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

Course Code	**:**	Seam 2A
Course Descriptive Title	**:**	Trim, Stability and Stress 1
Course Credits	**:**	5 units
Lecture Contact Hours per Week	**:**	5 hours
Laboratory Contact Hours per Week	**:**	0 hours
Prerequisite	**:**	Seam 1
Reference/s	**:**	1. Table A-II/1 of the 1978 STCW Code as amended Function: Controlling the operation of the ship and care for persons on board at the operational level Function: Cargo handling and stowage at the operational level 2. Table A-II/2 of the 1978 STCW Code as amended Function: Cargo handling and stowage at the management level 3. Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMT)

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
Monitor the loading, stowage, securing and unloading of cargoes and their care		Draught, Trim and Stability – Defines 'deadweight' and 'displacement tonnages' – Sketches a ship's load line indicating marks for various seasonal zones, areas and periods – Uses a ship's hydrostatic particulars and given mean draughts to determine the approximate weight loaded or discharged	10

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
during the voyage		– Uses a deadweight scale to determine the change in mean draught resulting from loading or discharging a given tonnage – Given the present draughts and the density of dock water, calculates the draughts in seawater – Given the draught amidships and dock-water density, calculates the amount to load to bring the ship to the appropriate load line in seawater – Uses hydrostatic data to find the position of the centre of flotation, MCT and TPC for a given draught – Calculates the change of trim resulting from loading or discharging a given weight at a specified position – Given the initial draughts, forward and aft, calculates the new draughts after loading or discharging a given quantity of cargo uses a trimming table or curves to determine changes in draughts resulting from loading, discharging or moving weights – Calculates final draughts and trim for a planned loading by considering changes to a similar previous loading – Calculates, by using moments about the keel, the position of G for a given disposition of cargo, fuel and water – Uses hydrostatic data to find the KM and thence the GM – States that, for a cargo ship, the recommended initial GM should not normally be less than 0.15m – Uses KN curves to construct a curve of statical stability and from it reads the maximum righting lever and angle at which it occurs – Calculates the arrival of GM from the departure conditions and the consumption of fuel and water, including the loss of GM due to FSE – Plans the use of fuel and water to keep free surface effects to a minimum – Estimates the loss of GM resulting from absorption of water by deck cargo	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		Cargo calculations and cargo plans – Distinguishes between bale capacity and grain capacity – Defines 'stowage factor' – Explains defines 'broken stowage' and states how an allowance for it is made – Given the capacity to hold and the stowage factor of the cargo, calculates the weight that the holds will contain – Given the weights and stowage factors of one or more cargoes, calculates the space required – Calculates the number of packages of given dimensions which can be loaded in a stated space, making allowance for broken stowage – Given the maximum permissible loading of a 'tween-deck, calculates the maximum height to which cargo of stated stowage factor can be loaded – Given the maximum permissible loading and height of a 'tween-deck, and the stowage factors of two commodities, calculates the depth of each required to fill the space at the maximum permitted deck loading – Defines 'ullage'	5
Plan and ensure safe loading, stowage, securing, care during the voyage and unloading cargoes	Knowledge of the effect on trim and stability of cargoes and cargo operations	.1 Draft, trim and stability (MC 7.01) - Given the draughts forward, aft and amidships, calculates the draught to use with the deadweight scale, making allowance for trim, deflection and density of the water - Given a ship's hydrostatic data, the weight and the intended disposition of cargo, stores, fuel and water, calculates the draughts, allowing for trim, deflection and water density - Calculates changes of draught resulting from change in distribution of masses	20

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		- Calculates changes of draught resulting from change in water density - Calculates the quantity of cargo to move between given locations to produce a required trim or maximum draught - Calculates how to divide a given mass between two given locations to produce a required trim or maximum draught after loading - Calculates the locations at which to load a given mass so as to leave the after draught unchanged - Given a ship's hydrostatic data and the disposition of cargo, fuel and water, calculates the metacentric height (GM) - Calculates the arrival GM from the conditions at departure and the consumption of fuel and water - Identities when the ship will have the worst stability conditions during the passage - Calculates the maximum weight which can be loaded at a given height above the keel to ensure a given minimum GM - Constructs a GZ curve for a given displacement and KG and checks that the ship meets the minimum intact stability requirements - Determines the list resulting from a change in distribution of masses - Determines the expected maximum heel during the loading or discharging of a heavy lift with the ship's gear - Calculates the increased draught resulting from the heel - Plans the loading and movement of cargo and other deadweight items to achieve specified draughts and/or stability conditions in terms of required statical and dynamic stability	
	Ship stability	Displacement	4

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS

Maintain seaworthiness of the ship	Working knowledge and application of stability, trim and stress tables, diagrams and stresscalculating equipment
	
	Understanding of fundamental actions to be taken in the event of partial loss of intact buoyancy
	
	Understanding of the fundamentals of watertight integrity
		– 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 tonnes
		– 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'(C_b)
		– Calculates C_b from given displacement and dimensions
		– Calculates displacement from given C_b and dimensions	

		Buoyancy	2

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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 – 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	
		Fresh water allowance – 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	3

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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	
		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 – 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	3

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS

		– 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, Δ x 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 Δ x GZ tends to turn the ship toward the upright, the ship is stable
		– States that for a stable ship:
		  – Δ x GZ is called the righting moment
		  – GZ is called the righting lever	

		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	4

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS

		– 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 x sinφ
		– 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	

		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 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	1

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– States that an unstable ship may loll to either side – Explains why the condition described in the above objective is potentially dangerous	

		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 φ
		– Derives the formula GZ = KN – KG sin φ
		– 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
		  – 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
			4

		Movement of centre of gravity	4

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS

		– 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:
		$GG_1 = \frac{mass\ added\ or\ removed \times distance\ of\ mass\ from\ G}{new\ displacement\ of\ the\ ship}$
		$GG_1 = \frac{mass\ moved \times distance\ mass\ is\ moved}{displacement\ of\ the\ ship}$
		– 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	

		List and Its Correction	6

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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 the centreline – Shows on a diagram that the angle of list (θ) is given by tan φ = 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	
		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	3

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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	
		Trim and draft calculations – 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 – 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	6

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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	
		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	1
		Stress tables and stress calculating equipment (Loadicator)	3

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	TOPICS/PERFORMANCE	APPROX HOURS
		– 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 overstressing the hull structure when loading certain bulk cargoes	
		TOTAL	79