Bachelor of Science in Marine Engineering
COURSE OUTLINE

Title:	**Part B: Course Outline**	**Date Created: 20 March, 2019**
Course Code	Auto 1	Rev. No. 0
Prerequisites	Electro 3 & Mechanics	
Descriptive Title	Basic Control Engineering	
Course Credits	3 units	
Contact Hours	96 hrs for 16 weeks	
Lecture	3 hours/week for 16 weeks =48 hours	
Laboratory	3 hours/week for 16 weeks = 48 hours	
References	Annex C of CMO no. 67, s2017 STCW '78 as amended 2017 ed. IMO Model Course 7.04 "Officer in Charge of an Engineering Watch" 2014 ed. IMO Model Course 7.02 "Chief Engineer Officer and Second Engineer Officer"	

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FUNCTION: ELECTRICAL, ELECTRONIC & CONTROL ENGINEERING AT THE OPERATIONAL LEVEL

Legend:
F = Function
C= Column
KUP=Knowledge Understanding Proficiency

Competence	**KUP**	**Course Content**	**Learning Outcomes**	**Hours**	
A-III/1; F2: C1: Operate electrical,	**A-III/1; F1: C2: KUP.8** Basic construction and	**Week 1** Lecture	1.1 define an automatic control and state its purpose	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
electronic and control systems	operation principles of machinery systems including: .8 automatic control systems	**1.Fundamentals of Automatic Control**	1.2 describe what devices/equipment construct control systems and their role/function 1.3 relate sensing unit, controller, controlled variable, manipulating variable and controlled object to each of them in the control system 1.4 describe what sort of devices are included in the sensing unit 1.5 describe variety of controllers such as electronic (PID, PLC, computer) controller and pneumatic controller 1.6 define setting value, input value, deviation and output value/controlled variable in the controller 1.7 describe what sort of devices are included as manipulators 1.8 describe variety of controlled objects 1.9 describe 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		
		Laboratory WSA#1 Block Diagram of an Automatic Control System	▪ Interpret process and instrument diagrams of automation system based on the industry standards.		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F1: C2: KUP.8** Basic construction and operation principles of machinery systems including: .8 automatic control systems	**Week 2** Lecture **2. Various Automatic Controls**	2.1 classify systematically automatic control in terms of control methodologies 2.2 state what an optimal control means 2.3 explain briefly feedback control and feedforward control 2.4 describe briefly on off control, sequential control, PID control and program control 2.5 explain how these automatic controls are applied to the control systems 2.6 explain briefly program control and how the control is realized 2.7 describe the applications of program control in the ship's propulsion machinery	**3**	
		Laboratory WSA#2 Feedback Control Systems	▪ Differentiate basic construction and principles in automation regarding various measuring instruments and automation devices used onboard ships.		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F1: C2: KUP.8** Basic construction and operation principles of machinery systems including: .8 automatic control systems	**Week 3** Lecture **3. ON-OFF controls**	3.1 explain what ON-OFF control means 3.2 explain the characteristics of ON-OFF control 3.3 explain how ON-OFF control is utilized 3.4 list components comprising ON-OFF control system 3.5 describe ON-OFF control taking some applications as examples	**3**	
		Laboratory WSA#3 ON-OFF Control	▪ Demonstrate performance test in accordance with		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
			themanufacturer's standards forthe automatic control devices.		
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a Various automatic control methodologies and characteristics	**Week 4** Lecture **4. Sequential Control**	4.1 explain what a sequential control means 4.2 explain the characteristic of sequential control 4.3 explain how a sequential control is utilized 4.4 list components comprising a sequential control system 4.5 describe sequential controls taking some applications as example	**3**	
		Laboratory WSA#4 Sequential Control	▪ Interpret process and instrument diagrams of automation system based on the industry standards		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3b Proportional -Integral-Derivative (PID) control characteristics and associated system device for process control	**Week 5** Lecture **5 Proportional Integral Derivative Control**	5.1 explain the principles/theory of PID Control 5.2 explain how P, I and D actions can be electrically/pneumatically available showing simple electronic circuits and pneumatic diagram 5.3 state that PID control is classical control methodology but even now it is still firm basis for controlling any physical/process value 5.4 state that PLC and computer controller produces the same actions as analogue PID controller when controlling any physical/process value 5.5 explain P, I, D, PI, PD & PID actions respectively using step or ramp input	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
		Laboratory WSA#5 Performance Check of a PID Controller	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP .1** Basic configuration and operation principles of the following electrical, electronic and control equipment; .3 control systems: .3a various automatic control methodologies and characteristics .3b Proportional-Integral-Derivative (PID) control characteristics	**Week 6** Lecture **PID Control**	5.6explain the characteristic of P action as well as the proportional band (PB) 5.7 explain the characteristics of I and D actions 5.8 explain 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 5.9 describe the step response test to PID action and what can be understood by its results 5.10 explain how P,I and D parameters for optimal control can be determined 5.11describe the components comprising PID control systems including sensing unit, transducer, manipulator and controller	**3**	
		Laboratory WSA#6 Controller Tuning	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic	**Week 7** Lecture **6 Temperature Measurement**	**6.1 Mechanical Thermometers** 6.1.1 state that it is common practice to call the measuring instrument for temperatures:	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
	and control equipment .3 Control systems: .3a various automatic control methodologies and characteristics		▪ above 500OC a pyrometer ▪ below 500OC a thermometer 6.1.2state the temperature range for which mercury is used 6.1.3name the fluids which can be used for the measurement of lower temperatures 6.1.4describe the principal features of thermometers based on the filled system, including: ▪ mercury in steel ▪ vapor pressure ▪ gas-filled 6.1.5describe the principal features of bi metallic thermometer		
