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

Course Code	:	Aux Mach 2
Course Descriptive Title	:	Auxiliary Machinery II
Course Credits	:	5 units
Lecture Contact Hours per Week	:	4 hour
Laboratory Contact Hours per Week	:	3 hours
Prerequisite	:	Aux Mach I
Reference/s	:	1. Table A-III/1 Function 1 : Operate main and auxiliary machinery and associated control systems 2. Table A-III/2 Function 1 : Plan and schedule operations 3. IMO Model Courses 7.02 and 7.04 4. Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE) 5. STCW'78 as amended

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main auxiliary machinery and associated control systems	Basic construction and operation principles of machinery systems, including: • Other auxiliaries	Refrigeration a. Marine refrigeration cycle ○ States the that Rankine cycle is the ideal cycle where the working fluid is used in both liquid and vapour phases such as steam power plant and refrigeration plant ○ States that a refrigeration cycle operates on a reversed heat-engine cycle ○ Describes the working fluids for this cycle as "refrigerants" ○ States that because working fluids are used in both the liquid and vapour phases during the cycle, energy levels and other properties for the working fluid must be obtained from tables of thermodynamic properties ○ Describes the four main components of the plant as: • the evaporator, in which the low-pressure refrigerant enters as a cold liquid and is evaporated to a cold low-pressure vapour • the compressor, in which the low-pressure cold vapour is compressed to a high pressure superheated vapour • the condenser, in which the hot-high-pressure vapour is cooled and condensed of a cool liquid ○ The expansion valve, where the cool high-pressure liquid is throttled and expanded to a low-pressure cold liquid ○ States that the energy required to evaporate the low-pressure liquid refrigerant to a low pressure vapour at constant low temperature is transferred from the refrigerated chambers, either directly or through a secondary coolant such as brine ○ States that the transfer of energy from the refrigerated chamber is that which produces and maintains its low temperature ○ States that the refrigeration plant performance is measured by the quantity of energy extracted from the refrigerated chambers per unit energy supplied in compressor work ○ States that the input energy from the compressor is the difference between values of the refrigerant energy at the inlet to and at the exit from the compressor ○ Using <u>energy extracted in the evaporator,</u> Energy input from compressor derived from the above objectives, calculated the performance of a refrigerator ○ Draws and labels a line diagram of a refrigeration plant, using "blocks" for the main components and arrows to indicate flow of the working fluid and indicating the energy	20 hrs.

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	values at important points of the cycle ○ Applies simple numerical calculations related to, and making use of the above objectives ○ Lists the refrigerants commonly used in marine refrigeration systems	
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	b. Principles of refrigeration ○ Explains, in simple terms, the difference between refrigeration, air conditioning and ventilation ○ States that marine refrigerating systems operate on a reversed Rankine cycle, which is also termed the vapour-compression cycle ○ Sketches a single line and block diagram of a refrigeration system, system components and arrows to indicate flow of refrigerant, showing the following components: • compressor • condenser • regulator valve and controlling sensor • evaporator • oil separator • drier ○ Shows on the diagram in the above objective the part of the system where the following processes take place: • removal of superheat • condensation • throttling • evaporation • compression	8hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		• expansion • charging ○ Describes the requirements of a primary refrigerant ○ Names common primary refrigerants currently specified under IMO recommendation (ozone protection) ○ Describes the purpose of a secondary refrigerant ○ Names common secondary refrigerants	
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	Refrigerating compressors ○ States the types of compressor in common use ○ Describes in simple terms the applications of the types of compressor in the above objective ○ States that cylinder blocks of a reciprocating compressor can be either in line or in a vee ○ Describes, with aid of simple sketches, a rotary gland seal ○ Describes how excessive pressure in the cylinder is relieved	2hrs
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	Refrigerating system components • States the function of the expansion valve • Describes how the expansion valve is controlled • Sketches an expansion valve in section as a single line diagram • Describes briefly how an oil separator works • States the function of a liquid receiver • Describes how the system can be controlled automatically, using the temperature of the cold room • Describes in simple terms a condenser • Describes in simple terms an evaporator	4hrs
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including:	Refrigerating system brines • Describes the composition of a brine • Explains how the density of a brine is varied to suit the temperature of operation • Determines the density of brine samples • States that a brine density should be sufficient to give a freezing temperature below the	4hrs

