**NAVAL/MECHANICAL ENGINEERING PROGRAMS**

**Program Officer:**
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**CURRICULUM 570**
The objective of this program is to provide graduate education, primarily in the field of Naval/Mechanical Engineering, to produce graduates with the technical competence to operate and maintain modern warships and naval systems. It establishes a broad background of basic engineering knowledge leading to advanced studies in heat transfer, fluid mechanics, control systems, solid mechanics and vibrations and material science. The graduate will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum.

**REQUIREMENTS FOR ENTRY**
A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 with one quarter refresher). This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible.

**NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY**
Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5601P. The curriculum sponsor is Naval Sea Systems Command. Completion of this curriculum including the Total Ship Systems Engineering option qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5602P. A limited number of particularly well qualified students may be able to further their education beyond the Master's Degree and seek the Degree of Mechanical Engineer and a 5601N or 5602N Subspecialty Codes.

**TYPICAL SUBSPECIALTY ASSIGNMENTS**
Upon award of the 5601P/5602P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval/Mechanical Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility, SIMA
Mechanical Engineering Instructor, USNA
Tender Repair Officer (Engineering Duty Officer)
Fleet/Type Commander Staff
Board of Inspection and Survey
Propulsion Examining Board
OPNAV/NAVSEA
Chief Engineer (Ships and Submarines)

**ENTRY DATES**
Naval/Mechanical Engineering is typically a eight-quarter 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 Program Officer or the Academic Associate.

**Curriculum 570**
**Academic Associate:**
Joshua H. Gordis, Associate Professor
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**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**

| | | |
|---|---|---|
| MA1115 | (4-0) | Multivariable Calculus |
| MA1116 | (3-0) | Vector Calculus |
| MS2201 | (3-2) | Materials Science |
| NW3230 | (4-2) | Strategy & Policy |
| EO2102 | (4-2) | Basic Electronics and Electrical Machines |

**Quarter 2**

| | | |
|---|---|---|
| MA2043 | (4-0) | Matrix and Linear Algebra |
| MA2121 | (4-0) | Differential Equations |
| ME2101 | (4-1) | Mechanics of Solids |
| ME2503 | (3-2) | Materials Science |
| ME2801 | (3-2) | System Dynamics |

**Quarter 3**

| | | |
|---|---|---|
| MA3132 | (4-0) | Partial Differential Equations |
| MA3232 | (4-1) | Numerical Analysis |
| ME2601 | (4-1) | Mechanics of Solids I |
| ME3801 | (3-2) | Automatic Controls |

**Quarter 4**

| | | |
|---|---|---|
| ME3711 | (4-1) | Machine Design |
| ME2201 | (3-2) | Introduction to Fluid Dynamics |
| MS3202 | (3-2) | Failure Analysis and Prevention |
| ME3611 | (4-0) | Mechanics of Solids II |

**Quarter 5**

| | | |
|---|---|---|
| ME3150 | (4-1) | Heat Transfer |
| ME3201 | (4-1) | Applied Fluid Mechanics |
| ME3712 | (4-2) | Systems Design |
| OS3104 | (4-0) | Probability and Statistics |

**Quarter 6**

| | | |
|---|---|---|
| MS3304 | (3-2) | Corrosion |
| ME0810 | (0-8) | Thesis Research |
| ME4XXX | (V-V) | Specialization Elective |
| ME4XXX | (V-V) | Specialization Elective |

**Quarter 7**

| | | |
|---|---|---|
| ME0810 | (0-8) | Thesis Research |
| TS3001 | (3-2) | Naval Architecture |
| ME3521 | (3-2) | Mechanical Vibrations |
| ME3240 | (4-2) | Marine Power and Propulsion |

**Quarter 8**

| | | |
|---|---|---|
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |
| ME3450 | (3-2) | Computational Methods in Mechanical Engineering |
| ME4XXX | (V-V) | Elective |

**TOTAL SHIP SYSTEMS ENGINEERING**

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Technology students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590/591 curricula.

**REQUIREMENTS FOR ENTRY**

A baccalaureate degree in an engineering discipline is desired, 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 5602P subspecialty code for completion of the TSSE Program.

**TYPICAL JOBS IN THIS SUBSPECIALTY**
Upon award of the subspecialty code, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

**ENTRY DATES**
Total Ship Systems Engineering will generally fit as part of an eight or nine quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the program officer or academic associate as early as possible.

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**TYPICAL COURSE OF STUDY**

**Quarter 1**

| | | |
|---|---|---|
| ME2101 | (4-2) | Thermodynamics |
| MA2121 | (4-0) | Differential Equations |
| ME2503 | (5-0) | Engineering Statics and Dynamics |
| NW3230 | (4-0) | Strategy & Policy |
| EC1010 | (1-1) | MATLAB |

**Quarter 2**

| | | |
|---|---|---|
| MA2043 | (4-0) | Matrix and Linear Algebra |
| ME2601 | (4-1) | Mechanics of Solids I |
| MS2201 | (3-2) | Materials Science |
| OS3104 | (4-0) | Probability and Statistics |

**Quarter 3**

| | | |
|---|---|---|
| ME2201 | (3-2) | Fluid Mechanics I |
| ME3611 | (4-0) | Mechanics of Solids II |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |
| MA3232 | (4-1) | Numerical Analysis |

