SHIP CONSTRUCTION & STABILITY – LEVEL 4

Registration code – NAUT SCS4

Duration – 270 hours

Pre-requisites

- Grade 9 level of mathematics, algebra and geometry
- Basic computer skills
- Camosun's Math 058 course recommended

Course description

This is a course designed to provide ship's officers and captains with the knowledge and skill required to: understand the basic design and construction of various types of vessels; perform stability calculations with emphasis on practical skills; extract data from hydrostatic tables and curves, perform calculations related to ship's drafts, trim, list and initial stability.

Required for the following certificates of competencies:

- Watchkeeping Mate, Near Coastal
- Watchkeeping Mate
- Chief Mate, Near Coastal
- Chief Mate
- Master 3000T, Domestic
- Master 3000T, Near Coastal
- Master, Near Coastal
- Master Mariner

Learning objectives/competencies

Subject	Knowledge required
Competence:	**Maintain seaworthiness of the ship**
Working knowledge and application of stability, trim and stress tables, diagrams and stress-calculating equipment	**Displacement** Definition of displacement; Given a displacement/draught curve or table find: a) Displacement for given mean draughts; b) Mean draught for given displacements; c) The change in mean draught when given masses are loaded or discharged; d) The mass of cargo to be loaded or discharged to produce a required change of draught; Definition of light displacement and load displacement; Definition of deadweight; Ability to use a deadweight scale to find the deadweight and displacement of a ship at various draughts in seawater; Definition of tonnes per centimetre immersion; Why TPC varies with different draughts; Ability to use a deadweight scale to obtain TPC at given draughts; Ability to use TPC obtained from a deadweight to find: a) The change of mean draught when given masses are loaded or discharged; b) The mass of cargo to be loaded or discharged to produce a required change of draught; Definition of block coefficient (CB); Ability to calculate CB from given displacement and dimensions; Ability to calculate displacement from given CB and dimensions. **Buoyancy** Meaning of buoyancy; Definition of force of buoyancy; What is meant by reserve buoyancy; Explain the importance of reserve buoyancy; Explain the purpose of load lines; Explain the requirement for maintaining water tight integrity; Ability to demonstrate an understanding of damage stability requirements for certain vessels; The reasons for damage stability requirements; Ability to identify damage stability requirements for Type A vessels, Type (B-60) and Type (B-100) vessels; Identify equilibrium condition after flooding for Type A, and all Type B vessels; Identify damage stability requirements for passenger vessels. **Fresh Water Allowance** Why the draught of a ship decreases when it passes from fresh water to seawater and vice versa; Given the FWA and TPC for fresh water, ability to calculate the amount which can be loaded after reaching the summer load line when loading in fresh water before sailing into seawater; Ability to use a hydrometer to find the density of dock water; Given the density of dock water and TPC for seawater, ability to calculate the TPC for dock water; Given the density of dock water and FWA, ability to calculate the amount by which the appropriate load line may be submerged; Given the present draught amidships and the density of dock water, ability to calculate the amount to load to bring the ship to the appropriate load line in seawater.

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Working knowledge and application of stability, trim and stress tables, diagrams and stress-calculating equipment	**Statical stability** Definition of centre of gravity (G); Definition of centre of buoyancy (B); Definition of the lever GZ; How variations in displacement and GZ affect the stability of the ship; Ability to draw a diagram of a heeled ship, showing: a) The forces B and G; b) The lever GZ **Initial stability** Definition of the transverse metacentre (M); Ability to draw a diagram of a ship heeled to a small angle and indicate G,B,Z and M; Definition of GM; Ability to show that for small angles of heel (θ), GZ = GM X sin θ; Ability to describe the effect on a ship's behaviour of: a) A large GM (stiff ship) b) A small GM (tender ship) Ability to use hydrostatic curves to find the height of the metacentre above the keel (KM) at given draughts; Given the values of KG, ability to use the values of KM obtained from hydrostatic curves to find the metacentre height, GM. Given a ship's hydrostatic data and the disposition of cargo, fuel and water, calculate the metacentric height (GM); Ability to calculate the arrival GM from the conditions at departure and the consumption of fuel and water; Ability to identify when the ship will have the worst stability conditions during the passage; Ability to calculate the maximum weight which can be loaded at a given height above the keel to ensure a given minimum GM. **Angle of Loll** Ability to show that if G is raised above M, the couple formed by the weight and buoyancy force will turn the ship further from the upright; How B may move sufficiently to reduce the capsizing moment to zero at some angle of heel; Definition of angle of loll; An unstable ship may loll to either side, why this condition is potentially dangerous. **Curves of Statical Stability** Ability to identify cross curves (KN curves and MS curves); Derive the formula GZ = MS + GM sinθ; Derive the formula GZ = KN – KG sinθ; Derive GZ curves for stable and initially unstable ships from KN curves; From a given curve of statical stability, ability to obtain: a) The maximum righting lever and the angle at which it occurs; b) The angle of vanishing stability; c) The range of stability. Ability to construct a GZ curve for a given displacement and KG and checks that the ship meets the minimum intact stability requirements; Ability to show how lowering the position of G increases all values of the righting lever and vice versa.

