



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Diploma Engineering**

**Level: Diploma**

**Branch: Instrumentation and Control Engineering /  
Automation & Robotics**

**Subject Code : DI04000221**

**Subject Name : Industrial Automation**

<b>w. e. f. Academic Year:</b>	2025-26
<b>Semester:</b>	4 <sup>th</sup>
<b>Category of the Course:</b>	MOPEC

<b>Prerequisite:</b>	To successfully complete this course, students must possess a fundamental understanding of three core areas. Proficiency in Digital Techniques is necessary, while basic Computer Networking concepts are vital for SCADA and IIoT integration. Additionally, a strong grasp of Control Systems.
<b>Rationale:</b>	The "Industrial Automation and System Architecture" course is pivotal for bridging the gap between traditional hardware control and the intelligent, data-driven demands of Industry 4.0. It equips students with a holistic understanding of operational excellence by integrating core technologies like DCS and SCADA with critical modern requirements such as Functional Safety, Cybersecurity, and IIoT. Beyond technical proficiency, the curriculum emphasizes sustainable engineering through Green Automation and energy management, ensuring graduates are prepared to design systems that are not only precise and secure but also economically and environmentally viable. This comprehensive approach cultivates versatile engineers capable of navigating the convergence of IT and OT to drive the future of smart manufacturing.

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Define the goals of industrial automation and list the hierarchical levels and components of PLC, DCS, and SCADA systems.	R
2	Apply standard control strategies (Feedback, Cascade) and documentation norms (P&ID symbols) to different stages of the automation project life cycle.	A
3	Explain the concepts of functional safety (SIL), Fire & Gas systems, and defense-in-depth cybersecurity strategies for industrial plants.	U
4	Describe the role of Data Historians, Manufacturing Execution Systems (MES), and IIoT in bridging the gap between control and enterprise levels.	U



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5	Calculate energy savings and Return on Investment (ROI) for automation projects by utilizing VFD optimization and waste minimization techniques.	A
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*\*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
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA(M)	PA(I)	ESE(V)	
3	0	0	3	70	30	00	00	100

**Course Content**

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit-1 Introduction to Industrial Automation and System Architecture	1.1 Definition and Evolution: Goals of automation (safety, quality, productivity). Hierarchy of automation (Field, Control, Supervisory, Planning/MIS levels). 1.2 Automation System Architecture: Centralized, Distributed System(DCS), and Hybrid control systems. Comparison of PLC vs. DCS. 1.3 Role of SCADA: Functions, components (MTU, RTU, Communication Infrastructure). SCADA vs. DCS. 1.4 Operator Interface: HMIs and their design principles. Alarm management.	8	20
Unit-2 Design, Implementation, and Control Strategies	2.1 Project Life Cycle: Stages of an automation project (Specification, Design, Programming, FAT, SAT, Commissioning). 2.2 Control Strategies: Feedback, Feed-forward, Ratio, Cascade, and Model Predictive Control (MPC) concepts (high-level introduction). 2.3 Batch Control: Concepts of ISA-S88 standard (Recipe, Procedure, Unit, Phase) and its application. 2.4 Documentation Standards: P&ID symbols (review), Loop diagrams, Functional Block Diagrams (FBD).	8	20
Unit-3 Industrial	3.1 Functional Safety: Introduction to Safety Instrumented Systems (SIS). Safety Life Cycle.	8	20



