

Jan Breemer, Research Associate Professor (1988); PhD, University of Southern California, 1987.

Donald P. Brutzman, Assistant Professor (1995); PhD, Naval Postgraduate School, Monterey, 1994.

Ching-Sang Chiu, Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

James Norfleet Eagle, II, Chairman and Professor of Operations Research (1983); PhD, Stanford University, 1975.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Henry Jones, CDR, U.S. Navy, Military Instructor (1996); BS, U.S. Naval Academy, 1979; MS, Naval Postgraduate School, 1986; MS, University of Southern California, 1983.

Thomas Muir, Chair of Mine Warfare and Research Professor of Physics (1997); PhD, University of Texas, 1971.

James Vincent Sanders, Associate Professor of Physics (1961); BS, Kent State University, 1954; PhD, Cornell University, 1961.

Clyde Scandrett, Associate Professor (1987); PhD, Northwestern University, 1985.

Kevin B. Smith, Assistant Professor (1995); PhD, University of Miami, 1991.

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

Academic Associate:
James Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 200B
(831) 656-3884, DSN 878-3884

The Undersea Warfare Academic Group is an association of faculty members representing several, distinct academic disciplines. An academic group is a less formal organization than an academic department. The Undersea Warfare Academic Group has administrative responsibility for the academic content of the Undersea Warfare program of study. Teaching in this interdisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Oceanography, Operations Research and Physics.

MASTER OF SCIENCE IN DEGREES AVAILABLE
Depending on the specialization track selected by the student, a Master of Science will be awarded in Applied Physics, Physical Oceanography, Electrical Engineering, Operations Research, or Applied Science.

The entire program must be approved by the Chairman of the Undersea Warfare Academic Group.

UNDERSEA WARFARE COURSE DESCRIPTIONS

UW0001 SEMINAR (NO CREDIT) (0 - 1).
Special lectures, and discussion of matters related to the USW Program. PREREQUISITE: Enrollment in the USW Curriculum and SECRET clearance.

UW0810 THESIS RESEARCH GROUP/PROJECT (0 - 8).
Students in the USW Curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

UW3000 STUDY PROJECT ON USW SYSTEMS PERFORMANCE (0 - 2).
This is a project course in which the project is a study and analysis of the performance of an assigned type of USW system under a variety of operating conditions. PREREQUISITE: Enrollment in the USW Curriculum or consent of the Group Chairman. Graded on a Pass/Fail basis only.

UW3303 MODELING AND SIMULATION FOR UNDERSEA WARFARE (4 - 1).
Design, implementation and analysis using digital simulation models, with emphasis on physics-based modeling of military systems. Simulation is a discipline that cut across all technical fields complementing both theory and experiment as a component of the scientific method. Course topics include a broad view of analytic simulation, properly designing and structuring simulation problems, extending student programming skills to include the C language (as necessary), use of on-line tutorials, and use of public domain C++ compiler/simulation toolkit (g++, simpack). UW3303 provides tools, techniques and a repeatable methodology that can be used to support thesis work and projects in other classes. Examples and class projects are typically oriented to problems of military or scientific interest.

UW4999 SPECIAL STUDIES IN UW (Variable hours 1-0 to 4-0.) (V - 0).
A course designed to meet the needs of students for special work in advanced topics related to USW. PREREQUISITES: Enrollment in the USW curriculum and consent of the Group Chairman.

DEFENSE RESOURCES MANAGEMENT INSTITUTE

Robert C. Chaplin, Rear Admiral, U.S. Navy; Director (1998)*; MS, Naval Postgraduate School, 1980.

Diana I. Angelis, Assistant Professor (1996); PhD, University of Florida, 1996.

James S. Blandin, Professor (1974); PhD, University of Oregon, 1974.

Donald E. Bonsper, Senior Lecturer (1982); MS, Naval Postgraduate School, 1970.

Robert E. Boynton, Associate Professor (1970); PhD, Stanford University, 1968.

Lisa M. Cappellari, Assistant Professor (1999); PhD, University of California at Davis, 1999.

Philip A. Costain, Senior Lecturer (1979); MS, Naval Postgraduate School, 1971.

Jonathan E. Czarnecki, LTC, ARNG; Assistant Professor (1997); PhD, State University of New York, 1979.

John E. Dawson, Professor (1966); PhD, Syracuse University, 1971.

James C. Felli, Assistant Professor (1995); PhD, Northwestern University, 1995.

Peter C. Frederiksen, Professor (1974); PhD, Washington State University, 1974.

Stephen F. Hurst, Senior Lecturer (1989); MS, Naval Postgraduate School, 1985.

Charles J. LaCivita, Executive Director (1985); PhD, University of California at Santa Barbara, 1981.

Scott Mahone, LtCol., USA, Lecturer (1999); MA, Florida Institute of Technology, 1991.

Francois Melese, Associate Professor (1987); PhD, University of Louvain, Belgium, 1982.

James H. Morris, Professor (1982); PhD, University of Oregon, 1976.

Mark A. Murphy, LCDR, USN; Lecturer (1997); MS, Naval Postgraduate School, 1997.

Allan C. Polley, LtCol, USMC; Lecturer (1997); MS, Naval Postgraduate School, 1990.

David J. Rose, Assistant Professor (1996); PhD, Rensselaer Polytechnic Institute, 1995.

Steve L. Standrowicz, CDR, USN, Lecturer (1999); MBA, University of Washington, 1993.

Larry E. Vaughan, Senior Lecturer (1992); MS, Naval Postgraduate School, 1974.

Kent D. Wall, Professor (1985); PhD, University of Minnesota, 1971.

Natalie J. Webb, Associate Professor (1992); PhD, Duke University, 1992.

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

DEFENSE RESOURCES MANAGEMENT INSTITUTE
Established in 1965 as the Navy Management Systems Center and redesignated to its present title in May 1992, the Defense Resources Management Institute is a jointly staffed U.S. Department of Defense sponsored educational institution located as a tenant activity at the Naval Postgraduate School. It conducts educational programs in resources management, both in residence at Monterey and on-site, for military officers and civilian defense officials of the U.S. and cooperating foreign nations. The focus of all programs conducted by the Institute is on the development of knowledge and improvement of understanding of the concepts, techniques and application of modern defense management, with specific emphasis on analytical decision making. The mission, objectives and responsibilities of the Institute are set forth in Department of Defense Directive 5010.35.

The Institute currently offers the following resident courses within its facilities at the Naval Postgraduate School:

DEFENSE RESOURCES MANAGEMENT COURSE - Four weeks in length; presented five times per year.

INTERNATIONAL DEFENSE MANAGEMENT COURSE - Eleven weeks in length; presented twice a year.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE - Four weeks in length; presented once each year (normally in the month of June).

Descriptions of these courses are provided below; detailed information on current quota control agencies and procedures may be found in DoD Publication 5010.16C (Defense Management Education and Training Catalog), or by calling DRMI at: Commercial (831) 656-2104, DSN 878-2104 or visiting our web site at http://web.nps.navy.mil/~drmi.

In addition to its regularly scheduled resident programs, the Institute also provides:

MOBILE EDUCATION COURSES - normally two weeks in length, for U.S. military services and defense agencies and for foreign governments upon specific request and approval.

COURSES FOR OTHER AGENCIES - programs are from two to four weeks duration, resident or on-site, for non-defense federal agencies and state and local governments, upon specific request and approval.

