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

Course Code	**:**	Auto 1
Course Descriptive Title	**:**	Basic Control Engineering
Course Credits	**:**	4 units
Lecture Contact Hours per Week	**:**	3 hours
Laboratory Contact Hours per Week	**:**	3 hours
1. **Prerequisite**	**:**	Electro 1
Reference/s	**:**	○ Table A-III/1 of the 1978 STCW Code as amended ○ Function: Electrical, Electronics and Control Engineering at the operational level ○ Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE) ○ IMO Model Courses 7.02 and 7.04 ○ STCW'78 as amended

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems	Basic configuration and operation principles of the following electrical, electronic and control equipment: .2 electronic equipment: .a characteristics of basic electronic circuit elements .b flowchart for automatic and control systems .c functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls	1. Electronic Control Equipment - Defines the following electronic control equipment and states briefly their control mechanism: - relay circuit unit - digital sequential control devices - Integrated Automation Control and Monitoring System (IACMS) - Programmable Logic Controller (PLC) - analogue/digital/computer PID Controller - computer programmable controller - States how control equipment cited above are utilized for main engine, CPP, generator, boiler and auxiliaries in terms of the following: - main engine; start/stop, revolution, injection timing, electronic governor and the others (auto-load, crash astern, automatic shut down, automatic slow down, etc) - controllable Pitch Propeller (CPP); autoload/blade angle control - generator; generator automatic control (GAC) (auto-synchro, load sharing, etc) primary mover start/stop sequence - boiler; Automatic Combustion Control (ACC), burner control, Feed Water Control (FWC), - Steam Temperature Control (STC), - auxiliary machinery; purifier automatic control (automatic sludge discharge), temperature/level/pressure/viscosity control	15 hours
Operate electrical, electronic and control systems	.3 control systems: .a various automatic control methodologies and characteristics .b Proportional–Integral– Derivative	2. Flowchart for Automatic and Control Systems - Explains symbol marks used in flow charts such as terminal, processing, determination, input/output, etc - States what is understood with flow charts - Explains flow charts indicating automatic control system for main engine, generator control system and others taking some of them as examples - Describes briefly the major components in relation to the function found in the flow charts	5 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
	(PID) control characteristics and associated system devices for process control		
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	3. Fundamentals of Automatic Control - Defines an automatic control and states its purpose - Describes what devices/equipment construct control systems and their role/functions - Relates sensing unit, controller, controlled variable, manipulating variable and controlled object to each of them in the control system - Describes what sort of devices are included in the sensing unit - Describes variety of controllers such as electronic (PID, PLC, computer) controller and pneumatic controller - Defines setting value, input value, deviation and output value/controlled variable in the controller - Describes what sort of devices are included as manipulators - Describes variety of controlled object - Describes how automatic controls are utilized in the ship's propulsion machinery, taking examples of temperature and level control systems, including control parameters such as time lag, time constant, dead time, first/second-order lag element, disturbance and offset	15 hours
		4. Various Automatic Controls - Classifies systematically automatic controls in terms of control methodologies - States what an optimal control means - Explains briefly feedback control and feedforward control - Describes briefly ON-OFF control, sequential control, PID control and program control - Explains how these automatic controls are applied to the control systems - Explains briefly program control and how the control is realized - Describes the applications of program control in the ship's propulsion machinery	5 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	5. ON-OFF Control - Explains what ON-OFF control means - Explains the characteristics of ON-OFF control - Explains how ON-OFF control is utilized - Lists components comprising ON-OFF control system - Describes ON-OFF control taking some applications as examples	5 hours
		6. Sequential Control - Explains what a sequential control means - Explains the characteristics of a sequential control - Explains how a sequential control is utilized - Lists components comprising a sequential control system - Describes sequential controls taking some applications as examples	5 hours
Operate electrical, electronic and control systems (cont)	. 3 control systems: (cont)	7. Proportional-Integral-Derivative (PID) Control - Explains the principles/theory of PID control - Explains how P, I and D actions can be electrically/pneumatically available showing simple electronic circuits and pneumatic diagrams - States that PID control is classical control methodology but even now, it is still firm basis for controlling any physical/process value - States that PLC and computer controller produces the same actions as analog PID controller when controlling physical/process value - Explains P, I, D, PI, PD and PID actions respectively using step or ramp input - Explains the characteristics of P action as well as proportional band (PB) - Explains the characteristics of I and D actions - Explains how P, I and D actions contribute to control systems, stating that P value contributes to strength of control, I value contributes to accuracy of control and D value contributes to speed of control - Describes the step response test to PID action and what can be understood by its results - Explains how P, I, and D parameters for optimal control can be determined - Describes the components comprising PID control systems including sensing unit, transducer, manipulator and controller	10 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	. 3 control systems: (cont)	8. Measurement of Process Value 1) Temperature (Mechanical) - States that it is common practice to call the measuring instrument for temperatures: -above 500°C a pyrometer -below 500°C a thermometer - States the temperature range for which mercury is used - Names the fluids which can be used for the measurement of lower temperatures - Describes the principal features of thermometers based on the filled system, including: -mercury in steel -vapour-pressure -gas –filled - Describes the principal features of a bimetallic thermometer (Electrical) - States that the range and accuracy varies according to the material used in the detecting element - Sketches and describes a resistance-type measuring instrument based on the Wheatstone bridge - Describes the characteristics of a thermistor and the conditions for which it is suitable - Sketches a circuit used in a thermocouple and describes its operation - Describes the principles of an optical pyrometer 2) Pressure - Describes the principle features of, and compares, the following: -Manometers -simple water -wide-cistern or well -inclined-tube -mercury -pressure gauges	26 hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	-Bourdon -diaphragm-sealed gauge -twin-bellows differential-pressure cell -strain gauge - Describes how pressure gauges can be tested on board ship - Tests a pressure pump - Sketches calibration curves for a Bourdon pressure gauge, showing the effect of: -zero adjustment -multiplication adjustment -angularity adjustment - States that calibration and testing are normally performed by specialists 3) Level (Direct Methods) - Describes the principle of a float-operated level-measuring device - Describes the principle of a probe element - Describes a displacement gauge (Inferential Methods) - Explains the principle of inferential methods - Describes a level sensor based on immersed resistors - Describes a level indicator based on a bubbler system - Describes a pneumercator gauge 4) Flow - Explains the difference between a quantity metre and a rate-of-flow-flow metre - Explains that a quantity metre is basically a rate-of-flow metre combined with an integrator - Describes the function of the two elements of a flow metre - Sketches a graph to show the relationship between velocity of a fluid and its pressure difference - From the above objective, shows the velocity is proportional to the square root of pressure - Explains the situations in which extractions of square roots are necessary - Describes the principal features of: -a rotormeter	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	. 3 control systems: (cont)	-an electrical flowmeter -a rotameter - Sketches an orifice and a Venturi, showing the direction of flow and the pressure-measuring points - Explains how a manometer can be used as a square-root extractor when measuring the pressure difference in an orifice or Venturi - States that extraction of a square root can also be accomplished pneumatically and electrically 5) General Measurement of Processes - Explains the principles of a tachometer - Explains the principles of A.C. and D.C. electric tachometers - Explains the principles of a torque metre based on the effect of stress in a magnetic field - Explains how the above objective can be developed to measure power - Explains the principal features of a viscometer - Describes the application of a photoelectric cell to: -an oil-in-water -a smoke-density detector -an oil-mist detector -a flame detector - Describes the common types of fire detector - Describes the principal features of: -an explosive-gas detector -a vibration monitor -an oxygen analyser -a CO_2 analyser -a relative humidity metre -salinity measurement -a dissolved-oxygen metre -a pH metre - Describes or performs routine setting up, testing and maintenance of the measuring devices included in the above objectives	

