

# Naval architectural engineering syllabus

## Naval architectural engineering examinations

### Group A - Compulsory examinations (six required)

#### 16- Nav-A1 Fundamentals of Naval Architecture

Hull form definition: principal dimensions, ships' lines, coefficients of form. Hull form characteristics: integration methods, Bonjean curves, wetted surface, hydrostatic curves. Equilibrium conditions. Initial stability, metacentric height, cross curves of stability, GZ curve, free surface effect, effects of changes in weight on stability, stability criteria, inclining experiment. Dynamical stability. Trim, moment causing trim, effect of added weights on draft, trim and heel. Submerged equilibrium, trim dive. Stability when grounded. Intact stability of unusual ship forms. Free communication effect. Subdivision and damage stability calculations. Stability criteria for damaged stability. Load line regulations, tonnage regulations. Use of computers in ship's calculations.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Edward V. Lewis ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapters 1, 2, 3, Volume 1.

Secondary Text:

- Barnaby, Kenneth C., Basic Naval Architecture, latest edition. Hutchinson's Scientific and Technical Publications.
- Van Lammeren, W.P.A. ed., Buoyancy and Stability of Ships. The Technical Publications H. Stam.
- Attwood, Edward L. et al., Theoretical Naval Architecture. Longmans, Green and Co.
- de Heere, R.F. Scheltema, Buoyancy and Stability of Ships. Technical Publications H. Stam.

#### 16-Nav-A2 Hydrodynamics of Ships (I): Resistance and Propulsion

Review of fluid dynamic concepts, dimensional analysis, frictional resistance, wave-making resistance, other components of resistance. Use of models, presenting model resistance data. Functional relationship between resistance and hull form. Algorithms for resistance calculations. Advanced marine vehicles. Powering of ships, theory of propeller action. Law of similitude for propellers, interaction between hull and propellers. Model self-propulsion tests. Geometry of screw propellers. Cavitation. Propeller selection and design. Other propulsion devices such as: jet propulsion, air propulsion (sail, air propellers), paddle wheels, vertical-axis propellers (Kirsten, Voith-Schneider) etc. Ship standardization trials.

*Textbooks (most recent edition is recommended):*

- Edward V. Lewis ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapters 5, 6, Volume II.

#### 16-Nav-A3 Hydrodynamics of Ships (II): Ship Motion

Ocean waves, wave spectral density. Rigid body dynamics of marine vehicles and structures, ship responses to regular and irregular waves. Introduction to hydroelastic analysis methods of ships and ocean structures. Manoeuvring and control of ship motions, assessing ship's performance in a seaway. Directional stability. Design aspects.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Saunders, Harold E. ed., Hydrodynamics in Ship Design. The Society of Naval Architects and Marine Engineers, Volumes I, II and III.
- Vossers, G., Behaviour of Ships on Waves. The Technical Publishing Company H. Stam.

Secondary Text:

- Edward V. Lewis, ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapter 8, Volume III.

### 16-Nav-A4 Ship Structure and Strength of Ships

Ship types, framing systems, longitudinal strength requirements, classification rules. Structural components, hull materials, methods of joining structural parts. Hull outfit and fittings with special emphasis on construction process, hull preservation and maintenance. Deckhouses and superstructures. Ship structural loads, analysis of hull girders (stress and deflection), vertical shear force, bending moment, torsion, midship section and bulkhead configurations. Thermal effects on primary stresses and deflections. Bending of flat plates, shear lag and stress diffusion. Load carrying capability and structural performance criteria. Reliability of structures, ultimate strength. Analytical optimization of structures.

*Textbooks (most recent edition is recommended):*

- Taggart ed., Ship Design and Construction. The Society of Naval Architects and Marine Engineers.
- Edward V. Lewis. ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapter 4, Volume I.

### 16-Nav-A5 Ship Design

Preliminary design methods for the design of marine platforms and vehicles from mission statement to the selection of one or more acceptable solutions. Weight and cost estimation, power requirements estimation, and selection of principal design characteristics. Economic and operational evaluation of alternative solutions. Optimization.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Taggart ed., Ship Design and Construction. The Society of Naval Architects and Marine Engineers.