Faculty of the Institute are members of the faculty of the Naval Postgraduate School on assignment to the Institute.

Since 1966, over 24,000 officials, of whom more than 11,000 represented 148 foreign nations, have participated in programs conducted by the Institute.

DEFENSE RESOURCES MANAGEMENT COURSE (DRMC)
Military officers of all services, grades 0-4 and above, and civilian employees GS-11 and above, are eligible to attend this course. Also civilians in accelerated career development programs may attend.

The objective of this four-week course is to provide an appreciation of the concepts, principles and methods of defense management as they concern planning, programming, budgeting and related activities. Emphasis is placed on the analytical aspects of management, stemming from the disciplines of management systems, economics and quantitative analysis.

Participants are not expected to become experts or technicians in the various disciplines and subjects included in the curriculum. The objectives are to provide orientation on the overall functioning of the defense management process; insights as to what defense management requires in the way of inputs and analysis for decision making; understanding of the principles, methods and techniques used; and awareness of the interfaces between management requirements of the Defense Department components and the Office of the Secretary of Defense. Course methodology includes lectures, small group discussions reinforced by illustrative case studies and problem sets, as well as selected daily reading assignments.

This course is primarily for U.S. officials, although limited numbers of international participants are normally also enrolled.

INTERNATIONAL DEFENSE MANAGEMENT COURSE (IDMC)
The course is designed for participants in the military grades of 0-4 (Major/Lieutenant Commander) through 0-6 (Colonel/Captain) and defense-related civilians of equivalent rank. Enrollment is currently limited to a maximum of 54 participants. Broad national representation is desired for this course, i.e., participation from as many as 45 nations enhances the value of the comparative management aspects of this curriculum.

The course is presented in English.

The course provides a series of lectures in three major areas: the defense management environment, quantitative and economic analysis and management systems in the context of strategy, implementation and operations. The lectures are supplemented by small group discussions and workshops that concentrate on the lecture topics and associated readings, problems and cases. In the discussion groups, faculty members guide the interchange of ideas and are available to answer questions. Readings are assigned from within texts and supplemental material given to the participants to facilitate preparation for each lecture. Lecture outlines with additional suggested reading lists are provided. Occasional open seminar speakers are invited for special topics.

Throughout the course, the participants are encouraged to present and discuss information with respect to the defense management systems of their countries and to examine how the management concepts and techniques discussed by both the faculty and the participants from other countries may be applied in their own situations. Comparative study by means of interaction among participants is considered to be an extremely valuable characteristic of the course.

During the course, the Institute conducts a field trip to selected military and government agencies in the Washington, D.C. area. This trip provides an opportunity for the participants to receive special briefings on management techniques and problems and to observe actual practices at the operating level.

In the second half of the course, the general concepts of defense management are elaborated in detail during the examination of actual systems in financial, material and human resources management. At the end of the course, a general review integrates the formal course material, special topics and field trip experiences.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE (SIDMC)
Enrollment is restricted to military flag and general officers (grades 0-7 and above) and defense-related civilians of equivalent rank, except that for countries where the 0-6 grade is comparable to flag/general rank, such officials may be enrolled on a waiver basis.

Participation in this course is normally from 50 to 54 senior officials from as many as 45 countries.

The course is presented in English.

The lecture, small discussion group, case study and problem format and content described above for the International Defense Management Course also apply, but are compressed in time. Two or three guest speakers are invited to address the class and a short field trip is conducted.

DEFENSE RESOURCES MANAGEMENT INSTITUTE
FISCAL YEAR 2000

COURSE NAME	COURSE NUMBER	LENGTH (weeks)	DATES (inclusive)
International Defense Management Course*	IDMC 99-2	11	27 SEP - 10 DEC 1999
Defense Resources Management Course	DRMC 00-1	4	10 JAN - 04 FEB 2000
International Defense Management Course	IDMC 00-1	11	07 FEB - 19 APR 2000
Defense Resources Management Course	DRMC 00-2	4	24 APR - 18 MAY 2000
Defense Resources Management Course	DRMC 00-3	4	22 MAY - 16 JUN 2000
29th Annual Senior International Defense Management Course	SIDMC 2000	4	26 JUN - 21 JUL 2000
Defense Resources Management Course	DRMC 00-4	4	24 JUL - 17 AUG 2000
Defense Resources Management Course	DRMC 00-5	4	21 AUG - 15 SEP 2000
International Defense Management Course*	IDMC 00-2	11	25 SEP - 08 DEC 2000

* These courses convene in one fiscal year and continue into the next fiscal year.

DISTRIBUTED LEARNING PROGRAMS

Video Tele-Education
Tracy Hammond
Deputy Associate Provost for Instruction
Code 01B1, Root Hall, Room 100
(831) 656-3059, DSN 878-3059
e-mail: thammond@nps.navy.mil

Internet Based Instruction
Tom R. Hazard
Executive Officer for Education Technology
Code 01B1, Root Hall, Room 103F
(831) 656-3580, DSN 878-3580
e-mail: trhazard@nps.navy.mil

Established in 1994, the Distributed Learning Programs at the Naval Postgraduate School offers four degree programs from the following academic departments: Computer Science, Electrical and Computer Engineering, Mechanical Engineering, and Systems Management. Among the advantages of the Distributed Learning Programs are:

DoD Relevance.
Programs are designed to meet current and future DoD needs in the areas of advanced military technology and operational capability.

Custom Options.
We design custom curricula to meet an agency's specific graduate-education needs in engineering, applied sciences, operational research, or management.

Minimal Job Interference.
Although students are not physically on campus, they are virtually in residence at NPS through the latest in real-time, interactive-video-teleconferencing technology. Courses require only three to five hours per week of classroom participation and are conducted during normal working hours.

Quality Learning.
Students participate simultaneously with resident NPS students. Office hours with the professors allow a student to further clarify course concepts and homework assignments.

Cost Effectiveness.
Cost per student is highly competitive with the local universities or other distributed-learning options. Courses are paid for by the sponsoring agency on a negotiated, fixed-fee basis.

ADMISSION TO DEGREE PROGRAM

Students wishing to enroll in a Distributed Learning Program with the object of earning a degree must formally request admission and must be accepted in that program. Requests for admission must be accompanied by official (sealed) transcripts of all previous college work.

For more information contact:
Director of Admissions
Code 01B3, Naval Postgraduate School,
589 Dyer Road, Room 103C
Monterey, CA 93943-5100
Telephone (831) 656-3093/ DSN 878-3093
Fax: (831) 656-2891
e-mail:grad-ed@nps.navy.mil

ADMISSION TO INDIVIDUAL CLASSES

Students not enrolled in a degree program may wish to enroll in courses. This can be done by simply registering for the courses of interest. For more information, contact the Academic Department Coordinator for the appropriate department.

