COURSE PACKAGE

Part A: Course Specifications

Course Code	:	Electro 1						
Course Descriptive Title	:	Basic Electricity						
Prerequisite	:	None		**Corequisite**	:	NGEC 9		
Year Level	:	First Year		**Semester Offered**	:	First Semester		
Course Credits	:	4 Units	**Theoretical Contact Hours Per Week**	:	3 hours	**Demonstration/ Practical Work Contact Hours Per Week**	:	3 hours
Course Description	:	The Course is the first series of the 3 – part course for the competencies of "Operate electrical, electronic and control systems" and "Maintenance and repair of electrical and electronic equipment." This Course is designed to provide students with fundamental knowledge and skills in electrical circuits, electrical diagrams, electrical safety, electrical tools and equipment, D.C. Circuits, and A.C. Circuits						

		STCW Table	**Function**	**Competence**	**Knowledge, Understanding, and Proficiency**
STCW Reference	:	A-III/1	Electrical, Electronic and Control Engineering at the Operational Level	Operate Electrical, Electronic, and Control systems	Basic Configuration and operation principles of the following electrical, electronic and control equipment .1 Electrical Equipment
				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 Construction and operation of electrical testing and measuring equipment The interpretation of electrical and simple electronic diagram Function and performance tests of the following equipment and their configuration: .3 protective devices Detection of electric malfunction, location of faults, and measures to

					prevent damage The interpretation of electrical and simple electronic diagrams.
Course Outcomes	:	*PO-E.4* *PO-E.5* *PO-E.6* *PO-E.7*	*After the end of the course, the student must be able to*: **CO1.** Apply safety measures in handling electrical components in accordance with Standard Marine Practices or ISM **CO2.** Apply the fundamental circuit laws, theorems, and techniques used in D.C. and A.C. circuit analysis. **CO3.** Explain basic configuration and operation principle of a transformer and other electrical machineries and/or component. **CO4.** Identify appropriate electrical hand tools, measuring instruments, and testing equipment required in handling electrical components. **CO5.** Carry-out function test of electrical protective devices **CO6.** Draw a simple electrical circuit diagram, construct, and test as per specification **CO7.** Diagnose a faulty electrical circuit as to open, shorted, or grounded		
Course Intake Limitations	:	The number of students that can be accommodated shall not exceed 40 per lecture and 20 for laboratory.			
Faculty Requirement	:	***Instructor*** The faculty that will be assigned to handle the Course must possess the following qualifications: • Officer-in-charge of an Engineering watch of seagoing ships powered by main propulsion machinery of 750 kW propulsion or more; • graduate of Bachelor of Science in Marine Engineering; • completed Training Course for Instructors (IMO Model Course 6.09) • completed Training Course on Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12); OR • Holder of COC for Electro-technical Officer (ETO) • completed Approved Training Course for Instructors (IMO Model Course 6.09); • completed Approved Training Course on Assessment, Examination and Certifications (IMO Model Course 3.12); OR • Registered professional holding a bachelor's degree in Electronics Engineering or Electrical Engineering with Master's degree in the same discipline; • with at least one (1) year industrial and/or teaching experience • Registered professional holding a bachelor's degree in Electronics Engineering or Electrical Engineering;			

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- completed Approved Training Course for Instructors (IMO Model Course 6.09);
- completed Approved Training Course on Assessment, Examination and Certifications (IMO Model Course 3.12);

OR

- Registered professional holding a bachelor's degree in Electronics Engineering or Electrical Engineering;
- completed Approved Training Course for Instructors (IMO Model Course 6.09);
- completed Approved Training Course on Assessment, Examination and Certifications (IMO Model Course 3.12);

Assessor
The assessor assigned shall have the same qualifications above.
Note:

- *The instructor shall conduct the formative assessment.*
- *Summative assessment shall be conducted by an Assessor not teaching the students (assessee).*

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<tr><td>Teaching Facilities and Equipment</td><td>:</td><td>

CLASSROOM
The standard classroom size shall be a minimum of 48 square meters; no side shall be less than 6 meters for a class of 40 students. The classroom must be illuminated at least 50.76 Lux and well-ventilated. It should contain the following:

- Tables and chairs or armed chairs
- Whiteboards or chalkboards
- Multimedia equipment
- Scientific Calculator *(shall be provided by the student)*

