GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Applied Instrumentation

Subject Code : ME02067081

Subject Name : Factory Automation

WEF Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite :	Industrial measurements, Process Control, Process Instrumentation
Rationale :	This course helps to understand the industrial production process which consists of a series of simple or complex machines through which the raw material undergoes a sequential treatment to achieve the production of an end product, while satisfying the goal of increased production, improving product quality, lowering costs, and increasing production flexibility. This course helpsto understand the functionality of the elements of automated systems and the fundamental principles of operation; analyze real-life problems from an industrial automation perspective and understand what is effective and what is not, based on engineering and cost-oriented thinking by integrating industrial automation tasks; integrate and synthesize a classical industrial automation; integrate, synthesize, and program a advanced PLC based on industrial automation.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understands the concept of factory automation	UN
02	Apply Logical Design of Automation Circuits for factory automation	AP
03	Apply and use The IEC 61131 Standard with Structural Programming for PC based automation.	AP
04	Analyze the system performancewith different industrial networking protocol for network based control systems (NCS)	AN
05	Evaluate the Automation Circuits for different factory automation tasks	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

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Teaching and Examination Scheme :

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

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Industrial Automation** The Industrial Control System, Automation and Process Control, Purpose of Industrial Automation, Industrial Automation Circuits, Computer-Based Industrial Control and Automation	5	12
2	**Industrial Automation Synthesis** Introductory Principles in Designing Automation Circuits, The Latch Principle, The Principle of "Command", Step-by-Step Basic Automation Examples Synthesis, Motor Operation with Thermal Overload Protection, Operation and Fault Indication, Machine Operation with Starting Delay, Machine Operation with Stopping Delay, Periodic Operation of Machine with Two Time Constants, Machine Operation with Automatic or Manual Control, Operation of Two Machines with a Common Manual Command, or Separate Automatic Commands, Operation of Two Machines with a Common Automatic Command, or Separate Manual Commands, Operation of a Machine from Two or More PointsControl Panel for Operating n Machines, The Meaning of the Electrical and Mechanical Latch, Sequential Start—Latch of Machines (Chain Latch),Motor Operation with Power Supply from Two Different Networks, Automation Circuits for Motors, Motor with Inversion in Rotation, Motor with a Star-Delta (Y-Δ) Start, Automation of Various Motor Types, Automation Circuits with Sensors, Starting a Machine with Cancelling Ability, Pump Operation Based on Level Control, Operation of Two	10	22

	Pumps According to Demand, Automation of a Garage Door, Automation Circuit Design Regulations, Implementation of Automation Circuits,Applications,Machine Operation Control from Multiple Positions,Operation Control of a Power Transformer,Operation of Two Pumps with a Cyclic Alteration, Basedon a Low- High DemandOperation of Three Air Compressors with Predefined Combinations		
3	**Logical Design of Automation Circuits** Introduction to Logical Design of Automation Circuits, Boolean Logic Components, Postulates and Theorems of Boolean AlgebraState Diagrams, Classical State Diagrams, State Diagrams with Sensors Step-by-Step Transition due to a Discrete Successive Signal, State Diagrams with Time Relays, Components' State Diagram Method State Diagrams and Minimum Realizations, Sequential Automation Systems, Applications, Bidirectional Lead Screw Movable Worktable with Two Speeds, Palindromic Movement of a Worktable with Memory, Operation of N Machines with Pause under Specific Conditions	10	22
4	**Programming Principles of PLCs** Introduction to Programming of PLCs The IEC 61131 Standard Structural Programming Basic Programming Instructions The Result of an Instruction Execution Boolean Logic Instructions Activation Instructions Complementary Instructions Programming According to the IEC 61131-3 Standard General Highlights and Restrictions in PLC Programming Programming with Boolean Logic and Activation Instructions Programming with Timers and Counters using Structural Programming Programming Mathematical Operations Applications of PLC Programming	10	22

5	**Industrial Networks of PLCs** Topology of a Network Ring Topology Bus Topology Communication Protocols Master/Slave Method of Access Carrier Sense with Collision Detection Method of Access Token Passing Method of Access Implementation of Industrial Networks Data Transmission Media The ISO/OSI Model Network Devices The Communication Task of PLCs The Actuator-Sensor Interface (AS-I) Network The Profibus Network SCADA Systems PID Control in PLCs	10	22
	Total	**45**	**100**

Reference Book:

1. Introduction toIndustrial Automation by Stamatios Manesis&George Nikolakopoulos, CRC PressTaylor & Francis Group
2. Overview of Industrial Process Automation by KLS Sharma, Elsevier.
3. Industrial AutomationHands-On by Frank Lamb, McGraw-Hill Education
4. TwinCAT open source tools reference manual

