Naval Construction and Engineering Program
USN Course 510 (Subspecialty Code 5100N)

EDUCATIONAL SKILL REQUIREMENTS

**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.

**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.

**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.

**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.

**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.

**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.

**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.

**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.

**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.

**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.

**Advanced Technical Options:** Advanced theoretical subjects to form a basis for specialization in one of the areas of concentration or an additional area of concentration related to Naval Engineering.

**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.
Naval Construction and Engineering Program
USN Course 510 (Subspecialty Code 5100P)

EDUCATIONAL SKILL REQUIREMENTS

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.

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.

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.

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.

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.

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.

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.

**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.

**Advanced Technical Options:** Advanced theoretical subjects to form a basis for specialization in one of the areas of concentration or an additional area of concentration related to Naval Engineering.

**Thesis:** An engineering-oriented thesis demonstrating a thorough understanding of the basic theories with application to naval engineering.
Nuclear Engineering Program
USN Course 520 (Subspecialty Code 5200N)

EDUCATIONAL SKILL REQUIREMENTS

**Physics**: Principles of atomic and nuclear physics. Interaction of radiation and matter.

**Nuclear Engineering**: Principles of nuclear reactor design. Reactor theory, including fission reactor physics, heat generation, heat transfer, fluid flow, fuel design and critical safety margins as the basis of reactor plant design with emphasis on pressurized water reactors and reactor safeguards and their application to steam propulsion plants.

**Automated Controls System**: In depth analytical and physical understanding of control system theory, methods and applications with emphasis on nuclear power plant instrumentation and control.

**Radiological Science and Technology**: Detailed knowledge of the effects of radiation on the environment with emphasis on protection, measurement, detection and monitoring. Knowledge of government directives associated with nuclear waste management. Knowledge of OSHA requirements. Understanding of shielding and shielding design principles.

**Reliability and Safety**: Basic understanding of the theory and applications of probabilistic concepts for engineers including a detailed understanding of the reliability, maintainability, and availability concepts as applied to ship power generation systems up to and including fault tree analysis.

**Mathematics**: Mathematics sufficient to support the scope of the technical program and to include linear algebra, differential equations, vector calculus, integral transforms, and system analysis.

**Naval Architecture**: Principles of naval architecture include ship geometry, hydrostatics, stability, hull structure strength, resistance and powering.

**Power and Propulsion**: Comparison of the problems and economics of alternative ship power generation systems; diesel, gas turbine, combined diesel and gas turbine, and fossil fuel versus nuclear power. First and Second Laws of thermodynamics, heat transfer, propulsors, analysis of shipboard engineering cycles including saturated steam plant technology.

**Materials and Fabrication, Chemistry and Corrosion Control**: Knowledge of materials and fabrication methods used in power plant and nuclear reactor technology. Knowledge of effects of pressurized water reactor environment on materials. Understanding water chemistry control processes as applicable: (1) to nuclear plant corrosion and ion exchange processes, (2) to steam generator (or boiler) corrosion processes, and (3) power plant piping system corrosion processes. Understanding environmental control processes as applicable to the corrosion of materials in general.
**Advanced Technical Option:** Advanced theoretical subjects to form a basis for specialization in one area related to Nuclear Engineering.

**Engineer Thesis:** Conduct independent research and analysis and present the results in an engineering-oriented thesis of superior quality, demonstrating a thorough understanding of the basic theories, related to reactor design, physics, control, thermal hydraulics, materials, safety, maintenance, reliability, fuel or other reactor plant related topic, and broadening the scope of nuclear engineering knowledge.

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Nuclear Engineering Program  
USN Course 520 (Subspecialty Code 5200P)

EDUCATIONAL SKILL REQUIREMENTS

**Physics**: Principles of atomic and nuclear physics. Interaction of radiation and matter.

**Nuclear Engineering**: Principles of nuclear reactor design. Reactor theory, including fission reactor physics, heat generation, heat transfer, fluid flow, fuel design and critical safety margins as the basis of reactor plant design with emphasis on pressurized water reactors and reactor safeguards and their application to steam propulsion plants.

**Automated Controls System**: In depth analytical and physical understanding of control system theory, methods and applications with emphasis on nuclear power plant instrumentation and control.

**Radiological Science and Technology**: Detailed knowledge of the effects of radiation on the environment with emphasis on protection, measurement, detection and monitoring. Knowledge of government directives associated with nuclear waste management. Knowledge of OSHA requirements. Understanding of shielding and shielding design principles.

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**Advanced Technical Option:** Advanced theoretical subjects to form a basis for specialization in one area related to Nuclear Engineering.

**Thesis:** Demonstrate the ability to conduct independent research and analysis and proficiency in presenting the results in writing and orally by means of a thesis related to reactor design, physics, control, thermal hydraulics, materials, safety, maintenance, reliability, fuel or other reactor plant related topic.