		Laboratory WSA#7 Performance Test of an PT100 (RTD) Sensor WSA#8 Calibration of a PT100 (RTD) Transmitter	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: .3a various automatic control methodologies and characteristics	**Week 8** Lecture **6 Temperature Measurements contd.**	**6.2 Electrical Thermometers** 6.2.1 state that the range and accuracy vary according to the material used in the detecting element 6.2.2 sketch and describe a resistance-type measuring instrument based on the Wheatstone bridge 6.2.3 describe the characteristics of a thermistor and the conditions for which it is suitable 6.2.4 sketch a circuit used in a thermocouple and describes its operation	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
			6.2.5 describe the principle of optical pyrometer		
		▪ Midterm Practical Assessment ▪ PA 01: Calibration of Pt100 Transmitter	▪ Demonstrate skills in performance test and automatic control devices ▪ Provide feedback on the practical aspects of automation		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 9** Lecture **6.3 Pressure Measurement**	**6.3 Pressure** 6.3.1 describe the principal features of, and compares, the following: *manometers:* ▪ simple water ▪ wide cistern or well ▪ inclined tube ▪ mercury *pressure gauges:* ▪ bourdon ▪ diaphragm-sealed gauge ▪ twin bellows ▪ differentialpressure cell ▪ strain gauge 6.3.2 describe how pressure gauges can be tested on board ship 6.3.3 test a pressure pump 6.3.4 sketch calibration curves for a bourdon pressure gauge, showing the effect of: ▪ zero adjustment ▪ multiplication adjustment ▪ angularity adjustment 6.3.5 state the calibration and testing are normally performed by specialists	**3**	
		Laboratory WSA#9 Performance Test of TC “K” Sensor	▪ Demonstrate performance test in accordance with the manufacturers standards for		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
		WSA# 10 Calibration of a TC" K" Transmitter WSA# 11 Performance Test of a Pressure Switch	the monitoring systems and automatic control devices ▪ Differentiate basic construction and principles in automation regarding various measuring instruments and automation devices used onboard ships.		
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 10** Lecture **6.4 Level measurement (Direct Method)**	**6.4 Level (Direct Method)** 6.4.1 describe the principle of a float-operated level measuring device 6.4.2 describe the principle of a probe element 6.4.3 describe a displacement gauge 6.5.1 explain the principle of inferential method 6.5.2 describe a level sensor based on immersed resistors	**3**	
		6.5 Level measurement (Inferential Method)	6.5.3 describe a level indicator based on a bubbler system 6.5.4 describe a pneumercator gauge		
		Laboratory WSA# 12 Performance test of a Float Level Sensor	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 11** Lecture **6.6. Flow Measurement**	6.6.1 explain the difference between a quantity meter and a rate of flow meter 6.6.2 explain that quantity metre is basically a rate of flow metre combined with an integrator 6.6.3 describe the function of the two elements of a flow meter 6.6.4 sketches a graph to show the relationship between velocity of a fluid and its pressure difference 6.6.5 from the above objective, show the velocity is proportional to the square root of pressure 6.6.6 explain the situations in which extractions of a square roots are necessary 6.6.7 describe the principal features of: ▪ a rotormeter ▪ an electrical flowmeter ▪ a rotameter 6.6.8 sketch an orifice and a venturi, showing the direction of flow and the pressure=measuring point 6.6.9 explain how a manometer can be used as a square-root extractor 6.6.10 state that extractions of square root can be accomplished pneumatically and electrically	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
		Laboratory WSA#13 Performance Test of a DP Transmitter	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 12** Lecture **6.7 General Measurement of Process**	6.7.1 explain the principle of a tachometer 6.7.2 explain the principles of AC and DC electric tachometer 6.7.3explain the principles of a torque metre based on the effect of stress in a magnetic field 6.7.4explain how the above objective can be developed to measure power 6.7.5explain the principal features of a viscometer 6.7.6describe the application of a photocell to: ▪ an oil in- water ▪ a smoke- density detector ▪ an oil mist detector ▪ a flame detector	**3**	
		Laboratory WSA# 14 Boiler Flame Scanner (Photocell)	▪ Demonstrate performance test in accordance with the manufacturers standards for the monitoring systems and automatic control devices		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 13** Lecture **6.7 General Measurement of Process contd.**	6.7.7 describe the common type of fire detectors 6.7.8 describe the principal features of: ▪ an explosive gas detector ▪ a vibration monitors ▪ an oxygen analyzer ▪ a CO2 analyzer ▪ a relative humidity meter ▪ salinity measurement ▪ a dissolved oxygen meter ▪ a pH meter 6.7.9 describe or perform routine setting up, testing and maintenance of the measuring devices included in the above objectives	**3**	
F2: Electrical, electronic and control engineering at the operational level **A-III/1; F2: C1:** Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP .1** Basic configuration and operation principles of the following electrical, electronic and control equipment; .3 control systems: .3a various automatic control methodologies and characteristics	7 Transmission of Signals **A. Transmitters**	7..1 Describe the function of a transducer/transmitter		
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 14** Lecture **B. Controlling Elements**	**B1: Pneumatic** 7.1 describe the flapper nozzle arrangement 7.2 explain what is meant by negative feedback and by positive feedback 7.3 sketch a flapper and nozzle arrangement with negative feedback 7.4 explain the function of a force	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
			balance transducer 7.5 describe the principal features of an electro-pneumatic transducer **B2: Electrical** 7.6 use a Wheatstone bridge used as a transducer 7.7 describe the principles of a variable inductance 7.8 describe the priciples of a variable capacitance transducer 7.9 describe the principles of an electronic force balance transducer 7.10 describe the principles of a voltage current transducer **B3: Receivers** 7.11 describe the principal features of: ▪ a pneumatic receiver integrator ▪ a potentiometric pen recorder 7.12 explain the function of an XY recorder 7.13 describe the basic principles of AC and DC servomotors		
		Laboratory WSA# 16 AC and DC Servomotors	▪ Differentiate basic construction and principles in automation regarding various measuring instruments and automation devices used onboard ships		**3**
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control	**Week 15** Lecture **8.Manipulator Elements** **A: Pneumatic**	8.1 State that the final controller might be operated pneumatically, hydraulically or electrically 8.2 Sketch a diaphragm operated control valve 8.3 Describe the characteristics of a motor element and the	**3**	

