Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Mechanical Engineering	Semester	IV
Course Code	20ME44P	Type of Course	Programme Core
Course Name	**Elements of Industrial Automation**	Contact Hours	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	Credits	6
CIE Marks	60	SEE Marks	40

1. Rationale: In present scenario, Manufacturing industries are moving towards complete automation. Small and medium industries are in a phase of switching to PLC and SCADA technology for data acquisition and control. Industrial automation systems are used to control and monitor a process, machine or device in a computerized manner that usually fulfils repetitive functions or tasks. They are intended to operate automatically in order to reduce and improve human work in the industry. Advantages of this technology is commonly attributed to higher production rates and increased productivity, more efficient use of materials, better product quality, improved safety, shorter workweeks for labour, and reduced factory lead times. The Automation Engineer will design, program, simulate and commission automated machines and plant-wide processes to perform many job functions. Depending on the size of the organization, the engineer will perform some or all of these responsibilities. Therefore, it is necessary for diploma engineers to have knowledge of both PLC and SCADA technology. This course attempts to provide basic theoretical and practical aspects of automation technologies to develop operational competency. Hence this course is the foundation for diploma engineers who want to further specialise in the field of industrial automation

2. Course Outcomes: At the end of this course, student will be able to

CO-01	Select the right sensor and/or actuator for automating a given application and demonstrate process variables using sensors and/or transducers.
CO-02	Perform specified control functions using a Programmable Logic Controller (PLC) and list various applications of embedded systems.
CO-03	Design and test an automation system for a required operational specification and troubleshoot to resolve any given issue(s).
CO-04	Explain the concepts of SCADA, HMI and DCS and list their various applications

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
1	01	01	Introduction:	Ref Table 1	Study the following appliances/ automation

			1. Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component 2. Automation technology as a part of engineering sciences, Key development milestones in the history of automation technology, Effects of automation on people. 3. Types of automation system:- Relay logic and PLC		systems and identify various elements used and their function 1. Air conditioning System 2. Automatic water level control 3. Elevator(for Three Floor) 4. Washing Machine Write the Block Diagram For each and explain with a Multimedia Presentation
2	01	01	Programmable logic controller: 1. Introduction, Compare Relay Logic Control and PLC Logic Control, Internal Architecture of PLC 2. I/O Modules (Interfaces), Memory organization. Input devices: • Mechanical Switches • Proximity Switches 3. Input devices: • Photo electric Sensors and Switches • Encoders • Temperature Sensors • Position/Displacement Sensors	Ref Table 1	Demonstrate the working of below shown Switches/Sensor. a. Various industrial Switches (Push Button, ON/OFF, Toggle, Emergency, Rotary Switches etc.) b. Proximity- Inductive, Capacitive and Optical Sensor c. Temperature Sensor d Float Sensors **Note: Connect each sensor directly to the LED/Lamp with appropriate power supply**
3	01	01	1. Input devices: • Strain Gauges • Pressure Sensors • Liquid level detectors 2. Input devices: • Fluid flow measurement • Smart Sensors 3. Output Devices: • Relay • Directional control Valve	Ref Table 1	You tube presentation on Input and Output devices

4	01	01	1. ADC and DAC 2.Motors- DC motor, Synchronous motor, Servo motor, 3.Induction motor, Stepper motor	Ref Table1	Demonstrate the Forward and Reversal of Stepper, Servo and DC Motors with the help of Drivers. **Note: Demonstrate the above without using any controllers**
5	02	02	PLC Programming: 1. Programming standards, List Different PLC Programming, Ladder diagram, 2. Standard IEC 1131-3 Symbols used for I/O Devices 3. Ladder diagram for logic gates. AND,OR,NOT,NAND,NOR,XOR, XNOR	Ref Table1	• Execute energized motor or bulb using Switches in series or Parallel • Write ladder diagram to test digital logic gates and Execute/Simulate the same.
6	02	01	1. Writing Equivalent ladder diagram for Electric Switch, Belt drive , motor circuit Latching, Sequential O/P 2. Introduction to Timer functions. Applications of timing functions in process control -- On Delay Timer Function, Off-delay Timer Function	Ref Table 1	• There are 3 mixing devices on a processing line A,B ,C. After the process begin mixer-A is to start after 7 seconds elapse, next mixer-B is to start 3.6 second after A. Mixer-C is to start 5 seconds after B. All of then remain ON until a master enable switch is turned off. Develop PLC ladder diagram, timing diagram and simulate the same • Write a Ladder Program to count the number of Items moving

