Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	IV
Course Code	20EE43P	**Type of Course**	Programme Core
Course Name	Fundamentals of Automation Technology	**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:
The aim of this course is to introduce students to the present Industrial Automation scenario in India. The broad knowledge of essential component of present industrial Automation Industry such as Programmable Logic Controller (PLC), Distributed Control System (DCS), Supervisory Control and Data Acquisition (SCADA), industrial drives, human machine interface will enable the students to maintain the above automation controls systems used in the present industry. Thus this course is very important for students who want to use their knowledge of electronic engineering for working in the industrial automation sector.

2. Course Outcomes/Skill Sets: On successful completion of the course, the students will be able to

CO-01	Select a suitable sensor and actuator for a given automation application and demonstrate its use in a specific application.
CO-02	Install, test & control the pneumatic actuators using various pneumatic valves.
CO-03	Develop ladder diagrams for a given application and explain its implementation process using PLC.
CO-04	Describe the concept of SCADA and DCS systems and list their various applications.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour/ week	4 hours/week (2 hours/batch twice in a week)
1	1	2,3, 4	1. How do engineers work, technical drawings and parts lists, Circuit diagrams, Flow charts and programs. **Ref.7(1)**	Refer Table 1	Video demonstration on Automation technology
			2. Technical plans and schematic diagrams, Calculations and simulation		
			3. Automation technology as a part of engineering sciences, Key development milestones in the history of automation technology, Effects of automation on people.		
2	1	1,4	1. How a solenoid works- Structure of a solenoid, Applications of solenoids **Ref.7(1)**	Refer Table 1	1.Test a Linear Actuator Solenoid
			2. Solenoids as simple actuators.		2.Install, wire and test digital time delay relay -
			3.How switches work and their structure-Normally open contacts, normally closed contacts, Changeover switches.		

			Relays and contactors-Structure of a relay, Applications of relays, Time relays. **Ref.7(1)**		
3	1	1,4	**1.Sensors: operation, characteristics and application:** Inductive Proximity Sensors, Magnetic Proximity Sensor. 2. Capacitive proximity sensors, Optical proximity sensors, Ultrasonic proximity sensors 3. Linear Position sensors, Photoelectric sensors. Infrared sensors Limit Switches.	Refer Table 1	1a. Identify and test different sensors. 1b. Select a suitable proximity sensor for a given application and wire up the same. **Ref 7(2)** 2.Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.
4	1	4	1. Inductive linear transducer, area sensors, flow sensors **Ref.7(1)** 2. Temperature sensors, colour sensors, Hall effect sensor 3a. Pressure sensors -Electronic pressure switches with binary output signal. 3b. Concept of Sensor latching. Latching Digital Hall effect sensor.		1.Identify and test different sensors. 2. Simple Hall effect sensor Latching ON/OFF Relay switch Circuit.
5	2	1,4	1. **Fundamentals of pneumatics-** Individual components in a pneumatic control system and their functions. **Ref.7(1)** 2. Functions and features of actuators (pneumatic cylinders)- Single-acting cylinder, Double-acting cylinders, Speed regulation with single-acting cylinders, Speed regulation with double-acting cylinders. 3. Functions and features of pneumatic valves- Pneumatic valve designations and symbols, Pneumatic valve actuation types, controlling a single-acting cylinder, Controlling a double-acting cylinder	Refer Table 1	1a. Controlling of single-acting cylinder by 3/2 push-button valve/ **solenoid valve** b. Controlling of double-acting cylinder by 5/2 push-button valve/S**olenoid valve** c. Identify industrial applications of Single acting and Double acting cylinder. **Ref 7(3,4)** 2 a. Speed control of single-acting cylinders by flow control valve b. Speed control of double-acting cylinders by flow control valve
6	2	1,4	1. Functions and features of pneumatic drives- Guided cylinders, rodless linear drives and rotary drives. **Ref.7(1)** 2. Pneumatic grippers.	Refer Table 1	1. Demonstrate the use of Pneumatic drives (used in small robots) 2. Demonstrate the use of Pneumatic grippers.

