ANNEX B OF CMO NO. 20, SERIES OF 2015
BACHELOR OF SCIENCE IN MARINE ENGINEERING
COURSE SPECIFICATIONS

Course Code	**:**	Nav Arch
Course Descriptive Title	**:**	Naval Architecture
Course Credits	**:**	4 units
Lecture Contact Hours per Week	**:**	4 hours
Laboratory Contact Hours per Week	**:**	1 hour
○ **Prerequisite**	**:**	None
Reference/s	**:**	○ Table A-III/1 Function: Controlling the Operation of the Ship and Care for Persons on Board ○ STCW'78 as amended ○ IMO Model Courses 7.02 and 7.04 ○ Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE)

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship	*Ship stability* Working knowledge and application of stability, trim and stress tables, diagrams and stress calculating equipment Understanding of the fundamentals of watertight integrity	1. Displacement – States that, for a ship to float, it must displace a mass of water equal to its own mass – Explains how, when the mass of a ship changes, the mass of water displaced changes by an equal amount – States that the displacement of a vessel is its mass and it is measured in tones – States that displacement is represented by the symbol ⊿ – Explains the relationship between the displacement and mean draught of a ship by using the graph or scale – Given a displacement/draught curve, finds: — displacements for given mean draughts — mean draughts for given displacements — the change in mean draught when given masses are loaded or discharged — the mass of cargo to be loaded or discharged to produce a required change of draught – Defines' light displacement' and 'load displacement' – Defines 'deadweight' – Uses a deadweight scale to find the deadweight and displacement of a ship at various draughts in seawater – Defines 'tonnes per centimetre immersion'(TPC) – Explains why TPC varies with different draughts – Uses a deadweight scale to obtain TPC at given draughts – Uses TPC obtained from a deadweight to find: — the change of mean draught when given masses are loaded or discharged — the mass of cargo to be loaded or discharged to produce a required change of draught – Defines 'block coefficient'(Cb) – Calculates Cb from given displacement and dimensions – Calculates displacement from given Cb and dimensions <u>Buoyancy</u> – Explains what is meant by 'buoyancy' – States that the force of buoyancy is an upward force on a floating object created by the pressure of liquid on the object – States that the buoyancy force is equal to the displacement of a floating object	4 Hours 2 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	– Describes reserve buoyancy – Explains the importance of reserve buoyancy – Explains how freeboard is related to reserve buoyancy – Explains the purpose of load lines – Explains the requirements for maintaining watertight integrity – Demonstrates an understanding of damage stability requirements for certain vessels – Explains reasons for damage stability requirements – Identifies damage stability requirements for Type A vessels, Type (B－60) and Type (B－100) vessels – Identifies equilibrium condition after flooding for Type A, and all Type B vessels – Identifies damage stability requirements for passenger vessels <u>Fresh Water Allowance</u> – Explains why the draught of a ship decreases when it passes from fresh water to seawater and vice versa – States that when loading in fresh water before proceeding into seawater, a ship is allowed a deeper maximum draught – Describes what it meant by the fresh water allowance (FWA) – Given the FWA and TPC for fresh water, calculates the amount which can be loaded after reaching the summer load line when loading in fresh water before sailing into seawater – Describes the uses a hydrometer to find the density of dock water – Describes the effect of changes of tide and rain on dock water density – Explains how to obtain the correct dock water density – Given the density of dock water and TPC for seawater, calculates the TPC for dock water – Given the density of dock water and FWA, calculates the amount by which the appropriate load line may be submerged – Given the present draught amidships and the density of dock water, calculates the amount to load to bring the ship to the appropriate load line in seawater 2. Statical Stability – States that weight is the force of gravity on a mass and always acts vertically downwards – States that the total weight of a ship and all its contents can be considered to act at a point called the centre of gravity (G) – States that the centre of buoyancy (B) as being the centre of the underwater volume of the ship – States that the force of buoyancy always acts vertically upwards	3 Hours 3 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	– Explains that the total force of buoyancy can be considered as a single force acting through B – States that when the shape of the underwater volume of a ship changes the position of B also changes – States that the position of B will change when the draught changes and when heeling occurs – Labels a diagram of a midship cross – section of an upright ship to show the weight acting through G and the buoyancy force acting through B – States that the buoyancy force is equal to the weight of the ship – Labels a