GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Robotics & Industrial Automation
(Course Code: 4352005)

Diploma program in which this course is offered	Semester in which offered
Mechatronics Engineering	5th Semester

1. RATIONALE

Nowadays industrial Automation demand continuous and fine quality work in different processes of industries. To get quality and quantity of work in toughest environment or the environment which is not suitable for the humans to work, industries demand for robots and its operator to upgrade the industrial automation to its peak. Operators which operate this robot need some basic knowledge of robotics. To fulfil the demand of industries and advancement in technology it is necessary for the mechatronics engineers to have knowledge and skill in robotics. Industrial automation and robotics looks set to continue growing and expanding into new regions, driving down the associated costs as new technologies emerge to provide smarter systems that can take data and react to environments in real time.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire the following competency:

- Operate and maintain different types of robots which are useful to upgrade Industrial Automation.
- Identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated withtheidentifiedcompetencyaretobedevelopedinthestudentfortheachievementofthefollowingCOs

CO-1	**To Evaluate Degree of freedom & able to select right parameter for robot.**
CO-2	**To Operate through Industrial Automation.**
CO-3	**Distinguish Servo & Non-Servo Control Systems.**
CO-4	**Operate robot through software.**
CO-5	**Troubleshoot minor problems.**

4. TEACHING AND EXAMINATION SCHEME

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

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 sub-components of the Course Outcomes (COs).Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the' Precision Level' of Dave's Taxonomy related to the 'Psycho motor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate configurations and anatomy of robots	1	2
02	Demonstrate robot end effectors	2	2
03	Demonstrate different types of sensor in robotics.	2	2
04	Control servo and non-servo system	3	2
05	Demonstrate operation of robot trainer kit.	3	4
06	Program a robot for golfer configuration.	4	2
07	Program a Robot for Coffee maker configuration.	4	2
08	Design a robot for a given application and simulate the movement using simulation software.	4	3
09	Identify a fault in a given robot and prepare trouble shooting chart.	5	3
10	Prepare a PPT on Various topics given by Subject Teacher	---	2
Total (Hours)		**---**	**24**

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 representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data(which and why)before the group starts their market survey.

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.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Experimentation/performance type PrOs (PrOs Number: 2,3,4,5,6,7,8,9,10&11)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
For Demonstration type PrOs (PrOs Number: 1&12)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number 1 &12)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labeling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Participation	25%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Punctuality	15%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Experimentation/performance type PrOs (PrOs number 2,3,4,5,6,7,8,9,10 & 11)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Procedure follows	30%	Student follow all the procedure with precaution in a logical order	Student follow all the procedure with some precaution in a logical order	Student follow all the procedure without precaution in a logical order	Student follow all the procedure without precaution in an illogical order
Observation Skill	20%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Conclusion/ Summary	10%	Student concept is mostly clear	Student concept is partly clear	Student concept is somewhat clear	Student concept is not clear
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labelling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Punctuality	10%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. No.	Equipment Name	PrO. No.
1.	Programmable Robot trainer kit (Golfer , Snake)	
2.	Trainer Kit Having Minimum 3 linkages	
3.	Trainer Kit Having Minimum 4 degree of freedom	
4.	Trainer Kit Having Mechanical end effector with servo control	

5.	Trainer Kit Having Interfacing card(RC servo output, sensors input)	

7. AFFECTIVE DOMAIN OUT COMES

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

a. Work as a leader/team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes.(Environment related)

The ADOs are best developed through 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. UNDER PINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4to6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction to Robot & Industrial Automation**	1a. Explain the basic concept of robot. 1b. Explain the structure of manipulator. 1c. Classify different robotic systems. 1d. Evaluate degrees of freedom. 1e. Automation & its types.	1.1 Robot-definition, need, brief history, social justification 1.2 Robot terminology, basic concepts, and key features 1.3 Robot anatomy. 1.4 Classification of robot according to:

