



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Diploma Engineering**

**Level: Diploma**

**Branch: Mechatronics Engineering/ Mechanical Engineering  
(CAD/CAM)/Automobile Engineering**

**Subject Code: DI05000331**

**Subject Name: Robotics & Automation**

<b>w. e. f. Academic Year:</b>	2026-27
<b>Semester:</b>	5 <sup>th</sup>
<b>Category of the Course:</b>	PEC-04

<b>Prerequisite:</b>	Students should possess fundamental knowledge of Engineering Mechanics, basic Electrical and Electronics, and Mathematics (algebra and coordinate systems). Prior exposure to Manufacturing Processes and CAD/CAM will support better understanding of robotics and industrial automation concepts.
<b>Rationale:</b>	<p>In modern industries, automation and robotics play a crucial role in improving productivity, quality, and safety. With the rapid advancement of technology, robots are increasingly used in manufacturing, healthcare, defense, and service sectors. This course provides an integrated understanding of mechanical systems, electronics, control systems, and computer programming involved in robotics. It helps students develop essential skills in robot selection, kinematics, sensors, programming, and industrial automation systems.</p> <p>Thus, the subject prepares diploma mechanical engineering students to meet current industrial requirements and enhances their employability in automation-driven industries.</p>

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Classify different types of robots and identify their components and subsystems
02	Select appropriate actuators, grippers, and sensors for robotic applications.
03	Analyze and calculate the position and orientation of robotic systems using kinematic principles.
04	Understand and apply basic robot programming concepts and languages.
05	Explain the principles and applications of industrial automation systems.



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## 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	2	4	70	30	20	30	150

## Course Content:

Unit No.	Content	No of Hours	% of Weightage
<b>Unit-I</b> Introduction to Robotics	1.1: Brief History of robotics. 1.2: Definition of a ROBOT 1.3: Laws of robotics. 1.4: Advantages and Disadvantages of robots 1.5: Component of an Industrial Robot 1.6: Robot Terminology 1.7: Robotic Joints 1.8: Classification of Robots 1.8.1: Based on Coordinate Systems 1.8.2: Based on Power Source 1.8.3: Based on Method of Control 1.8.4: Based on programming Method 1.9: Industrial Applications of Robot. 1.10: Safety practices with robots	5	11
<b>Unit-II</b> Actuators and Grippers	2.1: Introduction to robotic actuators: 2.1.1: Block Diagram of an actuator system 2.1.2: Subsystems of actuator system: 2.1.2.1: Power supply, 2.1.2.2: Power amplifier, 2.1.2.3: Servomotor, and 2.1.2.4: Transmission system. 2.2: Classification of actuators: 2.2.1: Pneumatic actuators, 2.2.2: Hydraulic actuators, 2.2.3: Electric actuators: 2.2.3.1: DC motor. 2.2.3.2: AC motor. 2.2.3.3: Induction motor. 2.2.3.4: Stepper motors.	9	20



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	<p>2.2.3.5: Linear actuators.</p> <p>2.3: Factors affecting selection of actuators.</p> <p>2.4: Introduction to Grippers.</p> <p>2.5: Classification of grippers:</p> <p style="padding-left: 20px;">2.5.1: Mechanical grippers.</p> <p style="padding-left: 20px;">2.5.2: Magnetic grippers.</p> <p style="padding-left: 20px;">2.5.3: Vacuum grippers.</p> <p style="padding-left: 20px;">2.5.4: Adhesive grippers.</p> <p style="padding-left: 20px;">2.5.5: Tools as grippers.</p> <p>2.6: Factors affecting design and Selection of grippers.</p>		
<b>Unit-III</b> Robot Kinematics	<p>3.1: What is kinematics?</p> <p>3.2: Types of kinematic links:</p> <p style="padding-left: 20px;">3.2.1: Rigid link.</p> <p style="padding-left: 20px;">3.2.2: Flexible link.</p> <p style="padding-left: 20px;">3.2.3: Floating link.</p> <p>3.3: Kinematic pair/constrains.</p> <p style="padding-left: 20px;">3.3.1: Types of constrains</p> <p style="padding-left: 20px;">3.3.2: Classification of kinematic pairs.</p> <p>3.4: Common types of robotic joints</p> <p>3.5: Kinematic chain:</p> <p style="padding-left: 20px;">3.5.1: Closed chain mechanism.</p> <p style="padding-left: 20px;">3.5.2: Open chain mechanism.</p> <p>3.6: Degree of freedom (DOF)</p> <p>3.7: Position and orientation of rigid body in space.</p> <p style="padding-left: 20px;">3.7.1: Configuration space</p> <p style="padding-left: 20px;">3.7.2: Coordinate systems</p> <p style="padding-left: 40px;">3.7.2.1: Cartesian coordinate system</p> <p style="padding-left: 40px;">3.7.2.2: Cylindrical coordinate system</p> <p style="padding-left: 40px;">3.7.2.3: Spherical Coordinate system</p> <p>3.8: Representation of points and vectors in coordinate systems.</p>	9	20
<b>Unit-IV</b> Robotic Sensors	<p>4.1: Types of Sensors in Robots</p> <p style="padding-left: 20px;">4.1.1: Internal Sensors</p> <p style="padding-left: 20px;">4.1.2: External Sensors</p> <p style="padding-left: 20px;">4.1.3: Contact sensors</p> <p style="padding-left: 20px;">4.1.4: Non-contact sensors</p> <p>4.2: Position and Displacement Sensor</p> <p style="padding-left: 20px;">4.2.1: Potentiometers</p> <p style="padding-left: 20px;">4.2.2: Optical Encoders</p> <p style="padding-left: 40px;">4.2.2.1: Absolute</p> <p style="padding-left: 40px;">4.2.2.2: Incremental</p> <p style="padding-left: 40px;">4.2.2.3: LVDT</p> <p>4.3: Touch or Tactile Sensor</p> <p style="padding-left: 20px;">4.3.1: Binary Sensor</p> <p style="padding-left: 20px;">4.3.2: Analog Sensor</p>	8	18



