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

Course Code	**:**	PPD
Course Descriptive Title	**:**	Power Plant Diesel
Course Credits	**:**	5 units
Lecture Contact Hours per Week	**:**	4 hour
Laboratory Contact Hours per Week	**:**	3 hours
Prerequisite	**:**	Thermodynamics
Co-requisite	**:**	Auto 1
Reference/s	**:**	1.STCW Table A-III/1, III/2 2.IMO Model Courses 7.02 and 7.04 3.Annex A of CMO 20, series of 2015 (Curriculum Mapping) 4.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: .1 marine diesel engine .	1. Heat-engine cycle - Defines "heat-engine cycle" as a number of thermodynamic processes arranged in a given sequence, and repealed over constant intervals of time - States that real practical cycles are based on "ideal" theoretical cycles - States that most ideal cycles involve the following thermodynamic processes: -heating or cooling, at constant pressure -heating or cooling, at constant volume -adiabatic compression or expansion - States that the cycle of thermodynamic processes (or operations) is called out on a "working fluid" - States that ideally the working fluid is "perfect", with its physical properties and structure remaining constant throughout the cycle - States that working fluids used in practical engines change during the cycle of processes - States that the function of a heat-engine cycle is to produce the maximum possible output of useful work(W) from a given quantity of energy supplied to the working fluid - States that, in the majority of practical heat-engine cycles, the energy input is obtained from the energy released by the combustion of a fuel with air - States that the "efficiency" of the cycle is measured by the energy output obtained per unit of energy supplied to the working fluid - States that, in the "ideal" case, the energy output will be the difference between the energy supplied during the cycle (Q1) and the energy remaining and rejected at the end of the cycle (Q2) - Deduces from the above objective that ideally the output energy is the difference between the energy supplied and the energy rejected, i.e. W = Q1 – Q2 - Deduces from the above objective that the cycle efficiently is given by the ratio: $\frac{Energy\ output}{Energy\ input} = \frac{W}{Q1} = \frac{Energy\ supplied - Energy\ rejected}{Energy\ supplied} = \frac{Q1 - Q2}{Q1}$ - Solves simple numerical problems related to the equation in the above objective 2. Ideal-gas cycle - Defines ideal-gas cycle as those which use a perfect(or ideal) gaseous working fluid	20 Hours 15 Hours

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: (cont) .1 marine diesel engine	- Defines the following cycles as a sketch on a plane of pressure-volume: -Otto cycle -Diesel cycle -Dual cycle -Joule cycle - Indicating where the thermodynamic processes given in the above objective have been used in each cycle - Names the practical engines whose cycle is modelled on the cycles listed in the above objective as: -Otto, internal-combustion reciprocating engine, using gas or petrol as a fuel; ignition of fuel is by spark -Diesel, compression-ignition reciprocating engine, using diesel or heavier fuel oil; ignition is by transfer of heat energy from compressed air -Dual, modern development of the diesel cycle -Joule, rotary turbine, using gaseous or light to medium fuels ("gas turbine") - Explains the meaning of "single-and double-acting" as applied to reciprocating engines - Describes the processes which take place in each stroke of the two-stroke and four-stroke cycles in diesel and petrol engines - Lists the usual maximum temperatures and pressures for the cycles listed in the above objective - Sketches a diagram showing typical crank angles at which air and exhaust valves or ports open and close and the periods of air inlet, compression, combustion, expansion and exhaust in the above objective 3. Diesel engine fuel atomization and combustion - Describes the combustion process in a boiler or an engine cylinder - Describes the chemical reaction in combustion as being between combustible materials such as hydrocarbon on fuels and the oxygen contained in atmospheric air - States that, as a result of combustion, heat energy become available, enabling thermodynamic operations to be carried out - States that the heat released during the combustion of a unit of a substance is termed calorific value (CV) - States that calorific values for fuels are usually stated with respect to unit mass in the case of solid and liquid fuels and unit volume in the case of gaseous fuels	20 Hours

