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

Course Code	**:**	Aux Mach 1
Course Descriptive Title	**:**	Auxiliary Machinery 1
Course Credits	**:**	6 units
Lecture Contact Hours per Week	**:**	5 hours
Laboratory Contact Hours per Week	**:**	3 hours
Prerequisite	**:**	None
Reference/s	**:**	• Table A-III/1 and Table A-III/2 Function: Marine Engineering STCW'78 as amended • Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE) • IMO Model Courses 7.02 and 7.04 • STCW'78 as amended

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main and auxiliary machinery and associated control systems	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger	– Various pumps – Principles – States that the function of a pump is to transfer fluid between two given points – Lists the losses of head in a pumping system – States that the viscosity of the fluid to be pumped must be within the range specified in the pump design States that permission should be obtained before any fluids are moved which might affect the stability of the ship and cause pollution overboard	5 hrs
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	– Types of pump – Names the types of pump generally used on ships and the purposes for which they are normally used – Explains the basic action of a displacement pump – Explains the necessity for a relief valve to be fitted in the discharge of any displacement pump – States that when a pump is handling oil or other hazardous material any discharge from the relief valve must be contained within the pumping system – Describes, with the aid of diagrams, how a reciprocating displacement pump works – Explains the purpose of an air vessel fitted to the discharge – Describes the characteristics of a reciprocating pump, referring to: – suction lift – priming – discharge pressure – vapour, or gas, in the fluid being pumped Explains the principle of rotary displacement pumps – Sketches a single line diagram to show the principle parts of: – a gear pump – a rotary vane pump – a screw-displacement pump – Describes the principles of operation of an axial-flow pump – Describes the type of duty best suited to an axial-flow pump – Explains the principles of a centrifugal pump, referring of the purpose of: – the impeller – the diffuser or volute	15 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		– Makes a single line sketch of a vertical single-entry centrifugal pump – Explains what is meant by a 'single-entry' and a 'double entry' impeller – Describes the arrangement of a vertical multi-stage single-entry centrifugal – Explains the purpose of a diffuser – Describes the characteristics of a centrifugal pump, referring to: – suction lift – priming – discharge pressure – vapour or gas in the fluid being pumped – Explains why and when priming and/or air extraction is necessary and makes single line sketches of: – a reciprocating air pump – a water-ring air pump – Makes a single line sketch of a central priming system and explains its advantage – Explains the principle of an ejector	
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	Heat Exchangers States that marine heat exchangers are normally of the surface heat-transfer type and that seawater is used for cooling and condensing steam for heating – Describes surface heat transfer, referring to the relative direction of flow of fluid – Defines 'contact heat transfer' as the heat flow between fluids initially at different temperatures when they are mixed together – Sketches the principle of construction of the following surface heat-exchangers: – shell and tube – flat plate type – Explains the meaning of single-pass, two-pass, etc – Lists the types of heat exchangers used for the following: – lubricating-oil coolers – fuel-oil heaters – fresh-water coolers – compressed-air coolers – fresh-water heaters – steam condensers – seawater evaporating and distilling plant – seawater heaters – evaporators and condensers in refrigerators – States the materials used for the shell, tubes and tube plates of heat exchangers	10 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		– Explains how: – differential expansion is allowed for – an effective seal is maintained between the fluids – leakage is detected – Explains how temperature control is achieved in coolers – Describes the effect of partially closing the cooling-water inlet valve – Explains the effect of entrained air in cooling water and how it is removed	
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	Evaporators and distillers – Explains why 'fresh water' may have to be produced from seawater – Lists the purposes for which the water might be used – Explains the effect that distillation has on the dissolved solids in seawater – States that evaporators and distillers are pressure vessels and as such must conform to approved standards for materials, fittings and construction – States that there are two main methods of obtaining vapour from seawater: – by direct boiling, using boiling water evaporators – by the evolution of vapour when the seawater is 'supersaturated', using flash evaporators – Describes in simple terms, using line sketches, the construction of a shell and coil evaporator, naming the materials of the principal parts – Lists the mountings fitted to a simple shell and coil evaporator – Explains why a reducing orifice is fitted in the steam supply line of such an evaporator – States that the heat transfer can be obtained from: – a supply of steam or other hot fluid passing through coils – tubes which are immersed in the seawater or – an electrical element immersed in the seawater – Explains why