			3. PLC counter functions, Applications of PLC counter function in process control		on a conveyor Belt and Execute/Simulate the same
7	03	02	1) Relay, Jumps and Subroutines 2) Develop Ladder Program for relay based motor control automation such that the motor reverses its direction when the limit switches are activated 3) Develop a PLC ladder diagram to construct an alarm system which operates as follows. - If one input is ON nothing happens. - If any two inputs are ON, a red light goes ON. - If any three inputs are ON, an alarm sirens sound. - If all are ON, the fire department is notified.	Ref Table 1	• Execute the Ladder Program for relay based motor control automation such that the motor reverses its direction when the limit switches are activated and also Demonstrate by interfacing with PLC • Simulate the PLC ladder diagram developed for an alarm system and also Demonstrate by interfacing with PLC
8	03	02	1 & 2) Develop PLC program for the following application a) Traffic Light 3)Develop PLC program for the following application b) Water Level Indicator	Ref Table 1	Execute a PLC program for the following applications i) Traffic light controlling ii) Water level controlling
9	03	02	1 & 2) Develop automatic door system using optical sensor and linear actuator 3) Develop Automatic Elevator control	Ref Table 1	• Execute automatic door system using optical sensor and linear actuator • Design ladder diagram for an Automatic Elevator control Also, Test and simulate the ladder diagram designed to operate and control the

					Automatic Elevator control
10	03	02	1 & 2) Design ladder diagram for car parking. (Hint: car is to be detected and enter the parking space to a particular location if space is available. If there is no space, a lamp should indicate that parking is full) 3) Design ladder diagram for operating and controlling the Lift.	Ref Table 1	• Simulate a ladder diagram for car parking. • Test and simulate a ladder diagram designed to operate and control the Lift
11	02	02,07	1) Embedded System- Block Diagram of Embedded System 2)Applications of Embedded System • Robotics Drones • Braking System • Air conditioning, Refrigerator • Engine control System, 3)Applications of Embedded System • Automatic Washing machine • Microwave Oven • Keyless entry in Automobiles.	Study the latest technological changes in this course and present the impact of these changes on industry	You tube Presentation on Applications of Embedded System
12	04	01,07	1)Concepts on Distributed control System, 2) Concepts on HMI 3)Introductions to SCADA		•Multi media Exposure to DCS system •Demonstrate the HMI interface to control Light in AND/OR Logic
13	04	01,07	1)Typical SCADA block diagram, 2)Benefits of SCADA, 3) Applications of SCADA		•Multi media Exposure to SCADA system OR •Make case study visiting any nearby industry (Packaging/Milk Dairy/Processing) using HMI, SCADA/DCS systems.

Total in hours	39	13	52

- *PO= Program Outcome as listed and defined in year 1 curriculum
- Course Co-Ordinator must prepare PO – CO mapping with strength (Low/Medium/High) before course planning

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl.No.	Suggestive Activities for Tutorials
01	Write a PLC Ladder Program to Switching on/off the Lamp whether they are at the bottom or the top of the staircase.
02	The production line may be powered off accidentally or turned off for noon break. The program is to control the counter to retain the counted number and resume counting after the power is turned ON again. When the daily production reaches 500, the target completed indicator will be ON to remind the operator for keeping a record. Press the Clear button to clear the history records. The counter will start counting from 0 again. Write a PLC Ladder Program to perform this operation.
03	Write a PLC Ladder Program Providing lubricant for the gear box before the lathe spindle starts to run which aims to ensure that the oil pump motor starts first and the main motor starts subsequently.
04	Write a PLC Ladder Program such that Once the photoelectric sensor detects 10 products, the robotic arm will begin to pack up. When the action is completed, the robotic arm and the counter will be reset.
05	Develop PLC Programming Examples on Industrial Automation according to the logic given below, - A Saw, Fan and oil pump all go ON when a start button is pressed. - If the saw has operated less than 20s, the oil pump should go off when the saw is turned off and the fan is to run for an additional 5s after the shutdown of the saw. - If the saw has operated for more than 20s, the fan should remain on until reset by a separate fan reset button and the oil pump should remain on for an additional 10 s after the saw is turned off.
06	Develop and Simulate a PLC Ladder Diagram for Bottle Filling Plant
07	Study and present a Report on home Automation
08	Study and present a Report on Embedded systems in Automation
09	Study and present a Report on Automation in Processing Industries

