

COURSE TITLE	DESIGN AND SYNTHESIS OF ROBOTS
COURSE CODE	01ME1712
COURSE CREDITS	4

Objective:

- 1 The course intends to provide understanding of recent developments in Industrial robotics to graduate students. The course enhance their ability to understand the mechanism of robots

Course Outcomes: After completion of this course, student will be able to:

- 1 Apply industrial robotics concepts to demonstrate their role in modern manufacturing systems.
- 2 Analyze the kinematic structure of robotic manipulators using transformation matrices and Denavit–Hartenberg (D–H) conventions.
- 3 Implement robot programs and trajectory planning strategies for industrial tasks.
- 4 Evaluate the effectiveness of sensors, vision systems, and control strategies in robotic automation and inspection.
- 5 Assess the performance, constraints, and safety considerations of industrial robotic applications.

Pre-requisite of course:Basic knowledge of Theory of machines

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Introduction: Industrial to Robotics; Classification of Robots, Payback period of robots; Application of Robots: Robots in Industry, Robots in Handling, Machine Loading and Unloading, Materials Transfer, Palletizing, Welding, Arc Welding, Spot Welding, Compliance, Assembly, Injection Moulding Advantages and Limitation of robots in application, RGV, AGV; Implementation of Robots in Industries- Various Steps; , Safety Considerations for Robot Operations - Economic Analysis of Robots.	5

Contents : Unit	Topics	Contact Hours
2	Grippers and Tools of Industrial robots: Introduction, Definitions of Industrial Robot, Configuration and Work Volume, Configuration of Human Body, Human Work Volume, Industrial Robot Configuration, Structural Configuration,, Robot Work Volume, Precision of Movement , Spatial Resolution, Example, Accuracy, Repeatability, Degrees of Freedom, Examples,End Effectors, Grippers, Tools, Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives, D.C. Servo Motors, Stepper Motors, A.C. Servo Motors Salient Features, Applications and Comparison of all these Drives	8
3	Co-ordinate transformation Introduction, 2D Coordinate Transformation, Example, , 2D Homogeneous Transformation, Example, Description of Object, Example,, 3D Coordinate Transformation, Examples, Inverse Transformation, , Kinematic Chain, Composite Transformation Matrix, Algorithm for Composite Transformation, Examples, Object Manipulation, Example, The Wrist – Example	8
4	Kinematics of robots Introduction, Joint Coordinate Space, Kinematics and Inverse Kinematics,, Two-Joint Two-DoF Robot, Use of Homogeneous, Transformations,, Robot Vision System, Link Parameters, Joint Parameters,, D-H Notation of Coordinate Frames, D-H Transformation Matrix, Symbolic Procedure, D-H Algorithm Application ,Examples Manipulator Jacobian, Jacobian Singularities	10
5	Robot sensors: Introduction, Internal and External Sensors, Applications of Robot Sensors, Desirable Features of Robot Sensors,, Proximity and Tactile Sensors, Proximity, Sensors, Touch Sensors, Slip Sensors, Range Sensors, Opto Range Sensors, Ultrasonic Range Sensors, Force Sensors,, Vision System for Inspection, Voice Recognition Devices, Voice Synthesizers,, Remote Center Compliance (RCC) Device, Image Processing versus Image Analysis , Machine vision	5
6	Robot Control: Introduction, Path vs trajectory, Joint-Space versus Cartesian-Space, Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Cartesian-Space Trajectories, Continuous Trajectory Recording	6
Total Hours		42

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	To study of various sensors in automation To study of various sensors in automation	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
2	Comparative study on the configuration of Human body with Industrial robots Comparative study on the configuration of Human body with Industrial robots	2
3	Apply the Composite Transformation algorithm on a robotic arm Apply the Composite Transformation algorithm on a robotic arm	2
4	Prepare a program of move nine objects on a pallet to a location Prepare a program of move nine objects on a pallet to a location	2
5	Develop a program to pick up identical objects and stack on top of each other to a maximum height of four objects. Develop a program to pick up identical objects and stack on top of each other to a maximum height of four objects.	2
6	Develop a Program for industrial robot which picks up a part from one location and transport to another location. Develop a Program for industrial robot which picks up a part from one location and transport to another location.	2
7	Prepare a transformation matrix for prismatic joint Prepare a transformation matrix for prismatic joint	2
8	Determine the Kinematic parameters of a Twist-Rotation-Rotation (TRR) robot. Determine the Kinematic parameters of a Twist-Rotation-Rotation (TRR) robot.	2
9	Case study on Spot welding application of Robots Case study on Spot welding application of Robots	2
10	Case study on Material Handling application of Robots. Case study on Material Handling application of Robots.	2
11	To determine estimation of accuracy, repeatability and resolution. To determine estimation of accuracy, repeatability and resolution.	2
12	Verification of transformation (position and orientation) with respect to gripper and world coordinate system Verification of transformation (position and orientation) with respect to gripper and world coordinate system	2
Total Hours		24

Textbook :

- 1 Introduction to Industrial robotics, Ramachandran Nagarjan,, Pearson India Education Services Pvt. Ltd, 2016
- 2 Robot Modeling and Kinematics, Rachid Manseur, Laxmi Publications, 2008

References:

- 1 Industrial Robotics Technology, Programming and Applications, Industrial Robotics Technology, Programming and Applications, Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, Tata –McGraw Hill Pub. Co.,, 2008
- 2 Robotics Technology and Flexible Automation, Robotics Technology and Flexible Automation, Deb.S.R and Sankha Deb, Tata McGraw Hill Publishing Company Limited, 2010
- 3 Fundamentals of robotics: analysis and control, Fundamentals of robotics: analysis and control, Robert J Schilling, Dorling Kindersley (india) Pvt Ltd, 2006
- 4 Introduction To Robotics: Analysis, Control, Applications , Introduction To Robotics: Analysis, Control, Applications , Saeed Benjamin Niku, John Wiley & Sons, Inc., 2018
- 5 Industrial Robotics -Technology ,Programming and Applications (SIE) | 2nd Edition, Industrial Robotics -Technology ,Programming and Applications (SIE) | 2nd Edition, Nicholas Odrey, McGraw Hill Education, 2017

Suggested Theory Distribution:

The suggested theory distribution as per Bloom’s taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
15.00	25.00	20.00	20.00	10.00	10.00

Instructional Method:

- 1 PPT, videos, animation

Supplementary Resources:

- 1 www.nptel.ac.in
- 2 <https://swayam.gov.in/explorer>