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	<p>4.4: Proximity Sensor            4.4.1: Contact Proximity            4.4.2: Non-Contact Proximity            4.4.3: Optical            4.4.4: Ultrasonic            4.4.5: Eddy Current            4.4.6: Inductive            4.4.7: Hall Effective            4.4.8: Capacitive</p> <p>4.5: Procedure to choose right sensor for particular Application</p>		
<p><b>Unit-V</b> Robot Programming and Control</p>	<p>5.0: Introduction            5.1: Requirement for robot language            5.2: Structure of robot language            5.3: Different Robot languages            5.4: Robot Programming Techniques:                5.4.1: Manual Programming Method                5.4.2: Walk through Programming method                5.4.3: Teach pendant or lead through programming method                5.4.4: Off-line programming method            5.5: Introduction to PLC:                5.5.1 Basic structure of PLC                5.5.2 Input/output modules                5.5.3 Ladder diagram basics            5.6: Simple automation logic using PLC            5.7: Interfacing of sensors and actuators</p>	7	16
<p><b>Unit-VI</b> Industrial Automation</p>	<p>6.1: Introduction            6.2: Advantages and Limitations of Automation            6.3: Application of Automation            6.4: Elements of Automation            6.5: Mechanization vs Automation            6.6: Types of Automation                6.6.1: Fixed (or Hard) Automation                6.6.2: Programmable Automation                6.6.3: Flexible (or soft) Automation            6.7: Assembly automation equipment:                6.7.1: Material handling System                    6.7.1.1: Classification of Material handling system                6.7.2: Transportation System:                    6.7.2.1: Transfer Systems                    6.7.2.2: Transfer Machines                    6.7.2.3: Transfer Devices                6.7.3: Feed System                    6.7.3.1: Introduction                    6.7.3.2: Characteristics of Feeder                    6.7.3.3: Types of Feeders                6.7.5: Automated Guided Vehicles (AGV's)                6.7.6: Automated Storage Systems:                    6.7.6.1: Introduction                    6.7.6.2: Automated storage/ Retrieval Systems            6.8: Flexible Manufacturing System (FMS)                6.8.1: Introduction                6.8.2: Flexible Manufacturing Cell and FMS                6.8.3: Components of FMS                6.8.4: Requirement of FMS</p>	7	16



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	6.8.5: Advantages and limitations of FMS 6.9: Group Technology 6.9.1: Introduction 6.9.2: Advantages and limitations of Group Technology 6.9.3: Part Families 6.9.4: Formation and establishment of component family 6.9.5: Collection of production data 6.10: Computer Aided Process planning system 6.11: Computer Integrated Manufacturing (CIM)		
	<b>Total</b>	<b>45</b>	<b>100</b>

### Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
26	23	21	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