		types of system, control loop, structure of manipulator (Cartesian, cylindrical, spherical, articulated, SCARA) 1.5 Degree of freedom: concept measuring and importance. 1.6 Introduction to Automation , its types and its future scope.
Unit– II **Robot Configurations & Robot Control System**	2a. Describe the end effecter's types. 2b. Robotic Drive System 2c. Differentiate between open loop and closed loop. 2d. Explain different robot configuration. 2e. Select robot for suitable application.	2.1 End effecters: types, sketches, working and applications 2.2 Drives: types and applications. 2.3 Control systems : Open loop and close loop with applications and its elements 2.4 Robot configurations : 2.5 Stand above, In-line, Cycle independent. 2.6 Selection criteria for robot 2.7 Robot machine vision
Unit-III **Robotic Controls**	3a. Explain the different level of control. 3b. Differentiate between servo and non-servo control. 3c. Explain various control techniques. 3d. Explain hardware which uses to control robot.	3.1 Need and scope of robot control 3.2 Levels of controls: Device controller, Work cell controller , Area controller, Plant host 3.3 Servo and non-servo control systems: Types, basic principles and block diagram 3.4 Controllers: Robot as work cell controller, Programmable logic controller, work cell control with local area networking, multiple network levels.
Unit-IV **Introduction to Robot Programming**	4a. Explain various robot programming languages. 4b. Simulate robot via software.	4.1 Need and functions of programming 4.2 Methods of robot programming: Manual Teaching, Lead through, Programming languages. 4.3 Programming languages: Types, features and applications 4.4 Simulation for robot movements
Unit - V **Robotics Applications in recent Industrial Automation , Maintenance & Safety**	5a. Explain general trouble shooting procedure. 5b.Explain safety norms. 5c. Describe maintenance procedure for robot.	5.1 Applications of robots in today's Automation (including special types) 5.2 Robot maintenance: Need and types. 5.3 Common troubles and remedies in robot operation. 5.4 General safety norms, aspects and precautions in robot handling

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Robot & Industrial Automation	7	4	4	4	12
II	Robot Configurations & Robot Control System	7	3	4	5	12
III	Robotic Controls	10	4	6	6	16
IV	Introduction to Robot Programming	12	3	4	10	17
V	Robotics Applications in recent Industrial Automation , Maintenance & Safety	6	6	4	3	13
Total		42	20	22	28	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's 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 STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Form a robotic club in the polytechnic and make robotic models. (polytechnic may give some grant for purchasing robotic kits by this club)
2.	Visit Industries having robots/websites of reputed suppliers of robots and prepare specification list, understand operational and maintenance practices.
3.	Download videos of robotic applications.
4.	Download free simulation software and check programme on it.
5.	Prepare a Chart of all robot configurations and give a presentation to the concerned faculty.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr.No	Unit		Strategies
1.	I	Introduction to Robot & Industrial Automation	Videos/animations/actual robots to explain different types of robots and their applications.
2.	II	Robot Configurations & Robot Control System	Show real picture of different types of robot elements./expert lectures

3.	**III**	**Robotic Controls**	Show some video related to Robot control/expert lectures
4.	**IV**	**Introduction to Robot Programming**	Download the perfect programming software for programming of the robot for robot simulation.
5.	**V**	**Robotics Applications in recent Industrial Automation , Maintenance & Safety**	Visit workshop floor/industries using robots.

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-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, 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 must maintain a dated work diary consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of these semesters to develop the industry-oriented COs.

A representative 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 or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

1) Make a Hydraulic Based Robot with the help of Wooden Card boards & Medical Syringes with a group of Maximum 3 to 4 Students.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Koren Yoram	Robotics for Engineers	Tata McGraw - Hill Education,, New Delhi, 1st Edition

2	Groover Mikell P.	Industrial Robotics: Technology, Programming, and Applications	McGraw Hill Education (India) Pvt Ltd, New Delhi, 2nd Edition
3	Lafter, Richard K	Robotic Engineering	PHI Learning, New Delhi, 2012

14. SOFTWARE/LEARNING WEBSITES

i. http://www.mtabindia.com/
ii. http://www.robotics.org/
iii. http://pcbheaven.com
iv. http://www.servodatabase.com
v. https://www.youtube.com/watch?v=fH4VwTgfyrQ
vi. https://www.youtube.com/watch?v=aW_BM_S0z4k

15. PO-COMPETENCY-CO-MAPPING

Semester V	Robotics & Industrial Automation (3352005)						
Semester V	**POs**						
Competency	PO1	PO2	PO3	PO4	PO5	PO6	PO7

&CourseOutcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	• **Operate and maintain different types of robots which are useful to upgrade Industrial Automation.** • **Identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications.**						
CO-1 To Evaluate Degree of freedom & able to select right parameter for robot.	2	1	2	----	--	---	3
CO-2 To Operate through Industrial Automation.	1	---	---	2	1	---	2
CO-3 Distinguish Servo & Non-Servo Control Systems.	2	1	1	--	--	2	2
CO-4 Operate robot through software.	2	2	---	3	1	---	2
CO-5 Troubleshoot minor problems.	---	2	1	--	--	2	2

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

16. CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. R.D Patel (Head Mechanical Engineering Dept.)	B & B Institute of Technology , VV Nagar	9825523982	rakeshgtu@gmail.com
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17. BOS Resource Persons

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