2017-19 EDUCATIONAL SKILL REQUIREMENTS
Naval Construction and Engineering
Subspecialty 510xN

Curriculum Number: 510

Curriculum taught at: Massachusetts Institute of Technology

Students are: Fully Funded

Curriculum Length: 36 Months

APC Required: n/a

The Engineering Duty Officer Community Manager has agreed to allow billets to be coded for Naval Construction and Engineering Subspecialty 510xN and officers to be educated for this curriculum.

Mr. Robert Klocek
Engineering Duty Officer Plans and Policies
(NAVSEA 00T1)
Approval date: 7 May 2015

1. Mathematics and Numerical Methods: Sufficient to support the scope of the technical program including linear algebra, differential equations, vector calculus, LaPlace's equation, integral transforms, orthogonal functions, calculus of variations, and Laplace and Fourier transforms. Numerical methods including fast Fourier Transforms, numerical integration, finite difference, finite element and spectral or boundary element methods.

2. Dynamics: In-depth physical and analytical understanding of energy and forces involving motion. Includes mathematical modeling of linear multi-element systems, modal analysis of continuous systems, stability analysis and shock dynamics.

3. Hydrodynamics: In-depth understanding to permit design and analysis of naval surface ships and submarine hull forms and equipment. Includes: dimensional analysis; Navier-Stokes equation; boundary layer theory; potential flows; vorticity; added-mass; slender body theory; free surface phenomena; random processes and ocean spectra; linear and nonlinear wave/body interaction; linear and nonlinear equations of motion and control of surface and underwater vehicles; hydrodynamic

coefficients; strip theory of ship motions; modeling and design of control surfaces; lifting surfaces; steady, unsteady and cavitating hydrofoil.

4. Materials and Fabrication: Practical utilization of theory and analytical ability for metallurgical processes, metal transformations, corrosion mechanisms, mechanical behavior of materials, welding and allied metal joining processes, material failure, metal hardening processes, structural materials, heat treatment, and fabrication, and behavior of non-metallic and composite materials.

5. Power and Propulsion: First and Second Law of Thermodynamics. Analysis of common engineering power cycles and propulsors. Design and economics of thermal power systems including steam, diesel, gas turbine, nuclear, electro-chemical and integrated electric. Analysis of subsystems including gears, shafting, turbines, pumps, compressors, electrical, heat exchangers, fresh water, HVAC and control. In depth understanding of electromagnetic theory, electrical machinery, switched power electronic inverters/converters, power distribution systems, electromagnetic interference phenomena and energy conversion and control systems.

6. Probability and Statistics: Engineering applications of probability theory, discrete and continuous distributions, sampling, estimating regression analysis, error propagation and curve fitting, ocean spectra and random processes, short-term and long-term statistics for ship motions and loads, reliability and maintainability, safety analysis and life-cycle decision analysis.

7. Structural Mechanics: In-depth understanding of determinate and indeterminate structure; stress, strain and deformation; derivation of elastic stress-strain relations for plate and shell structures; bending, buckling and collapse modes of failure for beams, plates and shells; post-buckling and ultimate strength; circular shells; composite materials; ship loads including oscillatory loads and shock loads; finite element analysis; rational ship structural design; collision and grounding protection of ships; and explosive loading analysis.

8. Acoustics: Understanding of sound wave propagation, multidirectional and linear arrays, directivity analysis, underwater explosions, near surface explosions, vibration and source level analysis, ship silencing and noise propagation.

9. ***Cybersecurity:*** Understand and apply the fundamentals of the underlying principles of cyber infrastructure and systems; inherent vulnerabilities and threats, including industrial control systems; and defensive security procedures.

10. Naval Architecture, Naval Engineering, Systems Engineering: In-depth and detailed working knowledge of the naval ship design process, total ship system integration and systems engineering. Includes mission analysis, concept formulation, mathematical models, hull form design, internal ship configurations, weight group analysis, intact and damage stability criteria, ship resistance and powering, launching and grounding forces, ship dynamics including maneuvering and sea keeping, ship survivability and weapons effects, and model testing. Application to submarines, displacement ships and advanced marine vehicles. Combat system fundamentals adequate to support total ship integration including: communications, radar and sonar theory; current threat and operational requirements; current systems (AAW, ASW, ASUW, MCM, Strike); system performance and effectiveness analysis; system modeling; functional flow diagrams and architecture; EMI; topside and internal design. Computer aided design including representation of 3-D objects and graphical display systems. Design of experiments, optimization methods and decision making models.

11. Ship Production: Modern ship production methods in a total ship system and concurrent engineering context. Includes basic fabrication and material handling processes, design/production integration, build strategy, group technology, zone construction, shipyard layout, CAD/CAM, accuracy control, process planning, scheduling and dynamic modeling. Understand design concepts to enhance producibility and reduce cost/environmental impact.

12. Technical Management: Advanced subjects in the management of technical projects and programs, covering topics such as communication, negotiation, real options, business case analysis, and business strategies and financials.