### References/Suggested Learning Resources:

#### (a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Robotics and Industrial Automation	R.K.Rajput	S.Chand and Company ISBN (13): 978-8121929974 ISBN (10): 8121929970
2	Industrial Automation and Robotics	A.K.Gupta S.K.Arora	University of Science Press (An imprint of Laxmi Publication Private Limited) ISBN: 978-1-938549-30-4
3	Introduction to robotics	Prof. Subair kumar Shah	McGraw Hill Education (India) Private Limited ISBN (13): 978-93-3290-280-0 ISBN (10): 93-3290-280-1
4	Robotics Simplified	Dr. Jisu Elsa Jacob Manjunath N	BPB Publications India ISBN: 978-93-91030-26-1
5	Fundamentals of Robotics	Prof. Dilip Kumar Pratihari	Narosa Publication House Pvt. Ltd., New Delhi, ISBN (13): 978-8184875775 ISBN (10): 8184875770
6	Fundamentals of Robot Technology	D J Todd	Kogan Page Ltd 120 Pentonville Road, London NI 9JN ISBN-13: 978-94-011-6770-3 e- ISBN-13: 978-94-011-6768-0



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## (b) Open source software and website:

Various link of free demo robotics software

1. <https://downloads.intelitek.com/PLTW/ROBOCELL/>
2. <https://intelitek.com/>
3. <https://convergent-it.com/robot-programming-demo/>
4. <https://cyberbotics.com/>
5. <https://www.robocamp.eu/en/lessons/demo/>
6. <https://instrumentationtools.com/download-free-robotics-software/>
7. [https://www.kuka.com/en-in/products/robotics-systems/software/simulation-planning-optimization/kuka\\_sim](https://www.kuka.com/en-in/products/robotics-systems/software/simulation-planning-optimization/kuka_sim)

## Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	To study history and laws of robotics.	1	2 Hrs
2	Demonstrate various subsystem of robotics.	1	4 Hrs
3	Demonstrate basic parts of robot.	1	4 Hrs
4	Demonstrate block diagram of actuator system.	2	2 Hrs
5	Demonstrate various types of grippers used in robotics.	2	2 Hrs
6	To study various types of motors used in robotics.	2	4 Hrs
7	To study kinematics of robotic arm.	3	2 Hrs
8	To calculate position of a point in Cartesian coordinate system.	3	2 Hrs
9	To classify robots based on coordinate system. Conversion of coordinates form one system to other.	3	4 Hrs
10	Prepare a chart of internal/external, contact /non-Contact robot sensors.	4	2 Hrs
11	To study structure of robot language.	5	2 Hrs
12	To study V-REP software or any robot language software.	5	4 Hrs
13	Create a program in V-REP for moving robot from one location to other.	5	4 Hrs
14	To study basic structure of PLC and develop a simple ladder logic program for automation of a given system.	5	4 Hrs
15	To Study various robots models on RoboDK and prepare report on any 3.	5	4 Hrs
16	To study various types of industrial automation system.	6	4 Hrs
17	Industrial Visit and report.	1 to 6	

**Note:** 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.



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## List of Laboratory/Learning Resources 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	Broad Specifications	PrO. No.
1	V-Rep /CoppeliaSim software	Education version - robot programming and simulation software	5
2	RoboDK software	Robot programming and simulation software	5
3	Robotic arm	6 axis robotic arm	1,2,3,7

## 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.

- Work as a leader/a team member for Micro project.
- Follow safety practices and procedure in Lab.
- Realize the importance of engineering for societal development.
- Develop gradually the engineering mindset in day-to-day observation.

## Suggested Project List:

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:

- Prepare a model of 2DOF robotic arm.
- Prepare a model of 3DOF robotic arm.
- Prepare a model of pick and place robot.
- Prepare a model for demonstration of hydraulics.
- Prepare a model for demonstration of Gripper mechanism.
- Prepare a model for demonstration of rigid links.
- Prepare a model for demonstration of flexible links.
- Prepare a model for demonstration of floating links.
- Prepare model for demonstration on flexible Manufacturing System.



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10) Prepare a model using robotic sensors.

### **Suggested Activities for Students:**

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) Prepare models of 2 DOF and 3 DOF robotic arms.
- b) Give seminar on drones and its controls.
- c) Undertake a market survey of different types of robots used in industries.
- d) Give seminar on advancement in robotics with development of AI.

### **Any Other:**

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Inspire Student to read books on development and evolution of robotics, instruct them to take notes in form of summary
- b) Prepare a short note on applications of robot in defense industry.
- c) Guide students to make presentation on various applications of robotics in medical field in small groups.
- d) List out various programming languages used in robotics along with their advantages and limitations.
- e) Make a model for 3D Cartesian coordinate system and explain calculation of position of point, vector and plane in it.

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