low-pressure evaporators are used – Explains what is meant by single-effect and by double-effect evaporation (Flash Evaporators) – Explains the principle of flash evaporation – States that flash evaporators can use a number of stages, with seawater feed passing through each stage in succession – Describes, with the aid of a simple sketch, a two-stage flash evaporator – Explains the principle of operation of the evaporator in the above objective – (Multiple-effect Evaporation) – States that shell and coil evaporators can be connected in series, with the vapour produced in the first unit being used as the heating fluid in the next unit, the seawater	15 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	passing through-each unit in turn – States that production of vapour in the second and successive units occurs partly by boiling and partly by flash evaporation – States that such a system is termed 'multiple effect' – States that multiple-effect evaporation produces an increased quantity of fresh water compared to a single evaporator using a similar input of heat – Describes, with the aid of a single line sketch, the arrangement of a two-stage Flash-evaporation plant	
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	Air compressor and system principles – Air Compressors – Describes an air compressor as a pump which takes air from the atmosphere and, with an input of energy, compresses it in one or more states to a smaller volume with higher pressure and temperature – Explains the reason for cooling the air, during and after the compression – States that the compressed air is stored in steel reservoirs until required for some purpose, such as staring a diesel engine – States that, during the compression process, the relationship: $PV^n = a$ constant will apply – States that air can be treated as an ideal gas and that the relationship: – constant $PV/T = a$ will also apply – States that for the air storage tank the relationship: $PV = mRT$ will apply, where: – m = mass of air stored in the tank (kg) – R = specific gas constant for air (=8314 J/kg/K) – T =temperature of air, in kelvin units – P = air pressure, in Newtons per square metre – V = volume of reservoir tank, in cubic metres Solves simple numerical problems related to the above objectives	10 hrs
Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: .6 other auxiliaries, including various pumps, air compressor, fresh water generator, heat exchanger (cont)	Air compressors and system principles – Lists shipboard uses of compressed air – States the common pressure limit of single-stage compressors – States that, in order to restrict the rise of air temperature during compression, the air is cooled by circulating water around the cylinder – States that air compressor can be single-stage or multi-stage reciprocating or rotary machines – Describes the compression processes in a two-stage reciprocating compressor – Draws a line diagram of a two-stage air compressor. indicating stage air pressures and	5 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		temperatures Explains why intercoolers and after-coolers are used	
Operate main and auxiliary machinery and associated control systems (cont)	.9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems (cont)	Fluid Flow and Characteristics of Major Systems – Describes what sorts of fittings are used to construct each plant system taking examples such as various types of valves, pipings, pressure regulator and the like – Describes characteristics appeared in the each piping system taking examples such as supplementary devices/pipings, pipe coloring and location of equipment/installations – Conduct a work shop meeting giving an opportunities to the trainees to present their research activities on construction of piping systems – Describes the means by which lengths of pipe are joined together, naming the materials used to seal joints for: – steam pipes – seawater pipes – the fire main – bilge and ballast pipes – starting air pipes – control air pipes – Explains how pipes are supported to reduce vibration – Explains how expansion and contraction of pipes is catered for – Names the materials used for the construction pipes carrying the fluids listed in the above objective – Describes the principle construction of a cock and materials generally used – Explains how the arrangement of ports in the plug is displayed – Describes the main features of a globe valve – Explains the difference between a screw-lift valve, a screw-down non-return valve and a non-return valve – Describes the main features of a gate valve – Describes a typical relief valve – Lists and describes the applications of quick-closing valve – Describes the main features of a quick-closing valve – Makes a single line sketch of a change-over sea chest – Explains the purpose and applications of change-over-sea chests – Explains how pipelines are blanked off – Describes the main features of a mud box	5 hrs
Operate main and auxiliary machinery and associated control systems (cont)	.10 deck machinery	Deck Machinery – Windlass /mooring winch – Describes what components construct typical electric/hydraulic windlass/mooring winch systems – Explains the construction of windlass/mooring winch with visual aids/illustrations of typical	10 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main and auxiliary machinery and associated control systems (cont)	.10 deck machinery	ones – Explains the operation mechanism of windlass/mooring winch with visual aids/illustrations of typical ones – Explains in simple words, speed control mechanism used in windlass/mooring winch with visual aids/illustrations of typical ones – Winch Describes components used in the construction of typical electric/hydraulic winch systems Explains the construction of a winch with visual aids/illustrations of typical ones – Explains the operation mechanism of a winch with visual aids/illustrations of typical ones – Explains in simple words, speed control mechanism used in winch with visual aids/illustrations of typical ones – – Boat winch – Explains the construction of a boat winch with visual aids/illustrations of typical ones – Explains the operation mechanism of a boat winch with visual aids/illustrations of typical ones	
