GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Automation & Robotics

Course / Subject Code: DI03041021

Course/Subject Name: Basics of Industrial Automation

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	To take this course, students should have basic knowledge of electrical circuits, digital electronics, and fundamentals of control systems.
Rationale:	This course has been designed for diploma students to help them learn the basic and practical knowledge of industrial automation through topics like PLC (Programmable Logic Controller), SCADA, and other control systems. In today's world, industries are moving towards automation to make their processes faster, safer, and more efficient. To work in such industries, students must know how to install, operate, and troubleshoot these systems. This course prepares students for jobs in the automation field and builds a strong base for further learning and specialization.

Course Outcome:

After Completion of the Course, Student will able to:

COs	Course Outcomes	RBT Level
CO-1	Describe the fundamental concepts, benefits, types, and applications of industrial automation systems	R,U
CO-2	Explain the basic principles, components, architecture, and working of PLC systems	R,U
CO-3	Describe the fundamentals of PLC programming, including languages, scan cycle, and memory mapping.	A,N
CO-4	Apply PLC programming functions (timers, counters, arithmetic, logic) to design control strategies.	A,N
CO-5	Study the key components of industrial automation systems, including RTUs, SCADA, DCS, and HMI.	R,U

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Introduction To Industrial Automation**	**08**	**18**
	1.1 Definition of Industrial Automation. **1.2** Objectives of Industrial Automation. **1.3** Benefits of Industrial Automation **1.4** Types of automation systems. **1.4.1** Fixed automation. **1.4.2** Programmable automation. **1.4.3** Flexible automation. **1.5** Basic components of automation systems. PLCs, Sensors, Actuators, HMI, Control system, Communication networks, Software & Programming. **1.6** Different types of industrial process technique. **1.6.1** Continuous Process. **1.6.2** Discrete-state Process. **1.6.3** Composite Process. **1.7** Applications of PLC based Automation system.		
2	**Fundamental Of PLCs.**	**08**	**18**
	2.1 Introduction of PLC. **2.2** Architecture & Working of PLC. **2.3** PLC hardware components and its working. **2.3.1** SMPS, CPU, Memory, Programming device. **2.3.2** Analog Input/output module. ▪ AC / DC input module		

	2.3.3 Digital Input/output module. ▪ AC / DC Output module **2.4** Peripherals devices of PLC. **2.4.1 Input Devices:** Pushbutton, Limit, level proximity switch & other input devices. **2.4.2 Output Devices:** Relay, SSR, contactor, solenoid valve and other output devices. **2.5** Selection Criteria of PLC. **2.6** Advantages and limitations of PLC.		
3.	**PLC Programming Techniques.**	**12**	**27**
	3.1 PLC Programming Languages. **3.1.1** Introduction to PLC Programming. **3.1.2 Type of PLC programming language**: Ladder Logic, Functional Block Diagram, Sequential Functional Chart, Structured Text. **3.2** Ladder Logic (LAD) in Detail **3.2.1 Introduction to Ladder Logic Elements** : (Contacts,Coils,Rungs and Power Flow, I/O Addressing) **3.2.2** Ladder Logic for Logic Gates **3.2.3** Boolean Expressions in Ladder Logic **3.2.4** Holding (latching relay) contact. **3.3** Understanding PLC Program Scan Cycle **3.4** Memory Mapping and Registers **3.4.1 Memory Mapping of PLC:** Input/output memory, data memory, system memory, timers, counters. **3.4.2 Types of Register in PLC:** Holding (Data) registers, Input/output registers, Status Registers, Control registers. **3.5** Simple and complex branching in Ladder logic. **3.6** Ladder logic Symbols of PLC.		
4	**Basic functions and Application of PLC**	**10**	**22**
	4.1 ON Delay timer, Off Delay timer, Retentive & Non-retentive timer **4.2** UP Counter, Down Counter. **4.3** PLC arithmetic functions. • Addition, • Subtraction, • Multiplication, • Square Root, • Division, **4.4** PLC comparison function.		

	• Equal, • Not equal, • less than , less than or equal • greater than, greater than or equal **4.5** PLC logical function. **4.6** LED blinking using various timers. **4.7** Object counting using counter function. **4.8** Temperature unit conversion using arithmetic function.		
5.	**Basic Components Of Automation System.**	**07**	**16**
	5.1 Definition of RTU (Remote terminal unit). **5.1.1** Function of RTU. **5.1.2** Importance of RTU in automation. **5.2** Introduction of SCADA. **5.2.1** Basic diagram of SCADA system. **5.2.2** Benefit of SCADA in automation. **5.3** About DCS (Distributed control system) **5.3.1** Architecture of DCS. **5.3.2** Application of DCS in automation. **5.4** Introduction of HMI. **5.4.1** Benefit of Human Machine Interface. **5.4.2** Application of HMI in automation.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	**35**	**30**	**10**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr.	Title of Book	Author Name	Publication/ISBN
1	Programmable logic Controllers Principles and applications.	John w. Webb Ronald A Reis	PHI Learning,
2	Programmable logic Controllers Programming methods and applications	John R Hackworth Frederick D. Hackworth Jr.	Pearson
3	Process Control Principles and applications	Surekha Bhanot	Oxford University press
4	Distributed Computer Control for Industrial automation	Dobrivoje Popovic and Vijay Bhatkar.	Marcel Dekker Inc.,1990
5	Process control Instrumentation technology	Curtis D Johnson	PHI pvt. Ltd.
6	Overview of Industrial Process Automation	KLS Sharma	Elsevier Publication
7	Programmable Controllers	Thomas A. Hughes	ISA
8	SCADA-Supervisory Control and Data Acquisition System	Stuart A. Boyer	ISA publication (3rd Edition)
9	Programmable Logic Controllers	Frank D. Petruzella	McGraw-Hill Education
10	Industrial automation	Vijay G. Yangalwar Kishor A. Jawalkar	Nirali Prakashan