diagram of a midship cross – section of a ship heeled to a small angle to show the weight acting through G and the buoyancy force acting through B – Describes stability as the ability of the ship to return to an upright position after being heeled by an external force – States that the lever GZ as the horizontal distance between the vertical forces acting through B and G – States that the forces of weight and buoyancy form a couple – States that the magnitude of the couple is displacement × lever, $\Delta \times GZ$ – Explains how variations in displacement and GZ affect the stability of the ship – On a diagram of a heeled ship, shows: — the forces at B and G — the lever GZ – States that the length of GZ will be different at different angles of heel – States that if the couple $\Delta \times GZ$ tends to turn the ship toward the upright, the ship is stable – States that for a stable ship: — $\Delta \times GZ$ is called the righting moment — GZ is called the righting lever 3. Initial Stability – States that it is common practice to describe the stability of a ship by its reaction to heeling to small angles (up to approximately 10°) – Defines the transverse metacentre (M) as the point of intersection of successive buoyancy force vectors as the angle of heel increases by a small angle – States that, for small angles of heel, M can be considered as a fixed point on the centreline on a diagram of a ship heeled to a small angle, indicates G, B, Z and M – Shows on a given diagram of a stable ship that M must be above G and states that the metacentric height GM is taken as positive – Shows that for small angles of heel, $GZ = GM \times \sin\theta$	4 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	– States that the value of GM is a useful guide to the stability of a ship – Describes the effect on a ship's behaviour of: — a large GM (stiff ship) — a small GM (tender ship) – Uses hydrostatic curves to find the height of the metacentre above the keel (KM) at given draughts – States that KM is only dependent on the draught of a given ship – Given the values of KG, uses the values of KM obtained from hydrostatic curves to find the metacentre heights, GM – States that, for a cargo ship, the recommended initial GM should not normally be less than 0.15m 4. Angle of Loll – Shows that if G is raised above M, the couple formed by the weight and buoyancy force will turn the ship further from the upright – States that in this condition, GM is said to be negative and $\Delta \times GZ$ is called the upsetting moment or capsizing moment – Explains how B may move sufficiently to reduce the capsizing moment to zero at some angle of heel – States that the angle at which the ship becomes stable is known as the angle of loll – States that the ship will roll about the angle of loll instead of the upright – States that an unstable ship may loll to either side – Explains why the condition described in the above objective is potentially dangerous 5. Curves of Statical Stability – States that for any one draught the lengths of GZ at various angles of heel can be drawn as a graph – States that the graph described in the above objective is called a curve of statical stability – States that different curves are obtained for different draughts with the same initial GM – Identifies cross curves (KN curves and MS curves) – Derives the formula $GZ = MS + GM \sin \theta$ – Derives the formula $GZ = KN + KG \sin \theta$ – Derives GZ curves for stable and initially unstable ships from KN curves – From a given curve of statical stability obtains: — the maximum righting lever and the angle at which it occurs — the angle of vanishing stability	1 Hour 4 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	— the range of stability – Shows how lowering the position of G increases all values of the righting lever and vice versa – States that angles of heel beyond approximately 40°are not normally of practical interest because of the probability of water entering the ship at larger angles 6. Movement of the Centre of Gravity – States that the centre of gravity (G) of a ship can move only when masses are moved within, added to, or removed from the ship – States that: — G moves directly towards the centre of gravity of added masses — G moves directly away from the centre of gravity of removed masses — G moves parallel to the path of movement of masses already on board – Calculates the movement of G (GG_1) from: – *GG_1 = (mass added or removed x distance of mass from G) / new displacement of the ship* – *GG_1 = (mass moved x distance mass is moved) / displacement of the ship* – Performs calculations as in the above objective to find the vertical and horizontal shifts of the centre of gravity resulting from adding, removing or moving masses – States that if a load is lifted by using a ship's derrick or crane, the weight is immediately transferred to the point of suspension – States that if the point of suspension is moved horizontally, the centre of gravity of the ship also moves horizontally – States that if the point of suspension is raised or lowered, the centre of gravity of the ship is raised or lowered – Calculates, by using moments about the keel, the position of G after loading