Secondary Text:

- Schokker, J.C., Arkenbout et al., The Design of Merchant Ships. The Technical Publishing Company H. Stam.
- Saunders, Harold E. ed., Hydrodynamics in Ship Design. The Society of Naval Architects and Marine Engineers, Volume I.

### 16-Nav-A6 Advanced Strength of Materials (16-Mec-A7)

Stress-Strain Analysis: Stress and strain, transformations, principle stresses, graphical representation by Mohr's circles of biaxial and triaxial cases, generalized Hooke's law including thermal strains, equations of equilibrium and compatibility, plane strain and plane stress problems. Failure theories and limit analysis. Euler critical loads for columns, curved beams, thick-walled cylinders and rotating discs, contact stresses, strain gauges and application, stress concentrations including fracture mechanics.

Energy Methods: Strain energy principles, virtual work, Castigliano's theorem. Applications to cases in axial, bending, and torsional loadings. Applications to statically indeterminate problems.

*Textbooks (most recent edition is recommended):*

- Ugural, Ansel, & Saul Fenster, Advanced Strength & Applied Elasticity, latest edition. Prentice Hall Englewood Cliffs New Jersey.

- Budynas, R.G., Advanced Strength & Applied Stress Analysis, latest edition. McGraw-Hill.
- Boresi, A.P., and R.J. Schmidt, Advanced Mechanics of Materials, latest edition. John Wiley & Sons.

## Group B - Optional examinations (three required)

### 16-Nav-B1 Applied Thermodynamics and Heat Transfer (16-Mec-A1)

Thermodynamics: Review of the fundamental laws of thermodynamics, introductory psychrometry and analysis of the ideal gas compressor cycle, Rankine cycle, Otto cycle, Diesel cycle, Brayton cycle and the vapour compression refrigeration cycle.

Heat Transfer: Application of the principles of steady and transient conduction heat transfer, natural and forced convection heat transfer and radiation heat transfer. Thermal analysis of heat exchangers.

*Textbooks (most recent edition is recommended):*

- Moran, M.J., H.N. Shapiro, B.R. Munson and D.P. DeWitt, Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer. John Wiley and Sons.

### 16-Nav-B2 Marine Engineering

Ship system formulations, main propulsion system requirements, main propulsion system trade-off studies, arrangement of machinery, piping diagrams, auxiliary systems.

Characteristics of internal combustion engines, marine uses for such engines. Marine steam generators, selection and design of boilers. Main propulsion steam engines. Main propulsion steam turbines. Main propulsion gas turbines. Electric propulsion drives.

Propeller shafting and shafting system vibration analysis. Pumps, blowers, compressors, ejectors, condensers, heat exchangers, distilling plants. Hull machinery design considerations and machinery installations, machinery foundation designs, hydrostatic power transmission equipment, and systems.

Machinery for environmental control and waste treatment. Electric generating plants, switchboards and panels, lighting and power distribution, power equipment, lighting fixtures. Electronics navigation and radio communication. Automation systems. Safety considerations.

Fundamentals of pressurized-water nuclear steam supply systems for use in marine propulsion, reactor design considerations, nuclear fuels, reactor coolants, reactor control, shielding, safety, health, physics, economics.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Harrington, Roy L. (ed.), Marine Engineering. The Society of Naval Architects and Marine Engineers.

Secondary Text:

- Sullivan, James A., Fluid Power Theory and Applications, latest edition. Prentice Hall, Inc.
- Henke, Russell W., Introduction to Fluid Power Circuits and Systems. Addison-Wesley.
- Labbarton, J.M. (ed.), Marine Engineers' Handbook. McGraw-Hill.
- I.R. Cameron, Nuclear Fission Reactors. Plenum Press.
- J.R. Lamarsh, Introduction to Nuclear Engineering, latest edition. Addison-Wesley.

### 16-Nav-B3 Small Commercial Ships

Types of small commercial ships. Specific design criteria for each type. Scantling, powering, propulsion and stability requirements. Type specific systems. Various construction materials and their construction techniques. Regulations applicable to small commercial ships. Classification society rules.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Taggart ed., Ship Design and Construction. The Society of Naval Architects and Marine Engineers.

Secondary Text:

- Schokker, J.C., Arkenbout et al., The Design of Merchant Ships. The Technical Publishing Company H. Stam.
- Saunders, Harold E. ed., Hydrodynamics in Ship Design. The Society of Naval Architects and Marine Engineers, Volume I.