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Safety and Security in Automation Systems	<p>3.2 Safety Standards: Overview of IEC 61508 and IEC 61511 (focus on concepts like Safety Integrity Level - SIL).</p> <p>3.3 Fire and Gas (F&amp;G) Systems: Basic design and interlocking concepts.</p> <p>3.4 Cybersecurity in Control Systems: Threats (malware, DoS), Defence-in-Depth strategy, basic network segmentation (DMZ).</p>		
Unit-4 Data Management and Integration in Automation	<p>4.1 Data Acquisition and Historians: Data types, sampling rate, and long-term data storage. Data Concentrators and Gateways.</p> <p>4.2 Manufacturing Execution Systems (MES): The gap between the control level and the enterprise level (ERP). Functions of MES (e.g., scheduling, quality).</p> <p>4.3 Introduction to Industrial IoT (IIoT) and Industry 4.0: Key concepts, impact on automation. Edge computing and Cloud integration (high-level overview).</p> <p>4.4 Data Reporting and Analytics: Basic concepts of using automation data for performance monitoring (OEE - Overall Equipment Effectiveness).</p>	9	20
Unit-5 Green Automation, Energy Management, and Economic Justification	<p>5.1 Energy Efficiency in Automation: Role of automation in energy conservation. Power Monitoring and Management Systems (PMMS).</p> <p>5.2 Variable Frequency Drives (VFD) Optimization: VFDs for motor control, application of Affinity Laws for pumps and fans, and VFD-based energy saving calculations.</p> <p>5.3 Waste Minimization: Automated material tracking and sorting. Use of precision control to reduce material waste (e.g., in dosing/cutting).</p> <p>5.4 Economic Justification &amp; ROI: Calculating Return on Investment (ROI) for energy-saving automation projects. Cost-benefit analysis based on reduced consumption and compliance.</p> <p>5.5 Introduction to Sustainable Manufacturing &amp; Carbon Credit: Concepts of Green Building Automation, Environmental KPIs (Key Performance Indicators) tracked by the automation system and Carbon Credit.</p>	12	20



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	<b>Total</b>	<b>45</b>	<b>100</b>
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## AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

- Work as a leader/a team member for assigned student activity.
- Realize the importance of engineering for societal development.
- Develop gradually the engineering mindset in day-to-day observation

## SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Sketch an HMI screen with proper alarm indicators.
- Compare PLC and DCS architectures using Venn diagrams.
- Draw P&ID symbols for a boiler control loop.
- Create a logic flowchart for a batch mixing process.
- Determine SIL levels using a risk assessment matrix.
- Identify cyber threats in a network topology diagram.
- Calculate OEE using provided sample production data.
- Diagram an IIoT network architecture for a factory.
- Calculate energy savings from using a VFD.
- Compute ROI for an automation energy upgrade project.

## SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:
- Case-Based Learning (CBL): Analysing real-world industrial failures (e.g., Stuxnet, Bhopal) to teach safety and security.
- Simulation-Integrated Lecturing: Using live software simulators (PLC/PID) during lectures to demonstrate dynamic system behaviour.



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- d) Role-Playing (Gamification): Simulating "Boardroom Pitches" where students defend automation ROI against "Finance Managers."
- e) Scaffolding (Incremental Design): Building complex P&IDs step-by-step interactively on a whiteboard rather than presenting finished diagrams.
- f) Flipped Classroom: Assigning virtual factory tours or hardware tear-down videos as pre-work to maximize class time for analysis.

## SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Industrial Instrumentation and Control	S.K. Singh	Tata McGraw Hill, New Delhi, 3rd Edition (2010). ISBN: 978-0070678200
2	Overview of Industrial Process Automation	K.L.S. Sharma	Elsevier, USA, 2nd Edition (2016). ISBN: 978-0128053546
3	Programmable Logic Controllers	Frank D. Petruzella	McGraw Hill Education, USA, 6th Edition (2023). ISBN: 978-9355325860
4	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson Education, USA, 8th Edition (2013). ISBN: 978-0131194571
5	Industrial Cybersecurity: Efficiently monitor the cybersecurity posture of your ICS environment	Pascal Ackerman	Packt Publishing, UK, 2nd Edition (2021). ISBN: 978-1800202092
6	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress, Berkely, 1st Edition (2016). ISBN: 978-1484220467
7	Energy Management Handbook	Stephen A. Roosa, Steve Doty, Wayne C. Turner	Fairmont Press (River Publishers), USA, 9th Edition (2018). ISBN: 978-1138666979

## SUGGESTED LEARNING WEBSITES



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- [www.siemens.com/sce](http://www.siemens.com/sce)
- [www.myenergyuniversity.com](http://www.myenergyuniversity.com)
- [www.realpars.com](http://www.realpars.com)
- [www.instrumentationtools.com](http://www.instrumentationtools.com)
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