GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2023)

Semester-VI

Course Title: Industrial Automation

(Course Code: 4361706)

Diploma programmer in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

The subject of Industrial Automation is crucial in the contemporary industrial landscape, as it addresses the growing need for increased efficiency, precision, and adaptability in various manufacturing and processing sectors. The rationale for this subject is rooted in the profound impact that automation has on enhancing productivity, reducing operational costs, and ensuring the overall competitiveness of industries.

2. COMPETENCY

Dynamic and evolving set of skills and attributes that enable students to design, implement, and maintain automated systems effectively, contributing to the efficiency, safety, and innovation within various industrial sectors.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Define Industrial Automation, know types, pros, and cons briefly.
b) Identify key parts: sensors, actuators, and I/O devices briefly.
c) Understand teleoperation for industry, addressing challenges with dexterous techniques.
d) Apply automation in power, petrochemical, and cement plants briefly.
e) Analyse Industry 4.0 evolution, key tech, and challenges briefly.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA*	ESE	CA	ESE	
3	0	2	5	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES:

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos). Some of the PrOs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Demonstration of Fixed Automation System.	1	2
2	Comparative Analysis of Automation Types.	1	2
3	Designing a Basic Automation System.	1	2
4	Sensor and Actuator Interfacing.	2	2
5	Analog-Digital Conversion Implementation.	2	2
6	Input/Output Device Integration.	2	2
7	Teleoperation Control Algorithm Implementation.	3	2
8	Communication Channel Analysis.	3	2
9	Dexterous Telemanipulation.	3	2
10	DCS Implementation in Power Plants.*	4	2
11	Petrochemical Processes Simulation.*	4	2
12	PLC and HMI Integration in Cement Plants.*	4	2
13	IoT Integration in Industrial Automation.	5	2
14	Big Data Analytics in Automation.	5	2
15	AI Application in Industrial Processes.	5	2
16	Cyber-Physical Systems Integration.	5	2
17	Cloud Computing for Industrial Data Storage.	5	2
18	Sustainable Energy Management.	5	2

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Programmable Logic Controllers (PLCs) such as Siemens S7-1200 or Allen-Bradley CompactLogix, or microcontroller kits like Arduino or Raspberry Pi.	12
2	Microcontroller Development Board	4
3	Sensors and Actuators Kit	5
4	Teleoperation Hardware Kit (Robotic arm, force feedback devices)	9
5	IoT Development Kit (Raspberry Pi with sensors)	13

7. 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. a) Work as a leader/a team member. b) Follow safety practices while using electrical appliances. c) Practice environmentally friendly methods and processes. (Environment related) The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below: i. 'Valuing Level' in 1st year ii. 'Organization Level' in 2nd year. iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY:

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
I. Introduction to Industrial Automation	1. Define industrial automation. 2. List the objectives of industrial automation. 3. Propose automation objectives for a given scenario. 4. Recall advantages and disadvantages of industrial automation. 5. Evaluate the impact of automation in a specific industry. 6. Identify fixed, programmable, and flexible automation. 7. Explain advanced automation functions. 8. Identify different levels of automation.	1.1 Definition of Industrial Automation 1.2 Objective of Industrial Automation 1.3 Advantage and Disadvantage of Industrial Automation 1.4 Types of automation system 1. Fixed automation 2. Programmable automation 3. Flexible automation 1.5 Basic Elements of an Automation System 1.6 Advance Automation Functions 1.7 Levels of Automation
II. Hardware components used for Industrial Automation	1. List types of sensors. 2. Select appropriate sensors for specific industrial applications. 3. Identify electric motors and other types of actuators. 4. Define analog-to-digital and digital-to-analog converters. 5. Convert analog signals to digital and vice versa. 6. Explain contact input/output interfaces.	2.1 Sensors 2.2 Actuators 2.2.1 Electric Motors 2.2.2 Other Types of Actuators 2.3 Analog–Digital Conversions 2.3.1 Analog-to-Digital Converters 2.3.2 Digital-to-Analog Converters 2.4 Input/Output Devices for Discrete Data 2.4.1 Contact Input/Output Interfaces 2.4.2 Pulse Counters and Generators
III. Teleoperation in Automation	1. List key historical events that shaped teleoperation development. 2. Define the driving forces behind the evolution of teleoperation technology 3. List the key components integral to a teleoperation system. 4. Explain the significance of each component in facilitating effective	3.1. Historical Background and Motivation 3.2. General Scheme and Components 3.2.1.Operation Principle 3.3. Challenges and Solutions 3.3.1.Control Algorithms 3.3.2.Communication Channels 3.3.3.Sensory Interaction and Immersion 3.3.4.Teleoperation Aids 3.3.5.Dexterous Telemanipulation

