ME465: INDUSTRIAL ROBOTICS
CREDITS = 5 (L=3, T=0, P=2)

Course Objective:

To formulate a mathematical model of an industrial robotic manipulator

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory		Practical		Total Marks
				ESE	CE	ESE	CE	
3	0	2	5	70	30	30	20	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**General considerations of Robotic Manipulator:** Robot anatomy; Feasible configurations of kinematic chains with prismatic, revolute, cylindrical and spherical joints. Degree of freedoms; Homogeneous transformations; Generalized rotations, Description of robotic pose, Orientation with RPY and Euler angles. (Forward and inverse formulations).	06
2	**Kinematics of Robotic Manipulators:** D-H representation, Direct Kinematics, Inverse Kinematics, Work space analysis, Singularity and solvability analysis, Differential motions.	10
3	**Dynamic Analysis of Robotic Manipulators:** Considerations of forces, moments and torques for robotic configurations; Dynamics formulations using Newtonian, Lagrangian, Forward and Inverse dynamics.	10
4	**Trajectory Generation:** Path and Trajectory, Joint space versus Cartesian space trajectories, Higher order polynomials; Linear function with parabolic blends; numerical based on different motion trajectories.	08

Unit No.	Topics	Teaching Hours
5	**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.	05
6	**Robot Languages and Programming:** Robot Languages, Classification of Robot Languages, Computer Control and Robot Software, VAL system and Language, RoboML.	04
	TOTAL	**43**

Reference Books:

1. S. K. Saha, "*Introduction to Robotics*", Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2. S. R. Deb and S. Deb, "*Robotics Technology and Flexible Automation*", Second Edition, Tata McGraw Hill Education Pvt, Ltd., New Delhi
3. R. K. Mittal, I. J. Nagrath, "*Robotics and Control*", Tata McGraw-Hill Publishing Company Ltd.
4. J. J. Graig, "*Introduction to Robotics – Mechanics and Control*", 2nd edition, Pearson Education, Inc.
5. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "*ROBOTICS – Control, Sensing, Vision, and Intelligence*", McGraw-Hill Book Company.
6. Saeed Niku, "*Introduction to Robotics – Analysis, Control, Applications*", John Wiley & Sons.
7. Mohsen Shahinpoor, Harper and Row, "*A Robot Engineering Textbook*", New York
8. Roboert J. Schilling, "*Fundamentals of Robotics – Analysis & Control*", Prentice-Hall of India Pvt. Ltd.

Course Outcomes (COs):

1. Outline a robotic manipulator.
2. Analyze the motion of robot arm with respect to a fixed reference coordinate system as a function of time.
3. Formulate dynamic equation of the robot arm motion relating the forces and torques to the positions, velocities and accelerations of the manipulator
4. Plan the path and trajectory of manipulator arm and its end effector.
5. Select gripper, sensor and actuator for adaptive control in automated manufacturing
6. Prepare program for end effector motion in automated manufacturing.