or discharging given masses at stated positions – Calculates the change in KG during a passage resulting from: — consumption of fuel and stores — absorption of water by a deck cargo — accretion of ice on decks and superstructures given the masses and their positions 7. List and its Correction – Shows on a diagram the forces which cause a ship to list when G is to one side of the centreline – States that the listing moment is given by displacement × transverse distance of G from	4 Hours 6 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	the centreline – Shows on a diagram that the angle of list (θ) is given by $\tan\theta = GG_1/GM$ where GG_1 is the transverse shift of G from the centerline – States that in a listed condition the range of stability is reduced – Given the displacement, KM and KG of a ship, calculates the angle of list resulting from loading or discharging a given mass at a stated position, or from moving a mass through a given transverse distance – Explains, with reference to moments about the centreline, how the list may be removed – Given the displacement, GM and the angle of list of a ship, calculates the mass to load or discharge at a given position to bring the ship upright – Given the displacement, GM and angle of list of a ship, calculates the mass to move through a given transverse distance to bring the ship upright – Given the draught, beam and rise of the floor, calculates the increase in draught resulting from a stated angle of list 8. Effect of Slack Tanks – States that if a tank is full of liquid, its effect on the position of the ship's centre of gravity is the same as if the liquid were a solid of the same mass – Explains by means of diagrams how the centre of gravity of the liquid in a partly filled tank moves during rolling – States that when the surface of a liquid is free to move, there is a virtual increase in KG, resulting in a corresponding decrease in GM – States that the increase in KG is affected mainly by the breadth of the free surface and is not dependent upon the mass of liquid in the tank – States that in tankers the tanks are often constructed with a longitudinal subdivision to reduce the breadth of free surface 9. Trim and draught calculations using trim tables – States that "trim" is the difference between the draught aft and the draught forward – States that trim may be changed by moving masses already on board forward or aft, or by adding or removing masses at a position forward of or abaft the centre of flotation – States that 'centre of flotation' is the point about which the ship trims, and states that it is sometimes called the tipping centre – States that the centre of flotation is situated at the centre of area of the waterplane, which may be forward of or abaft amidships – Demonstrates the uses hydrostatic data to find the position of the centre of flotation for various draughts	3 Hours 6 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship stability (Cont)*	– States that a trimming moment as mass added or removed × its distance forward or aft of the centre of flotation; or, for masses already on board, as mass moved × the distance moved forward or aft – States that the moment to change trim by 1 cm (MCT 1cm) as the moment about the centre of flotation necessary to change the trim of a ship by 1 cm – Demonstrates the uses hydrostatic curves or deadweight scale to find the MCT 1cm for various draughts – Given the value of MCT 1cm, masses moved and the distances moved forward or aft, calculates the change in trim – Given the value of MCT 1 cm, the position of the centre of flotation, masses added or removed and their distances forward of or abaft the centre of flotation, calculates the change of trim – Given initial draughts and the position of the centre of f1otation, extends the calculation in the above objective to find the new draughts – Given initial draughts and TPC, extends the calculation in the above objective to find the new draughts – Given initial draughts and TPC, extends the calculation to find the new draughts – Demonstrates the uses of a trimming table or trimming curves to determine changes in draughts resulting from loading, discharging or moving weights – States that in cases where the change of mean draught is large, calculation of change of trim by taking moments about the centre of flotation or by means of trimming tables should not be used – Calculates final draughts and trim for a planned loading by considering changes to a similar previous loading 10. Stress tables and stress calculating equipment (Loadicator) – States that each ship above a specified length is required to carry a loading manual, in which are set out acceptable loading patterns to keep shear forces and bending moments within acceptable limits – States that the classification society may also require a ship to carry an approved means of calculating shear forces and bending moment at stipulated stations – Demonstrates the basic knowledge and use of a stress tables – Demonstrates the basic knowledge and use of a stress calculating equipment (loadicator) – States the information available from loadicator – States that the loading manual and instrument, where provided, should be used to ensure that shear forces and bending moments do not exceed the permissible limits in still water during cargo and ballast handling – Describes the likelihood of over stressing the hull structure when loading certain bulk	1 Hour 1 Hour