	teleoperation. 5. Explain how various control algorithms address specific challenges in teleoperation. 6. Explain the specific applications of teleoperation in industry, construction, mining, and underwater operations.	3.4. Application Fields 3.4.1.Industry and Construction 3.4.2.Mining 3.4.3. Underwater
IV. Industrial Automation Applications	1. Apply knowledge of Distributed Control Systems (DCS) in power plants. 2. Explain the role of instrumentation in petrochemical plants. 3. Apply principles of petrochemical processes and instrumentation for enhanced efficiency. 4. Explain applications of PLC and HMI in cement plants for automation. 5. Apply energy management principles to define strategies for optimizing efficiency in cement plants.	4.1 Automation in Power Plants (Control of boiler and HRGS) 4.1.1 Overview of Power Plants 4.1.2 Distributed Control Systems (DCS) in Power Plants 4.2 Automation in Petrochemical Plants 4.2.1 Petrochemical Processes 4.2.2 Instrumentation in Petrochemical Plants 4.3 Automation in Cement Plants 4.3.1 Cement Manufacturing Process 4.3.2 PLC and HMI Applications in Cement Plants 4.3.3 Energy Management in Cement Plants
V. Industry 4.0 in Industrial Automation	1. Recall historical context and core principles leading to Industry 4.0. 2. Explain the evolution leading to Industry 4.0. 3. Explain IoT, Big Data Analytics, AI, CPS, and Cloud Computing. 4. Integrate key technologies in an Industry 4.0 framework. 5. Explain the linkage between Industry 4.0 and sustainable energy. 6. List challenges in implementing Industry 4.0. 7. Propose strategies to overcome resistance to change and address cybersecurity concerns and skill gaps.	5.1 Definition and Evolution • Historical context leading to Industry 4.0 • Core principles and characteristics 5.2 Key Technologies in Industry 4.0 • Internet of Things (IoT) • Big Data Analytics • Artificial Intelligence (AI) • Cyber-Physical Systems (CPS) • Cloud Computing 5.3 Combining Industry 4.0 and Sustainable Energy • Why link the two systems? 5.4 Implementation Challenges • Challenges in Implementing Industry 4.0 • Overcoming resistance to change

		• Addressing cybersecurity concerns and skill gaps

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Introduction to Industrial Automation	06	3	4	3	10
II	Hardware components used for Industrial Automation	12	7	7	4	18
III	Teleoperation in Automation	08	3	7	4	14
IV	Industrial Automation Applications	08	4	3	7	14
V	Industry 4.0 in Industrial Automation	08	7	4	3	14
Total		**42**	**24**	**25**	**21**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Get students hands-on with real projects, simulations, and group tasks in industrial automation. Blend theory with practice through industry visits, webinars, and online learning. Boost practical experience with internships and research projects. Encourage teamwork and critical thinking, guide towards certifications, and offer career counseling for a well-rounded understanding of industrial automation careers.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Incorporate hands-on labs and simulations to help students practically engage with automation equipment. Introduce real-world case studies and industry expert sessions for practical insights. Encourage collaborative projects and field visits to industries for real-world exposure. Use multimedia resources and online competitions to make learning interactive and competitive. Invite practitioners for practical sessions, and implement self-paced learning modules. Conduct continuous assessments, recommend professional certifications, and encourage peer teaching to create a dynamic and engaging educational experience in industrial automation, fostering both practical skills and theoretical understanding.

12. SUGGESTED PROJECT LIST

1. PLC-based Traffic Light Controller
2. Automated Conveyor Belt System
3. Temperature Control System
4. Water Level Control System
5. Smart Home Automation
6. Automated Parking System
7. Pneumatic Pick and Place Robot
8. PLC-based Bottle Filling Plant
9. Automated Greenhouse System

10. Material Handling System
11. Water Treatment Plant Simulation
12. Automated Coffee Machine
13. Smart Lighting Control
14. Automated Pet Feeder
15. PLC-based Elevator Control
16. Solar Tracking System

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of book	Author	Publication with place, year and ISBN
1	Industrial Automation	Frank Lamb	McGraw Hill Education, 2013 ISBN: 978-0-07-181647-2
2	Springer Handbook of Automation	Editor : Shimon Y. Nof	Springer ISBN: 978-3-540-78830-0
3	Fundamentals of Industrial Instrumentation and Process Control	William C. Dunn	McGraw Hill Professional, 2018 ISBN: 1260122263, 9781260122268
4	Automation, Production Systems, and Computer-Integrated Manufacturing	Mikell P. Groover	Pearson, 2016 ISBN 13: 978-0-13-349961-2 ISBN 10: 0-13-349961-8
5	Pocket Guide on Industrial Automation	Edited by Srinivas Medida	IDC Technbologies

14. SOFTWARE/LEARNING WEBSITES

https://www.isa.org/
https://www.automationdirect.com/
https://learn.org/

15. PO-COMPETENCY-CO MAPPING:

Semester V	**Industrial Automation (Course Code:4361706)**						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	P O 3 Design/ development of solutions	PO 4 Engineering Tools, Experimenta tion & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	**Dynamic and evolving set of skills and attributes that enable students to design, implement, and maintain automated systems effectively, contributing to the efficiency, safety, and innovation within various industrial sectors.**						

Course Outcomes CO1 Define Industrial Automation, know types, pros, and cons briefly.	3	2	-	-	-	-	2
CO2 Identify key parts: sensors, actuators, and I/O devices briefly.	3	2	-	-	-	-	-
CO3 Understand teleoperation for industry, addressing challenges with dexterous techniques.	2	2	3	-	-	-	3
CO4 Apply automation in power, petrochemical, and cement plants briefly.	2	2	2	3	2	2	-
CO5 Analyse Industry 4.0 evolution, key tech, and challenges briefly.	2	1	1	2	3	1	-

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Member – Board of Studies (GTU), Electrical and Allied branches

Prof. Suresh Z. Shyara, IC Engineering, AVPTI, Rajkot

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