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

Course Code	**:**	Electro 1
Course Descriptive Title	**:**	Basic Electricity
Course Credits	**:**	4 units
Lecture Contact Hours per Week	**:**	3 hours
Laboratory Contact Hours per Week	**:**	3 hours
○ **Prerequisite**	**:**	None
Reference/s	**:**	○ Table A-III/1 Function: Electrical, Electronic and Control 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

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems	Electrical Equipment	1. Electrical Theory *Ohm's law* – Describes the effect of resistors in a circuit and uses the symbol R – Names and uses the symbol Ω – Defines the unit of resistance – Defines Ohm's law – Defines Ohm's law to find current, voltage and resistance in simple problems – Describes how the current through and the voltage across resisters are affected in series and in parallel circuits *Kirchhoff's law* – States and applies Kirchhoff's: – voltage law – current law – Calculates the current flowing and the voltage drop across resistors in simple circuits – Constructs and uses a Wheatstone Bridge – Given the voltage and total current, calculates the total (or equivalent) resistance of a parallel circuit – Given the values of the resistances in a parallel circuit, calculates the total resistance – Compares the effect of adding a further resistance to: – a parallel circuit – a series circuit – Explains how the objective affects the e.m.f. and the terminal potential difference of a supply, demonstrating the effect by calculations and by experiment – Explains the effect of internal resistance in the supply source – Determines current flows, resistance values and voltages in: – series circuits – parallel circuits by calculation	25 Hours
		Electrical circuit – States that current can only flow in a closed circuit – Explains why some materials are – conductors	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	– insulators – and names commonly used materials in each group – Names the different sources of electricity and explains their effect when connected to a conductor – Explains potential difference and electromotive force, stating the units and the symbols used – Explains the current flow, stating its symbol(I) – States that current strength is measured in amperes, represented by A – States that a steady current flowing in a single direction is called a direct current (D.C.) – States that when the direction of flow of a current is continually reversing it is called an alternating current (A.C.) – States that in modern ships the main supply is usually A.C. but that D.C. has many uses – Describes what is meant by static electricity – Describes electrostatic charging and the principles of overcoming potential hazards	
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	*Impedance and Inductance* – Explains what is meant by “impedance” and uses the correct symbol – Compares impedance of an A.C. circuit with resistance of a D.C. circuit – States the relationship between impedance, voltage and current – Compares the effect in an A.C. circuit and in a D.C. circuit of a simple resistance the same resistance wound in the form of a coil the same coiled resistance, into which an iron core is inserted – Describes what is meant by “reactance” and uses the correct symbol – Sketches the impedance triangle, indicating R, X, Z and the phase angle (φ) – States that the cosine of the phase angle is called the power factor – Calculates impedances and power factors, given the resistance and reactance of coils	
		– Explains the effect of changing current and its associated magnetic flux on the induced e.m.f. – Explains why, in a circuit containing only reactance, there is a difference in phase of 90°between the applied voltage and the current – Sketches graphs showing the variation of current, applied voltage and back e.m.f.	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	over one cycle when an A.C. is applied to a circuit containing: – only pure resistance – a choke having inductance only – Superimposes a curve representing the power dissipated in both cases in the above objective – States the value of the power factor in both cases in the above objective – States that, in practice, an inductor will always have a resistance – Sketches a phasor diagram for a circuit containing an inductance which has resistance, indicating the resultant applied voltage and the phase angle – States that in cases such as those in the above objective, i.e. in inductive circuits, the current always lags the applied voltage – States that shipboard installations produce power demand with a lagging power factor – Explains the effect of varying power factor on the power consumed – States that *Power = V x I x R/Z or V x I x cos φ* – Solves simple problems concerning power, current, resistance, impedance, reactance and power factor and verifies the solutions, using laboratory equipment	
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	2. Fundamentals of Alternating Current – *Alternating current* – Explains how alternating current is produced in a simple loop rotating in a magnetic field – By means of sketches, relates the position of the loop in the above objective to the voltage wave form for one cycle at 90°intervals of rotation – Explains the relationship between: instantaneous voltage conductor velocity the sine of the displaced angle θ – Sketches the wave form of an a. c. voltage – Shows diagrammatically a simple circuit for a three-phase supply from an alternator – Develops the expression $e = BIv$ to produce $e = E_{max} \sin \theta$, where e is the instantaneous voltage, E_{max}, is the maximum voltage and θ is the displaced angle – Projects the vertical components of a rotating vector to draw one complete cycle of a sine wave – States that the rotating vector is called a phasor – Using a triangle produced from the above objective, confirms that $e / E_{max} = \sin \theta$	40 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	– Superimposes degrees and radians on the sine wave drawn in the above objective – Uses the correct symbols and conventions for: – Rotation – angular velocity – periodic time – frequency – peak value – amplitude – Deduces the expression $e = E_{max} \sin \theta \; 2\pi ft$ – Calculates instantaneous voltages, given the unknown quantities – Explains what is meant by phase difference between voltage and current values – Explains why root mean square (r.m.s.) values are used – Given a series of values of instantaneous voltage or current for a hall cycle, calculates r.m.s. value States that the r.m.s. value for a sine wave is 0.707 of the peak value	