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	General knowledge of the principal structural members of a ship and the proper names for the various parts *Ship construction*	11. Actions to be Taken in the Event of Partial Loss of Intact Buoyancy – States that flooding should be countered by prompt closing of watertight doors, valves and any other openings which could lead to flooding of other compartments – States that cross—flooding arrangements, where they exist, should be put into operation immediately to limit the resulting list – States that any action which could stop or reduce the inflow of water should be taken 12. Ship dimensions and form – Illustrates the general arrangement of the following ship types: — general cargo — oil, chemical and gas tankers — bulk carriers — combination carriers — container — RO-RO — passenger – Sketches an elevation and plan views of various ship types such as a general cargo ship, crude oil carrier, and bulker showing the arrangement and illustrate a general knowledge of the primary structural members and indicate the proper names for the various parts to include holds, engine—room, peak tanks, double—bottom tanks, hatchway, tween deck and position of bulkheads, cofferdams, pump—room, cargo tanks, slop tank and permanent ballast tanks: — camber — rise of floor — tumblehome — flare — sheer — rake — parallel middle body — entrance — run – Defines: — forward perpendicular(FP)	4 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship construction (Cont)*	— after perpendicular (AP) — length between perpendiculars(LBP) — length on the waterline (LWL) — length overall (LOA) — base line — moulded depth, beam and draught — extreme depth, beam and draught 13. Ship Stresses – Describes in qualitative terms shear force and bending moments – Explains what is meant by 'hogging' and by 'sagging' and distinguishes between them – Describes the loading conditions which give rise to hogging and sagging stresses – Describes how hogging and sagging stresses are caused by the sea state – Explains how hogging and sagging stresses result in tensile or compressive forces in the deck and bottom structure – Describes water pressure loads on the ship's hull – Describes liquid pressure loading on the tank structures – Calculates the pressure at any depth below the liquid surface, given the density of the liquid – Describes qualitatively the stresses set up by liquid sloshing in a partly filled tank – Describes racking stress and its causes – Explains what is meant by 'pounding 'or 'slamming' and states which part of the ship is affected – Explains what is meant by 'panting' and states which part of the ship is affected – Describes stresses caused by localized loading – Describes corrosion – Describes the causes of corrosion onboard – Describes the various methods that being used to minimize the effect of corrosion 14. Hull Structure – Identifies structural components on ships' plans and drawings: — frames, floors, transverse frames, deck beams, knees, brackets — shell plating, decks, tank top, stringers — bulkheads and stiffeners, pillars — hatch girders and beams, coamings, bulwarks	2 hours 2 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship construction (Cont)*	— bow and stern framing, cant beams, breasthooks – Describes the types of materials that are used in the construction of a ship – Describes and illustrates standard steel sections: — flat plate — offset bulb plate — equal angle — unequal angle — channel — tee – Describes with aids of sketches the longitudinal, transverse and combined systems of framing on transverse sections of the ships – Sketches the arrangement of frames, webs and transverse members for each system – Illustrates double—bottom structure for longitudinal and transverse framing – Illustrates hold drainage systems and related structure – Illustrates a duct keel – Sketches the deck edge, showing attachment of sheer strake and stringer plate – Sketches a radiused sheer strake and attached structure – Describes the stress concentration in the deck round hatch openings – Explains compensation for loss of strength at hatch openings – Sketches a transverse section through a hatch coaming, showing the arrangement of coamings and deep webs – Sketches a hatch corner in plain view, showing the structural arrangements – Sketches deck—freeing arrangements, scuppers, freeing ports, open rails – Illustrates the connection of superstructures to the hull at the ship's side – Sketches a plane bulkhead, showing connections to deck, sides and double bottom and the arrangement of stiffeners – Sketches a corrugated bulkhead – Explains why transverse bulkheads have vertical corrugations and for—and—aft bulkheads have horizontal ones – Describes the purpose of bilge keels and how they are attached to the ship's side 15. Bow and Stern Regions – Describes the provisions of additional structural strength to withstand pounding – Describes and illustrates the structural