Suggested Course Practical List for Factory Automation:

1. Prepare logical design and do programming for automation task of Conveyor System for an Assortment of Objects by Pairs (Use: Suggested open source tools like TwinCAT, etc) .
2. Prepare logical design and do programming forautomation task of Packaging System of Different Balls (Use: Suggested open source tools like TwinCAT, etc) .
3. Prepare logical design and do programming for automation task of Conveyor System for Transferring Granular Material with Weight Control(Use: Suggested open source tools like TwinCAT, etc) .
4. Prepare logical design and do programming for automation task of The Food Industry: A Machine for Production of Tzatziki Salad (Use: Suggested open source tools like TwinCAT, etc) .

5. Prepare logical design and do programming for automation task of Retentive Reciprocating Movement of a Worktable (Use: Suggested open source tools like TwinCAT, etc) .
6. Prepare logical design and do programming for automation task of Wooden Plate Stacking, Painting and Transferring Process(Use: Suggested open source tools like TwinCAT, etc)
7. Prepare logical design and do programming for automation task of An Automated Billiard Table Controlled by a PLC(Use: Suggested open source tools like TwinCAT, etc)
8. Prepare logical design and do programming for automation task of Automated Filling of Two Milk Tanks(Use: Suggested open source tools like TwinCAT, etc)
9. Prepare logical design and do programming for automation task ofModular Programming for a Set of Processing and Repairing Stations(Use: Suggested open source tools like TwinCAT, etc)
10. Prepare logical design and do programming for automation task of Combined Operation of Two Conveyor Belts(Use: Suggested open source tools like TwinCAT, etc)
11. Prepare logical design and do programming for automation task of A Machine with Three Operational States and an Acknowledgement Signal(Use: Suggested open source tools like TwinCAT, etc)
12. Prepare logical design and do programming for automation task ofChemical Cleaning Process of Metallic Objects(Use: Suggested open source tools like TwinCAT, etc)
13. Prepare logical design and do programming for automation task of Driving a Step Motor Through a PLC(Use: Suggested open source tools like TwinCAT, etc)
14. Prepare logical design and do programming for automation task of Stacking Machine of Light Objects(Use: Suggested open source tools like TwinCAT, etc)
15. Prepare logical design and do programming for automation task of A Simple Robotic Arm for Pickup and Placement of Light Objects(Use: Suggested open source tools like TwinCAT, etc)
16. Prepare logical design and do programming for automation task ofHeat Treatment Process in a Chamber Furnace(Use: Suggested open source tools like TwinCAT, etc)
17. Prepare logical design and do programming for automation task of Working Time Monitoring of a Machine under a Three-Shift Schedule(Use: Suggested open source tools like TwinCAT, etc)
18. Prepare logical design and do programming for automation task of Feeding an Assembly Machine with Components in Bulk(Use: Suggested open source tools like TwinCAT, etc)
19. Prepare logical design and do programming for automation task ofA Roller Conveyor System for Wrapping Plastic Membrane(Use: Suggested open source tools like TwinCAT, etc)
20. Prepare logical design and do programming for automation task of The Shearing Machine of an Unfolded Aluminum Sheet(Use: Suggested open source tools like TwinCAT, etc)
21. Prepare logical design and do programming for automation task ofInlet and Outlet Rate Monitoring of Transferred Objects In and Outof a Process Machine(Use: Suggested open source tools like TwinCAT, etc)
22. Prepare logical design and do programming for automation task of A Metal Plate Rolling Mill Machine and Control of Their Thickness(Use: Suggested open source tools like TwinCAT, etc)

23. Prepare logical design and do programming for automation task of An Object Painting and Transporting System(Use: Suggested open source tools like TwinCAT, etc)
24. Prepare logical design and do programming for automation task of A Multiple Bottle Packing Station(Use: Suggested open source tools like TwinCAT, etc)
25. Prepare logical design and do programming for automation task of A Barrel-Filling System for Dry Bulk Material(Use: Suggested open source tools like TwinCAT, etc)
26. Prepare logical design and do programming for automation task ofAn Electro-Pneumatic System for Pickup and Lay Down of Plastic Containers(Use: Suggested open source tools like TwinCAT, etc)
27. Analyse network based control system (NCS) performance with different industrial network protocol for different class and order of systems (Use: Suggested open source tools like Scilab, MATLAB, etc)

List of Laboratory/Learning Resources Required:

- Suggested open source tools like Twin CAT, Scilab, MATLAB, etc**.**

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