

Subject Code: 1ET2010401	Subject Title: Robotics
Pre-requisite Subject	Zeal to learn the subject.

Course Objective: To provide comprehensive knowledge of robotic configurations, kinematics, singularity, dynamics, Trajectory planning, Motion control of robot manipulators, Robot Programming & Applications of Robots in production systems.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total (T+P)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	5	60	40	30	20	150

Subject Contents			
Sr. No.	Topic	Total Hours	Weight (%)
01	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
02	Kinematics of 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	09	20
03	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.	09	20
04	Introduction to Grippers, Sensors and Actuators: Types of grippers, Properties of grippers, Types of sensors along with working principle, sensor properties, Translational and rotary actuators and their selection.	03	10
05	Motion Control of Robotic manipulators: Robotic open and closed loop control systems, 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.	09	15
06	Robot programming, Artificial Intelligence and Expert Systems: Methods of	09	15

	Robot Programming, Characteristics of task level languages lead through programming methods, Motion interpolation, Artificial intelligence, Basics, Goals of artificial intelligence, AI techniques, and Problem representation in AI, Problem reduction and solution techniques.		
07	Application of Robots in production systems: Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.	03	10

Course Outcome:

The students shall be able to

1. Synthesize various configurations with different joints for required degrees of freedom.
2. Understand the various approaches to write position as well as motion equations for open and closed loop configurations.
3. Apply the concept of DH convention for forward and inverse kinematics.
4. Know the role of friction models and control strategies for various tasks performed by robots.
5. Students will be able to select the various controllers of robotic manipulators.
6. Design and select robots for Industrial and Non-Industrial applications.

List of Practicals:

1. Synthesize the robotic configuration for specific degrees of freedom as given by instructor.
2. Direct kinematics implementation for open/closed loop robotic configurations.
3. Inverse kinematics implementation for open/closed loop robotic configurations
4. Coding/simulation of direct kinematics for open/closed loop configurations along with work space generation using high end software.
5. Formulation of DH parameters of robot configuration and its simulation using open source software.
6. Lagrangian formulation of the given configuration along with its coding/ validation using simulation software
7. Newtonian formulation of the given configuration along with its coding/ validation using simulation software.
8. Design of trajectory for a specific task as given by instructor.
9. Simulation/ performance of a trajectory planning of a robot.
10. Simulation/performance on the control of open kinematic architecture.

List of References:

1. K S Fu, R C Gonzalez, CSG Lee, Robotics control, sensing, vision and intelligence, Tata McGraw 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. Ganesh S Hegde, Industrial Robotics, Laxmi Publications (P) Ltd, 2006, First edition
9. Elaine Rich, Kevin Knight, 'Artificial Intelligence', 2nd , Tata McGraw-Hill, 1990
10. Mikell P. Groover, Mitchell Weiss, 'Industrial Robotics (Technology, Programming and Applications)', 2nd Edition, McGraw-Hill Education.