GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Automation & Robotics

Course / Subject Code: DI03041031

Course / Subject Name: Basics of Robotics

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	Basic Mechanical Engineering, Basic Programming, Mathematics
Rationale:	The purpose of this course is to present an introduction to the multidisciplinary field of automation and robotics for industrial applications. The course initially covers the fundamental concepts of robot building and its application in real and industrial world. It covers the concepts of robot kinematics and methods in trajectory and motion planning of a robot.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Classify types of robots and identify its subsystems.	
02	Select an actuator and its gripper/s for a robot based on given application	
03	Calculate robot position and orientation.	
04	Identification of robot programming language.	
05	Summarize various industrial and non-industrial applications of robots.	

**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
				Theory		Tutorial / Practical		
L	T	PR	C	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
1.	Unit – I Introduction to robotics 1.1: Brief History of robotics. 1.1.1: Laws of robotics. 1.2: Definition of a ROBOT. 1.3: Types of robots: 1.3.1: Based on Application 1.3.1.1: Industrial robots 1.3.1.2: Service robots. 1.3.2: Based on Environment. 1.3.2.1: Fixed robots. 1.3.2.2: Mobile robots. 1.4: Robot economics: 1.4.1: Price of robot. 1.4.2: Special tools. 1.4.3: Installation cost. 1.4.4: Maintenance. 1.4.5: Operating power. 1.4.6: Finance. 1.4.7: Depreciation. 1.4.8: Enhanced Productivity. 1.4.9: Improved Quality. 1.5: Safety practices with robots. 1.6: Robot Subsystems: 1.6.1: Motion Subsystem: 1.6.1.1: Manipulators. 1.6.1.2: End-Effectors. 1.6.1.3: Actuators. 1.6.1.4: Transmission. 1.6.2: Recognition Subsystem: 1.6.2.1: Sensors. 1.6.2.2: Analog to digital converter. 1.6.3: Control Subsystem. 1.6.3.1: Digital Controller. 1.6.3.2: Digital to analog Converter. 1.6.3.3: Amplifiers.	9	20%

	1.7: Classification of robots based on coordinate systems, actuators, and control method: 1.7.1: Coordinate system: 1.7.1.1: Cartesian. 1.7.1.2: Cylindrical. 1.7.1.3: Spherical. 1.7.1.4: Articulated. 1.7.2: Actuators systems. 1.7.3: Control Methods: 1.7.3.1: Servo/Non-Servo Control. 1.7.3.2: Motion Control.		
2.	Unit – II 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. 2.2.3.5: Linear actuators. 2.3: Factors affecting selection of actuators. 2.4: Introduction to Grippers. 2.5: Classification of grippers: 2.5.1: Mechanical grippers. 2.5.2: Magnetic grippers. 2.5.3: Vacuum grippers. 2.5.4: Adhesive grippers. 2.5.5: Tools as grippers. 2.6: Factors affecting design and Selection of grippers.	10	20%
3.	Unit – III Introduction to Kinematics 3.1: What is kinematics?	9	20%

	3.2: Types of kinematic links: 3.2.1: Rigid link. 3.2.2: Flexible link. 3.2.3: Floating link. 3.3: Kinematic pair/constrains. 3.3.1: Types of constrains 3.3.2: Classification of kinematic pairs. 3.4: Common types of robotic joints 3.5: Kinematic chain: 3.5.1: Closed chain mechanism. 3.5.2: Open chain mechanism. 3.6: Degree of freedom (DOF) 3.7: Position and orientation of rigid body in space. 3.7.1: Configuration space 3.7.2: Coordinate systems 3.7.2.1: Cartesian coordinate system 3.7.2.2: Cylindrical coordinate system 3.7.2.3: Spherical Coordinate system 3.8: Representation of points and vectors in coordinate systems.		
4.	Unit – IV Control Hardware and Robot Programming 4.1: Control Considerations 4.1.1: Control modules 4.1.2: Modules for advance robots 4.2: Hardware Architecture 4.2.1: BUS 4.2.2: System board 4.2.3: Kinematics board 4.2.4: Servo board 4.2.5: force board & vision board 4.3: Hardware for Joint Controllers 4.4: Computational Speed: 4.4.1: Using Integer Arithmetic 4.4.2: Computing Trigonometric Functions 4.4.3: Matrix Operations 4.4.4: Hardware Considerations 4.5: Robot Languages 4.5.1: Requirement for robot language 4.5.2: Structure of robot language 4.5.3: Different robot languages	9	20%