EQUIPMENT FOR PRACTICAL WORK

Facilities and Equipment	Equipment to Student Ratio
Safety Equipment *(Shall be provided by the students)*	
1. Coverall	1:1
2. Helmet	1:1
3. Safety shoes	1:1
4. Rubber Insulated gloves	1:1
(Shall be provided by the MHEI)	
5. Insulated matting	1:5
6. Lockout and Tagout Devices including padlocks	1:5
Electrical Tools and Equipment *(Shall be provided by the MHEI)*	

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		1. Wire Strippers	1:2
		2. Wire Gauge	1:2
		3. Longnose pliers	1:2
		4. Set of screwdrivers	1:2
		5. Digital Multimeter	1:2
		6. Analog Multimeter	1:2
		7. Insulation resistance tester	1:2
		7. Clamp meter	1:2
		8. Set of Sample Cables	1:2
		9. Sample of Batteries	1:5
		10. Sample of Lights Fixtures	1:5
		11. Switches and Breakers	1:5
		12. Fuse	1:5
		13. Terminal log	1:5
		14. Cable/Wire Tag	1:5
		Training Modules *(Shall be provided by the MHEI)*	
		1. Electrical A.C. and D.C. Training Module Kit *(Note that the Training kit shall be able to comply with required exercise plan stated in the teaching aids)*	1:4
		Note: The MHEIs can use additional teaching facilities and equipment as deemed necessary to meet the learning outcomes of this course.	
Teaching Aids	:	**TA1** Safety and Electrical Hazards **TA2** Electrical Tools and Equipment **TA3** DC Circuits **TA4** A.C. Circuits **TA5** Insulation and Cables	

		TA6 Transformers **TA7** Protective Devices **TA8** Lighting Fixtures **TA9** Basic Electrical Trouble Shooting *Note: The MHEIs can use alternate and/or additional teaching aids as deemed necessary to meet the learning outcomes of this course.*
References/ Bibliographies	:	**References:** **R1** Officer in Charge of an Engineering watch (IMO Model Course 7.04) **R2** Hall, D.T. (1984) Practical Marine Electrical Knowledge. London, Witherby & Co Ltd. **R3** Kraal, E.G.R., (1985) Basic Electrotechnology for Engineers. 3rd ed. London, Thomas Reed Publications Ltd. **R4** Brown, M., Jawahar, R., Dinesh, P., (2005), Practical Troubleshooting of Electrical Equipment and Control Circuits, An imprint of Elsevier **R5** Manufacturer's Manual / Specifications *Note: The MHEIs can use alternate and/or additional references/bibliographies as deemed necessary to meet the learning outcomes of this course.*

Part B: Course Outline and Timetable

Note:
Considering that practical work activities could not be performed per weekly basis because of the required underpinning knowledge, the MHEI can deliver the same on the specified weeks provided below:

Term	Week	Topic	Time Allotment (in hours)	
			Theoretical	Demonstration / Practical Work
Note: MHEIs shall determine the number of periods for terms the semester is divided based on their school calendar activities	1	**1. Electrical Safety**	3	-
	2 - 5	**2. D.C. Circuits** 2.1 Fundamentals of Electricity 2.2 Current 2.3 Voltage and Batteries 2.4 Resistance 2.5 Ohm's Law 2.6 Work, Power and Energy 2.7 Voltage / Current Divider 2.8 Kirchhoff's Voltage and Current Law 2.9 Capacitance 2.10 Inductance	12	-
	6 - 8	**3. A.C. Circuits** 3.1 Alternating Current 3.2 Resistive A.C. Circuits 3.3 Capacitive A.C. Circuits 3.4 Inductive A.C. Circuits 3.5 A.C. Measurements 3.6 Reactance and Resonance Circuit / Power Factor 3.7 Three-phase circuits	15	-
	9 - 12	**4. Electrical Machineries and Components** 4.1 Transformers 4.2 Generators and motors 4.3 Protective devices	15	-