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	• Other auxiliaries (cont.)	lowest temperature required • States that a brine should be maintained with an alkalinity between pH 8 and 9 to minimize corrosion • Determines the pH value of brine samples • Explains the precautions to be taken if a brine has to be made with sodium chloride • Describes the process of making a brine	
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	Cold storage spaces • Describes the principles of insulation of storage spaces • States that range of temperature for spaces containing: • frozen meat and fish • vegetables • lobby	2 hrs
Operate main auxiliary machinery and associated control systems (cont.)	Basic construction and operation principles of machinery systems, including: • Other auxiliaries (cont.)	Air conditioning and ventilation systems • Sketches a single line and block diagram of an air conditioning system, system components and arrows to indicate flow of refrigeration, showing the following components: - fan - thermo tank - thermostat - fresh air dumper - return air dumper • States how to control temperature and humidity in the air conditioning system	5 hrs
Operate main auxiliary machinery and	Basic construction and operation principles of	Purifier and fuel oil treatment ○ Describes the following with the aid of sketches: ▪ bowl assembly	10hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
associated control systems (cont.)	machinery systems, including: • Other auxiliaries (cont.)	▪ operating water ▪ seal water ▪ gravity disk ▪ valve cylinder ▪ Separation disk/plate o States principles of purifying to eliminate water or dirt particles from oil o Explains why fuel oil treatment is necessary o Explains in simple terms, the purification by using gravity force and filters, and centrifugal separation o Describes the following types of filter, which are used in fuel oil lines ▪ mesh/gauze elements ▪ magnetic elements ▪ fibre assemblies o Explains how the force of gravity is used to separate out liquids and solids of different densities o Describes the operation principles of an oil purifier o Explains why the use of centrifugal separation is much faster and more effective than gravity in the separation process o Describes, with the aid of simple sketches, a bowl separator and a tube separator, showing the main components and the principal differences between the two o States the rotation speeds used in the equipment described in the above objective	
Operate main and auxiliary machinery and associated control systems (cont.)	Steering Gear	Steering Gear Principle (10 hrs) o State that the gear is vital to the safety of a ship; it must function correctly and be properly serviced and maintained; o State that there must be two independent means of steering; o State that alternative control of the steering gear must be provided in the steering gear compartment; o Draw a line and block diagram to represent the major component of a steering system showing: • the steering-wheel transmitter–located in the bridge space • the rudder-control receiver unit-located aft in the steering compartment • the systems conveying the transmitter signal to the receiver	20 hrs.

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate main and auxiliary machinery and associated control systems (cont.)	Steering Gear (cont)	• the power system which moves the rudder • the rudder-control feedback to the system ○ State that the function of the receiver is to act on the signal from the transmitter and through a control element to operate the rudder power system; ○ State that the rudder power system can be hydraulic or electrical; ○ Identify the particular requirements of oil tankers Steering gear electrical control (2 hour) – Describes the principles of operation of an electrical control system Hydraulic power-operated rudder systems (4 hours) – Explains that the systems can be principally cylinders and rams or a radial-vane motor – Sketches, using lines and block diagrams, the system of cylinders and rams, showing how, with a pair of rams in line and two rams in parallel, hydraulic pressure actuates the rudder through a crosshead or trunnion and tiller-arm assembly – States that, in a radial-vane-type system, hydraulic pressure acts on radial vanes attached to the rudder stock, this producing movement of the rudder – Describes normal operation of rudder drive pumps and system, indicating which valves are open and which are closed – States the materials normally used in the main components in the above objectives Hydraulic power rotary pumps (4 hours) – States that a rotary positive-displacement pump is used to obtain displacement of fluid and produce movement of the rudder – States that the pump in the above objective is driven by an electric motor – Describes the principle of operation of a radial cylinder pump – Describes the principle of operation of a swash-plate pump – Describes how the pumping action is controlled: – by linkage to the telemotor receiver and – by linkage to the rudder, for feedback control – Describes, with the aid of single line sketch, how the pump is controlled to move the rudder from one position to another – States that the fluid in the system must be the correct mineral-base oil which is clean and free of moisture – Explains how shocks to the system from wave action on the rudder are absorbed	

