Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electronics and Communication	**Semester**	IV
Course Code	20EC44P	**Type of Course**	Programme Core
Course Name	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

Automation in the industrial workplace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety, and adding flexibility to the manufacturing process. Industrial automation results in increased productivity, more efficient use of materials, increased safety, reliability, better product quality, shorter workweeks for labour, profitability and reduced factory lead times. Worker safety is an important reason for automating an industrial operation. A wide range of industrial controls and automation depends on power electronics. PLC is an industrial computer control system used to control the state of output devices based upon a custom program. SCADA is a centralized system that monitors and controls field devices at remote sites.

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

CO-01	Explain the role and importance of power electronics in today's industrial automation and for a given application list the commonly used components in power electronics.
CO-02	Build a power electronic circuit and demonstrate the working of that circuit for a specific application either in a real or simulated environment.
CO-03	Design, test and troubleshoot a given PLC automation system to meet defined operational specifications in a simulated environment.
CO-04	Explain the concept of SCADA, DCS and HMI and list their various applications in industry.

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	1	1. Introduction to industrial automation, need for power devices, features of power diode, power BJT. 2. Features of SCR, IGBT and Power MOSFET. 3. DIAC and TRIAC - working, applications.	Refer Table 1	1. Conduct an experiment to find the holding current and latching current of SCR. 2.Conduct an experiment to determine break-over voltage of an SCR.
2	1,2	1	1. Triggering-Need, Triggering circuits- R-triggering, RC–triggering.	Refer Table 1	1. Construct a R triggering circuit and verify its working.

			2. Pulse triggering using UJT relaxation oscillators. 3. Commutation-Need, natural and forced commutation of SCR. resonant commutation.		2. Construct a R-C triggering circuit and verify its working.
3	1,2	1,3	1. Auxiliary commutation and Complementary commutation. 2. Protection of SCR-Snubber circuit- turn ON, turn OFF and over- voltage. 3. Controlled rectifiers- Single phase half-wave controlled rectifier, single phase full-wave bridge controlled rectifier (only resistive load), importance of freewheeling diode.	Refer Table 1	1. Verify SCR triggering by UJT relaxation oscillator using a kit. 2. Construct a full-wave controlled rectifier circuit using R-C triggering and verify its working.
4	1,2	1,3	1. Chopper- working principle, duty cycle, chopper control schemes. 2. Chopper classifications, Step-up and Step-down choppers. 3. Working of first quadrant, second quadrant choppers.	Refer Table 1	1. Verify the working of a constant frequency voltage commutated chopper using a kit. 2. Verify the working of a variable frequency voltage commutated chopper using a kit.
5	1,2	1,3	1. Working of two quadrant and four quadrant choppers, Buck and Boost converters. 2. Inverters- working principle and types, Half-bridge inverter. 3. Full-bridge inverter, Series inverter,	Refer Table 1	1. Verify working of series inverter using a kit. 2. Verify working of full bridge inverter using a kit.
6	1,2	1,3	1. Variable dc link inverter, voltage source and current source inverters. 2. PWM techniques used in inverters. 3. Cycloconverter- classification, working of single phase to single phase midpoint cycloconverter.	Refer Table 1	1. Verify PWM techniques in inverters using a simulator. 2. Verify single phase to single phase cycloconverter using a kit.
7	1,2	1,3	1. Photo-electric control of SCR, Light dimmer circuit using DIAC and TRIAC. 2. Burglar alarm circuit. Need for electronic control of motors. 3. Armature voltage control method and Field control method for speed control of DC shunt motor.	Refer Table 1	1. Verify light dimmer circuit using DIAC and TRIAC. 2. Simulate and verify the working of Burglar alarm circuit/Photo electric control of SCR/Speed control of DC shunt motor.