Electrical and Computer Engineering
Jeff Knorr, Chair and Professor
(831) 656-2815, DSN 878-2815
Fax: (831) 656-2081
e-mail: jknorr@nps.navy.mil

John Powers, Professor
(831) 656-2679, DSN 878-2679
e-mail: jppowers@nps.navy.mil

Mechanical Engineering
Terry R. McNelley, Professor
(831) 656-2589, DSN 878-2589
Fax: (831) 656-2238
e-mail: tmcnelley@nps.navy.mil

Software Engineering
Man-Tak Shing, Associate Professor
(831) 656-2634, DSN 878-2634
Fax: (831) 656-2814
e-mail: mantak@cs.nps.navy.mil

Systems Management
Wally Owen, Professor
(831) 656-2048, DSN 878-2048
Fax: (831) 656-2407
e-mail: wowen@nps.navy.mil

Acquisition Degree Programs
David V. Lamm
(831) 656-2775, DSN 878-2775, Fax: (831) 656-2447
e-mail: dlamm@nps.navy.mil

JOINT PROFESSIONAL MILITARY EDUCATION

Chairman
Fred P. Drake
Professor
Glasgow Hall
Room 231
(831) 656-3003
DSN 878-3003

Associate Chair:
Harold D. Blanton
Associate Professor
Glasgow Hall
Room 229
(831) 656-2302
DSN 878-2302

Harold D. Blanton, Associate Professor (1999); PhD, Florida State University,1999.

R. Mitchell Brown, III, Associate Professor (1999); MA, Naval Postgraduate School, 1980; MBA, Wharton (University of Pennsylvania), 1976.

Fred P. Drake, Professor (1999); MA, U.S. Naval War College, 1996; MS, Troy State
University, 1988.

Kenneth J. Hagan, Professor (1999); PhD, Claremont Graduate School, 1970; Professor Emeritus, U.S. Naval Academy.

Douglas V. Smith, Distinguished Visiting Professor (1999); MA, U.S. Naval War College, 1988, MS, Naval Postgraduate School, 1983.

Donald J. Stoker, Associate Professor (1999); PhD, Florida State University, 1997.

PROFESSIONAL MILITARY EDUCATION (PME) AND JOINT PROFESSIONAL MILITARY EDUCATION (JPME)

The U.S. Naval War College curricula offered at NPS meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for Joint PME (as established by the Chairman, Joint Chiefs of Staff) for Intermediate Level Professional Military Education. The importance of offering a program that blends graduate level study with Joint Professional Military Education (JPME) was recognized in the early 1990s by NPS. Originally called the Joint Education Electives Program (JEEP) when it debuted in 1993, the program's name was changed to the Program for Joint Education (PJE) to make its terminology consistent with current military education policy. In academic year 1999-00, NPS teamed with the U.S. Naval War College (NWC), Newport, RI, to provide a tailored program for NPS students which leads to a Naval War College diploma and PJE Phase I certification. It should be recognized that the courses described below are Naval War College courses, which are taught by Naval War College faculty. As such, course content, teaching methodology and program management are the sole responsibility of the Naval War College. The entire three-course sequence of Strategy and Policy, National Security Decision Making and Joint Maritime Operations has been reviewed and approved through the Program for Accreditation of Joint Education (PAJE) process conducted at the Naval War College's College of Continuing Education.

The three-course NWC program provides coverage of all mandatory "learning areas" outlined in CJCS's Officer Professional Military Education Policy (OPMEP), CJCSINST 1800.01. The NWC program, both at NPS and on the College's main campus in Newport, RI, provides instruction in three course areas: *Strategy and Policy* (S&P), *National Security Decision Making* (NSDM), and *Joint Maritime Operations* (JMO). Effective in September 1999, the S&P curriculum replaces the NPS course *Maritime Strategy* NS-3252, which has been mandatory for all Department of the Navy (DON) students since 1989. Completion of the NWC S&P course is a mandatory requirement that must be met by all DON students. The JMO and NSDM courses replace or supplement various other NPS offerings, and these courses may be taken on a voluntary basis.

Note: Phase I PJE certification will only be earned by students who complete the entire three-course sequence: i.e., the mandatory S&P course plus NSDM and JMO.

Transcripts of those students who complete the Intermediate Level PME and the JPME Phase I courses, through any combination of the three methodologies (resident seminar, nonresident seminar and independent directed study) will be annotated to verify their qualification for JPME Phase I certification.

In order to provide NPS students with the maximum degree of flexibility, the NWC program in Monterey will provide study in the three topical areas in a variety of ways. Classes will be offered as traditional "daytime" courses, as "evening study" seminars, and/or as "mentored independent directed study". Each student should select the approach that is best suited to their educational needs and best aligns with their other graduate studies at NPS.

All versions of the NWC courses are academically rigorous and will require significant effort on the part of each student. The goal is to enable each student to earn both their NPS degree and the NWC diploma (and Phase I JPME). It should be recognized, however, that students who cannot complete all of the NWC requirements while in Monterey can enroll in the remaining NWC courses (either by seminar or correspondence) at their next (or a subsequent) duty station.

STRATEGY AND POLICY: The Strategy and Policy Course is founded on the Clausewitzian premise that "*war is a continuation of policy with the addition of other means*." This concept dictates the subject matter of the course, as well as the unique manner in which the material is presented. The program of study is designed to prepare the military officer for the advanced stages of a professional career in which he or she may be intimately involved in the interplay between military power and the political process -- that is, between strategy and policy. The course uses historical examples to demonstrate the military officer's urgent need for a joint and combined warfare perspective on the military profession. That perspective significantly enhances the ability of strategic thinkers and war-fighters to wield the military instrument in support of national goals. In the early stages of an officer's career he or she is trained in tactics. The S&P curriculum, in contrast, is designed to teach officers to think strategically. The course illustrates the relationship between a nation's political interests and goals and the ways military force may be used to achieve them. It focuses on the seamless line that begins with interests, continues through conflict and ends with the final post-war settlement. Academic disciplines are harnessed for that purpose, including history, political science, military studies, and international relations. The curriculum weaves them into a coherent analysis of how wars begin, how they are fought and how they end.

The Strategy and Policy Course hones the officer's ability to analyze past operations and apply historical lessons to future joint and combined operations. Three facets of the course develop strategic thought. First and foremost, the course focuses extensively on the strategic analyses that are the cornerstone of strategic thought, particularly the works of Clausewitz, Sun Tzu, Mahan and Corbett. Second, the masters' work is used to analyze strategic decisions made during several historical conflicts. Collectively these case studies sharpen the student's understanding of the essence of strategy. Clear, objective and imaginative thinking is the framework for the third and final part of the curriculum, in which students consider recent wars as well as conflicts that may occur in the future.

The Strategy and Policy course will be conducted each quarter and will consist of a series of seven topics centered on "Wars of the American Experience." These topics include the Land and Naval Theorists, American Revolution, American Civil War, World War II, The Cold War and Korea, Vietnam, and The Gulf War with a Retrospect and Prospect conclusion. Students will attend two lectures and two follow-on moderated seminars for each topic. The curriculum addresses themes such as: the policy to strategy match; intelligence assessment and planning; the instruments of war; the implementation and integration of strategy; war termination and post-war settlement; and, the international, material, institutional and social dimensions of strategy.

Note: The majority of students are expected to complete S&P via the daytime course (NW-3230). However, evening seminar and correspondence versions of this course may be available in the future.