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	9. Transmission of Signals 1) Transmitters - Describes the function of a transducer 2) Controlling Elements (Pneumatic) - Describes the flapper and nozzle arrangement - Explains what is meant by negative feedback and by positive feedback - Sketches a flapper and nozzle arrangement with negative feedback - Explains the function of a force-balance transducer - Describes the principle features of an electro pneumatic transducer (Electrical) - Uses a Wheatstone bridge used as a transducer - Describes the principles of a variable-inductance - Describes the principles of a variable-capacitance transducer - Describes the principles of an electronic force-balance system - Describes the principles of a voltage-current transducer (Receivers) - Describes the principal features of: -a pneumatic receiver integrator -a potentiometric pen recorder - Explains the function of an X-Y recorder - Describes the basic principles of ac and dc servo motors	5 hrs
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	10. Manipulator Elements 1) Pneumatic - States that the final controller might be operated pneumatically, hydraulically or electrically - Sketches a diaphragm-operated control valve - Describes the characteristics of the motor element and the correcting element in the above objective - Describes or, preferably, determines by experiment the flow characteristics and	5 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOUR
Operate electrical, electronic and control systems (cont)	.3 control systems: (cont)	applications of: -mitre valves -vee-ported valves - Explains what is meant by "turn-down ratio" - Describes the conditions which may dictate the need for a positioner - Describes the principal features of a positioner - Explains the circumstances when piston actuators might be used - Describes the conditions where butterfly valves might be used - Describes the wax-element temperature-control valve and states its normal temperature range 2) Electrical Servomotors - Describes a dc servomotor and explains how it varies from the common motor - Explains the problems of using a three-phase ac machine as a servomotor - Describes the applications of a two-phase ac servomotor, explaining how its characteristics can be varied 3) Hydraulic Servomotor - Describes the principles of a swash plate pump - Explains the advantage of using high pressures - Explains the applications of a hydraulic ram servomotor	
		Total No. of hours	96 hrs.

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