13. Engineer Thesis: An engineering-oriented thesis of superior quality demonstrating a thorough understanding of the basic theories, broadening the scope of the ship engineering knowledge and application to naval engineering.

FY17-19 EDUCATIONAL SKILL REQUIREMENTS
Naval Construction and Engineering
Subspecialty 510xP

Curriculum Number: 510

Curriculum taught at: Massachusetts Institute of Technology

Students are: Fully Funded

Curriculum Length: 24 Months

APC Required: n/a

The Engineering Duty Officer Community Manager has agreed to allow billets to be coded for Naval Construction and Engineering Subspecialty 510xN and officers to be educated for this curriculum.

Mr. Robert Klocek
Engineering Duty Officer Plans and Policies
(NAVSEA 00T1)
Approval date: 7 May 2015

1. Mathematics and Numerical Methods: Sufficient to support the scope of the technical program including linear algebra, differential equations, vector calculus, LaPlace's equation, integral transforms, orthogonal functions, calculus of variations, and Laplace and Fourier transforms. Numerical methods including fast Fourier Transforms, numerical integration, finite difference, finite element and spectral or boundary element methods.

2. Hydrodynamics: In-depth understanding to permit design and analysis of naval surface ships and submarine hull forms and equipment. Includes: dimensional analysis; Navier-Stokes equation; boundary layer theory; potential flows; vorticity; added-mass; slender body theory; free surface phenomena; random processes and ocean spectra; lifting surfaces; steady, unsteady and cavitating hydrofoil.

3. Materials and Fabrication: Practical utilization of theory and analytical ability for metallurgical processes, metal transformations, corrosion mechanisms, mechanical behavior of materials, welding and allied metal joining processes, material failure, metal hardening processes, structural materials, heat

treatment, and fabrication, and behavior of non-metallic and composite materials.

4. Power and Propulsion: First and Second Law of Thermodynamics. Analysis of common engineering power cycles and propulsors. Design and economics of thermal power systems including steam, diesel, gas turbine, nuclear, electro-chemical and integrated electric. Analysis of subsystems including gears, shafting, turbines, pumps, compressors, electrical, heat exchangers, fresh water, HVAC and control. In depth understanding of electromagnetic theory, electrical machinery, switched power electronic inverters/converters, power distribution systems, electromagnetic interference phenomena and energy conversion and control systems.

5. Probability and Statistics: Engineering applications of probability theory, discrete and continuous distributions, sampling, estimating regression analysis, error propagation and curve fitting, ocean spectra and random processes, short-term and long-term statistics for ship motions and loads, reliability and maintainability, safety analysis and life-cycle decision analysis.

6. Structural Mechanics: In-depth understanding of determinate and indeterminate structure; stress, strain and deformation; derivation of elastic stress-strain relations for plate and shell structures; bending, buckling and collapse modes of failure for beams, plates and shells; post-buckling and ultimate strength; circular shells; composite materials; ship loads including oscillatory loads and shock loads; finite element analysis; rational ship structural design; collision and grounding protection of ships; and explosive loading analysis.

7. ***Cybersecurity:*** Understand and apply the fundamentals of the underlying principles of cyber infrastructure and systems; inherent vulnerabilities and threats, including industrial control systems; and defensive security procedures.

8. Naval Architecture, Naval Engineering, Systems Engineering: In-depth and detailed working knowledge of the naval ship design process, total ship system integration and systems engineering. Includes mission analysis, concept formulation, mathematical models, hull form design, internal ship configurations, weight group analysis, intact and damage stability criteria, ship resistance and powering, launching and grounding forces, ship dynamics including maneuvering and sea keeping, ship survivability and weapons effects, and model testing.

Application to submarines, displacement ships and advanced marine vehicles. Combat system fundamentals adequate to support total ship integration including: communications, radar and sonar theory; current threat and operational requirements; current systems (AAW, ASW, ASUW, MCM, Strike); system performance and effectiveness analysis; system modeling; functional flow diagrams and architecture; EMI; topside and internal design. Computer aided design including representation of 3-D objects and graphical display systems. Design of experiments, optimization methods and decision making models.

9. Ship Production: Modern ship production methods in a total ship system and concurrent engineering context. Includes basic fabrication and material handling processes, design/production integration, build strategy, group technology, zone construction, shipyard layout, CAD/CAM, accuracy control, process planning, scheduling and dynamic modeling. Understand design concepts to enhance producibility and reduce cost/environmental impact.

10. Technical Management: Advanced subjects in the management of technical projects and programs, covering topics such as communication, negotiation, real options, business case analysis, and business strategies and financials.

11. Thesis: An engineering-oriented thesis demonstrating a thorough understanding of the basic theories with application to naval engineering.

APPROVED: Brian K Britonis — 05 MAY 2017
Major Area Sponsor — Date

APPROVED: [signature] — JUN 07 2017
President, NPS — Date

APPROVED: [signature] — 24 July 2017
Director, TFTE (OPNAV N12) — Date