**Quarter 4**

| | | |
|---|---|---|
| TS3001 | (3-2) | Fundamental Principles of Naval Architecture |
| ME3150 | (4-1) | Heat Transfer |
| ME3201 | (4-1) | Applied Fluid Mechanics |
| EO2102 | (4-2) | Circuit and Power System Analysis |
| ME3521 | (3-2) | Mechanical Vibrations |

**Quarter 5**

| | | |
|---|---|---|
| TS3000 | (3-2) | Electrical Power Engineering |
| ME2801 | (3-2) | System Dynamics |
| ME3711 | (4-1) | Design of Machine Elements |
| MS3202 | (3-2) | Failure Analysis & Prevention |

**Quarter 6**

| | | |
|---|---|---|
| TS3002 | (3-2) | Principles of Ship Design and Case Studies |
| TS3003 | (3-2) | Naval Combat System Elements |
| ME3801 | (3-2) | Automatic Controls |
| ME4XXX | (V-V) | Specialization Elective |

**Quarter 7**

| | | |
|---|---|---|
| TS4000 | (3-2) | Naval Combat System Design |
| TS4001 | (2-4) | Design of Naval Engineering Subsystems |
| ME3450 | (3-2) | Computational Methods in Mechanical Engineering |
| ME4XXX | (V-V) | Specialization Elective |

**Quarter 8**

| | | |
|---|---|---|
| TS4002 | (2-4) | Ship Design Integration |

| | | |
|---|---|---|
| ME3240 | (4-2) | Marine Power and Propulsion |
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |

**Quarter 9**

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

**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 5200, which applies to their reactor design training. This Naval Postgraduate School curriculum will not affect that subspecialty code nor provide any additional subspecialty code education or training. No additional subspecialty codes will be earned through this program.

**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:**
Anthony J. Healey
Distinguished Professor
Code ME/Hy

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**PRIMARY CONSULTANT:**
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**ACADEMIC ASSOCIATE:**
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**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**
**For NAVAL/MECHANICAL ENGINEERING**
**CURRICULUM (570)**
**Subspecialty Code 5601P**

Officers entering into the Naval/Mechanical Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET). At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, design, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core program requirements, specialization and thesis research. In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the 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.

| | |
|---|---|
| ME2101 | THERMODYNAMICS (4-1) |
| ME3150 | HEAT TRANSFER (4-1) |
| ME3240 | MARINE POWER AND PROULSION (4-2) |

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).
ME2201 INTRODUCTION TO FLUID DYNAMICS (3-2)
ME3201 INTERMEDIATE FLUID MECHANICS (3-2)
3. DYNAMICS AND CONTROL: Kinematics and dynamics of particle, rigid-body and multi-body mechanical systems. Modeling and simulation of engineering systems with mechanical, electrical and hydraulic components. Feedback control concepts, both frequency response and time domain, with applications to the design of component, platform, and weapon systems. Control of systems with continuous, discrete and combined logic states. Navigation and control for single and network-centric systems. Design of intelligent systems for machinery monitoring and automation, as well as autonomous vehicle operations.
ME2503 STATICS AND DYNAMICS (5-0)
ME2801 INTRODUCTION TO ENGINEERING SYSTEM DYNAMICS (3-2)
ME3801 LINEAR AUTOMATIC CONTROLS (3-2)
4. STRUCTURAL MECHANICS AND VIBRATION: Statically determinant and indeterminate structural analysis, stress/strain analysis, buckling and fatigue. Shock and vibration response of marine structures, including surface ships and submarines.
ME2503 STATICS AND DYNAMICS (5-0)?
ME2601 SOLID MECHANICS I (3-2)
ME3521 MECHANICAL VIBRATIONS (3-2)
ME3611 SOLID MECHANICS II (4-0)
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.
MS2201 ENGINEERING MATERIALS (3-2)
MS3202 FAILURE ANALYSIS AND PREVENTION (3-2)
MS3304 CORROSION AND MARINE ENV. DEGRADATION (3-2)
MS3606 INTRODUCTION TO WELDING & JOINING METALLURGY (3-2)
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.
EC1010 MATLAB (1-1)
ME3450 COMPUTATIONAL METHODS IN MECH. ENG. (3-2)
7. MATHEMATICS: Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.
MA1118 MULTI-VARIABLE CALCULUS (5-2)
MA2121 ORDINARY DIFFERENTIAL EQUATIONS (4-0)? replaced by:
MA2139 Introduction to Differential Equations and Vector Calculus
MA2049 VECTOR ANALYSIS (3-0)? Did this replace MA1042?
MA3132 PARTIAL DIFFERENTIAL EQUATIONS (4-0)
MA3232 NUMERICAL METHODS FOR PDE (3-2)
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.
ME3711 DESIGN OF MACHINE ELEMENTS (4-1)
ME3712 CAPSTONE DESIGN PROJECT(1-6)
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.
EO2102 INTRODUCTION TO CIRCUIT AND POWER SYSTEM ANALYSIS (4-2)
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.
TS3001 FUNDAMENTAL PRINCIPLES IN NAVAL ARCHITECTURE
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.
Three (3) ME4XXX COURSES (minimum of 12 quarter hours)
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.

NW3230 STRATEGY AND POLICY: THE AMERICAN EXPERIENCE (4-2)

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.