arrangements forward to withstand panting – Describes the function of the stern frame – Describes and sketches a stern frame for a single—screw ship	1 Hour 2 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship construction (Cont)*	– Describes and illustrates the construction of a transom stern, showing the connections to the stern frame 16. Fittings – Describes and sketches an arrangement of modern weather—deck mechanical steel hatches – Describes how water tightness is achieved at the coamings and cross joints – Describes the cleating arrangements for the hatch covers – Describes the arrangement of portable beams, wooden hatch covers and tarpaulins – Sketches an oiltight hatchcover – Describes roller, multi—angle, pedestal and Panama fairleads – Sketches mooring bitts, showing their attachment to the deck – Sketches typical forecastle mooring and anchoring arrangements showing the leads of moorings – Describes the construction and attachment to the deck of tension winches and explains how they are used – Describes the anchor handling arrangements from hawse pipe to spurling pipe – Describes the construction of chain lockers and how the bitter-ends are secured in the lockers – Explains how to secure anchors and make spurling pipes watertight in preparation for a sea passage – Describes the construction and use of a cable stopper – Describes the construction of masts and Sampson posts and how they are supported at the base – Describes the construction of derricks and deck cranes – Describes the bilge piping system of a cargo ship – States that each section is fitted with a screw-down non-return suction valve – Describes and sketches a bilge strum box – Describes a ballast system in a cargo ship – Describes the arrangement of a fire main and states what pumps may be used to pressurize it – Describes the provision of sounding pipes and sketches a sounding pipe arrangement – Describes the fitting of air pipes to ballast tanks or fuel oil tanks – Describes the arrangement of fittings and lashings for the carriage of containers on deck 17. Rudder and Propellers – Describes the action of the rudder in steering a ship	6 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintain seaworthiness of the ship (Cont)	*Ship construction (Cont)*	– Reproduces drawings of modern rudders: semi balanced, balanced and spade – Explains the purpose of the rudder carrier and pintles – Explains how the weight of the rudder is supported by the rudder carrier – Describes the rudder trunk – Describes the arrangement of a watertight gland round the rudder stock – Explains the principle of screw propulsion – Describes a propeller and defines, with respect to : — boss — rake — skew — face — back — tip — radius — pitch – Compares fixed—pitch with controllable—pitch propellers – Sketches the arrangement of an oil—lubricated sterntube and tailshaft – Describes how the propeller is attached to the tailshaft – Sketches a cross—section of a shaft tunnel for water cooled and oil cooled type – Explains why the shaft tunnel must be of watertight construction and how water is prevented from entering the engine—room if the tunnel becomes flooded	3 Hours
Control trim, stability and stress (ML)	*Ship construction (Cont)*	18. Load Lines and Draught Marks – Explains where the deck line is marked – Defines 'freeboard' – Explains what is meant by 'assigned summer freeboard' – Draws to scale the load line mark and the load lines for a ship of a given summer moulded draught, displacement and tonnes per centimetre immersion in salt water – Explains how the chart of zones, areas and seasonal periods is used to find the applicable load line – Demonstrates how to read draughts – Explains that the freeboard, measured from the upper edge of the deck line to the water on each side, is used to check that the ship is within its permitted limits of loading – Lists the items in the conditions of assignment of freeboard – Describes why the height of sill are varies between different type of vessels based on Load Line Rules	20 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Control trim, stability and stress (ML) (cont)	*Ship construction (Cont)* Ship construction arrangements Ship construction arrangements (cont)	Ship Construction Arrangements Describes common arrangements for: - Double bottom construction. - Safety features for duct keels. - Forward and after peak structures. - Anchor cable termination details. - Longitudinal, transverse and combined framed vessels. - Decks - Hatch covers - Bulwarks - Deep frames. - Design consideration for discontinuities in the vessel structure. - Bilge keel consideration. - Strakes for the hull. - Fitting through the hull. Engine, deck machinery and stabiliser strength members. - Bulkhead construction and their position. - Maintenance of strength and watertight integrity when bulkheads are pierced for normal operation. - Rudder and its support arrangements. - Stern frame - Design criteria for specialised ships. - Structural fire protection. - Ship's General arrangement drawing - Shell expansion - Deck plan - Midship section	
		Total No. of Hours	82 Hours

* discrepancy between course specifications and course map total hour is intended for assessment