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Working knowledge and application of stability, trim and stress tables, diagrams and stress-calculating equipment	**Trim** Definition of trim; Definition of centre of flotation (CF); Ability to use hydrostatic data to find the position of the centre of flotation (CF) for various draughts; Definition of a trimming moment; Definition of the moment to change trim by 1 cm (MCT 1 cm); Ability to use hydrostatic curves/tables or deadweight scale to find the MCT 1 cm for various draughts; Given the value of MCT 1 cm, masses moved and the distances moved forward or aft, ability to calculate 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, ability to calculate the change of trim; Given initial draughts and the position of the centre of flotation, ability to extend the calculation in the above objective to find the new draughts; Given initial draughts and TPC, ability to extend the calculation in the above objective to find the new draughts; Given initial draughts and TPC, ability to extend the calculation to find the new draughts; Ability to use a trimming table or trimming curves to determine changes in draughts resulting from loading, discharging or moving weights; Ability to calculate how to divide a given mass between two given locations to produce a required trim or maximum draught after loading; Ability to calculate the locations at which to load a given mass so as to leave the after draught unchanged ability to calculate final draughts and trim for a planned loading by considering changes to a similar previous loading.
Understanding of fundamental actions to be taken in the event of partial loss of intact buoyancy	Knowledge that flooding should be countered by prompt closing of watertight doors, valves and any other openings which could lead to flooding or other compartments; Knowledge that cross-flooding arrangements, where they exist, should be put into operation immediately to limit the resulting list; Knowledge that any action, which could stop or reduce the inflow of water, should be taken.
Understanding of the fundamentals of watertight integrity	Understanding of the fundamentals of watertight integrity.
General knowledge of the principal structural members of a ship and the proper names for the various parts	**Ship dimensions and form** General arrangement of different types of ship; Ability to draw an elevation of the principal ship types, showing holds, engine room, peak tanks, double bottom tanks, hatchways and position of bulkheads; Ability to draw an elevation of a typical crude oil carrier, showing bulkheads, cofferdams, pump-room, engine-room, bunker and peak tanks, cargo tanks and permanent ballast tanks; Ability to draw a plan view of a tanker, showing the arrangement of cargo and ballast tanks; Definitions of the different dimensions and forms.. **Ship stresses** Describe in qualitative terms shear force and bending moments; What is meant by hogging and sagging; Ability to describe the loading conditions which give rise to hogging and sagging stresses; How hogging and sagging stresses are caused by the sea state; How hogging and sagging stresses result in tensile or compressive forces in the deck and bottom structure; Describe water pressure loads on the ship's hull; Describe liquid pressure loading on the tank structures; Ability to calculate the pressure at any depth below the liquid surface, given the density of the liquid; Describe the stresses set up by liquid sloshing in a partly filled tank; Describe racking stress and its causes; What is meant by panting and which part of the ship is affected; What is meant by pounding or slamming and which part of the ship is affected; Describe the stress caused by localized loading; Ability to demonstrate understanding of modern methods

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	of determining the effects of different loading and ballasting on the ship's structure; Ability to use modern computer software for determining stress; Have a working knowledge of the stress tables; How output data from ship stress finding system may be used; Torsion stress particularly with reference to container ship loading; Ability to analyse the stress areas created by bending moments and shearing forces derived by a stress indicator; Analyse the causes and effects of shearing forces and bending moments on ship's structures; Definition of bending moment; Definition of Shearing forces; Ability to extract information from shear force and bending moment diagrams; Describe the constructional features, which compensate for stress. **Hull structure** Ability to identify structural components on ship's plans and drawings: a) Frames, floor, transverse frames, deck beams, knees, brackets b) Shell plating, decks, tank top, stringers c) Bulkheads and stiffeners, pillars d) Hatch girders and beams, coamings, bulwarks e) Bow and stern framing, cant beams, breasthooks Ability to describe and illustrate standard steel sections: a) Flat plate b) Offset bulb plate c) Equal angle d) Unequal angle e) Channel f) Tee Ability to identify longitudinal, transverse and combined systems of framing on transverse sections of the ships; Ability to sketch the arrangement of frames, webs and transverse members for each system; Ability to illustrate double-bottom structure for longitudinal and transverse framing; Ability to illustrate hold drainage systems and related structure; Ability to illustrate a duct keel; Ability to sketch the deck edge, showing attachment of sheer strake and stringer plate; Ability to sketch a radiused sheer strake and attached structure; Describe the stress concentration in the deck round hatch openings; Explain compensation for loss of strength at hatch openings; Ability to sketch a transverse section through a hatch coaming, showing the arrangement of coamings and deep webs; Ability to sketch a hatch corner in plan view, showing the structural arrangements; Ability to sketch deck-freeing arrangements, scuppers, freeing ports, open rails; Ability to illustrate the connection of superstructures to the hull at the ship's side; Ability to sketch a plane bulkhead, showing connections to deck, sides and double bottom and the arrangement of stiffeners; Ability to sketch a corrugated bulkhead; Why transverse bulkheads have vertical corrugations and for-and-aft bulkheads have horizontal ones; Ability to describe the purpose of bilge keels and how they are attached to the ship's side.

