Naval architectural engineering syllabus

Naval architectural engineering examinations

Group A - Compulsory examinations (Seven required)

25- Nav-A1 Fundamentals of Naval Architecture

Hull form definition: principal dimensions, ships' lines, coefficients of form. Hull form characteristics including integration methods, Bonjean curves, wetted surface, and 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 surface effect. Subdivision and damage stability calculations. Stability criteria for damaged stability. Load line regulations, tonnage regulations. Use of numerical methods 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.

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

Review of fluid dynamic concepts, dimensional analysis, frictional resistance, wave-making resistance, and other components of resistance. Use of models, presenting model resistance data. The 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).. Ship standardization trials.

Textbooks (most recent edition is recommended):

- Lewis, Edward V. ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapters 5, 6, Volume II.
- Molland, Anthony F., The Maritime Engineering Reference Book, 2008

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

Applications of the linearized equations of motion to ocean vehicle problems with single and multiple degrees of freedom in waves; Dynamics of marine vehicles: regular and irregular waves; motions in waves; hydrodynamic effects such as added mass, radiation and viscous damping; experimental and numerical methods (strip theory and panel method) for measurement and prediction of wave-induced motions..

Textbooks (most recent edition is recommended):

Primary Text:

- Lewis, Edward V. ed., Principles of Naval Architecture. The Society of Naval Architects and Marine Engineers, Chapter 8, Volume III.
- Dynamics of Marine Vehicles, R. Bhattacharyya, John Wiley & Sons, New York, 1978.

Secondary 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.

25-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 and buckling of flat plates and stiffened panels. 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.
- Hughes, O.F., 1983, Ship Structural Design, Wiley-Interscience, Published by the Society of Naval Architects and Marine Engineers, New York (1988).
- Hughes, O.F. and Paik J.K., 2010. Ship Structural Analysis and Design, Published by the Society of Naval Architects and Marine Engineers, New Jersey.D.W. Chalmers, Design of Ships' Structures, HMSO

25-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. Statement of requirements for ships. Environmental design considerations. Weight and cost estimation, power requirements estimation, and selection of principal design characteristics. Global bending strength requirements, seakeeping implications on ship designs. Economic and operational evaluation of alternative solutions. Optimization and design trade-offs.

Textbooks (most recent edition is recommended):

Primary Text:

- Taggart ed., Ship Design and Construction. The Society of Naval Architects and Marine Engineers.
- Watson, D.G.M., Practical Ship Design, 1998

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.

25-Nav-A6 Advanced Strength of Materials (25-Mec-A6)

Analysis of statically indeterminate structures, including trusses, beams and frames. Moment distribution, slope deflection and energy methods. 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.
- Hibbler, R.C., Mechanics of Materials, 11th edition, Pearson.
- Goodno and Gere, Mechanics of Materials, Enhanced 9th Edition, Cengage Learning.

25-Nav-A7 Hydrodynamics of Ships (III): Ship Manoeuvering

The manoeuverability of ocean vehicles; derivation of linear and nonlinear equations of motion and hydrodynamic coefficients; stability of motion; standard maneuvers such as turning circle, turning spiral, and PMM test; modelling and simulations of the engine, propulsion, rudder and transmission systems during manoeuvring; systems for course keeping, autopilot, motion control and dynamic positioning.

Textbooks (most recent edition is recommended):

Primary Text:

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

Secondary Text:

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

Group B - Optional examinations (three required)

25-Nav-B1 Applied Thermodynamics and Heat Transfer (25-Mec-A1)

Thermodynamics: 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.

25-Nav-B2 Marine Engineering and Vibrations

Topics in marine engineering such as, shafting system design; shafting system vibration analysis, study of exciting forces and moments, and balancing of reciprocating and rotating machinery; heat transfer and marine heat exchangers; incompressible fluid flow and piping system design and selection of appropriate pumping devices.

Concepts in mechanical vibration with a focus on the vibration of marine machinery and the dynamic response of marine structures. Topics include: single degree of freedom systems – free vibration, energy methods, response to harmonic excitation, response to arbitrary inputs; multi degree of freedom systems – natural frequencies and mode shapes, response to harmonic excitation; frequency response functions; on-board sources of vibration, vibration measurement techniques and instrumentation.

Textbooks (most recent edition is recommended):

Primary Text:

- Harrington, Roy L. (ed.), Marine Engineering. The Society of Naval Architects and Marine Engineers.
- William S. Vorus (2010), The principles of naval architecture Series: Vibration, Editor: J. Randolph Pauling, 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.
- Rao S. (2017), Mechanical Vibrations, Pearson.

25-Nav-B3 Finite Element Analysis for Ship Structures

Application of the finite element method (FEM) to the design and assessment of ship hull structures. Simulation of static, quasi-static, and impact loads on hull structures. Implicit and explicit finite element (FE) implementations with consideration of nonlinearity, elements, contact, problem type, adequate model geometry, elements/mesh, boundary conditions, loads, assessment of model quality, and benchmarking of results.

Textbooks (most recent edition is recommended):

- Liu, G.R., Quek, S.S., Finite Element Method: A Practical Course, Butterworth-Heinemann, 2003.
- Wu, S.R., Gu, L., Introduction to the Explicit Finite Element Method for Nonlinear Transient Dynamics, Wiley, 2012.

25-Nav-B4 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:

- R. L. Storch, et al., Ship Production, Second Edition, SNAME, 2007
- D. J. Eyres and G. J. Bruce, Ship Construction, 7th Edition, Butterworth Heinemann, 2012
- N. R. Mandal, Ship Construction and Welding, Springer, 2017
- 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.

25-Nav-B5 Marine Control Systems

Considers propulsion and motion control of ships, submersibles and offshore structures, as well as dynamic positioning and power management. The exam will also include fundamental control theory concepts, such as time and frequency domain analysis, spring-mass-damper systems, Laplace transforms, stability of control systems, PID controllers, and modelling of 1 DOF and 2 DOF control systems.

Textbooks (most recent edition is recommended):

- Fossen, TI (1994), Guidance and Control of Ocean Vehicles, Wiley.
- Ogata, K (2021), Modern Control Engineering, Pearson.
- Fossen TI (2011), Handbook of Marine Craft Hydrodynamics and Motion Control, Wiley.

25-Nav-B6 Ocean Engineering and Offshore Structures

Hydrostatics of rigid floating or submerged structures; mooring systems; Environmental loads including wave, current, wind and ice loads; diffraction theory; offshore platform design requirements; safety, hazards and risk management; functional requirements of drilling and production floating structures.

Textbooks (most recent edition is recommended):

- Offshore Structures, D.V. Reddy and M. Arockiasamy, Krieger Publishing. Co., 1991.
- Offshore Structures, G. Clauss, E. Lehman and C. Ostergaard, Vol. 1 and 2, Springer-Varlag, 1992.
- Elements of Ocean Engineering, R.E. Randall, Society of Naval Architect s and Marine Engineers, Jersey City, NJ, 1997.
- Floating Structures: A Guide for Design and Analysis, Barltrop, N.D.P. (ed.), Vol.
- 1 and 2, The Centre for Marine and Petroleum Technology, Oilfield Publication Limited, 1998.
- Hydrodynamics of Offshore Structures, S.K. Chakrabarti, WIT Press, 1987.