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	*CIE-5 Skill Test-Practice	12	180	100	

6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
			Total CIE Marks		60
	Semester End Examination (Practice)		180	100	40
				Total Marks	100

5. Format for CIE written Test

Course Name	**Elements of Automation**	Test	I/II/III	Sem	IV
Course Code	**20ME44P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section		Assessment Questions	Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1				
	2				
II	3				
	4				
III	5				
	6				

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

5.(a)For CIE Skill Test -4   **Duration :240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02	Select a suitable Sensor / Switch for a given Process Variable and activate • Selection of Sensor/Transducer – 05Marks • Activation and Result – 15 Marks	20
2	02	Select a suitable motor for the given case and energize • Selection of the Motor – 10 Marks • Energize and Result – 20 Marks	30
3	03	Develop and Simulate a simple ladder diagram for a given Case • Writing Ladder Program – 20 Marks • Simulate and Troubleshoot - 20 Marks	40
4	01,02,03	Portfolio evaluation based on the average of all Practice Sessions (1 -6 Weeks)	10
Total Marks			100

5 . (b) For CIE Skill Test -5   **Duration: 240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	03	Device and Simulate a ladder diagram for the given Case Study (PLC Based) • Writing Ladder Program – 40 Marks • Simulate and Troubleshoot - 20 Marks	60
2	04	Prepare a SCADA Block Diagram for the given Case	30
3	03,04	Portfolio evaluation based on the average of all Practice Sessions (7-12 Weeks)	10
Total Marks			100

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
					Average Marks= (8+6+2+2)/4=4.5		5

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference :

Sl. No.	Description
1	Programmable logic Controllers By W. BOLTON
2	Digital electronics By FLYOD
3	Exploring PLC with applications By PRADEEP KUMAR SRIVATSAVA
4	Automation , Production systems and Computer integrated Manufacturing By MIKELL GROOVER
5	Sensors Hand book-SABRIE SOLOMAN-MC-GRAW HILL publications
6	Hand book of Modern Sensors" Physics ,Designs and Applications- JACOB FRADEN-Springer Publications
7	Electric Motors and Drives BY AUSTIN HUGHES and BILL DRURY

8. LIST OF SOFTWARE/LEARNING WEBSITES

1.http://www.vlab.com

2. http://www.mtabindia.com

3. http://www.nptel.ac.in

9. SEE Scheme of Evaluation   Duration :180 Min

SL. No.	CO	Particulars/Dimension	Marks
1	02	Select a suitable Sensor / Switch for a given Process Variable and activate • Selection of Sensor/Transducer – 10 Marks • Activation and Result –20Marks **OR** Select a suitable motor for the given case and energize • Selection of the Motor – 10 Marks • Energize and Result – 20 Marks	30
3	03	Device and Simulate a ladder diagram for the given Case Study • Writing Ladder Program –30 Marks • Simulate and Troubleshoot –20 Marks	50
4	01,02, 03,04	Viva voce	20
	Total Marks		**100**

10. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	PLC Trainer Kit with the following Modules		05 No

	• Door Controller • Car Parking Application • Water Level Controller • Conveyor Controller Application • Lift control Application With different Length Patch Cords		

02	Switches
	    • Mechanical Switches
	    • Proximity Switches
	    • Photo electric Sensors and Switches
			05 No each

03	Sensors
	    • Temperature Sensors
	    • Position/Displacement Sensors
	    • Strain Gauges
	    • Pressure Sensors
	    • Liquid level detectors
	    • Fluid flow measurement
	    • Smart Sensors
	    • Proximity Sensors
			05 No each

04	Induction Motor with DOL Starter	3 Phase Ac 50 Hz	01
05	Synchronise Motor with DOL Starter	3 Phase Ac 50 Hz	01
06	Stepper Motor	Standard size	01
07	Relays	Standard size	10
08	Counter and Timers	Standard size	10