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: (cont) .1 marine diesel engine	- States that the main combustible elements in marine fuels are carbon, hydrogen and sulphur - States the appropriate calorific values of the elements given in the above objective - States that sulphur is usually present in marine fuels - States that the salts of sodium and vanadium are usually present in marine fuels - States that sulphur, although combustible, is an undesirable element in a fuel - States that sodium and vanadium are also undesirable elements in a fuel - States typical percentages of carbon, hydrogen and sulphur for: -fuel oil for a steam boiler -marine diesel fuel - States typical calorific values for marine fuels - States the average proportions, by percentage, of oxygen and nitrogen in atmospheric air - Sketches a section through a typical injector nozzle assembly, including dual fuel injector - Explains how atomization is produced by the injector nozzle - Explains why swirl and penetration are important to the ignition and combustion of the fuel/air mixture - Describes the care necessary with injector nozzle holes 4. Engine types - States that marine diesel engines are normally described in broad categories by the bore of their cylinders and their rotational speed - States that large-bore engines are normally fitted with piston rods and crossheads - States that smaller diesel engines normally have trunk pistons and gudgeon pin in the place of piston rods and crossheads - States that large-bore engines are normally directly connected to the propeller and therefore rotated at low speed - States that other diesel engines may run at medium speed or high speed, depending upon their duty - States that medium-speed and high-speed engines are often used as direct drives for generation of electrical power - States that medium-speed engines (and occasionally high-speed engines) are used, through some form of speed reduction, as main propulsion engines - States the approximate speed ranges related to the following engines: -low-speed -medium-speed -high-speed	10 Hours

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: (cont) .1 marine diesel engine	5. Engine principles - Sketches typical indicator diagrams for: -a two-stroke engine -a four-stroke engine - Explains the problems of obtaining indicator diagrams from slow-speed, medium-speed and high-speed engines - States that peak pressures are sometimes measured which give an indication of engine power and performance - Develops the expression: work = pressure x volume, to produce an expression for the power of a diesel engine in terms of m.e.p., number of cylinders, length of stroke, diameter of piston and r.p.m. - Calculates indicated power, using given dimensions, r.p.m., m.e.p. and the expression developed in the above objective - States typical compressions and maximum pressures for slow-, medium-and high-speed engines - Explains the reasons for supercharging, giving typical supercharge pressures - Using the equation PV = mRT, shows the effect of varying P and T in a diesel-engine cylinder - Sketches and labels a diagrammatic arrangement of a supercharging system - Explains why high pressures are required for the injection of fuel into the cylinder - Describes the essential features of a hydraulic fuel injector - States, as approximate percentages or fractions, a simple distribution of energy obtained from the fuel into: -output as useful work -heat to the cooling media -energy retained in the exhaust gases -energy absorbed in engine friction -energy lost through radiation -states, for a marine propulsion diesel engine, typical values of: -brake thermal efficiency -mechanical efficiency -fuel consumption in kg per kW hour 6. Basic Construction Large-bore (two-stroke) engine details	15 Hours 10 Hours

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: (cont) .1 marine diesel engine	- Describes with the aid of a simple single line sketch, naming the material of manufacture, the assembled construction of the principal components of a diesel engine, including: -the bedplate -a main bearing -an 'A' frame and entablature -guides -a liner -a cooling-water jacket -a cylinder head -a diaphragm -a turbocharger -the scavenge trunk -an air cooler -the crankshaft -a connecting rod -a crosshead -a piston -crankpin bearing -gudgeon/piston pin bearing -the camshaft -a push rod -a rocker -an exhaust valve or port -an air-inlet port -the chain or gear train driving the camshaft - Sketches a section through a piston, showing the cooling arrangements - Sketches a section through an engine bedplate, showing the longitudinal and transverse girders, the main-bearing and tie-bolt housings - Describes, with the aid of simple sketches, the following valves, showing principle parts, materials and method of operation: -exhaust valve -cylinder lubricator -fuel valve -cylinder relief valve -air-starting valve -crankcase relief valve	