Term	Week	Topic	Time Allotment (in hours)	
			Theoretical	**Demonstration / Practical Work**
		4.4 Insulation 4.5 Cables		
	13 - 14	**5. Electrical hand tools, measuring and testing equipment** 5.1 Insulation resistance tester 5.2 Multimeter 5.3 Clamp meter 5.4 Live-line tester 5.5 Electrical hand tools	6	-
	15 – 17	**6. Practical Work** 6.1 Analysis of Basic electrical circuits 6.2 Function Test of Protective Devices 6.3 Basic electrical installation 6.4 Circuit Fault Diagnosis	-	51
Sub-total (Contact Hours)			**51**	**51**
Total Contact Hours			**102**	
Examination and Assessment				

Note:

1. *The MHEIs are to develop their respective timetable according to their resources but meets with the minimum time allocation for the contact hours. OR*
2. *The MHEIs shall determine the time allotment for the conduct of summative assessments.*

Part C: Course Syllabus

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
CO1	**1. Electrical Safety** 1.1. Explain the hazards in working with electricity 1.2. Identify the proper personal protective equipment (PPE) in working with electricity 1.3. Explain the procedures in handling electrical components 1.4. Apply safety procedures in handling electrical components including lock out – tag out (LOTO)	R2, R3, R4	TA1
CO2	**2. D.C. Circuits** 2.1. Fundamentals of Electricity .1 Identify the unit for measuring current. .2 Draw the symbol used to represent current flow in a circuit. .3 Explain the differences among conductors, insulators, and semiconductors. .4 Explain the differences among potential, electromotive force, and voltage. .5 Draw the symbol used to represent voltage. .6 Identify the unit used to measure voltage. .7 Define resistance and identify the unit for measuring resistance. .8 Identify characteristics of resistance in a circuit. .9 Identify the symbol used to represent resistance in a circuit. 2.2. Current .1 Explain the two laws of electrostatic charges. .2 Define coulomb. .3 Identify the unit used to measure current flow. .4 Define the relationship of amperes, coulombs, and time through a formula. .5 Explain how current flows in a circuit. .6 Explain how electrons travel in a conductor. 2.3. Voltage and Batteries .1 Identify the six most common voltage sources. .2 Explain six different methods of producing electricity. .3 Define a cell and a battery. .4 Explain the difference between primary and secondary cells.	R1, R2, R3	TA3, TA4

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	.5 Explain how cells and batteries are rated. .6 Identify ways to connect cells or batteries to increase current or voltage output or both. .7 Define voltage rise and voltage drop. .8 Identify the two types of grounds associated with electrical circuits. .9 List the routine and emergency services normally supplied by batteries .10 Explain the range of voltages and alkaline batteries which are used .11 Explain that lead-acid and alkaline batteries are used .12 Explain the effect on current and voltage when connecting cells: • in series • in parallel .13 Explain how 12 lead-acid or 20 alkaline cells are connected in series to produce a nominal 24 volts .14 Explain how cells or batteries are connected to increase their capacity .15 Explain capacity rating of battery .16 Explain the dangers which may exist in a battery compartment and explains how they are overcome .17 Explain the topping up procedure for batteries .18 Explain how the condition of an alkaline battery is determined .19 Explain the effect of the internal resistance of a battery on its terminal voltage 2.4. Resistance .1 Define resistance and explain its effect in a circuit. .2 Identify the tolerance range of a resistor. .3 Identify carbon composition, wire-wound, and film resistors. .4 Identify potentiometers and rheostats. .5 Explain how a variable resistor operates. .6 Interpret the resistor's value using the color code or alphanumeric code. .7 Identify the three types of resistor circuits. .8 Calculate total resistance in series, parallel, and series-parallel circuits. 2.5. Ohm's Law .1 Identify the three essential parts of a circuit. .2 Identify three types of circuit configurations. .3 Explain how current flow can be varied in a circuit. .4 Explain Ohm's law concerning current, voltage, and resistance.		