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General knowledge of the principal structural members of a ship and the proper names for the various parts	Ability to identify longitudinal, transverse and combined systems of framing on transverse sections of the ships; Ability to sketch the arrangement of frames, webs and transverse members for each system; Ability to illustrate double-bottom structure for longitudinal and transverse framing; Ability to illustrate hold drainage systems and related structure; Ability to illustrate a duct keel; Ability to sketch the deck edge, showing attachment of sheer strake and stringer plate; Ability to sketch a radiused sheer strake and attached structure; Describe the stress concentration in the deck round hatch openings; Explain compensation for loss of strength at hatch openings; Ability to sketch a transverse section through a hatch coaming, showing the arrangement of coamings and deep webs; Ability to sketch a hatch corner in plan view, showing the structural arrangements; Ability to sketch deck-freeing arrangements, scuppers, freeing ports, open rails; Ability to illustrate the connection of superstructures to the hull at the ship's side; Ability to sketch a plane bulkhead, showing connections to deck, sides and double bottom and the arrangement of stiffeners; Ability to sketch a corrugated bulkhead; Why transverse bulkheads have vertical corrugations and for-and-aft bulkheads have horizontal ones; Ability to describe the purpose of bilge keels and how they are attached to the ship's side. **Bow and Stern** Describe the provisions of additional structural strength to withstand pounding; Describe and illustrate the structural arrangements forward to withstand panting; Describe the function of the sternframe; Describe and sketch a sternframe for a single-screw ship; Describe and illustrate the construction of a transom stern, showing the connections to the sternframe. **Fittings** Describe and sketch an arrangement of modern weather-deck mechanical steel hatches; How watertightness is achieved at the coamings and cross joints; Describe the cleating arrangements for the hatch covers; Ability to sketch an oil tight hatchcover; Describe roller, multi-angle, pedestal and panama fairleads; Ability to sketch mooring bitts, showing their attachments to the deck; Ability to sketch typical forecastle mooring and anchoring arrangements, showing the leads of moorings; Describe the construction and attachment to the deck of tension winches and explain how they are used; Describe the anchor handling arrangements from hawse pipe to spurling pipe; Describe the construction of chain lockers and how cables are secured in the lockers; How to secure anchors and make spurling pipes watertight in preparation for a sea passage; Describe the construction and use of a cable stopper; Describe the construction of masts and Sampson posts and how they are supported at the base; Describe the construction of derricks and deck cranes; Describe the bilge piping system of a cargo ship; Describe and sketch a bilge strum box; Describe a ballast system in a cargo ship; Describe the arrangement of a fire main; Describe the provision of sounding pipes and sketch a sounding pipe arrangement; Describe the fitting of air pipes to ballast tanks or fuel oil tanks; Describe the arrangement of fittings and lashings for the carriage of containers on deck.

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General knowledge of the principal structural members of a ship and the proper names for the various parts	**Rudder and propellers** Ability to describe the action of the rudder in steering a ship; Drawing of modern rudders: semi balanced, balanced and spade; Explain the purpose of the rudder carrier and pintles; How the weight of the rudder is supported by the rudder carrier; Ability to describe a rudder trunk; Ability to describe the arrangement of a watertight gland round the rudder stock; The principle of screw propulsion; Describe a propeller and define boss, rake, skew, face, back, tip, radius, pitch; Compare fixed-pitch with controllable-pitch propellers; Ability to sketch the arrangement of an oil lubricated sterntube and tailshaft; Ability to sketch a cross-section of a shaft tunnel; Why the shaft tunnel must be of watertight construction and how water is prevented from entering the engine-room if the tunnel becomes flooded. **Load lines and draught marks** Explain where the deck line is marked; Definition of freeboard; What is meant by assigned summer freeboard; Ability to distinguished between ships of Type A and Type B for the purposes of computation of freeboard; Ability to draw to scale the load line mark and the load lines for a ship given summer moulded draught, displacement and tonnes per centimetre immersion in salt water; Ability to use the chart of zones and seasonal areas to determine the load lines which apply for a particular passage; Given the ship's hydrostatic data and the daily consumption of fuel and water, ability to determine the minimum departure freeboard and quantity to load, taking into account the zones, seasonal zones and areas through which the ship will pass; Ability to calculate the maximum quantity to load, taking account of loading, discharging and bunkering at an intermediate port or ports, so as to comply throughout with the load line regulations; Demonstrate how to read draughts.