NATIONAL SECURITY DECISION MAKING: The National Security Decision Making curriculum educates military officers in the effective selection and leadership of armed forces within national resource constraints, providing instruction in: the strategic planning and selection of future military forces; systematic approaches to programmatic resource choices under conditions of high uncertainty; and the nature of economic, political, organizational and behavioral factors affecting selection and command of military forces. The NSDM curriculum is an executive development course wherein major emphasis is placed on the preparation of officers for intermediate-level command and staff assignments. Selection of concepts and materials is predicated on the belief that an effective career executive does not apply discrete disciplines, but rather is required to synthesize many disciplines relevant to different situations. Moreover, the appropriate point of view is an integrative one that seeks a balanced use of reasoning based on both an academic and professional foundation. For this reason, the NSDM curriculum employs a multidiscipline approach, synthesizing selected concepts from economics, political science, strategy, operations research, leadership, psychology, management control, and other related fields. All instruction seeks to utilize the broad experience of the student body and focuses on making and implementing critical decisions within the national security environment. NSDM is offered either as an independent directed study or a nonresident seminar course. The independent directed study course requires six months to complete while the nonresident seminar meets one night a week for thirty-two weeks.

JOINT MARITIME OPERATIONS: The Joint Maritime Operations curriculum develops the ability to translate contemporary national and regional military strategies into naval, joint, and multinational operations, with particular emphasis on the operational art and employment of the Sea Services. Thus, it enables officers to make sound operational decisions in both command and staff positions. JMO is an executive development course that emphasizes planning and decision-making factors at the joint task force level for operations in the maritime environment. Operational problems require military officers to make increasing use of many disciplines. This differs from the past where application of a single discrete discipline was more often the norm. Officers must have a firm grasp of military strategy, an understanding of joint and combined operations, and a thorough background in the essential elements of the military planning and decision-making process to deploy, employ and sustain U.S. military forces efficiently and successfully. Consequently, the JMO course employs a multi-discipline approach, providing the student the opportunity to synthesize various ideas that include maritime strategy, joint and Service doctrine, military decision-making, operational planning, naval warfare, military warfare, threat assessment, and war gaming techniques. JMO *applies* these ideas to military problems requiring decisions in dynamic situations. The integrating themes of the course are joint maritime operations, the operational level of war, and military decision-making. Emphasis is placed on the ability to identify the military conditions required to achieve strategic goals, the required sequence of actions, resources and associated costs or risks in that process. JMO will be offered as either an independent directed study or a nonresident seminar similar to NSDM. However, completion of the independent directed study course requires twelve months. The nonresident seminar meets one night a week for thirty-two weeks.

JOINT PROFESSIONAL MILITARY EDUCATION COURSE DESCRIPTIONS

NW3210 NATIONAL SECURITY DECISION MAKING: DIRECTED STUDY - PART I (RESOURCE ALLOCATION: RA + POLICY MAKING AND IMPLEMENTATION: PMI) (2 - 0).
This is a directed study course, which will be augmented by scheduled discussion sessions. These sessions are voluntary, but students are encouraged to participate in order to get the most from the course of study. The overall National Security Decision Making (NSDM) course is comprised of three sub-courses, two of which will be covered during this period of directed study. The Resource Allocation (RA) sub-course deals with the Planning, Programming and Budgeting System (PPBS), and structured decision-making in the national security environment. The Policy Making and Implementation (PMI) sub-course deals with the political, organizational, and behavioral influences on decision-making, as well as strategies for leading large, complex national security organizations. First of a sequence of two NSDM courses, must be followed by NW3211. OFFERED: Winter, Spring and Summer quarters.

NW3211 NATIONAL SECURITY DECISION MAKING: DIRECTED STUDY - PART II (STRATEGY AND FORCE PLANNING: SFP) (2 - 0).
This period of directed study will focus on the third of the three components of the NSDM course. The Strategy and Force Planning (SFP) sub-course addresses how a nation establishes interests and develops a national security strategy, a supporting military strategy, and then buys forces to support these decisions. The two-course sequence of NW3210 and NW3211 must be taken over a two-quarter period. Completion of these two courses will earn four graduate credit hours, and represents one-third of the entire NWC program. PREREQUISITE: NW3210. OFFERED: Winter, Spring and Summer quarters.

NW3220 JOINT MARITIME OPERATIONS: DIRECTED STUDY - PART I (BLOCKS 1&2) (1 - 0).
The Joint Maritime Operations (JMO) course provides instruction in the organization and employment of joint and combined military forces in maritime contingencies. This course is divided into six blocks of instruction, which are designed to be completed over three academic quarters. This is a directed study course, which students may pursue at their own pace. NWC faculty will hold periodic discussion sessions (which are not mandatory) to assist students with completing the assigned work. First of a sequence of three JMO courses, must be followed by NW3221 and NW3222. OFFERED: Fall and Summer quarters.

NW3221 JOINT MARITIME OPERATIONS: DIRECTED STUDY - PART II (BLOCKS 3&4) (1 - 0).
PREREQUISITE: NW3220. (See NW3220 for info). OFFERED: Winter quarter.

NW3222 JOINT MARITIME OPERATIONS: DIRECTED STUDY - PART III (BLOCKS 5&6) (2 - 0).
Completion of the three course sequence (NW3220, NW3221, and NW3222) will earn four graduate credit hours, and represents one-third of the entire NWC program. PREREQUISITES: NW3220 and NW3221. (See NW-3220 for info). OFFERED: Spring quarter.

NW3223 JOINT MARITIME OPERATIONS: ACCELERATED DIRECTED STUDY - PART I (BLOCKS 1, 2, &3) (2 - 0).
This course is intended for students using JMO to replace an elective course in their degree program. The course content is identical to that offered in NW3220, NW3221, and NW3222, but the coursework is completed over a two-quarter period. First of a sequence of two JMO courses, must be followed by NW3224. OFFERED: Fall and Spring quarters.

NW3224 JOINT MARITIME OPERATIONS: ACCELERATED DIRECTED STUDY - PART II (BLOCKS 4, 5, &6) (2 - 0).
Completion of the two course sequence (NW3223 and NW3224) will earn four graduate credit hours, and represents one-third of the entire NWC program. PREREQUISITE: NW3223. (See NW3223 for info). OFFERED: Winter and Summer quarters.

NW3230 STRATEGY AND POLICY: THE AMERICAN EXPERIENCE (4 - 0).
This course is a tailored version of the Strategy and Policy (S&P) course taught at the NWC in Newport, RI. It has been revised to focus on the critique of strategies and their utility in achieving a nation's policy objectives. The course utilizes case studies derived from the American experience. This course is mandatory for all DON students, and it will be taught by NWC faculty during the normal academic day. (This course replaces the previously mandatory course NS3252 Maritime Strategy). Completion of this course will earn four graduate credit hours, and represents one-third of the entire NWC program. OFFERED: All quarters.

NW3240 STRATEGY AND POLICY: DIRECTED STUDY - PART I (2 - 0).
* Admission by special permission only. This course represents a directed study version of the S&P course, which will be available only to students with special circumstances that preclude them from taking NW3230. First of a sequence of two Strategy and Policy courses, must be followed by NW3241. OFFERED: As needed.

NW3241 STRATEGY AND POLICY: DIRECTED STUDY - PART II (2 - 0).
* Admission by special permission only. (See NW3240 for info). PREREQUISITE: NW3240. OFFERED: As needed.

NW3250 STRATEGY AND POLICY: NONRESIDENT SEMINAR- PART I (2 - 0).
This provides is a more detailed coverage of S&P topics than is offered in NW3230. It closely follows the course of study in the resident program at the NWC. It is a faculty- led seminar class, taught in the evening in three segments of one quarter each. Since it is in greater depth, completion of the 3-course sequence earns seven graduate credit hours, and represents one-third of the entire NWC program. First of a sequence of three Strategy and Policy courses, must be followed by NW3251 and NW3252. OFFERED: Summer quarter AY 99-00.

