GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Semester- V

Course Title: Factory Automation

(Course Code: 4354102)

Diploma program in which this course is offered	Semester in which offered
Automation and Robotics	Fifth

1. RATIONALE

The course provides introduction to Factory Automation. Factory automation refers to the use of control systems, such as computers or robots, and information technologies to handle different processes and machinery in a factory. Automation allows for continuous operation without breaks, leading to higher output rates in the industry.

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2. COMPETENCY ('Program Outcome' according to NBA Terminology)

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- Understanding the fundamentals of automation, its benefits, and its applications in modern manufacturing. Understanding the concepts of industrial robots, their types, and applications in manufacturing.

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) CO1: **Understanding of Automation Principles.**
b) CO2: **Describe Material handling and identification technologies.**
c) CO3: **Identify scope of automation in different industrial application.**
d) CO4:**Demonstrate Maintenance and Troubleshooting concepts for Factory Automation Systems.**
e) CO5: Application of Factory Automation for Environment Sustainability.

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	4	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

The following practical outcomes (PrOs) are the subcomponents of the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	To study about fundamental of automations.	1	02
2	To study about Material handling and Identification Technologies	2	02
3	Demonstrate Automated Manufacturing Systems	3	02
4	Demonstrate Control Technologies in Automation..	4	02
5	Demonstrate Computer Based Industrial Control	4	02
6	Design a PLC program to control the speed and direction of a conveyor belt.	3	02
7	Implement emergency stop functionality and sensor-based control.	3-4	02
8	Develop a system using PLCs and sensors to sort different objects based on color, size, or shape.	3-4	02
9	Include HMI interface for operator control and monitoring.	3-4	02
10	Program an industrial robot to pick and place objects onto pallets according to specified patterns.	3-4	02
11	Integrate vision sensors for object detection and positioning.	3-4	02
12	Design and simulate an assembly line using PLCs, conveyors, and robotic arms to assemble a product (e.g., a toy or electronic device).	3-4	02
13	Implement quality control checks and error handling.	3-4	02
14	Build and program a packaging machine to fill and seal containers with specified quantities of a product.	4-5	02

Note

i. *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some* ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Ability to Identify and solve engineering problems	20
2	Ability to Prepare experimental setup	20
3	Ability to Conduct the experiment	20
4	Ability to Record observations correctly	20
5	Ability to Interpret the result and conclude	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the Pros is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications.
1	Industrial Robots: Articulated robots kit
2	Industrial Robots :SCARA robots kit
3	Programmable Logic Controllers (PLCs) trainer kit
4	Human-Machine Interface (HMI) device
5	Motion Control Systems
6	Flexible Manufacturing System Kit
7	PC with SCADA System software

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. Positively Influence others as a leader/a team member.
b. Meet the expectations of your superior/teacher/guide.
c. Cooperate your team mates and colleagues.
d. Help worker/staff/personnel nearby you.
e. Obey your higher officials/trainers/guide/manager.
f. Respect more experienced persons in your field.
g. Aid new comers/new joinees in your field.
h. Empathize your coworkers.

i. Tolerate the unpleasant and extreme environment conditions in the field.
j. Follow safety practices while using electrical appliances.
k. 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

Only the major Underpinning Theory is formulated as higher level UOs of Revised Bloom's taxonomy in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-I Introduction to Factory Automation	1a Introduction to virtual Factory Automation 1b Justify the need of Factory Automation 1c Levels of Automation	1.1 Introduction: Automation in Production 1.2 System Principles and Strategies of Automation 1.3 Types of Automation System 1.4 Basic Elements of an Automated System 1.5 Advanced Automation Functions and Levels 1.6 Automation. Flow lines & Transfer Mechanisms 1.7 Fundamentals of Transfer Lines. 1.8 Scalable approach in Factory automation

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-II Material handling and Identification Technologies:	2a Basics of Manufacturing Systems 2b Components of Manufacturing Systems 2c Different concepts of manufacturing system	2.1 Overview of Material Handling Systems 2.2 Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. 2.3 Components, Classification and Overview of Manufacturing Systems 2.4 Manufacturing Cells, GT and Cellular Manufacturing,
Unit III Automation in Manufacturing System	3a Overview of FMS 3b Principle of FMS system 3c Practices Inspection Technologies	3.1 FMS, FMS and its Planning and Implementation. 3.2 Quality Control Systems: Traditional Modern Quality Control Methods, SPC Tools, 3.3 Inspection Principles and Practices Inspection Technologies
Unit – IV Maintenance and Troubleshooting concepts for Factory Automation Systems	4a Introduction to Maintenance and Troubleshooting 4b Basic Troubleshooting Concepts	4.1Preventive vs. corrective maintenance 4.2Impact on productivity and efficiency 4.3Troubleshooting methodologies 4.4Common problems in automation systems 4.5Preventive Maintenance Techniques 4.6Predictive Maintenance Fundamental 4.7Maintenance Schedules 4.8 Safety in Maintenance and Troubleshooting