			3. Pneumatic control system represented in a circuit diagram- Symbol designations in circuit diagrams.		
7	1	1,4	1. **Electric drives:** Physical/technical fundamentals of the DC motor.	Refer Table 1	1. Activate the DC motor using 2 relays to run the motor forward and backward direction.
			2. Activating DC motors		
			3. Working principle of Variable frequency drive.		2. Install and control speed of 3-ph motor using VFD.
8	3	1,4	1. **Fundamentals of control technology**: Meaning of control system, open loop and closed system with examples. Different types of controllers (PLC, CNC, Hard-wired programmed control systems, robot controllers)	Refer Table 1	1.Demonstrate open loop and closed systems observed in everyday life.
			2. How programmable logic controllers (PLCs) work and their structure. Advantages and Disadvantages of PLC. Mathematical fundamentals – basic logic functions-Identity (YES function), Negation (NOT function), Conjunction (AND function), Disjunction (OR function), XNOR and XOR.		
			3. Examples of controller structure.		2. Demonstrate Industrial applications of PLC
9	3	1,4	1. **Programmable logic controllers-** Internal architecture and functional structure. Input/output modules.	Refer Table 1	1.a. Identify Components of PLC b. Identify different types of PLC c. Identify different input and output devices of PLC d. Identify the wiring mode of PLC- sourcing and sinking modes
			2a. List input / output devices of PLC. -List types of PLC. 2b. Functions of Programming equipment (Programmer/monitor)		2.Identify and Install Programming Software and communication driver.
			3a. Explain PLC Programming Languages –Ladder diagram/ Functional Block Diagram /Instruction List/structured text. 3b. Explain scope of f IEC standard for PLC: IEC 61131		
10	3	2,3, 4	1a. **Operation cycle of PLC**: Input scan, Program scan and Output scan. **1b. Operation modes of PLC**: program, run and test modes. Data files and program files.		1.Develop and test the ladder programs for the following motor controls: a) Starting from two different locations (OR Function) b) Stopping from one position (NOT Function)
			2.Configuration of I/Os and Addressing I/Os, study of PLC symbols.		

			3. Procedure for drawing ladder diagram, connection of inputs and outputs to input and output module and entering ladder program into PLC (CPU). Draw the ladder diagram for a simple example of one-contact, one-coil circuit and connection diagram showing how inputs are connected to the input and output module of PLC.		c) Two hand operation (AND Function) d) Stopping from two different locations (NOT+OR or NOR Functions) e) Stopping if both signals are given (NOT+AND or NAND functions) f) Memory function (Signal is maintained or holding) g) Interlocking protection (XNOR/XOR)
					2. Develop and test the ladder program for interlocking two motors, using **PLC simulation software.**
11	3	2,3, 4	1.Most commonly used PLC programming instructions and their applications: XIC, XIO, OTE. Latch, Unlatch		1a. Develop and test ladder program for switching ON motor 1, motor 2 and motor 3 in sequence with some time delay, using **PLC simulation software.** 1b. Develop and test the ladder program of the Alarm system for the following conditions: If one input is ON- nothing happens, if any two inputs are ON- a red light turns ON, If any three inputs are ON- a Hooter/Alarm turns ON, using PLC simulation software.
			2.Describe Timer instructions and their application: Describe Timer On Delay (TON), Timer Off Delay (TOF), Retentive Timer On (RTO)		
			3.Describe counter instructions and their application: COUNT UP, COUNTDOWN, UP/DOWN COUNTER Examples of use of counter and timer instructions.		2a. Develop and test ladder Program for fully Automatic Star-Delta starter, using **PLC simulation software.** 2b. Develop and test ladder Program to control automatic washing machine, using **PLC simulation software.**
12	3	2,3, 4	Wiring sensors to PLC 1.Wiring push button to PLC, and selector switch to PLC		1.Develop and run simple Ladder programs to read sensor status and to control various output. **LED is turned ON when a (proximity sensor) sensor is activated.** i. Draw the ladder diagram ii. Draw PLC wiring diagram. iii. Wire push buttons to input module and LED to output module. iv. Enter the ladder program into the PLC simulator and execute.

