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

Course Code	**:**	Electro 2
Course Descriptive Title	**:**	Marine Electricity
Course Credits	**:**	5 units
Lecture Contact Hours per Week	**:**	4 hours
Laboratory Contact Hours per Week	**:**	3 hours
○ **Prerequisite**	**:**	Electro 1
Reference/s	**:**	○ Table A-III/1 and Table III/2 Function: Electrical, Electronic and Control Engineering ○ IMO Model course 7.02 and 7.04 ○ STCW'78 as amended ○ Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE)

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems	Electrical equipment	1. Generators *A.C. Generators* – Uses Fleming's hand rules to determine the directions of magnetic field, motion and current – On an actual machine, or by using a given diagram that shows the arrangement of a simple generator, identifies and explains the function of: – the armature – slip rings – brushes and springs – field poles – field coils – Sketches a graph showing the variation of e.m.f. when a simple loop generator coil is rotated between two poles – States the range of voltage and frequency at which ships' electrical power is generated – States that the A.C. voltages normally given are root mean square values and that all equipment is rated in these terms – States that peak values are 2 times larger than r.m.s. values – Describes in simple terms an A.C. generator with three-phase windings, stating the phase difference – Sketches a schematic arrangement of a three-phase alternator with star connection – In the terminal box of a stator field winding, identifies the outlets of the three phases and the common neutral connection – Explains how excitation of the rotor is produced and supplied – Describes how a generator is cooled – Lists the parts of a generator fitted with temperature alarms – Explains why heaters are fitted to a generator – Explains the function of an automatic voltage regulator – Sketches a block diagram of an automatic voltage regulator, naming the main components – and explaining the purpose of the hand trimmer – Explains such sources of supply can be run in parallel and those which cannot – Performs or describes the synchronizing sequence to bring a generator into	30 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	service in parallel with a running generator, using both a synchroscope and lamps – Adjusts, or describes how to adjust, the load sharing of two generators running in parallel – Either performs the procedure, or describes how, to reduce the load on a generator and takes it out of service – States that load sharing can be automatically controlled – States that the emergency generator feeds its own switchboard and that both are usually installed in the same compartment above the waterline – Describes the connections between the emergency and main switchboards and the necessary safeguards – Describes the situation where the emergency generator would be started up automatically and the methods of starting – Describes the regular "no load" running and the occasional "on load" running of the emergency generator	
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	*D.C Generators* – Sketches, in diagrammatic form, the basic circuit for a D.C. generator – On a given drawing or an actual generator, identifies the field poles, yoke, shoe, field windings and interpoles – Describes the differences in appearance of shunt coils and series coils – On a given drawing or an actual generator, identifies the windings, commutator, commutator insulation, laminations, clamping arrangement, ventilation holes, coil-retaining arrangements, brushes, tails, brush loading arrangement and bearings – Names the two types of winding used on armatures – On an actual machine or by using a given diagram that shows the arrangement of a simple direct-current generator, identifies and explains the function of: – the armature – the commutator – brushes and springs – field poles – field coils	
		2. Power Distribution Systems *Distribution* – Explains the basic purposes of switches, circuit breakers and fuses – Describes briefly the principle of the various types of closing mechanism of circuit	15 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	breakers – Lists the ways in which a circuit breaker can be tripped – Explains the purpose of interlocks fitted to circuit breakers – Lists the essential services which are supplied by electrical power – Explains the purpose of an emergency power supply – States the possible sources of emergency power supply and how they are brought into use – Draws a system diagram of a typical distribution system, showing: – main generators – emergency generators – shore supply – battery charging – 440 volt supply – 220 volt supply – circuit breakers – transformers – By means of simple sketches, shows the difference between insulated systems and earthed-neutral systems	
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	*Insulation* – Explains what is meant by an insulator and the purpose of insulation – Describes leakage in an insulated cable – Explains why the insulation resistance of large installations is normally relatively lower than those of small installations – Describes the factors which affect the value of insulation resistance – Explains why the current-carrying capacity of a machine is governed by its insulation – Describes what is meant by insulation resistance and explains how it often deteriorates – Describes the materials and general physical characteristics of insulation materials and the factors and conditions which cause deterioration – States the maximum temperature which common insulation materials can withstand and the maximum ambient air temperature used in design – Explains why the ventilation and cooling of insulation is essential	
		Transformers – States that transformers on ships are usually air-cooled – Shows diagrammatically the connections between the main switchboard and the	

