GENERAL APTITUDE(GA)

Verbal Aptitude

Basic English grammar: tenses, articles, adjectives, prepositions, conjunctions, verb-noun agreement, and other parts of speech

Basic vocabulary: words, idioms, and phrases in context

Reading and comprehension

Narrative sequencing

Quantitative Aptitude

Data interpretation: data graphs (bar graphs, pie charts, and other graphs representing data), 2- and 3-dimensional plots, maps, and tables

Numerical computation and estimation: ratios, percentages, powers, exponents and logarithms, permutations and combinations, and series

Mensuration and geometry

Elementary statistics and probability

Analytical Aptitude

Logic: deduction and induction

Analogy

Numerical relations and reasoning

Spatial Aptitude

Transformation of shapes: translation, rotation, scaling, mirroring, assembling, and grouping

Paper folding, cutting, and patterns in 2 and 3 dimensions

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Naval Architecture and Marine Engg.(NM)

Section 1: Engineering Mathematics

Determinants and matrices, Systems of linear equations, Eigenvalues and eigenvectors. Functions, gradient, divergence, curl, chain rules, partial derivatives, directional derivatives, definite and indefinite integrals, line surface and volume integrals, theorems of Stokes, Gauss and Green. Linear, non-linear, first and higher order ordinary and partial differential equations, separation of variables. Laplace transformation, analytical functions of complex variables, Fourier series, numerical methods for differentiation and integration, complex analysis, probability and statistics.

Section 2: Applied Mechanics and Structures

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; shear force and bending moment diagrams; bending and shear stresses; torsion; Euler's theory of columns; energy methods; theories and failure, material testing methods.

Vibrations: Free and forced vibration of damped and undamped systems, single and multi DOF systems.

Machine Design: Design for static and dynamic loading; Design of machine elements such as shafts, gears, rolling and sliding contact bearings; Joining technics such as bolting, riveting and welding.

Section 3: Fluid Mechanics and Marine Hydrodynamics

Fluid Mechanics: Fluid properties; fluid statics, stability of floating bodies; Conservation laws: Mass, momentum and energy (Integral and differential form); Dimensional analysis and dynamic similarity; sources, sinks, doublets, line vortex and their superposition; Stoke's integral theorem. Generalised Bernoulli's equation, sources, sinks, dipole, Flow with circulation, potential flow with rotational symmetry, hydrodynamical lift, Kutta-Joukowski theorem. Vortex

motion- Fundamental concepts, vortex analogy to Biot-Savart's law, straight parallel vortex filaments, vortex sheets. Viscous flowNavier-Stokes equations, Couette flow, Plane poiseuille flow. Equation of continuity, Euler's equation, Bernoulli's equation, Viscous flow of incompressible fluids, elementary turbulent flow, boundary layer, flow through pipes.

Boundary layer theory- Prandtl's boundary layer equations, criterion for separation, Blasius solution, Skin friction, displacement thickness, momentum thickness, Turbulent boundary layer, Boundary layer control. Airfoils- Lift, drag, circulation, pressure distribution-theory of thin aerofoils, wings of infinite and finite span, circulation distribution, Cavitation.

Vorticity and Kelvin's theorem, Potential flow theory, Sources, Sinks and Doublets, hydrodynamic forces in potential flow, D'Alembert's paradox, added-mass, slender-body theory, hydrodynamic model testing, scaling laws, application of potential theory to surface waves, energy transport, wave/body forces, linearised theory of lifting surfaces.

Section 4: Naval Architecture and Ocean Engineering

Ship geometry and physical fundamentals - Archimedes' principle, buoyancy and weight of ship, laws of flotation, heel and trim, stable and unstable equilibrium of ships, importance of streamlined hull shape, ship main particulars, hydrostatic calculations,

Stability and trim of Ships: Statical stability at small angles of heel, Inclining experiment. Shift of centre of gravity due to addition or removal of mass, transverse movement of mass and effect, Free surface effect, Effect of suspended mass, Stability at large angles of heel, angle of loll, curves of statical stability, dynamical stability, Probabilistic and deterministic Damage Stability Different Characteristic curves of dynamic stability. Floodable length calculations and curves. Loss of stability due to grounding, docking stability.

Resistance & Propulsion: Components of ship resistance, form factor, hull roughness, model testing and ship resistance prediction methods, tank wall effects, determination of ship resistance different series test results, resistance of advanced vehicles, appendage and added resistance. Geometry of screw propeller, propeller theories, hull-propeller interactions, different propulsive

efficiency definitions. Propeller cavitation and effects. Propeller design and series. Open water and selfpropulsion model tests. Different types of propellers and their working principles. Propeller material, strength and manufacturing.Unconventional propellers

Ship Manoeuvring and Motions: Ship path keeping and changing, equations of motion, linearised equations and control fixed stability indexes, model tests. Stability and control in the horizontal and vertical planes – definitive manoeuvres and sea trials. Rudder hydrodynamics, design and operation. Influence of propeller, hull, appendages etc. on rudder performance. Experimental methods for the determination of hydrodynamic derivatives.