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	.5 Solve problems using Ohm's law for current, resistance, or voltage in series, parallel, and series-parallel circuits. .6 Explain how the total current flow differs between series and parallel circuits. .7 Explain how the total voltage drop differs between series and parallel circuits. .8 Explain how the total resistance differs between series and parallel circuits. .9 Explain and apply Kirchhoff's current and voltage laws on electrical circuits 2.6. Work, Power and Energy .1 Define power as it relates to electric circuits. .2 Explain the relationship of current and voltage. .3 Solve for power consumption in an electrical circuit. .4 Calculate the total power consumption in a series, parallel, or series-parallel circuit. 3.7 Voltage / Current Divider .1 Explain the principles of voltage and current divider in analysing DC circuits .2 Calculate parameters in a circuit using voltage and/or current divider 3.8 Kirchhoff's Voltage and Current Law .1 Explain the principles of Kirchhoff's Voltage and Current Law in analysing circuits .2 Calculate parameters in a circuit using Kirchhoff's Voltage and Current Law 3.9 Capacitance .1 Explain the principles of capacitance. .2 Identify the basic units of capacitance. .3 Identify different types of capacitors. .4 Calculate total capacitance in series and parallel circuits. .5 Explain R.C. time constants and how they relate to capacitance. 3.10 Inductance .1 Explain the principles of inductance. .2 Identify the basic units of inductance. .3 Identify different types of inductors. .4 Calculate the total inductance in series and parallel circuits. .5 Explain L/R time constants and how they relate to inductance.		

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	3. A.C. Circuits 3.1. Alternating Current .1 Explain how an A.C. voltage is produced with an A.C. generator (alternator). .2 Define alternation, cycle, hertz, sine wave, period, and frequency. .3 Define peak, peak-to-peak, effective, and rms. .4 Explain the relationship between time and frequency. .5 Identify and describe three basic non-sinusoidal waveforms. .6 Explain how non-sinusoidal waveforms consist of the fundamental frequency and harmonics. .7 Explain why A.C. is used in today's society. .8 Explain how an A.C. distribution system works. 3.2. Resistive A.C Circuits .1 Explain the phase relationship between current and voltage in a resistive circuit. .2 Apply Ohm's law to A.C. resistive circuits. .3 Solve for unknown quantities in series A.C. resistive circuits. .4 Solve for unknown quantities in parallel A.C. resistive circuits. .5 Solve for power in A.C. resistive circuits. 3.3. Capacitive A.C. Circuits .1 Explain the phase relationship between current and voltage in a capacitive A.C. circuit. .2 Explain the capacitive reactance in an A.C. capacitive circuit. .3 Explain how resistor-capacitor networks can be used for filtering, coupling, and phase shifting. .4 Explain how low-pass and high-pass R.C. filters operate. 3.4. Inductive A.C Circuits .1 Explain the phase relationship between current and voltage in an inductive A.C. circuit. .2 Explain the inductive reactance in an A.C. circuit. .3 Explain impedance and its effect on inductive circuits. .4 Explain how an inductor-resistor network can be used for filtering and phase shifting. .5 Explain how low-pass and high-pass inductive circuits operate. 3.5. A.C. Measurements .1 Identify the types of meters available for A.C. measurements. .2 Identify the types of meter movements used to make A.C. measurements. .3 Explain the function of an oscilloscope. .4 Identify the essential parts of an oscilloscope and explain their functions. .5 Explain how to use an oscilloscope to take a measurement. 3.6. Reactance and Resonance Circuits / Power Factors		

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	.1 Identify the formulas for determining capacitive and inductive reactance. .2 Identify how A.C. current and voltage react in capacitors and inductors. .3 Identify the reactance of a series circuit, and identify whether it is capacitive or inductive. .4 Define the term impedance. .5 Solve problems for impedance that contain both resistance and capacitance or inductance. .6 Explain how Ohm's law must be modified before using it for A.C. circuits. .7 Solve for XC, XL, X, Z, and I.T. in RLC series circuits. .8 Solve for I.C., IL, IX, I.R., and I.Z. in RLC parallel circuits. 4.7 Three-phase circuits .1 Explain the principles of a three-phase circuit .2 Identify the applications of three-phase circuit on board .3 Differentiate three-phase circuit from single phase circuit in terms of applications .3 Calculate the reactive, apparent and true power of a delta-connected and wye-connected load circuit		
CO3	**5. Electrical machineries and components** 5.1 Transformers .1 Explain the functions of a transformer .2 Explain the configuration and construction of a transformer .3 Explain the types of transformers used on board .4 Explain the connections in the main switchboard, distribution board, panel board through: • delta-delta transformers • delta-star transformers • delta-star transformers with an earthed neutral .5 Calculate the primary and secondary windings of a step-down or step-up transformer 5.2 Generators and motors .1 Explain the principles and construction of a DC and AC generator .2 Explain the functions of generator on board .3 Explain the range of voltage and frequency at which ships' electrical power is generated .4 Explain the principles and construction of a DC and AC motor .5 Explain the functions of the different types of motor 5.3 Protective Devices .1 Explain the different electrical protective devices such as:	R1, R2, R3	TA3, TA4, TA5, TA6