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Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	main distribution board through: – delta-delta transformers – delta-star transformers – delta-star transformers with an earthed neutral – Describes the procedure when connecting up to a shore supply	
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	3. Electrical Motors *A.C. motors* – States the normal supply for three-phase induction motors – Names the types of motor commonly used on board ships, giving their applications – Given the actual components from a three-phase induction motor, identifies: – rotor – bearings – fan – stator – field windings – rotor cage – method of lubrication – terminals – Explains the differences between the following motor enclosure, describing how cooling is achieved in each case: – drip-proof – totally enclosed – deck watertight – flameproof – Sketches a graph showing the relationship between speed and load and between current and load, from no load to full load – Given a motor name plate, explains the meaning of all of the information displayed – Explains in simple terms how the driving torque is produced in an induction motor – Explains why slip is essential	20 Hours
		D.C. motor – Explains what is meant by the back e.m.f. (E_b) of a motor – Relates the supply voltage to the back e.m.f. and to the voltage drop in the armature	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	$V = E_b + I_aR_a$ – Explains why the starting current is high compared to the load current – Explains why a starter is required and the principle involved – States that rotational speed (*N*) is approximately proportional to: – *applied voltage / field flux* or $N \propto V/\Phi$ – From the above objective, explains how the rotational speed is affected by: – varying the voltage – varying the strength of the magnetic field – Describes typical applications of: – shunt motors – series motors – In compound motors, explains what is meant by: – long shunt – short shunt – cumulatively connected	
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	4. Electrical Motor Starting Methodologies – Explains the following starting methods for D.C. motors and its characteristics: – starting rheostat – automatic starter – Explains the following starting methods for A.C. motors and its characteristics: – direct on line starting – star-delta starting – compensator starting – States what should be taken into consideration when selecting starting methods for A.C. motors – Explains the basic reason for the provision of motor protection – Explains the principles of the most common over current relays – Explains the difference between the largest possible overload current and a fault current – Describes the function of the over-current trip, time delays and fuses with both overload and fault currents – Explains the basis upon which fuses are chosen – Explains the principle of a thermal relay, including the means of its adjustment	10 Hours
		5. High-Voltage Installations – States that more than 1,000 V is usually called high-voltage	10 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical equipment (cont)	– States how and why high-voltage installations are used on board ships – States what voltages are mostly used as high voltage on board ships – Describes equipment/installations in high-voltage systems such as high-voltage generator, distribution board, motors etc. – States the special characteristics and features of high-voltage installations in comparison with less than 1,000 V – States that high-voltage systems are normally earthed via a resistor – Explains how the presence of earth faults is indicated in a high-voltage system with an earthed neutral – States safety precautions to be strictly observed to prevent accidents when working on high-voltage electrical equipment – States that any operation of high-voltage installations must be carried out remotely at places where a certain distance is being kept from the installations	
Operate electrical, electronic and control systems (cont)	Marine Electro-technology	– Discusses the following in terms of electrical practice in ships – Materials of conductors - single wire and multi-stranded – Commonly used insulation material – Effect of temperature, oxidation, fire, oil, seawater, acids and solvents on insulation materials – Sheathing of electric cables – Cable runs in machinery spaces, cargo holds and cold-storage chambers – Passing of cables through bulkheads and decks o Deck Machinery – Fail safe brake – Coil operated brake – Deck winches and capstans, windlass and deck cranes o Electrical Interference – Equipment susceptible to electric interference o Common sources of interference – Method of suppression of interference	10 Hours
Manage operation of electrical and electronic control equipment (ML)	Design features and system configurations of operational control equipment for electrical motors	6. Three Phase A.C. Motors – Construction, principle of operation of 3-phase induction motors – Design features of star and delta motors – Starting, speed controlling and braking methods of 3-phase induction motors – Load-torque characteristics and protection	6 Hours
		7. Three Phase Synchronous Motors – Construction. Principle of operation. Load characteristics – Power factor improvement with synchronous motors	4 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Manage operation of electrical and electronic control equipment (ML)	Design features and system configurations of operational control equipment for electrical motors	8. Motor control and protection – D.C. motors – A.C. motors – Relay / ladder logic control	6 Hours
		9. Distribution – Main switchboard construction and configuration – Short circuit protection - fuses, main circuit breakers – The generator air circuit breaker – Protection co-ordination – Distribution configuration – Electrical equipment for tankers and hazardous areas and safety systems	4 Hours
		10. Emergency Power – Automatic starting arrangements for the emergency generator – Emergency power requirements – Essential and non essential circuits – Batteries	3 Hours
		Total No. of Hours	118 Hours

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