Competence	KUP	Course Content	Learning Outcomes	Hours	
	methodologies and characteristics		correctingelement in the above objective 8.4 describes or, preferably, determines by experiment the flow characteristics and applications of: ▪ mitre valves ▪ vee-ported valves 8.5 explains what is meant by “turn-down ratio” 8.6 describes the conditions which may dictate the need for a positioned 8.7 describes the principal features of a positioned 8.8 explains the circumstances when piston actuators might be used 8.9 describes the conditions where butterfly valves might be used 8.10 describes the wax-element temperature-control valve and states its normal temperature range		
		Laboratory WSA# 17 Diaphragm Operated Control Valve	▪ Differentiate basic construction and principles in automation regarding various measuring instruments and automation devices used onboard ships.		**3**

Competence	KUP	Course Content	Learning Outcomes	Hours	
A-III/1; F2: C1: Operate electrical, electronic and control systems	**A-III/1; F2: C2: KUP 3** Basic configuration and operation principles of the following electrical, electronic and control equipment .3 Control systems: 3a various automatic control methodologies and characteristics	**Week 16** Lecture **B: Electrical servomotors** **C: Hydraulic servomotor**	8.11 describes a D.C. servomotor and explains how it varies from the common motor 8.12 explains the problems of using a three-phase 8.13 describes the principles of a swash plate pump 8.14 explains the advantage of using high pressures 8.15 explains the applications of a hydraulic ram servomotor	**3**	
		Laboratory ▪ Submission of Compilation ▪ Final Practical Assessment PA02: Controller Tuning	▪ Provide feedback to the instructor on the practical aspect of Control Engineering ▪ Demonstrate confidence in dealing with automated system		**3**
			TOTAL (hours)	**48**	**48**