



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Power Electronics

Course / Subject Code: ME01000281

Course / Subject Name: Industrial Automation

w. e. f. Academic Year:	2024-25
Semester:	1 <sup>st</sup> Semester
Category of the Course:	PEC

Prerequisite:	NA
Rationale:	In recent years, industries increasingly adopt automation to enhance productivity, efficiency, and safety. So, the demand for skilled engineers who can work with modern day automation required for manufacturing processes and advanced manufacturing technologies is growing. These engineers essentially require knowledge of automation systems and control technologies. Additionally, understanding these concepts prepares students for careers in various sectors, including manufacturing, automotive, aerospace, and energy, thus equipping them with valuable skills that are in high demand in the job market. It also fosters innovation and development in automation technologies, which are critical for modern economic growth. Considering this, this course has been designed so that student can understand, and master skills required for modern manufacturing processes and practices.

## Course Outcome:

After Completion of the Course, the student will able to:

No	Course Outcomes
01	Understand the Programmable Logic Controller (PLC) and its functions.
02	Develop PLC programs for different industrial applications.
03	Explain basic SCADA System Hardware, Software and Protocols.
04	Explain the architecture and local control unit of DCS and various industrial applications.

## Teaching and Examination Scheme:

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



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## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>INTRODUCTION</b> Physical Process, Types of Industrial Processes, Process Automation System, Needs Met by automation, Advantages of Automation, Steps of Automation, Main Components of Industrial Automation. Localized Process, Distributed Process, Supervisory Control and Data Acquisition.	03	8%
2.	<b>PLC BASICS</b> Introduction, definition & history of the PLC, PLC advantage & disadvantage, overall PLC system, CPU & programmer/monitors, PLC input & output modules, the PLC as a computer, the central processing unit, the processor, I/O modules, power supplies, programming equipment, programming formats, process scanning consideration, input ON/OFF switching device, input analog device, output ON/OFF device, output analog device.	06	15%
3.	<b>PLC PROGRAMMING</b> PLC input instruction, output: coils, inductors & others, operational procedures, contact & coil input/output programming examples, a look at fail-safe circuit, industrial process examples. Relation of Digital Gate Logic to Contact/Coil Logic - Digital logic gates, Boolean algebra PLC programming, conversion examples. Creating Ladder Diagrams from Process Control Descriptions - Ladder diagram & sequence listing, large process ladder diagram construction, flow charting as programming method	03	7%



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4.	<p><b>PLC BASIC &amp; INTERMEDIATE FUNCTIONS</b></p> <p>Register - general characteristics of registers, module addressing, holding registers, input registers: single &amp; group, output registers: single &amp; group. PLC Timer Functions - PLC timer functions, examples of timer function industrial application, industrial process timing application. PLC Counter Functions - Introduction, PLC counters examples of counter function industrial application. PLC Arithmetic Functions - PLC addition &amp; subtraction, PLC multiplication, division &amp; square root: PLC trigonometric &amp; log function. PLC Number Comparison Functions - Introduction, PLC basic comparison function, PLC basic comparison function application, PLC advanced comparison function.</p>	06	15%
5.	<p><b>DATA HANDLING FUNCTIONS &amp; PLC FUNCTIONS WORKING WITH BITS</b></p> <p>The PLC SKIP and MASTER CONTROL RELAY Functions - the SKIP function &amp; application, the MASTER CONTROL RELAY function &amp; application. Jump Functions - jump with non-return, jump with return. PLC Data Move Systems - PLC MOVE function &amp; application, moving large blocks of PLC data, PLC table &amp; registers moves, other PLC MOVE functions. PLC Digital Bit Functions and Applications - Introduction, bit pattern in a register, changing a register bit status, shift register function, shift register application. PLC Sequencer Functions - electromechanical sequencing, the basic PLC sequencer function, a basic PLC sequencer application with timing, other PLC sequencer function, cascading sequencer.</p>	07	15%
6	<p><b>SCADA SYSTEMS HARDWARE and SOFTWARE</b></p> <p>Introduction, History of SCADA, Fundamental Principles of Modern SCADA Systems, SCADA Hardware and Software, Comparison of the terms SCADA, DCS, PLC and smart instrument, Benefits of SCADA system, Remote Terminal Unit (RTU), Application Programs, PLCs used as RTUs, The Master Station, Master Terminal unit (MTU), System Reliability and Availability, Communication Architecture, Configuration of MTU. The components of a SCADA system, SCADA software package, Specialized SCADA Protocols, Error Detection, Distributed Network Protocols, New technologies in SCADA systems.</p>	10	20%



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7	<p>DISTRIBUTED CONTROL SYSTEM</p> <p>System Availability: Introduction of System availability, Standby Schemes, Distributed Control System, Network Control System, I/O Redundancy.</p> <p>Common Configurations of DCS: Introduction, Common configurations, Distributed Control System, Network Control System, An engineering station, System/project tree structure DCS system database, Configuration of control functions, Configuration of operator/monitoring functions, Configuration of system hardware structure, Configuration of system software, Documentation, Commissioning.</p> <p>Applications: Use of DCS in pulp, paper environment, Use of DCS in petroleum-refining environment, Use of DCS in oil and gas processing environment, DCS Applications in power plants, Iron plant, steel plant, Cement plant.</p>	10	20%
<b>Total</b>		<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	30	20	10	10	5

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:

1. Programmable Logic Controllers: Principles and Applications, John W. Webb and Ronald A. Reis, Prentice– Hall India publication
2. Overview of Industrial Process Automation, KLS Sharma, Elsevier Publication
3. Practical SCADA for Industry, David Bailey, Elsevier Publication
4. Practical Distributed Control Systems (DCS) for Engineers and Technicians, IDC Technologies
5. Programmable logic controller, Frank D. Petruzella, Tata McGraw-Hill publication
6. Programmable Logic Controllers, W. Bolton, Elsevier Newness publication

### (b) Open-source software and website:

1. <https://nptel.ac.in>
2. <http://nptel.iitm.ac.in/courses.php>
3. <http://coep.vlab.co.in/?sub=33&brch=97>
4. <http://www.plcdev.com/book/export/html/9>



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5. <http://www.plcmanual.com/>
6. <http://literature.rockwellautomation.com/>
7. <http://www.automation.siemens.com/>
8. <http://www.abb.com>
9. <http://www.schneider-electric.co.in>
10. <http://www.ge.com><https://nptel.ac.in/>

## **Suggested Course Practical List:**

1. To study block diagram of Programmable Logic Controller.
2. To study I/O modules of PLC.
3. Introduction to Ladder Programming and to implement basic Logic Gates.
4. To study different Registers of PLC.
5. To study different Timers and Counters of PLC.
6. To perform basic PLC programs using Timer.
7. To perform basic PLC programs using Counter.
8. To study Data Handling functions of PLC.
9. To study Distributed Control System Configuration.
10. To study the application of Distributed Control System.
11. To study Remote Terminal Unit and Master Terminal Unit.
12. To study SCADA system protocols.

## **List of Laboratory/Learning Resources Required:**

Personal computer/Laptop, Simulation software, PLCs, Input/ Output devices.

## **Suggested Activities for Students: If any**

In addition to experiments, a small project work / case study with presentation related to the subject should be assigned.

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