

Branch Name:	Mechanical Engineering (CAD/CAM)
Program Code:	ET201
Course Name:	Robotics
Course Code:	2ET2010401T
Pre-requisite Course:	Zeal to learn the subject.

Course Objectives:

1. To understand the general considerations of robotics manipulator.
2. To design the manipulator by using kinematics and dynamics analysis.
3. To understand the grippers, sensors and actuators for robotic manipulators.
4. To give students an elementary idea about Application of Robots in production systems.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
03	03	-	-	03	24	60	16	40	-	-	-	-	100

Subject Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	General considerations of Robotic Manipulator: Robot anatomy; Feasible configurations of kinematic chains with prismatic, revolute, cylindrical and spherical joints. Degree of freedoms; Homogeneous transformation; Generalized rotations, Description of robotic pose, Orientation with RPY and Euler angles (Forward and inverse formulations).	03	10
2	Kinematicsof Robotic Manipulators: Position, orientation, different types of rotation matrix, homogeneous rotation, Link description, forward kinematics: DH parameters, forward kinematics equation, Frames with standard names, work volume, singularity, redundancy, Inverse kinematics equation. Algebraic v/s Geometric solution, repeatability and accuracy, Velocity vectors, velocity propagation from link to link, Jacobians: velocity & statics forces, trajectory planning.	08	20
3	Dynamic Analysis of Robotic Manipulators: Considerations of forces, moments and torques for robotic configurations; Dynamics formulations using Newtonian, Lagrangian and Hamiltonian principle, Properties of dynamic equations.	08	20
4	Introduction to Grippers, Sensors and Actuators: Types of grippers,	03	10

	Properties of grippers, Types of sensors along with working principle, sensor properties, Translational and rotary actuators and their selection.		
5	Motion Control of Robotic manipulators: Robotic open and closed loop controlsystems, Second order systems, Non –linear closed loop equation of motion, Different friction models, Control of Single axis robotic arm, Generalized motion control laws for robotic manipulators, Common control system for industrial robots, Error controlled Robotic dynamics, Independent joint PID control, Independent joint PID control with effective joint inertia, Force control of robotic manipulator, Tracking error analysis, Coordinated movement..	08	15
6	Robot programming, Artificial Intelligence and Expert Systems: Methods of Robot Programming, Characteristics of task level languages lead through programming methods, Motion interpolation, and Artificial intelligence, Basics, Goals of artificial intelligence, AI techniques, and Problem representation in AI, Problem reduction and solution techniques.	08	15
7	Application of Robots in production systems: Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.	02	10

Review Presentation:

The student is expected to refer at least two peer reviewed journal papers related to this domain/subject so as to identify issues/challenges and emerging trends. Student is supposed to explore various video lectures (E.g. NPTEL) available in the domain/subject. Student is required to make a review-presentation on the work carried out for the same.

Recommended sites for journal papers are (1) asmedigitalcollection.asme.org (2) springer.com(3) sciencedirect.com (4) ieeexplore.ieee.org (5) scholar.google.co.in or others of similar repute.

List of Reference Books:

1.	K S Fu, R C Gonzalez, C S G Lee, Robotics control, sensing, vision and intelligence,Tata Mc Graw Hill Edition 2008.
2.	John J Craig, Pearson/Prentice Hall, Introduction to robotics, 2005, Third edition
3.	Saeed Niku, Introduction to Robotics: Analysis, Control, Applications, John Wiley & Sons.
4.	S K Saha, “Introduction to Robotics”, Tata McGraw-Hill.
5.	R K Mittal, I J Nagrath, “Robotics and control”, Tata McGraw Hill 2003.
6.	Mohsen Shahinpoor, Harper and Row, “A Robot Engineering Textbook”, New York Publisher.
7.	Ashitava Ghoshal, “Robotics Fundamental Concepts & Analysis”, Oxford University Press
8.	Johnson Ray C., “Optimum Design of Mechanical elements” Wiley, John & Sons.
9.	Ganesh S Hegde, Industrial Robotics, Laxmi Publications (P) Ltd, 2006, First edition
10.	Mikell P. Groover, Mitchell Weiss, ‘Industrial Robotics (Technology, Programming and Applications)’, 2nd Edition, McGraw-Hill Education.

E-Resources:

1. <https://nptel.ac.in/courses/112105249>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Recall the general considerations of Robotics Manipulator.	2 Understanding
CLO2	Make use of kinematics for robotics manipulator.	1 Remembering
CLO3	Understand dynamics for robotic manipulator.	3 Applying 4 Analyze
CLO4	Design the grippers, sensors and actuators.	2 Understanding 6 Creating
CLO5	Determine the motion control of robotic manipulator by the use of robotic programming	5 Evaluating
CLO6	Learn the applications of robotics in production systems.	2 Understanding

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	H	M	L			M	L				L			
CLO2			M	M	L	L							L	
CLO3		L	M		H			L	M	M			M	
CLO4		L	M		H			L	M	M			M	
CLO5		M		M	L		L							M
CLO6								M		M	L	L		L

H:High, M:Medium, L:Low