(b) Open-source software and website:

No.	Resource Name	Web Address
1	PLCs.net	www.plcs.net
2	Tri-PLC	www.triplc.com
3	Instrumentation Tools (DCS, PLC, RTU)	https://instrumentationtools.com/dcs-plc-rtu/
4	The Automation Blog	theautomationblog.com
5	Engineers Community	https://engineerscommunity.com/
6	PLC Development	www.plcdev.com
7	PLC Programming	www.plcprogramming.com
8	PLC Manual	https://plcmanual.com/
9	Electrical Engineering Portal (SCADA, DCS, PLC, RTU)	https://electrical-engineering-portal.com/scada-dcs-plc-rtu-smart-instrument
10	Engineering Hulk (RTU)	https://engineeringhulk.com/rtu-remote-terminal-unit-definition-functions-importance/
11	Instrumentation Tools (DCS)	https://instrumentationtools.com/distributed-control-systems-dcs/
12	Automation Community (HMI)	https://automationcommunity.com/human-machine-interface/
13	PLC Gurus	www.plcgurus.net

Suggested Course Practical List:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	CO	Approx. hours required.
1	Learn the basics Basic components of automation system.	1	1	2
2	Learn the basics and hardware components of PLC.	1	1	2
3	Identify various modules and component of PLC hardware.	1	1	2
4	Draw wiring Diagrams for Digital Input (DI) and Digital Output (DO) signals for PLC.	2	2	2
5	Draw wiring Diagrams for Analog Input (AI), and Analog Output (AO) signals for PLC.	2	2	2
6	Study different types of programming language for PLC.	3	3	2
7	Demonstrate procedure for Ladder diagram Preparation, downloading and running status of PLC.	3	3	2
8	Describe the sequence of program scanning in PLC.	3	3	2
9	Study Memory Mapping and I/O addressing for PLC.	3	3	2
10	Develop ladder logic to test functionality of basic logic gates	3	3	2
11	Draw ladder diagram for given Boolean expression.	3	3	2
12	Develop ladder diagram to prepare latching relay.	3	3	2
13	Draw basic ladder logic symbols for PLC.	3	3	2
14	Implementation of simple ladder logic program using timer.	4	4	2
15	Implementation of simple ladder logic program using Counter.	4	4	2
16	Simulate Industrial application of Arithmetic Function for plc.	4	4	2
17	Simulate Industrial application of Comparison Functions.	4	4	2
18	Implement a simple ladder logic to test the START/ STOP logic for two inputs and one output.	4	4	2
19	Write and implement ladder logic program to blink LED using timer.	4	4	2
20	Use of various functions in SCADA simulation editors to develop simple project.	5	5	2
Note: Minimum 10 to 12 Practical Exercises to be perform (30 hrs.)				

List of Laboratory / Learning Resources Required:

Sr.No	Equipment Name with Broad Specifications
1	D.C. power supply, Multi-meter, Breadboard, patch cord.
2	Computer system with latest operating system.
3	PLC, SCADA trainer kit.
4	DCS ,HMI ,RTU MODULE/KIT
5	Digital and analog module.
6	Level, flow, proximity and limit switch.
7	License/Free copy of ladder logic editor.
8	Simulator software for virtual simulation.
9	Level, flow, pressure control trainer kit.
10	DC motor, solenoid valve, relay and other switching devices.

Suggested Project List:

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Make a working model of traffic light control using PLC.
b) Make a working model of elevator using PLC.
c) PLC Based Door Open and Closing System.
d) PLC Based Automatic Counting System.
e) PLC Based ON/OFF type Level Control System.
f) PLC based Automatic Dam Shutter Control System.
g) Collect specifications from different manufacturers of PLC /DCS/SCADA and prepare a market survey report.
h) Create a model of small robotic arm that can pick up objects from one location and place them in another location using manual control.

i) PLC based home automation system model.

j) PLC based railway crossing system.

Suggested Activities for Students:

In addition to classroom and laboratory sessions, students are encouraged to engage in co-curricular, group-based activities that complement their theoretical knowledge with hands-on experience in industrial automation systems. These activities aim to foster practical skills in PLC programming, automation system design, and industrial communication technologies.

List of Suggested Activities for Students:

1. Industry Visits and Guest Lectures
2. Virtual Labs & Interactive Simulations
3. Workshops
4. Group Discussions & Problem-Solving Sessions
5. Mini Projects (Hands-on Prototyping)
6. Online Courses & Certifications

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