	4.6: Robot Programming 4.6.1: Online Programming 4.6.2: Offline programming 4.6.3: Robot oriented programming 4.6.4: Task level programming		
5.	Unit - V Robotics Industry and Robotics in Industry 5.1: Introduction to robotic industry. 5.2: Industrial Applications of robots: 5.2.1: Material Handling 5.2.2: Processing 5.2.2.1: Welding (Spot, Arc) 5.2.2.2: Spray painting 5.2.2.3: Machining (Drilling, Deburring) 5.2.2.4: Cutting. 5.1.3: Assembling. 5.3: Application of robotics in space technology 5.4: Defense and military applications of robots. 5.5: Medical and health service applications.	8	20%
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
30	**35**	**35**	**0**	**0**	**0**

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
1	Introduction to robotics	Prof. Subair kumar Shah	McGraw Hill Education (India) Private Limited
2	Robotics Simplified	Dr. Jisu Elsa Jacob Manjunath N	BPB Publications India
3	Fundamentals of Robotics	Prof. Dilip Kumar Pratihar	Narosa Publication House Pvt. Ltd., New Delhi

4	Robotics and Control	R K Mittal	Nagrath McGraw Hill Education
5	Fundamentals of Robot Technology	D J Todd	Kogan Page Ltd 120 Pentonville Road, London

(b) Open source software and website:

1. SCILAB
2. COPPELIA SIM
3. https://www.futurelearn.com/
4. https://ocw.mit.edu/ (MIT open course)
5. ProE
6. Solid Edge

Suggested Course Practical List: If any

1. To study history and laws of robotics.
2. To study various subsystem of robotics.
3. To study basic parts of robot.
4. To study Block diagram of actuator system.
5. To perform DC motor direction control using H Bridge IC.
6. To perform DC Motor speed control using PWM.
7. To study construction and control of Stepper motor
8. To Study construction and control of Servo motors
9. To study construction and control of Induction motors
10. To study various types of grippers used in robotics.
11. To study kinematics of robotic arm.
12. To calculate position of a point in Cartesian coordinate system.
13. To study close chain and open chain mechanism in kinematics.
14. To classify robots based on coordinate system. Conversion of co-ordinates form one system to other
15. To study structure of robot language.
16. Introduction to V-REP (Coppelia Sim) Software.
17. Create a Program in V-REP for moving robot from one location to other
18. Introduction to robotics toolkit in SCILAB
19. Study various robots models on RoboDK and prepare report on any 3.
20. Write offline program in MATLAB for Pick and place operation.
21. Write offline program in MATLAB for stacking operation.

List of Laboratory/Learning Resources Required:

1. DC Motors, motor drivers (L293D) and power supply. Connectors, function generators etc.
2. MATLAB Simulation software
3. Coppelia Sim software

Suggested Project List:

1. Prepare a cardboard model of 2DOF robotic arm.
2. Prepare a cardboard model of 3DOF robotic arm.
3. Prepare a cardboard model of pick and place robot.
4. Prepare a model for demonstration of hydraulics.
5. Prepare a model for demonstration of Gripper mechanism.
6. Prepare a cardboard model for demonstration of rigid links
7. Prepare a cardboard model for demonstration of flexible links
8. Prepare a cardboard model for demonstration of floating links

Suggested Activities for Students: If any

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 cardboard 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.

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