Ocean waves – regular, irregular, trochoidal. Wave spectrum, encounter frequency. Types of ship motions, coupled and non-coupled motions, equations of motion. Dynamic effects of ship motion in seaway. Different ship motion stabilisers – passive and active. Different numerical and experimental methods to determine ship motions – strip theory, BEM, FEM. Seakeeping features of highperformance marine vehicles.

Ship Structures & Strength: Shipbuilding materials, joining techniques, ship structural and framing systems – bottom, side, deck, bulkhead, end structures, and structural connections. Primary and secondary structural members, superstructure, hatch covers, machinery foundations, cargo handling systems and support structures.

Loads acting on ships in seaway, longitudinal and transverse strength considerations and estimation methods. Strength of hull girder, stiffened plate analysis, torsion of hull girder, deformation and stresses, local strength analysis; Reliability analysis and ultimate strength of hull girder, structural vibrations, fatigue and fracture.

Physical Oceanography: Physical properties of seawater, Different types of ocean waves - tides and wind waves, and their importance. Offshore Structures: Fixed offshore platforms - Jackets, Gravity platforms; Floating platforms - semi-submersibles, jack-ups, TLPs, FPSOs; Mooring, station keeping. Port and Harbour Engineering: Ports and Harbours, Port structures - Jetties, Dolphins, Liquid berths, Dredging, Navigation

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Section 5: Thermodynamics and Marine Engineering

Thermodynamics: First law of thermodynamics - Closed system undergoing a cycle; closed system undergoing a change of state; Internal energy of a system; Expansion work; Process using ideal gas - constant pressure, constant volume, isothermal; adiabatic and polytropic process -work done and heat added in different process; First law applied to one - dimensional steady flow process, flow energy, steady flow energy equation (ID). Second law of Thermodynamics - Different statements; Reversible and irreversible process; Corollaries of second law - Absolute temperature scale; Carnot cycle - Carnot engine, refrigerator and heat pump. Clausius inequality and definition of entropy, change of entropy of an ideal gas; Gas power cycles and I.C.Engines; Gas power cycles: Carnot cycle, Brayton cycle, Erricson cycle, Sterling cycle etc.; Air standard cycles- Otto- Diesel, Dual and Joule cycle; Evaluation of thermal efficiency and mean effective pressure; Internal Combustion engine - Classification of I.C. engines -Principle of operation of spark Ignition and Compression Ignition engines both two stroke and four stroke; Stages of combustion in S.I. and C.I. engines; Knocking and detonation-factors controlling knock and detonation, methods of preventing Knocking and detonation; Refrigeration - principle of operation of Simple vapour compression system, Comparison with vapour compression systems; Air conditioning principles - Sensible heating and cooling, Humidification and dehumidification, Cooling and humidification, Cooling and dehumidification-Heating and humidification, Heating and dehumidification, Adiabatic mixing of air streams –cooling and heating load calculation.

Marine Diesel Engines: General engine principles, Low speed and medium speed diesel engines, Two and Four stroke engines, Scavenging and turbocharging, Fuel oil system, Lubricating oil systems, cooling systems, torque and power measurement, Starting air systems and reversing systems, controls and safety devices, Couplings and Gearboxes, Specific Fuel Consumption. Waste heat recovery system, MARPOL regulations and Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP).

Marine Steam Turbines: Types of turbines, compounding, reheat, turbine construction, rotors, blades, casing, Gland sealing, diaphragms, nozzles, bearings etc. Lubrication systems, expansion arrangements, Gearings. Marine gas turbines – fundamentals of G.T, Structure of gas turbines, gearing,

operational features, controls, combined cycles. Nuclear propulsion –physical principles of the operation of nuclear reactors – use of nuclear propulsion on seagoing vessels, Electrical Propulsion,

Marine Boilers: Types - fire tube, water tube boilers, Package boilers, Cochran Boilers, Composite boilers, steam to steam generators, double evaporation boilers, exhaust gas heat exchangers, auxiliary steam plant systems, exhaust gas boilers, composite boilers. Boiler mounting, combustion, feed system, feedwater treatment.

Engine Dynamics: Torsional vibration of engine and shafting, axial shaft vibration, critical speeds, engine rating, rating corrections, trial tests etc. Relationship of engine to the propeller classification society rules on engine construction, Engine room arrangement. Automation of ship propulsion plants, Maintenance requirements and reliability of propulsion plants.

Marine Auxiliary Machinery & Systems: Different types of pumps and piping systems in ships - hot water, drinking water, cooling water and seawater, fuel oil systems, lubricating oil system filters, coolers, centrifuges, purifiers and clarifiers, bilge and ballast systems, sewage disposal, oily water separator, air compressors, boilers, heat exchangers, waste heat recovery systems; Heat, ventilation and air conditioning systems; Dech machinery and cargo handling systems; Propulsions and steering gear systems.

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