	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .4 other auxiliaries, including refrigeration, air-conditioning and ventilation systems	Air compressor – States that cylinder lubrication must be kept to a minimum consistent with correct and safe operation – States that cylinder lubricating oil should not have a flashpoint below 210°C and the use of synthetic lubricating oil to reduce a hazard – Describes the attention required to keep the intake air filter working effectively – Explains the reason for fitting drain valves after air coolers – Describes the starting-up and stopping procedures – Explains the principles upon which air compressors are run automatically – Describes the particular quality required for compressed air that is to be used in control systems Explains how the required quality in the above objective is achieved	4 hours
		Evaporators and distillers – Describes the need for starting fresh water generator and the limitation of keeping its running – Explains the outlines of starting procedures in accordance with typical type of fresh water generators (Control of water density and scale) – Explains how the formation of scale on the heating surfaces of coils, tubes and other heat-transfer elements is controlled – States the limiting pressure and temperature in the shell in order to control the formation of	10 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main and auxiliary machinery and associated control systems (cont)	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .4 other auxiliaries, including refrigeration, air-conditioning and ventilation systems	scale – States that the seawater in evaporator vessels is termed 'brine' – Explains that the density of this brine is sometimes measured relative to that of seawater, e.g. 0.5/32, 2/32, 2.5/32 etc – Explains why the density of the brine must be carefully controlled during the operation of an evaporator – Explains how, when an evaporator is operating normally, the brine is maintained at optimum density – States that excessive density of the brine should be avoided as it will cause the metallic salts contained in seawater to carry over with the vapour – States the effect of maintaining the density of the brine too low – Describes the type of scale deposited on the heating surfaces – Explains how the scale described in the above objective is removed (Distillation) – Defines the term distillation as used in marine engineering practice – Describes the function of a distiller as that of condensing fresh water from the vapour produced in an evaporator States that cooling is usually achieved by heat exchange with seawater flowing through tubes or coils	
Operate fuel, lubrication, ballast and other pumping systems and associated control systems	Operational characteristics of pumps and piping systems, including control systems Operation of pumping systems: .1 routine pumping operations	– States that performance will deteriorate if the temperature of the liquid being handled approaches that at which vapour is produced at the pressure in the suction pipe – States that performance deteriorates if the viscosity of the fluid increases – States that, if there is no positive head at the inlet to a centrifugal pump, a priming device must be used – Describes or performs the correct procedure for starting up and stopping: – positive-displacement pumps – axial-flow pumps – centrifugal pumps – making reference to: – suction valves – discharge valves – priming – Explains the attention necessary of ensure the satisfactory operation of: – an adjustable gland – a non-adjustable gland – Explains possible reasons for a loss of performance of a pump – Lists the ship's services which receive a supply of:	10 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		– seawater fresh water	
		Routine Pumping Operations – States the need to understand the pipe lines constructing pumping systems to be daily used in order to maintain the normal operation of the plant – States that the status of valves concerned in both manual and automatic pumping systems must be periodically checked States that any operation of pumping systems should be recorded in such a routine works record book	2 hours