### **16-Nav-B4 Advanced Structural Analysis**

Analysis of statically indeterminate structures, including trusses, beams and frames. Moment distribution, slope deflection and energy methods. Force and deformation methods applied to matrix formulation. Bending and buckling of plates. (Prerequisite examinations: 16-Nav-A4 and 16-Mec-A4)

*Textbooks (most recent edition is recommended):*

- Timoshenko, S. and Young, D.H., Theory of Structures, latest edition. McGraw Hill.

### **16-Nav-B5 Ship Production and Shipyard Management**

General aspects of shipyard organization and management; history and background of modern industry; industrial tendencies; principles of organization; principles of management. Plant location, layout and construction; handling of materials, production engineering and inspection, quality control, procedure control and systems. Control of production, time and motion study. Material control, plant safety. Industrial relations, personnel management, training, human relations and labour organizations. Drydocking and maintenance of ships.

*Textbooks (most recent edition is recommended):*

Primary Text:

- Buffa , Modern Production Operations Management, latest edition. Wiley.
- Juran and Gryna , Quality Planning and Analysis, latest edition. Wiley & Sons.
- Taggart ed., Ship Design and Construction. The Society of Naval Architects and Marine Engineers, Chapter 15.

Secondary Text:

- Chase and Aquilano, Production and Operations Management: A Life Cycle Approach, latest edition. Erwin.
- Halpern, The Assurance Sciences: An Introduction to Quality Control and Reliability. Prentice-Hall.
- Kennedy and Nelville, Basic Statistical Methods for Engineers and Scientists, latest edition. Harper and Row.
- Duncan, Quality Control and Industrial Statistics, latest edition. Erwin.
- Sule, D.R. (Dileep R.), Manufacturing Facilities. PWS-KENT Publishing Co.
- Riggs, James L., Production Systems, latest edition. John Wiley & Sons, Inc.

### **16-Nav-B6 Design and Manufacture of Machine Elements (16-Mec-A4)**

Theory and methodology related to conceptual design; review of the methods used in stress analysis; simple design factor approach; variable loads; stress concentrations; bolts and bolted joints; welded joints; springs; shaft and bearing design; clutches, brakes, and braking systems.

The role and characterization of manufacturing technology within the manufacturing enterprise is also examined. Topics include an overview of the deformation process, joining processes, consolidation

processes, material removal processes, material alteration processes; composites manufacturing, nano-and-microfabrication technologies rubber processing, glass working, coating processes, mechanical assembly, electronics packaging and assembly, and production lines; and process selection and planning; quality control systems.

*Textbooks (most recent edition is recommended):*

- No Referenced Textbooks

## **16-Nav-B7 Environmental Control in Ships**

Heating, Ventilation and Air Conditioning: Psychometrics, heating load, cooling load, comfort, ventilation and room air distribution. Humidifying and dehumidifying, duct and fan design, piping and pump design. Heating, ventilating and cooling systems and components. Refrigeration.

Noise Control: Sound wave characteristics, measurement instruments. Sources of noise, absorption and transmission. Free field and reverberant conditions. Noise control techniques in ships.

Energy Management Technology: Energy resources and supplies, control systems and instrumentation, lighting, systems operation, engineering/economic analysis principles, energy audit procedures.

Shipboard waste management, collection systems. Environmental pollution and management. Water quality; principles involved in design and operation and physical, chemical, and biological treatment processes, and shipboard waste treatment.

*Textbooks (most recent edition is recommended):*

Primary Text:

- McQuiston and Parker, Heating Ventilating and Air Conditioning Analysis and Design. Wiley & Sons.
- Irwin and Graf, Industrial Noise and Vibration Control. Prentice-Hall.

Secondary Text:

- Jennings, Environmental Engineering. International Text Book Co.
- Carrier and Trane Systems Manuals. (ASHRAE Handbooks).
- ASHRAE: Environmental Control Principles: an Educational Supplement to ASHRAE Handbook Fundamentals Volume.

## **16-Nav-B8 Ocean Engineering and Offshore Structures**

Hydrostatics of rigid floating or submerged structures; mooring systems; wave and ice loads; diffraction theory; offshore platform design requirements; safety and risk management.

*Textbooks (most recent edition is recommended):*

- No Referenced Textbooks