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	*Electromagnetic induction* – Describes the principle of electromagnetic induction and states its main applications – Explains how the following factors affect the induced voltage: flux density – number of turns in the coil – conductor/flux cutting rate – Explains Faraday's law of electromagnetic induction – Explains Lenz's law Explains in simple terms the principle of static induction, to include mutual induction and self-induction	
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	– *Work, energy and power* – Explains the difference between work, energy and power, giving the units and symbols commonly used – States that *work = current x time x voltage*, giving the units used – Makes simple calculations to determine energy and work – Defines power, giving the units and symbols used – From the above objective, derives the expression *power = voltage x current (P = VI)*, giving the units used Using the equations from above objectives, derives $P = I^2 R$ and $P = V^2 / R$	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	– 3. Lighting – States that correct levels of lighting are vital to safety, efficiency and comfort – Describes the principle of the incandescent lamp – Explains the difference between lamps for general lighting and for rough service – Describes briefly the principle, application and care when handling tungsten-halogen lamps – Explains the principle of discharge lamps – Explains how fluorescent tubes are started up – Explains how the power factor of fluorescent tubes is improved – Explains how radio interference is suppressed in a fluorescent tube – Explains the effect of variation in voltage on both incandescent and gas-discharge lamps – Explains how energy lights are marked States which emergency lights are on the emergency switchboard system and which lights – may be on the battery circuit Explains why the correct power of lamp should be used	5 Hours
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	4. Cables – Names materials commonly used for the following part of cables: – conductors – insulation – sheathing – Describes the reaction of electric cables to a fire – Explains why cable sockets need to be securely attached and locked on to the terminal	5 Hours
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	5. Batteries – Describes the principle of the voltaic cell – Quotes an example of and explains the difference between: – primary cells – secondary cells – Lists the routine and emergency services normally supplied by batteries – States the range of voltages and/or alkaline batteries are used – States that lead-acid and/or alkaline batteries are used – Explains the effect on current and voltage when connecting cells:	10 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Operate electrical, electronic and control systems (cont)	Electrical Equipment (cont)	– in series – in parallel – States that 12 lead-acid or 20 alkaline cells connected in series produce a nominal 24 volts – Explains how cells or batteries are connected to increase their capacity – Explains how capacity is stated and what it means – Describes the dangers which may exist in a battery compartment and explains how they are overcome – Explains the topping up procedure for batteries – Describes how batteries are recharged and the periods during which gassing takes place – Describes how a battery is connected for recharging – Explains how the condition of an alkaline battery is determined – Explains the effect of the internal resistance of a battery on its terminal voltage – Demonstrates the above objective by means of simple examples – Describes the first-aid necessary if parts of the body and eyes are in contact with electrolyte from: – a lead-acid battery – an alkaline battery States that the appropriate first-aid equipment should be available in the place where the batteries are housed	
Maintenance and repair of electrical and electronic equipment	Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment	– Describes the cause of electric shock, giving the level of current which could be fatal – States the voltage range which is considered safe – Applies safety precautions necessary when working on electrical equipment in practice – States the isolation procedures required for electrical equipment – States the safety and isolation precautions necessary before commencing work – Explains the purpose of interlocks fitted to circuit breakers – Explains the danger associated with the spaces in the vicinity of busbars – Explains the potential danger of instrument voltage/current transformer circuits and the safe procedure for working on such circuits – Describes the protection normally provided on the doors of switchboard cubicles – Explains that safety and emergency procedures are documented in the ship's safety management system	10 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Maintenance and repair of electrical and electronic equipment	Construction and operation of electrical testing and measuring equipment	*Insulation tester* – States the operation principles of an insulation tester – States the precautions when using an insulation tester – States the range of voltages used for testing ships' equipment – Uses an insulation tester: – to check the zero reading – to check that the equipment is dead – to measure values of phase-to-phase insulation – to measure values of phase-to-earth insulation	10 Hours
		Continuity tester – Uses a continuity tester to: – check that the equipment is dead – measure the resistance of circuits – Enters test readings and relevant comments on an appropriate record card – Explains the significance of individual and comparative test readings	
		Multi-tester – Uses digital and analogue multimeters, taking the necessary precautions, to: – check the accuracy of the meter – check for battery failure – measure resistance – measure voltage – measure current – test diodes	
		Clampmeter – States the operation principles of a clampmeter – States the precautions when using a clampmeter – Uses a clampmeter to measure current – Uses a live-line tester to determine whether equipment is live or dead	
		Total No. of Hours	105 Hours

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