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	a. Fuse b. circuit breaker c. overcurrent / thermal overload relay d. earth leakage relay 5.4 Insulation .1 Explain the basic principles of and construction of insulation .2 Explain the purpose of insulation 5.5 Cables .1 Identify materials commonly used for the following part of wires: a. conductors b. insulation c. sheathing .2 Identify the wire / cable size as per type of application .3 Explain the proper installation of cables with emphasis on the following: • safety requirements on installation • running the cable • securing ground wires • and crimping of neutral and hot wires • connecting to switch of component • testing the installation		
CO4	**6. Electrical hand tools, measuring and testing equipment** 6.5 Insulation resistance tester .1 Explain the operation principles and functions of an insulation resistance tester .2 Explain the safety precautions when using an insulation resistance tester .3 Explain the procedure in using insulation resistance tester .4 Explain the range of voltages used for testing equipment's insulation 6.6 Multimeter (with continuity feature) .1 Explain the operation principles and functions of a multimeter .2 Explain the safety precautions when using a multimeter tester .3 Explain the procedure in using multimeter .4 Explain the ranges of current, voltage and resistance when testing an equipment 6.7 Clamp Meter .1 Explain the operation principles and functions of a clamp meter	R1, R2, R3, R4, R5	TA2, TA9

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	.2 Explain the safety precautions when using a clamp meter .3 Explain the procedure in using clamp meter .4 Explain the ranges of current used for testing equipment 6.8 Live-line tester .1 Explain the operation principles and functions of a live-line tester .2 Explain the safety precautions when using a live-line tester .3 Explain the procedure in using live-line tester 6.9 Electrical Hand Tools .1 Identify the different types of electrical hand tools .2 Explain the safety precautions in using electrical hand tools		
CO5	**7. Function test of Electrical Protective Devices (practical)** 7.1 Function test of electrical protective devices .1 Use an insulation resistance tester, taking the necessary safety precautions, to measure values of phase-to-phase insulation and phase-to-earth insulation. .2 Use digital and analog multimeters, taking the necessary safety precautions, to measure voltage input and output of a circuit breaker, .3 Use digital and analog multimeters, taking the safety precaution, to measure voltage, current and resistance of a component in a basic electrical circuit .3 Use digital and analog multimeters, taking the necessary safety precautions, to check continuity of the fuse and switches .4 Use a clamp meter to measure current in the wires connected in a circuit breaker .5 Use a live-line tester to determine whether equipment is energized or de-energized	R2, R3, R4, R5	TA2, TA9
CO6	**8. Basic Electric Circuit Application (practical)** 8.1 Basic Circuits .1 Draw an electrical circuit consisting resistors, capacitor, inductor in a combination of series and parallel supplied both in DC or AC as per specification .2 Calculate parameters such as total power consumption, total resistance, and total current .3 Construct the drawn electrical circuit .4 Test the values of components and compare to the calculated value 8.2 Basic Lighting Fixtures .1 Draw a simple lighting circuit consisting of at least 8 bulbs, circuit breaker, switch and power supply .2 Calculate the power consumption of the lighting circuit and identify the current rating of the circuit breaker to be used	R2, R3, R4, R5	TA3, TA4, TA8. TA9

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	.3 Construct the drawn lighting fixture .4 Test the values of components in the lighting fixture circuit		
CO7	**9. Basic Electric Circuit Fault Diagnosis (practical)** 9.1 Identify the parameters need to be evaluated in the circuit to be diagnosed 9.2 Test the parameters in the faulty circuit 9.3 Identify the source of the problem in the faulty circuit	R4, R5	TA9

Note: The MHEIs are to develop Part D: Detailed Teaching Syllabus and Instructional Materials (IMs), and Part E: Course Assessment and Assessment Tools (ATs) which satisfactorily meets with the requirements of the course as prescribed in the course outcomes and learning outcomes.