NW3251 STRATEGY AND POLICY: NONRESIDENT SEMINAR- PART II (2 - 0).
This course is the second (sequential) part of the S&P evening study program. PREREQUISITE: NW3250. OFFERED: Fall quarter AY 00-01.

NW3252 STRATEGY AND POLICY: NONRESIDENT SEMINAR- PART III (3 - 0).
This course is the third (sequential) part of the S&P evening study program. PREREQUISITES: NW3250 and NW3251. OFFERED: Winter quarter AY 00-01.

NW3260 NATIONAL SECURITY DECISION MAKING: NONRESIDENT SEMINAR- PART I (2 - 0).
This course provides more detailed coverage of NSDM topics than is offered in the directed study program. It closely follows the course of study in the resident program at the NWC. It is a faculty-led seminar class, taught in the evening in three segments of one quarter each. Since it is in greater depth, completion of the 3-course sequence earns seven graduate credit hours, and represents one-third of the entire NWC program. First of a sequence of three NSDM courses, must be followed by NW3261 and NW3262. OFFERED: Fall quarter AY 99-00.

NW3261 NATIONAL SECURITY DECISION MAKING: NONRESIDENT SEMINAR- PART II (2 - 0).
This course is the second (sequential) part of the NSDM evening study program.
PREREQUISITE: NW3260. OFFERED: Winter quarter AY 99-00.

NW3262 NATIONAL SECURITY DECISION MAKING: NONRESIDENT SEMINAR- PART III (3 - 0).
This course is the third (sequential) part of the NSDM evening study program.
PREREQUISITES: NW3260 and NW3261. OFFERED: Spring quarter AY 99-00.

NW3270 JOINT MARITIME OPERATIONS: NONRESIDENT SEMINAR- PART I (2 - 0).
This course provides more detailed coverage of JMO topics than is provided in the directed study program. It closely follows the course of study in the resident program at the NWC. It is a faculty-led seminar class, taught in the evening in three segments of one quarter each. Since it is in greater depth, completion of this course earns seven graduate credit hours, and represents one-third of the entire NWC program. First of a sequence of three JMO courses, must be followed by NW3271 and NW3272. OFFERED: Fall quarter AY 99-00.

NW3271 JOINT MARITIME OPERATIONS: NONRESIDENT SEMINAR- PART II (2 - 0).
This course is the second (sequential) part of the JMO evening study program. PREREQUISITE: NW3270. OFFERED: Winter quarter AY 99-00.

NW3272 JOINT MARITIME OPERATIONS: NONRESIDENT SEMINAR - PART III (3 - 0).
This course is the third (sequential) part of the JMO evening study program. PREREQUISITES: NW3270 and NW3271. OFFERED: Spring quarter AY 99-00.

SCHOOL OF AVIATION SAFETY

Rodney L. Casey, CAPT, U.S. Navy; Director (1998); B.S.M.E., Oregon State University, 1970.

Brian P. Wood, CDR, U.S. Navy; Associate Director (Military Affairs); Lecturer in Aviation Safety Programs (1998); BS, U.S. Naval Academy, 1980.

Milton Harold Bank, II, Associate Director (Academic Affairs); Associate Professor of Aeronautical Engineering and Safety (1971); PhD, Georgia Institute of Technology, 1971.

Glenn C. Cooper, LCDR, U.S. Navy, Lecturer in Fixed-Wing Aerodynamics (1998); MSAE, University of Tennessee, 1995.

Robert C. Figlock, Visiting Assistant Professor of Safety Psychology (1999); MS, University of Southern California, 1982.

Todd C. Hyson, MAJ, U.S. Marine Corps; Lecturer in Mishap Investigation (1999); BS (Chemistry), Pennsylvania State University, 1975.

Christopher F. Keene, MAJ, U.S. Marine Corps; Lecturer in Rotary-Wing Aerodynamics (1998); MSAE, Naval Postgraduate School, 1998.

Edward John Kennedy, Senior Lecturer in Aviation Physiology (1972); MD, University of Iowa College of Medicine, 1962.

William F. Miller, CAPT, U.S. Navy; Assistant Professor of Aerospace Medicine (1998); MD, Baylor College of Medicine, 1978.

Stephen P. Robey, LCDR, U.S. Navy; Lecturer in Aviation Safety Information Management (1999); MSEE, Naval Postgraduate School, 1995.

John K. Schmidt, LCDR, MSC, U.S. Navy; Assistant Professor of Psychology (1997); PhD, University of Houston, 1987.

Markus A. Woehler, CDR, U.S. Navy; Lecturer in Aviation Safety Programs (1995); BA (Economics), University of California at Los Angeles, 1979.

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

AVIATION SAFETY OFFICER COURSE

An Aviation Safety Officer (ASO) course is offered seven times each year on a temporary additional duty basis for those commands needing an Aviation Safety Officer. This course prepares the graduate to assist his or her commanding officer in conducting an aggressive mishap prevention program. When the ASO completes the course he or she will be able to organize and administer a mishap prevention program at the squadron level as defined in OPNAVINST 3750.6.

This twenty-eight instructional-day course consists of approximately 165 classroom and laboratory hours. Subjects addressed include safety programs, operational risk management and mishap prevention techniques, operational aerodynamics and aerostructures, mishap investigation and reporting, psychology, human factors, safety law and aeromedical support.

Prior completion of college-level courses in algebra and physics is highly desirable for the prospective student. Designated naval aviators and naval flight officers of the Navy and Marine Corps in the rank of Lieutenant, USN or Captain, USMC (or equivalent), and above are eligible to attend. Exceptions must be approved by the Director, School of Aviation Safety. Details of quota control and class schedules are defined in NAVPGSCOLNOTE 1520.

Resident Students

Officers regularly enrolled in other curricula of the Naval Postgraduate School may qualify for the Aviation Safety Officer Certificate by completing these required courses: AO2020, AO2030, AO3000, AO3010 and AO3040. Substitutions of equivalent courses taken in other departments for some of these courses may be made upon approval of the Director of the School of Aviation Safety. For example, AO2020 may be replaced by upper division or graduate courses in aeronautical engineering which cover the essential subject matter of the course.

AVIATION SAFETY COMMAND COURSE

An Aviation Safety Command (ASC) course is offered nine times each year on a temporary additional duty basis to commanding officers, executive officers, officers in charge of aviation detachments, officers screened for command and staff officers in the rank of Lieutenant Commander, USN, Major, USMC and above. This course is designed to provide information which will assist commanding officers in conducting an aggressive mishap prevention program and to prepare the graduate for the duties of Senior Member of a Mishap Board.

The course consists of approximately 35 classroom and laboratory hours over five instructional days, addressing subjects including safety programs, safety psychology and human factors, aviation law, aircraft systems, mishap investigation techniques, mishap and incident reports and endorsements and aerospace medicine.

No academic credit is given for this course.

SCHOOL OF AVIATION SAFETY COURSE DESCRIPTIONS

AO2020 AERODYNAMICS FOR AIRCRAFT ACCIDENT PREVENTION AND INVESTIGATION (2 - 0).
Survey of aerodynamics, performance, stability and control, with emphasis on pre-mishap hazard identification and risk management. Effects of varying designs, configurations, atmospheric conditions, crew techniques and degraded aircraft capabilities on critical areas of operation are discussed and related to current mishap experience. Introduction to current aircraft technology and future design considerations. (Taught in separate rotary-wing and fixed-wing sections).