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – V Factory Automation for Environment Sustainability	5a Advantage of Factory automation. for environment sustainability 5b Role of Factory automation. in environment conservation 5c Different Industrial controller's application for Factory automation.	5.1Introduction to Automatic Process Control 5.2Building Blocks of Automation Systems: Communication protocols (Ethernet, Wireless protocols), Analog & Digital I/O Modules, safety barriers. 5.3 Application of Supervisory Control And Data Acquisition (SCADA) Systems for Factory automation 5.4 Application of Remote Terminal Unit (RTU) and HMI for Factory automation. 5.5 Role of Distributed Control System (DCS) in Factory automation 5.6 Application of Servo control, 5.6.1 servo motor 5.6.2 Encoders 5.6.3Servo selection 5.7 Application of Variable Frequency Drive (VFD) 5.7.1 Control 5.7.2 Data Analysis 5.7.3 Digital connectivity 5.8 Key aspects of Factory automation. for environment sustainability 5.9 Concepts of data handling in factory automation 5.9.1 Implementation of AI-ML 5.9.2 3D simulation and digital twin 5.9.3 Future trends

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	Marks
I	**Introduction to Factory Automation**	10	4	2	4	10
II	**Material handling and Identification Technologies:**	8	4	4	6	14
III	**Automation in Manufacturing System**	8	4	4	4	12
IV	**Maintenance and Troubleshooting concepts for Factory Automation Systems**	10	4	4	8	16
V	**Factory Automation for Environment Sustainability**	6	2	8	8	18
	Total	**42**	**18**	**22**	**30**	**70**

Legends: *R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)*
Note: *This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.*

10. SUGGESTED LIST OF 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 of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

A. Industrial visit for students in order to have an exposure to the real-world environment
B. A workshop/seminar where students can have interaction with industry personnel.
C. Simulate different system and generate output
D. Model preparation. E.g. prepare model of heated type air dryer.
E. Present a seminar on any one technical topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Display of animation videos of industrial loops.
ii. Arrange industrial visit to nearby process industry.
iii. Compliment student for his/her work done during the practical in order to motivate him/her by student and Instruct him/her remedies to improve his work if required.

iv. Arrange expert lectures of instrumentation engineers working in process industries.
v. Utilize Massive Open Online Courses (MOOCs) to teach various topics/sub-topics.
vi. Research through net i.e. internet based home assignments.
vii. Assign preparation of mini projects.
viii. Guide students to focus on energy savings in industry and home.
ix. Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that he/she contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

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) Develop an automated system using PLCs to control water purification and treatment processes in a plant.
b) Monitor water quality parameters, adjust chemical dosing, and manage filtration systems.
c) Create a system to transport materials between storage areas and production lines using PLC-controlled AGVs (Automated Guided Vehicles) or conveyors.
d) Include route optimization, collision avoidance, and integration with warehouse management systems.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Books	Author	Publication
1	Automation, Production Systems and Computer Integrated Manufacturing	M.P. Groover ·	Pearson Education
2	Computer Based Industrial Control	Krishna Kant	PHI

14. List of Software/Learning Websites

- PLC

- SCADA
- Tinker CAD
- Solid Works
- LabVIEW
- www.mathworks.in

15. PO-COMPETENCY-CO MAPPING

Semester V	Factory Automation						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	To Demonstrate Factory Automation system						
CO1: Understanding of Automation Principles	2	1	-	1	1	-	1
CO2: Describe Material handling and identification technologies.	2	1	1	2	1	1	1
CO3: Identify scope of automation in different industrial application	2	2	2	2	2	1	2
CO4: Understand Maintenance and Troubleshooting concepts for Factory Automation Systems	2	1	1	2	1	2	1
CO5: Application of Factory Automation for Environment Sustainability.	1	1	2	2	2	1	1

Legend: *'**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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