Operate fuel, lubrication, ballast and other pumping systems and associated control systems (cont)	Operational characteristics of pumps and piping systems, including control systems Operation of pumping systems: (cont) .2 operation of bilge, ballast and cargo pumping systems Oily-water separators (or similar equipment) requirements and operation Operational characteristics of pumps and piping systems, including control systems Operation of pumping systems: (cont) .2 operation of bilge, ballast and cargo pumping systems Oily-water separators (or similar equipment) requirements and operation	Operation of Bilge, Ballast and Cargo Pumping Systems – (Bilge) – Explains the purpose of a bilge pumping system – Explains why non-return valves are fitted to bilge pipes in watertight compartments which contain the open end of the pipe – Sketches a diagrammatic arrangement of a bilge pumping system, including the connections to other pumps – Describes the purpose, siting and common principal connections of an emergency bilge suction – Describes the principle features of an emergency bilge pump (Ballast) – Explains the purpose of a ballast pumping system – Explains the fittings necessary when a space may be used for: – ballast or dry cargo – ballast or oil – Sketches a diagrammatic arrangement of a ballast system – (Fresh water and Seawater) – Lists the main uses of fresh water and seawater – Describes a domestic fresh-water pumping system, explaining how: – the water pressure is maintained – the pump is started and stopped – the water is heated – Describes a domestic seawater pumping system – Describes the treatment necessary for water produced by evaporators for human consumption (Hydraulic system) – Lists the machinery which might be controlled or driven by hydraulic motors	20 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		– Describes a hydraulic system – Describes the properties of hydraulic fluid – Explains the care necessary when topping up the fluid from a hydraulic system	
Operate fuel, lubrication, ballast and other pumping systems and associated control systems	Oily-water separators (or similar equipment) requirements and operation	– Describes the requirements necessary for oily water separators/similar equipment – Describes the structure of oily water separators/similar equipment – Describes the oil separation principles of oily water separators/similar equipment – Describes the components constructing oily water separators/similar equipment – States the reasons to use positive-displacement pump for oily water separators/similar equipment – States the principles of oil content meter attached to oily water separators/similar equipment – Explains how to prevent oil being mixed into discharging bilge when oil content exceeds 15 ppm – States that fluid going through inside the pipe lines and oily-water separator/similar equipment can be correctly checked with pressure gauges – States that pollution of the sea is an offense under international law – States that the dumping of oil or oil-water mixtures is strictly prohibited – States that there is a legal maximum oil content of water to be discharged overboard – States that any discharge which could be contaminated must be passed through an oily-water separator which produces an effluent containing less than 100 ppm. of oil under all inlet conditions – States that the effluent should be further filtered to give an output containing a maximum of 15 ppm. of oil under all inlet conditions – Describes, with the aid of a single line sketch, the operation of an automatic three-stage oily-water separator/similar equipment Lists the information which must be entered in the Oil Record Book when pumping out bilges	8 hours
Operation, surveillance, Performance assessment and maintaining safety of propulsion plant and auxiliary machinery (ML)	Functions and mechanism of automatic control for auxiliary machinery including but not limited to: .5 pumping and piping systems .7 cargo-handling equipment and deck machinery	Pumping and piping system – Explains the automation, monitoring and alarms of pumping and piping system: – automatic start of standby pumps – automatic start/stop of hydrophore pumps – automatic water level control of boiler by feed pumps – automatic cargo stripping system onboard tankers automatic heeling system	1 hour

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		Cargo-handling equipment and deck machinery – Explains the automation, monitoring and alarms of steering systems – self-tensioning mooring winches – automatic shut-down of cargo -pumping on abnormal operating conditions of inert gas system on board tankers automatic shut-down of cargo pumping / loading on tankers and gas carriers	1 hour
Manage fuel, lubrication and ballast operations (ML)	Operation and maintenance of machinery, including pumps and piping systems	Bilge and Ballast – Describe procedures for evaluating pumps, ejectors, and pumping systems including ship side valves, explain methods of identifying problems which affect performance, and identify common faults and evaluate methods of assessment – Illustrate the operation of self-priming systems as used on ballast or cargo pumping arrangements – Explains the purpose and procedure for using bilge injection – Explain the main causes of corrosion in sea water systems and the regions most affected Compare corrosion and marine growth prevention systems used for pumps and pumping systems, including impressed current, sacrificial anodes, chemical injection, special coatings, chlorination, and special materials	2 hours
		Sewage and sludge – Describes a sewage retention system – Explains why vacuum transportation systems are used – Describes the process where a comminutor and treatment with chlorine are used – Describes the processes in a biological treatment plant – Explains how the sludge from a biological treatment plant is disposed of – Explains why biological treatment should be kept working continuously – Names the contaminants which would impair the treatment process – Describes the operation of chemical treatment plants – Lists the waste materials that can be incinerated Explains how liquid and solid waste are prepared for combustion in an incinerator	4 hours
		Total No. of Hours	137 Hours

* discrepancy between course specifications and course map total number of hours is intended for assessment