AO2030 AIRCRAFT STRUCTURAL ANALYSIS (1 - 0).
Fundamentals of strength of materials, design criteria, and theories of failure. Buckling. Effects of stress concentrations; fatigue process and fatigue life management. Identification of static and fatigue fractures. Introduction to composite materials technology.

AO3000 MANAGEMENT OF ACCIDENT PREVENTION PROGRAMS (2 - 1).
Management theories and practices with emphasis on planning, leading, organizing and controlling. Automatic data-processing systems and analysis of accident statistics. Organizational effectiveness theory and techniques as applied to Navy safety programs. Systems safety theories and techniques applied to hazard detection, analysis, and Operational Risk Management. Group dynamics and human behavior.

AO3010 SAFETY INFORMATION MANAGEMENT (2 - 1).
Techniques of mishap investigation and reporting. Introduction to causation analysis, including deductive and inductive methods. Witness interviewing techniques. The legal doctrine of Safety Privilege. Organization and administration of investigative boards and commissions. Through case studies, laboratory and field exercises, the course provides practical experience in investigating and reporting simulated aircraft mishaps.

AO3040 SAFETY PSYCHOLOGY/HUMAN FACTORS (2 - 0).
Applied psychological and physiological principles in aircraft mishap investigation and prevention. A survey of human performance factors in mishap causation. Human factors related to safe and effective behavior in high performance/ high risk environments, covering capabilities and limitations in sensation and perception, knowledge and skill acquisition motivation and emotion, stress and social adjustment, communication and interpersonal skills.

AO3100 MANAGEMENT OF ACCIDENT-PREVENTION PROGRAMS (3 - 2).
Management theories, practices, communications and controls; automatic data-processing and analysis of accident statistics; legal consideration in safety management; use of systems safety in hazard identification.

AO3120 TECHNOLOGICAL ASPECTS OF ACCIDENT-PREVENTION AND ANALYSIS (3 - 2).
Topics include case studies of technological design-related aviation mishaps; identification of structural failure modes; computer and simulator methods in aeronautics; safety-related problems of Navy weapons systems evaluation and acquisition.

APPENDICES

APPENDIX A: DISTINGUISHED ALUMNI

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers (USN unless otherwise indicated) have attained flag rank and were on the active list as of July 1999:

General John A. Gordon, USAF
Admiral Joseph P. Reason

Vice Admiral James F. Amerault
Vice Admiral Arthur K. Cebrowski
Vice Admiral Lee F. Gunn
Lieutenant General David Kenneth Heebner, USA
Vice Admiral John A. Lockard
Vice Admiral Joseph S. Mobley
Vice Admiral Edward Moore, Jr.
Vice Admiral Robert J. Natter
Vice Admiral Patricia A. Tracey

Brigadier General Keith Alexander, USA
Rear Admiral Phillip Balisle
Rear Admiral Kenneth Barbor
Brigadier General John Batiste, USA
Rear Admiral (S) Dale E. Baugh
Rear Admiral Timothy R. Beard
Rear Admiral John J. Bepko, III
Rear Admiral (S) Linda J. Bird
Rear Admiral (S) Richard Brooks
Rear Admiral John E. Boyington
Rear Admiral (S) Annette E. Brown
Rear Admiral John F. Brunelli
Colonel (P) William B. Caldwell, IV, USA
Rear Admiral Robert C. Chaplin
Rear Admiral Albert T. Church
Rear Admiral William W. Cobb
Rear Admiral John P. Davis
Rear Admiral James C. J. Dawson
Major General Robert F. Dees, USA
Rear Admiral (S) Dennis M. Dwyer
Rear Admiral Joseph W. J. Dyer
Rear Admiral Lillian Fishburne
Colonel (P) George A. Fisher, Jr., USA
Rear Admiral Rand H. Fisher
Rear Admiral John A. Gauss
Rear Admiral Kevin P. Green
Major General Michael W. Hagee, USMC
Rear Admiral James B. Hinkle
Rear Admiral Edward E. Hunter
Rear Admiral Lowell E. Jacoby
Rear Admiral Gwilym H. Jenkins
Rear Admiral (S) Charles Johnston
Rear Admiral Herbert C. Kaler
Rear Admiral Stephen T. Keith, USNR
Rear Admiral (S) John M. Kelly
Rear Admiral Curtis A. Kemp
Rear Admiral Timothy W. Lafleur
Major General Paul M. Lee, USMC
Rear Admiral (S) Anthony Lengerich
Rear Admiral Keith W. Lippert
Rear Admiral Peter A. C. Long
Rear Admiral John T. Lyons, III
Rear Admiral William Marshall
Rear Admiral Peter Marzluff
Rear Admiral Michael Mathis
Rear Admiral Richard W. Mayo
Rear Admiral Justin D. McCarthy
Rear Admiral Joseph J. McClelland, Jr., USCG
Rear Admiral Dennis Morral
Rear Admiral Michael G. Mullen
Rear Admiral Richard J. Naughton
Rear Admiral Larry D. Newsome
Rear Admiral Robert M. Nutwell
Rear Admiral Robert Olsen, USCG
Rear Admiral (S) Eric T. Olson
Rear Admiral John Paddock, Jr.
Rear Admiral Kathleen K. Paige
Rear Admiral Ronald A. Route
Brigadier General Ricardo Sanchez, USA
Rear Admiral David P. Sargent, Jr.
Rear Admiral Kenneth Slaght
Rear Admiral Raymond C. Smith, Jr.
Major General James Ralph Snider, USA
Rear Admiral Paul O. Soderberg
Rear Admiral Robert G. Sprigg
Rear Admiral (S) David M. Stone
Rear Admiral Stanley Szemborski
Rear Admiral James L. Taylor
Colonel (P) Thomas Turner, USA
Rear Admiral Henry G. Ulrich
Colonel (P) John M. Urias, USA
Colonel (P) Michael A. Vane, USA
Rear Admiral (S) George Voelker
Major General William Scott Wallace, USA
Rear Admiral George R. Yount

APPENDIX B: AWARDS FOR GRADUATES

Monterey Peninsula Council Navy League Award for Outstanding Academic Achievement
Presented quarterly to graduating USN, USMC, USCG, or NOAA student who has maintained an outstanding academic record as exhibited by academic achievement, thesis research, motivation, and community involvement.

Naval Postgraduate School Outstanding Academic Achievement Award for Department of Defense Students
Presented quarterly to a graduating USA, USAF, or Department of Defense civilian who has maintained an outstanding academic record as exhibited by academic achievement, thesis research, motivation, and community involvement.

Naval Postgraduate School Outstanding Academic Achievement Award for International Students
Presented quarterly to a graduating military or civilian non-U.S. citizen student who has exhibited outstanding academic achievement, conducted notable thesis research, maintained motivation and a serious interest in the community, and who has interacted well with other students in the interest of international alliance.

Naval Postgraduate School Superior Service Award
Presented to a graduating student who has demonstrated outstanding dedication to service while at NPS. The award is presented on the basis of superior contributions to the student body, professional community, and local Monterey area.