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Operate main and auxiliary machinery and associated control systems (cont)	Basic construction and operation principles of machinery systems, including: (cont) .1 marine diesel engine	-jerk fuel pump including the pressures at which the two relief valves operate - With the aid of engine manufacturers' manuals, defines specified work clearances of all bearing and sliding surfaces and interference fits, where applicable - Describes, with the aid of diagrams, the distribution of lubricating oil to the guides, piston pin, crankpin and main bearings when pistons are oil-cooled and when water-cooled Medium-speed and high-speed (four-stroke) diesel engines - Lists the services for which auxiliary diesel engines are used - Name the materials used in the manufacture of the listed items, then describe, with the aid of sketches, the assembled construction of these items: -the bedplate -a cylinder block -a cylinder jacket -a cylinder liner -a cylinder head -the exhaust gas manifold -the air-inlet manifold -the air cooler -the engine crankcase -a bearing housing and shell -the lubrication-oil sump -a piston -a connecting rod -a gudgeon/piston pin -the crankshaft -the camshaft and chain -the push rods -the fuel injector -the air inlet and exhaust valves and rockers - Describes in simple terms the principal features of a typical "V"-type medium-speed diesel engine - Sketches a diagrammatic arrangement of a propeller drive from two medium-speed	10 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
		engines - Sketches typical timing diagrams for medium-speed and high-speed diesel engines - Describes a simple governor to maintain normal running speed under conditions of variable load - Describes, with the aid of diagrams, a lubrication and piston-cooling system for a medium-speed diesel engine - Identifies that the power starting of an auxiliary diesel engine can be pneumatic, hydraulic or electrical - Explains why it is important to maintain the lubricating oil and fuel filters clean and in good condition - Uses engine builders' manuals to obtain working clearances specified by the instructor - Describes how the diesel engine of an emergency generator is started - States the normal intervals between checking and testing the emergency generating engine	
Manage the operation of propulsion plant (ML)	Design features and operative mechanism of Marine Diesel Engines and associated auxiliaries	o Describes with the aid of sketches/computer aided drawing, material selection, and design features of the structure of diesel engine: □ Structure of the bedplate □ Bedplate connection to the tank top □ Arrangement of holding down bolts □ Structure of A-frames and columns □ Arrangement of tie bolts □ Cylinder block and entablature □ Arrangement of main bearing caps □ Arrangement of piston rod gland assembly □ Arrangement of turbochargers and air coolers o Describes with the aid of sketches/computer aided drawing, material selection, and design features of the running gear of diesel engine: □ Crankshaft □ Main bearing □ Thrust block and bearing □ Bottom end bearing □ Connecting rod	15 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Manage the operation of propulsion plant (ML) (cont.)	Design features and operative mechanism of Marine Diesel Engines and associated auxiliaries (cont.)	□ Cross head and bearing □ Guides and guide shoes □ Lubrication of main bearing, bottom end bearing and cross head bearing □ Cam shaft drive arrangement □ Gear wheel transmission □ Chain wheel transmission □ Cam shaft bearing arrangement o Describes with the aid of sketches/computer aided drawing, material selection, and design features of the fuel injection equipment of diesel engine: □ Fuel injection pumps including fuel pumps for common rail system □ Fuel injectors □ Arrangement of fuel injectors □ Variable injection timing o Describes with the aid of sketches/computer aided drawing, material selection, and design features of the combustion chamber components of diesel engine: □ Cylinder cover and mountings / excess pressure release method □ Cooling of cylinder cover □ Cylinder Liner and cooling arrangements □ Piston crown □ Piston assembly □ Geometry of combustion chamber □ Exhaust valve and cooling arrangement o Describes with the aid of sketches/computer aided drawing, material selection, and design features of piston rings, compatibility to cylinder liner and cylinder lubrication employed in a diesel engine: □ Cylinder liner material □ Piston rings material □ Manufacturing methods of cylinder liner □ Manufacturing methods of piston rings □ Types of cylinder lubrication and mechanism. □ Selection of cylinder lubrication oil	

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		o Describes with the aid of sketches the operative mechanism of diesel engine system □ Starting and Reversing system □ Cooling water system □ Lubrication oil system □ Fuel oil system □ Scavenging, supercharging and exhausting. □ Engine safety system □ Engine emergency operating system	
Plan and schedule operations (theoretical knowledge)	Design features and operative mechanism of Marine Diesel Engines and associated auxiliaries	Combustion Demonstrates knowledge and understanding of: • Combustion equations • Fuel composition • Air-fuel ratio • Excess air • Volumetric analysis of combustion products • Calorific value.	6 hrs.
		Total No. of Hours	121 Hours

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