8	2,3	1,3, 5	1. Speed control of DC motors using dual converters, speed control of Induction motor. 2. PLC-introduction, compare Relay logic control and PLC logic control, block diagram of PLC system, PLC scanning. 3. Internal architecture of PLC, memory organization.	Refer Table 1	1. Verify the speed control of universal motor using a kit. 2. Verify the speed control of stepper motor using inverter in clockwise and anti-clockwise direction using a kit.
9	3	1,3, 5	1. PLC input devices – switches, proximity sensors, photoelectric sensors, temperature sensors, liquid level sensors. 2. PLC output devices – solenoids, relay, directional control valve, motors & stepper motors. 3. Programming standards, PLC Ladder diagram, ladder diagram for logic gates.	Refer Table 1	1. Familiarization of software for PLC simulation (Keyence/Picosoft). 2. Write ladder diagrams and verify the truth table of all logic gates.
10	3	3,5, 7	1.PLC input instructions and outputs- coils, indicators, Conversion of Boolean functions from word description to ladder diagram and vice-versa. 2.Write the ladder diagrams for different applications Ex i. A system where there has to be no output when any one of four sensors gives an output, otherwise there is to be an output. ii. Staircase light application. iii.Conveyor control application. 3. PLC register basics- Input, Holding, Output, PLC arithmetic functions- addition, subtraction, multiplication & division.	Refer Table 1	1. Write a ladder diagram for DOL starter and test the output using PLC trainer kit module. 2.Simulate and test the following task using PLC, A signal lamp is required to be switched ON if a pump is running and the pressure is satisfactory, or if the lamp test switch is closed, otherwise the signal lamp should remain OFF.
11	3	3,5, 7	1. PLC Basic comparison functions and its applications. 2. PLC Timer functions- on delay timer, off-delay timer, pulsed timer , one shot, applications of timing functions in process control. 3. PLC Counter functions- up/down counter, applications of	Refer Table 1	1. Write a ladder diagram, timing diagram and simulate a circuit for the following process control application. There are 3 mixing devices on a processing line A, B and C. After the process begins mixer-A is to start after 7 seconds elapse, next mixer-B is to start 3.6 seconds after A. Mixer-C is to start 5 seconds after B. All of them remain ON until a master enable switch is turned OFF.

			PLC counter functions in process control.		2. Write a ladder diagram and simulate a circuit for a process control application in which a paint spray has to run for 40 seconds when the count reaches the value of 25.
12	3,4	3,5, 7	1. PLC and the internet, selection of PLC and its maintenance, PID module. 2. Distributed Control System- Introduction, features, hierarchical architecture, advantages. 3. DCS application in chemical plants/ cement plants/ paper and pulp industries, Introduction to HMI/MMI.	Refer Table 1	1. Write the ladder diagram and execute the Water level controller/Staircase light controller application using PLC trainer kit module. 2. Video demonstration and documentation of DCS application in any plant.
13	4	3,5, 7	1. SCADA-Introduction, background, definition, features, typical SCADA system. 2. SCADA architecture, SCADA hardware & software. 3. SCADA protocols, interfacing PLC with SCADA. applications of SCADA.	Refer Table 1	1. Write the ladder diagram and execute the Lift control/Conveyor control application using PLC trainer kit module. 2. Video demonstration and documentation of the SCADA systems.
Total in hours			**39**	**13**	**52**

Note: 1) In Practice sessions Video demonstration should be followed by MCQs/Quiz/Subjective questions and the evaluation has to be documented.

2) In Practice sessions, all discrete circuits should be simulated using suitable software before its construction and verification.

TABLE 1: Suggested activities for tutorials

The list is shared as an example and not inclusive of all possible activities of the course.

The list of activities for one week can be shared among teams in a batch of students.

Week no.	**Suggested activities for tutorials**
01	1. Give a presentation on constructional features of SCR, its specifications and ratings. 2. Prepare a report on specifications and ratings of Diac and Triac. 3. Discuss feasibility of Germanium Controlled Rectifier.
02	1. Discuss the importance of triggering an SCR. 2. Explain the comparison of natural and forced commutation of SCR.

