GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code : ME02000461

Subject Name : Robotics

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective

Prerequisite:	Zeal to learn the Subject
Rationale:	This subject deals with study of robot actuators, kinematics, dynamics and motion control of robotic manipulators which is useful for proper design and selection of robot manipulators.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Students will able to understand the workspace and degree of freedom of various robot configurations.	20
2	Students will able to learn about forward and inverse kinematics of robotic manipulators.	20
3	Students will able to calculate static and dynamic forces and torques of manipulator. This will help in selection of robotic actuators.	20
4	Students will able understand the trajectory generation of robotic manipulators.	20
5	Students will able to select the various controllers of robotic manipulators and machine vision systems.	20

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 / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**General considerations of Robotic Manipulator** Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, History of robot; Application of Robot, Geometric configurations, Work volumes and Degree of freedoms; Robot actuators and drives; Analysis of Robotic inaccuracies and resolutions.	08	16
2.	**Kinematics of Robotic Manipulator** Service Index of different configurations; Position, velocity and acceleration analysis of various robot configuration, Jacobian, Homogeneous transformation; Direct Kinematic; Inverse Kinematics; D-H representation.	08	16
3.	**Forces in Manipulators** Statics and dynamics of robot manipulator; Considerations of forces, Moments and torques for various basic robotic configurations; Joint torque and force calculation, Counter balancing systems	10	22
4.	**Trajectory Generation** Basics of trajectory planning, Joint space vs. Cartesian space descriptions, Joint space trajectory planning, Cubic polynomials; Higher order polynomials; Linear function with parabolic blends; Numerical based on different motion trajectories, Cartesian space trajectories.	06	15
5.	**Motion Control of Robotic manipulators** Robotic open and closed loop control systems, Second order systems, Non –linear closed loop equation of motion, Error controlled Robotic dynamics, Control of Single axis robotic arm, Generalized motion control laws for robotic manipulators, Common control system for industrial robots, simple robotic manipulator, Independent joint PID control, Independent joint PID control with effective joint inertia, Force control of robotic manipulator, Tracking error analysis, Coordinated movement	07	16
6.	**Machine Vision System:** Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation. Robot Programming: - Methods of	06	15

	robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
-	**20**	**30**	**30**	**20**	**-**

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:

1. A Robot Engineering Textbook, Mohsen Shahinpoor, Harper and Row, Publisher, New York.
2. Mechanical Design of Robots, Eugene I. Rivin, McGraw Hill Book Company, New York.
3. Introductin to Robotics: Analysis, Control, Applications, Saeed Niku, John Wiley & Sons.
4. Introduction to Robotics, S K Saha, Tata McGraw-Hill.
5. Robotics control, sensing, vision and intelligence, K S Fu, R C Gonzalez, CSG Lee, Tata McGraw Hill Edition.
6. Introduction to robotics, John J Craig, Pearson/Prentice Hall, Third edition.
7. Industrial Automation, W.P. David, John Wiley and Sons.

(b) Open-source software and website:

1. NPTEL Course
2. RoboAnalyzer, Scilab

Suggested Course Practical List:

List of Laboratory/Learning Resources Required:

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