Marine Corps Association Superior Service Award for Outstanding U.S. Marine Student
Presented quarterly to the graduating U.S. Marine Corps student in any curriculum for superior service. The award is presented on the basis of superior contributions to the student body, professional community, and local Monterey area.

Carl E. Menneken Research Award
Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions. Both staff members and students are eligible for this award.

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

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

Armed Forces Communications and Electronics Association Award
Presented to the officer graduate who has achieved academic excellence and best demonstrated professional qualities in one of the following programs: Electronics and Communications; Joint Command, Control, Communications, Computers and Intelligence (C4I) and NSA Intelligence.

Military Operations Research Society Stephen A. Tisdale Graduate Research Award
Presented in recognition of outstanding achievement in graduate research directed toward improving military force utilization. The primary award criterion is research which leads to demonstration of or potential for increased operating effectiveness of currently available or near term assets.

Chief of Naval Operations Award for Excellence in Operations Research
Presented semiannually to the outstanding USN or USMC graduate of the Operation Research program on the basis of academic achievement, experience tour performance, thesis work and demonstration of those qualities indicative of an outstanding military officer.

Army Chief of Staff Award for Excellence in Operations Research
Presented semiannually to an outstanding U.S. Army student in the Operations Research Curriculum on a basis of academic achievement, research excellence, experience tour performance, and military professionalism.

Admiral William Adger Moffett Award (Aeronautics)
Presented annually to an officer student in the Aeronautical Engineering program on the basis of academic excellence, including thesis, and career potential.

Chief of Naval Operations Communications Award
Presented in recognition of distinguished academic achievement in the Electronics Systems Engineering program to that graduate who has attained an outstanding academic record and who exhibited those qualities of an outstanding military officer.

Space and Naval Warfare Systems Command Award in Electronic Systems Engineering
Presented semiannually to a graduating student for distinguished academic achievement in the advanced Electronics Engineering program.

Naval Sea Systems Command Award for Weapons Systems Engineering and Excellence
Presented in recognition of distinguished scholastic achievement in Weapons Systems Engineering. Selection is based on marks attained, quality and applicability of thesis and demonstrated leadership potential in the field of Weapons Engineering and Excellence.

Naval Undersea Warfare Center Award for Excellence in Undersea Warfare Systems Technology
Presented annually to any NPS officer student who successfully completes a curricular program and a thesis that relates to one or more of the NSWC surface warfare product lines.

Chief of Naval Operations Information Warfare Award
Presented in recognition of excellence in the Information Warfare Systems Engineering program to that graduate who has attained and outstanding academic record and who has exhibited outstanding leadership qualities.

Joint Assistant Secretary of Navy (Research, Development and Acquisition) American Defense Preparedness Award for Excellence in Undersea Warfare Technology
Presented annually at the March graduation ceremony to an outstanding officer student who successfully completes any curricular program and a thesis which demonstrates outstanding potential for application to undersea warfare technology.

Chief of Naval Operations Undersea Warfare Award
Sponsored by the National Security Industrial Association and presented in recognition of distinguished academic achievement to the USW Curriculum graduate who has demonstrated outstanding academic performance and exhibited those qualities indicative of an outstanding military officer.

Captain John C. Woelfel Award
Presented each June to the outstanding Naval Engineering program officer graduate on the basis of academic and leadership qualities and performance. Officers from the past September, December, March and the present June graduation are considered.

Naval Sea Systems Command Award in Naval Engineering
Presented in recognition of distinguished academic achievement in the Naval Engineering Program. The criteria for the award includes demonstrated academic excellence measured by marks attained, contents of thesis, and demonstrated leadership potential in Naval Engineering.

Oceanographer of the Navy Air-Ocean Sciences Award
Awarded annually to an Air-Ocean Sciences graduate with outstanding academic performance and exhibition of those qualities indicative of an outstanding military officer.

Rear Admiral Thomas R. McClellan Award for Academic Excellence in Systems Management
Presented to a graduate of Systems Management based upon academic performance, professional commitment, and leadership potential.

Chief of Naval Operations Award for Academic Excellence in Manpower Systems Analysis
Presented annually to an outstanding U.S. Naval Officer student or OP-01 sponsored civilian in the Manpower Systems Analysis curriculum. The award is based on an outstanding academic record, thesis quality and leadership ability.

Naval Supply Systems Command Award for Academic Excellence in Systems Management
Presented semiannually to an outstanding U.S. Naval Supply Corps officer in Systems Management at the Naval Postgraduate School. The award is made on the basis of academic achievement, research excellence, contribution to the professional and civilian community and faculty recommendations.

Department of the Navy Award for Academic Excellence in Financial Management
The award is presented semiannually to a Financial Management student who demonstrates overall academic performance, academic excellence in financial management courses, high leadership potential, future ability to contribute to professional, academic and public forums while meeting the highest standards of stewardship of the national trust and thesis excellence.

Systems Management Faculty Award for Excellence in Management
Presented to a graduating student in any of the Systems Management curricula. The award is based on exceptional academic ability and is presented only when the caliber of potential nominees is considered high enough to make a presentation of award.

Conrad Scholar Award for Distinguished Academic Excellence in Financial Management
Presented semiannually to an outstanding Unrestricted Line (URL) officer in the Financial Management community who has demonstrated academic excellence, presented a financial management essay for publication, and exhibited the potential for outstanding leadership while attending the Naval Postgraduate School.

Rear Admiral Grace Murray Hopper Computer Technology Award
Presented in recognition of excellence in the Computer Technology program to the outstanding graduate in Computer Science and Information Technology Management who has demonstrated outstanding academic performance, thesis quality and leadership ability.

United States Naval Institute Award
Presented to a student in the National Security and Intelligence curricula whose thesis is judged to be of the most importance to the U.S. Navy and meets the highest standards of excellence.

Joint Chiefs of Staff Command, Control and Communications Award for Academic Achievement
Presented annually to the outstanding graduate of the Joint Command, Control, Communications, Computers and Intelligence Program in recognition of distinguished academic achievement based on marks attained, quality of thesis and overall performance.

Space Systems Operations Award for Academic Excellence
Presented annually at the September commencement exercises to an outstanding student in Space Systems Operations who has graduated since the last award. Selection criteria for this award is based on Quality Point Rating, thesis, academic achievement, and extra curricula activities.

Space Systems Engineering Award for Academic Excellence
Presented annually at the June graduation to an outstanding Space Systems Engineering student. The award is made based on grade point average, thesis work, curricular and extra-curricular activities.

Astronaut Michael J. Smith, CAPT, USN, Astronautics Award
Presented annually to an outstanding graduate of the Space Systems Engineering or Space Systems Operations curricula. The award is made on the basis of the student’s academic excellence, including thesis, and career potential.

Monterey Kiwanis Club Outstanding Foreign Student Award
Presented annually at the September commencement exercises to two outstanding foreign students. Selection criteria for this award is based on academic standing and achievement, and involvement in community affairs.

Army Acquisition Corps Award for Scholastic Achievement
Presented to the graduating US Army Acquisition student who has exhibited outstanding academic excellence through academic achievement, thesis research, and leadership potential.

Systems Management Faculty Outstanding International Student Award
Presented to a graduating International student in any of the Systems Management curricula. The award is based on exceptional academic achievement and is presented only when the caliber of potential nominees is considered high enough to make a presentation of award.