					v. If the program is error free, Upload the program into PLC and execute. vi . observe the output
			2.Wiring NPN sensor to PLC		2. Double acting cylinder is used to perform machining operations. Pneumatic cylinder is advanced by pressing two push buttons simultaneously. If any one of the push button is released, cylinder comes back to start position. Draw the pneumatic circuit, PLC wiring diagram and ladder diagram to implement this task.
			3.Wiring PNP sensor to PLC		
13	4	2,3, 4	1.Meaning of SCADA -Functions of each component of SCADA system, -Describe SCADA Hardware and software -Applications of SCADA.		Demonstrate application of SCADA/HMI/DCS
			2.Meaning of HMI and its applications. -Need & types of HMI. -Advantages of HMI. -Various software's used for Programming HMI. -Interfacing HMI and PLC- General block diagram.		
			3. Concept of DCS -Hierarchy of DCS. -Functions of each level of DCS.		
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

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.	Week	Activity
1	1	Prepare a report on how Automation impacts our lives at present.

2	2	Study time relay 1. Explain the use of time relay in Traffic signal control with a circuit diagram 2. Explain working of circuit 3. List different types of timer relays used in circuit 4. Explain specification and feature of given INTERVAL ON delay relay 5. Explain specification and feature of given SINGLE SHOT time delay relay
3	3	I. Study LVDT 1. Explain working principle of LVDT 2. List the applications of LVDT 3. List the benefits of LVDT II. Develop an automatic door system using optical sensor and linear actuator. https://www.instructables.com/Automatic-Door-Opening-and-Closing-System-Using-IR/
4	4	Study digital Hall effect sensor (SS361RT, SS461R). 1. List features of Hall effect sensor 2. List applications Hall effect sensor 3. Explain electrical characteristics of Hall effect sensor
5	5	I. List the advantages of pneumatics and explain application of pneumatics in automation. II. Problem statement: Workpieces are transported to a processing unit on a conveyor belt. The workpieces have to be separated upstream of the processing unit. The separating cylinder's end positions are monitored using magnetic proximity switches. 1. Describe the function of a magnetic proximity switch. 2. Select a suitable proximity switch for monitoring the end position of a cylinder 3. Explain terminology from the field of proximity switch technology. 4. Determine whether or not a solenoid valve can be directly actuated by a proximity switch. 5. Describe different types of proximity switches
6	6	I. For the given application (Sorting device for metal stampings) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram II. For the given application (separating parcel post) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram III. For the given application (Quarry stone sorter) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram
7	**7**	Study given commercially available VFD 1. List its features 2. Applications of VFD 3. Explain specification of VFD 4. Types of VFD available in the market.
8	**8**	Study PLC based sand mixing Machine 1. Explain sequence of operation 2. Draw and explain the relay Ladder Logic diagram 3. Draw and explain the Ladder diagram
9	**9**	Study LIFT Control using PLC 1. Explain sequence of operation. 2. Draw and explain the Ladder diagram.
10	10	Study PLC Conveyor Motor Ladder Logic 1. Explain sequence of operation

		2. Draw the relay schematic 3. Draw the Ladder diagram 4. Explain the type of sensor used to detect the object
11	11	Prepare a report on Industry 4.0 and present.
12	12	Study the latest technological changes in this course and present the impact of these changes on industry.
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

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	**Fundamentals of Automation Technology**	Test	I/II/III	Sem	III/IV
Course Code	**20EE44P**	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	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.					