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Operate main auxiliary machinery and associated control systems (cont.)	Other auxiliaries (purifier and fuel oil treatment; refrigeration)	○ Purifier and Fuel Oil Treatment (operation) ○ states sequence of discharging sludge ○ states why oil purifier needs following data concerning oil: ▪ temperature ▪ quantity of flow ▪ density/specific gravity ○ explains the function of gravity disk ○ explain the function of low and high pressure water ○ describes sludge discharging mechanism of an oil purifier ○ explains the difference between purifying and clarifying ○ describes the purification process of fuel oil, starting the approximate temperatures of the oil necessary both in the supply tank and immediately prior to centrifuging ○ explains precautions for starting purifier and checking points to ensure a good working order ○ describes the correct procedures for the disposal of waste oil, sludge residue, etc	8 hrs
Operate main auxiliary machinery and associated control systems (cont.)	Other auxiliaries (purifier and fuel oil treatment; refrigeration) (cont)	Refrigerating System, operation and maintenance (operation) ● States the preparation and precautions for starting a refrigerator ● States precautions and checking points on a refrigerator while its running ● States how the operating conditions is identified in a good working order ● States what malfunctions/troubles likely occur in refrigerators ● Describes the effect of variations in seawater temperature on the running of a refrigerating system ● Describes the effect in refrigeration unit of air, moisture and oil ● Explains how to charge refrigerant into a refrigerator and vice versa ● Explains how to charge lubricating oil into a refrigerator and vice versa ● Explains how to remove air from a refrigerator unit ● States how to inspect leaking of refrigerant ● States how to make a leak test for a refrigerator unit such as pressure test/ vacuum test	8 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Plan and schedule operations (ML)	Thermodynamics and heat transmission	Gas Cycles/Engine Analysis Demonstrates knowledge and understanding of: • Constant pressure and constant volume air standard cycles • Reciprocating internal combustion engine performance parameters: indicator diagrams, power, mean effective pressure, thermal efficiency, brake specific fuel consumption , mechanical efficiency, energy balance • Open and closed gas turbine systems • Power, isentropic efficiency and thermal efficiency for gas turbines Refrigeration Demonstrates knowledge and understanding of: • Vapour compression cycle • Refrigerant properties and hazards • Refrigerant tables • Cycle on p-h diagram • Coefficient of performance • Refrigerant mass flow • Compressor calculations • Secondary refrigerants Air Conditioning • Demonstrates knowledge and understanding of: • Comfort conditions • Psychometric charts • Wet and dry bulb temperatures • Humidity • Dew point • Dehumidifying and humidifying processes • Air conditioning system	12 hrs
Plan and schedule operations (ML)	Theoretical knowledge of heat cycle, thermal efficiency and heat balance of refrigerators and	Refrigeration and Air-conditioning System at Management Level • Assess common refrigerants used on board, using factors such as their properties, economics of use, handling, health hazards, and environmental impacts • Explain the environmental concerns of traditional refrigerants and the methods used to address these concerns • Explain correct procedures for the recovery of refrigerants from refrigeration systems	6 hrs

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	refrigeration cycle Refrigerators and refrigeration cycle	• analyze functions and operation of all components including fittings and safety devices of refrigeration and air conditioning plants • Interpret symptoms, effects and remedial actions for common faults in refrigeration and air conditioning system • Precautions during cargo operations – re-circulation system of AHU • explain purposes and procedures for pumping down, leak test, refrigerant charging and oil changing • Record keeping of refrigerant consumption	
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery (ML)	Oil Purifier	Oil purifier automation, monitoring and alarms of oil purifiers O Explains the automation, monitoring and alarms of oil purifiers Temperature control Automatic start Automatic desludging Partial desludging Total desludging Monitoring and alarms Low/high temperature Water content Leakage monitoring Treated oil flowing into heavy liquid side Non-closure of bowl Discharge detector for monitoring sludge discharge	6 hrs
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery (ML) (cont.)	Refrigeration system	Refrigeration and air conditioning system Explains the automation, monitoring and alarms in refrigeration systems If pump down cycle used on board for refrigeration system: Automatic shutdown of compressor when all cold rooms attain temperature by shutting off of solenoid valves and low pressure cut out in suction line When one or more cold rooms temperature rises and solenoid valve/s open and suction pressure rises, thereby suction cut in operates and automatic start of	3 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		compressor • Automatic shut down and alarm in case of high pressure in discharge line. Manual reset for restarting of compressor • Automatic shut down of compressor and alarm in case of low pressure of lubricating oil • Timer control for defrosting of evaporator coils of meat room and fish room Capacity control may be used on board for refrigeration compressor Automatic control of steam spray for accommodation air conditioning heating system	
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery (ML) (cont.)	Steering Gear System	Explains the automation, monitoring and alarms of steering systems • Main and emergency steering systems • Autopilot system • Regaining of steering capability in case of single failure of the hydraulic system	2 hrs
		Total No. of Hours	120 Hours

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