American Society of Military Comptrollers Award for Excellence is Research (Graduate Level)
Presented semiannually to an outstanding graduate of the Financial Management curriculum. This award is based on the student's contributions to the field of financial management through innovative research and thesis quality.

APPENDIX C: AWARDS FOR FACULTY

The Carl E. and Jessie W. Menneken Annual Faculty Award for Excellence in Scientific Research
This monetary award is presented annually to a junior NPS faculty member in recognition of meritorious research which has significant identifiable impact on military technology. Funding for the award has been provided to the NPS Foundation by Mrs. Jessie W. Menneken. Presented at the December graduation if suitable candidates are nominated.

Carl E. Menneken Research Award
Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions. Both staff members and students are eligible for this award.

Distinguished Professor Award
Presented to a faculty member who has merited recognition for his or her scholarly accomplishments and lasting educational contributions to the Naval Postgraduate School. The recipient of this award joins a select group of faculty bearing the title of Distinguished Professor who has made significant impacts on the Naval Postgraduate School.

Rear Admiral John Jay Schieffelin Award for Excellence in Teaching
This monetary award is presented annually, at the June graduation, to recognize a faculty member who, through wide consensus, excels as a teacher. The consensus is ascertained through a ballot polling of current students and graduates. Funding for the award was provided to the NPS Foundation by a gift from Mr. William J. Schieffelin.

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ACADEMIC CALENDARS

ACADEMIC CALENDAR AY 2000

FALL QUARTER

Reporting Date	Monday, 20 Sep 1999
Instruction Begins	Monday, 27 Sep
Columbus Day (Holiday)	Monday, 11 Oct
Reporting Date for Refresher	Monday, 1 Nov
Refresher Begins	Monday, 8 Nov
Veteran's Day (Holiday)	Thursday, 11 Nov
Thanksgiving Day (Holiday)	Thursday, 25 Nov
Final Examinations Begin	Monday, 13 Dec
Graduation	Thursday, 16 Dec
Christmas Break	17 Dec 1999 - 7 Jan 2000
Christmas (Federal Holiday)	Friday, 24 Dec1999
New Year's (Federal Holiday)	Friday, 31 Dec 1999

WINTER QUARTER

Reporting Date	Monday, 3 Jan 2000
Instruction Begins	Monday, 10 Jan
Martin Luther King's Birthday (Holiday)	Monday, 17 Jan
Reporting Date for Refresher	Monday, 14 Feb
President's Day (Holiday)	Monday, 21 Feb
Refresher Begins	Tuesday, 22 Feb
Final Examinations Begin	Monday, 27 Mar
Graduation	Thursday, 30 Mar

SPRING QUARTER

Reporting Date	Monday, 27 Mar
Instruction Begins	Monday, 3 Apr
Reporting Date for Refresher	Monday, 8 May
Refresher Begins	Monday, 15 May
Memorial Day (Holiday)	Monday, 29 May
Final Examinations Begin	Monday, 19 Jun
Graduation	Thursday, 22 Jun
Summer Break	23 Jun - 7 Jul

SUMMER QUARTER

Reporting Date	Wednesday, 28 Jun
Independence Day (Holiday)	Tuesday, 4 Jul
Instruction Begins	Monday, 10 Jul
Reporting Date for Refresher	Monday, 14 Aug
Refresher Begins	Monday, 21 Aug
Labor Day (Holiday)	Monday, 4 Sep
Final Examinations Begin	Monday, 25 Sep
Graduation	Thursday, 28 Sep

ACADEMIC CALENDAR AY 2001

FALL QUARTER

Reporting Date	Monday, 25 Sep 2000
Instruction Begins	Monday, 2 Oct
Columbus Day (Holiday)	Monday, 9 Oct
Reporting Date for Refresher	Monday, 6 Nov
Veteran's Day (Holiday)	Friday, 10 Nov
Refresher Begins	Monday, 13 Nov
Thanksgiving Day (Holiday)	Thursday, 23 Nov
Final Examinations Begin	Monday, 18 Dec
Graduation	Thursday, 21 Dec
Christmas Break	22 Dec 2000 - 5 Jan 2001

WINTER QUARTER

Reporting Date	Tuesday, 2 Jan 2001
Instruction Begins	Monday, 8 Jan
Martin Luther King's Birthday (Holiday)	Monday, 15 Jan
Reporting Date for Refresher	Monday, 12 Feb
President's Day (Holiday)	Monday, 19 Feb
Refresher Begins	Tuesday, 20 Feb
Final Examinations Begin	Monday, 26 Mar
Graduation	Thursday, 29 Mar

SPRING QUARTER

Reporting Date	Monday, 26 Mar
Instruction Begins	Monday, 2 April
Reporting Date for Refresher	Monday, 7 May
Refresher Begins	Monday, 14 May
Memorial Day (Holiday)	Monday, 28 May
Final Examinations Begin	Monday, 18 Jun
Graduation	Thursday, 21 Jun
Summer Break	22 Jun - 6 Jul

SUMMER QUARTER

Reporting Date	Monday, 2 Jul
Independence Day (Holiday)	Wednesday, 4 Jul
Instruction Begins	Monday, 9 Jul
Reporting Date for Refresher	Monday, 13 Aug
Refresher Begins	Monday, 20 Aug
Labor Day (Holiday)	Monday, 3 Sep
Final Examinations Begin	Monday, 24 Sep
Graduation	Thursday, 27 Sep

ACADEMIC CALENDAR AY 2002

<u>Fall Quarter</u>	
Reporting Date	Monday, 24 Sept 2001
Instruction Begins	Monday, 1 Oct
Columbus Day (Holiday)	Monday, 8 Oct
Reporting Date for Refresher	Monday, 5 Nov
Veteran's Day (Observed)	Monday, 12 Nov
Refresher Begins	Monday, 12 Nov
Thanksgiving Day (Holiday)	Thursday, 22 Nov
Final Examinations Begin	Monday, 17 Dec
Graduation	Thursday, 20 Dec
Christmas Break	21 Dec 2001 - 4 Jan 2002
<u>Winter Quarter</u>	
Reporting Date	Wednesday, 2 Jan 2002
Instruction Begins	Monday, 7 Jan
Martin Luther King's Birthday (Holiday)	Monday, 21 Jan
Reporting Date for Refresher	Monday, 11 Feb
President's Day (Holiday)	Monday, 18 Feb
Refresher Begins	Tuesday, 19 Feb
Final Examinations Begin	Monday, 25 Mar
Graduation	Thursday, 28 Mar
<u>Spring Quarter</u>	
Reporting Date	Monday, 25 Mar
Instruction Begins	Monday, 1 April
Reporting Date for Refresher	Monday, 6 May
Refresher Begins	Monday, 13 May
Memorial Day (Holiday)	Monday, 27 May
Final Examinations Begin	Monday, 17 Jun
Graduation	Thursday, 20 Jun
Summer Break	21 Jun - 5 Jul
<u>Summer Quarter</u>	
Reporting Date	Monday, 1 Jul
Independence Day (Holiday)	Thursday, 4 Jul
Instruction Begins	Monday, 8 Jul
Reporting Date for Refresher	Monday, 12 Aug
Refresher Begins	Monday, 19 Aug
Labor Day (Holiday)	Monday, 2 Sep
Final Examinations Begin	Monday, 23 Sep
Graduation	Thursday, 26 Sep