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	https://dlb.sa.edu.au/rehsmoodle/file.php/441/Teachware/563060 Fundamentals of automation technology.pdf
2	https://www.festo-didactic.com/ov3/media/customers/1100/566920 leseprobe en 2.pdf
3	https://www.youtube.com/watch?v=ZXANgP-q6b4
4	https://www.festo-didactic.com/ov3/media/customers/1100/566910 leseprobe.pdf
5	https://www.youtube.com/watch?v=GhS1qpHoSX0
6	https://www.youtube.com/watch?v=O-hbGD HsYk
7	**Control of Machines- S.K. Bhattacharya & Brijinder Singh, New Age International Publishers**
8	**Programmable Logic Controllers: John W.Webb, Ronald A.Reis, PHI**
9	**Introduction to PLC by Gary Dunning, Cengage Learning.**
10	**Mechatronics: W.Bolton**
11	https://nptel.ac.in/content/storage2/courses/112106175/downloads/Module%204/SELF%20EVALAUTION/SE-Lecture%2041.pdf
12	https://accautomation.ca/wiring-push-buttons-and-selector-switch-to-click-plc/
13	https://realpars.com/discrete-sensors-part-1/
14	https://www.automationdirect.com/adc/overview/catalog/sensors -z- encoders
15	https://www.rtautomation.com/technologies/control-iec-61131-3/
16	https://davidrojasticsplc.files.wordpress.com/2009/01/libro-en-espanol.pdf

8.1 CIE-4 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week1-week6)		10
2	1. Identify different pneumatic components 2. Identify various sensors	1 & 2	10
3	Select and test suitable sensor for a given application 05+15	2	20
4	Test a given Linear Actuator Solenoid OR Install, wire and test digital time delay relay	2	15
5	Demonstrate & control the Pneumatic actuators using pneumatic valves. i. Draw the circuit diagram using right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the operation of a Pneumatic actuators 20	3	35
6	Viva voce		10
	Total Marks		**100**

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7- week12)		10
2	i. Identify different input and output devices of PLC	3	10

	ii. Identify various indicators on PLC Modules.		
3	Explain Scope of IEC standard for PLC: **IEC 61131**	3	10
4	Demonstrate the implementation of given application using PLC i. Draw the ladder diagram and PLC wiring diagram using right symbols 10 ii. Simulate the ladder diagram using PLC simulator and check the automation logic by activating the respective inputs 20 iii. Upload the Ladder program into PLC and execute 10 iv. Demonstrate desired output from PLC. 20	3	60
5	Viva voce		10
	Total Marks		**100**

8.3 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	i. For a given automation application select suitable pneumatic components and sensors.	1, 2	10
3	Demonstrate & control the Pneumatic actuators using pneumatic valves. i. Draw the circuit diagram using right symbols 10 ii. Build the circuit as per the circuit diagram 20 iii. Demonstrate the operation of a Pneumatic actuators 10 **OR** Demonstrate the implementation of given application using PLC i. Draw the ladder diagram using right symbols 10 ii. Simulate the ladder diagram using PLC simulator and check the automation logic by activating the respective inputs 15 iii. Upload the Ladder program into PLC and execute 05 iv. Demonstrate desired output from PLC. 10	1 /3	40
4	Demonstrate simple application of SCADA using SCADA software.	4	20
5	Viva voce		20
	Total Marks		**100**

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

Sl. No.	Particulars	Specification	Quantity
1	Small compressor	4 bar, 1.5 HP,0-4 bar pressure, 0-10 litres	1
2	Linear Actuator Solenoid 12V		20
3	Inductive. Proximity Sensors. Magnetic Proximity Sensor, Limit Switches		20 each
4	Capacitive proximity sensors, Optical proximity sensors Ultrasonic proximity sensors		20 each
5	Infrared sensors, Pressure Sensor and Switch		20 each
6	Inductive linear transducer , Area sensors, Flow sensors, Temperature sensors, colour sensors		20 each
7	single-acting cylinder, double-acting cylinder		10 each
8	3/2 and 5/2 push-button valve		10
9	3/2 and 5/2 solenoid valve		10
10	Flow control valves		10
11	Digital time delay relay		5
12	Direction control Valve, Double Acting Solenoid		10 each

13	Pneumatic Grippers		5
14	FRL (filter, regulator and lubricator) unit		2
15	PLC Systems with digital I/P, O/P modules and software	12/24v Dc/relay, 8 Digital Inputs, 4 Digital Outputs, ethernet card standard micro SD card, integrated webserver	10
16	Variable frequency drive	3-phase, 1HP, VFD	1
17	1 HP induction motor with DOL starter	1 HP	1
18	SCADA Software		1