03	1. List the applications of controlled rectifiers in industries. 2. Explain any one real time application of a controlled rectifier.
04	1. Explain any one real time application of choppers.
05	1. Explain the differences between Buck and Boost converters. 2. Collect the information on the type and working of inverter used in your lab UPS.
06	1. Differentiate between step up and step down cyclo converter with their applications. 2. Explain the role of a cycloconverter in the working of a washing machine.
07	1. Construct and demonstrate any one real time application of SCR/TRIAC(ex:Automatic street lighting/Smoke detector).
08	1. List the leading PLC manufacturers around the world and collect information on applications of PLC systems. 2. Prepare a report on advantages of using PLC in automation.
09	1. Collect information on the specifications/parameters / datasheets of input devices used with PLC. 2. Collect information on the specifications/parameters / datasheets of output devices used with PLC.
10	1. Develop a fire alarm system which has Fire sensors providing inputs to a SET-RESET function block so that if one of the sensors is activated, the alarm is set and remains set until it is cleared by being reset. 2. Two Conveyors feed a main conveyor, find the main conveyor count from the count of parts entering the two conveyors.
11	1. Give a presentation on real time PLC Counter applications. 2. Prepare a report on all types of PLC timer functions. 3. Give a presentation on PLC advanced comparison functions.
12	1. Give a presentation on applications of HMI/MMI. 2. Give a presentation on the different levels of industrial control with respect to networking of PLCs. 3. Prepare a report on DCS system integration and DCS flow sheet symbols.
13	1. Study the latest technological changes in this course and present the impact of these changes on industry.

	2. Prepare a report on different ways of deploying SCADA systems along with advantages and disadvantages. 3. Prepare a report on the security threat and vulnerability of SCADA Systems.

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 tests 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Activity through Rubrics	1-13		10	10
				Total CIE Marks	60
	Semester End Examination (Practice)		180	100	40
				Total Marks	**100**

5. Format for CIE (1, 2, 3) Written Test

Course Name	Industrial Automation	Test	I/II/III	Sem	III/IV
Course Code	20EC44P	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.					

5. (a) Format for CIE-4 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	1	Identify the various components used in Power Electronics and demonstrate its use for a given application.	20
2	2	Build a power electronic circuit and demonstrate the working of that circuit for a specific application either in a Real or Simulated environment. Construction of circuit diagram -20 Marks Conduction -20 Marks Output -30 Marks.	70
3	1,2	Portfolio evaluation of Practice sessions through Rubrics	10
		Total Marks	**100**

5. (b) Format for CIE-5 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	3	Design, Test and Troubleshoot a specific PLC Automation System to meet defined operational specifications in a simulated environment. Writing Ladder diagram (2 applications) - 40 Marks Interfacing to kit - 20 Marks Result - 10 Marks	70
2	4	Concept of SCADA/DCS/HMI and list their various applications	20
3	3,4	Portfolio evaluation of Practice sessions through Rubrics	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 Principles and Applications" by John W. Webb – Ronald A. Reis. 5th Edition, Published by PHI Publication.
2	"Introduction to PLC's" by Gary Dunning, 3rd Edition, Thomson India Edition
3	"PLC's" by W. Bolton, 4th edition.
4	Programmable Logic Controllers by Frank D Petruzella, 4th Edition, McGraw Hill Publications.

8. SEE Scheme of Evaluation

SL. No.	COs	Particulars/Dimension	Marks
1	1	Identify the various components used in Power Electronics and demonstrate its use for a given application.	10
2	2	Build a power electronic circuit and demonstrate the working of that circuit for a specific application either in a Real or Simulated environment. Construction of circuit diagram - 10 Marks Conduction -10 Marks Output -10 Marks	30
3	3	Design, Test and Troubleshoot a specific PLC Automation System to meet defined operational specifications in a simulated environment. Writing Ladder diagram - 10 Marks Interfacing to kit - 10 Marks Result - 10 Marks	30
4	4	Concept of SCADA/DCS/HMI and their applications.	10
5	1,2,3, 4	Viva-Voce	20
		Total Marks	**100**

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

Sl. No.	Particulars	Specification	Quantity
1	Computers	Intel Core i5 11th gen/8GB RAM/1 TB HDD/256GB SSD/ Graphics 2 GB	20
2	POWERSIM simulation software		
3	Kit for SCR triggering by UJT relaxation oscillator		10
4	Kit for Voltage commutated chopper both constant frequency & variable frequency.		10
5	Series Inverter kit		10
6	Full bridge inverter kit		10
7	PWM inverter kit		10
8	Single phase to Single phase cyclo converter kit		10
9	Light Dimmer kit		10

10	Speed control of universal motor kit		10
11	Speed control of stepper motor kit		10
12	PLC kits		10
13	PLC interfacing kits for Lift control, water level control		3 each