# ROBOT ANALYSIS AND DESIGN

**Subject Code: 13ME2209** **L P C**
**4 0 3**

**Pre requisites:** Automation in Manufacturing and Industrial robotics

**Course Educational Objectives:**

To make the student learn

1. the fundamental issues related to the research and applications of robotic systems
2. different robotic components, like sensors and actuators, and their effects
3. mathematical tools for modelling, analysis, and control of a robotic system
4. forward and inverse kinematics and dynamics analyses, motion planning and control aspects of robots
5. concepts of robot vision and image processing techniques

**Course Outcomes:**

The student will be able to

1. explain the basic theory of robot manipulators
2. apply knowledge in robot kinematics, dynamics and control, and image processing
3. model and perform forward and inverse kinematics and dynamics of robots
4. analyze and design industrial robot
5. implement suitable robot controllers for industrial robots
6. analyze common industrial robots and their configurations

## UNIT-I

Introduction: Types of robots, overview of robot subsystems, resolution, repeatability and accuracy, degrees of freedom of robots, robot configurations and concept of workspace, mechanisms and transmission, pneumatic, hydraulic and electrical actuators, specifications of different industrial robots.

Kinematics: Rotation matrices, Euler angle and RPY representation, homogeneous transformation matrices, Denavit-Hartenberg notation, direct kinematics, inverse kinematics, Jacobian of RR and RP type planar robots, singularities, trajectory planning: joint interpolation, task space interpolation.

**UNIT-II**

Dynamics and control: Use of Lagrangian and Newton-Euler formulations for the dynamics of RR and RP type planar robots, independent joint control, PD and PID feedback, actuator models, force feedback, hybrid control.

**UNIT-III**

Sensors and end-effectors: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Grippers - types, operation, mechanism, force analysis, tools as end effectors, considerations in gripper selection and design.

**UNIT–IV**

Robot vision: image processing fundamentals for robotic applications, image acquisition and pre-processing, segmentation and region characterization object recognition by image matching and based on features

Robot programming and languages: Lead through programming, robot programming as a path in space, motion interpolation, WAIT, SIGNAL and DELAY commands, branching capabilities and limitations. textual robot languages, generations, robot language structures, elements in functions.

**UNIT-V**

Robot cell design and control: Robot cell layouts -robot centered cell, inline robot cell, mobile robot cell; considerations in work cell design, work cell control, interlocks, error detection, work cell controller.

Robot applications: Material transfer, machine loading/unloading, processing operations, assembly and inspections.

**TEXT BOOKS:**

1. 1. Nagrath and Mittal, "*Robotics and Control*", Tata McGraw-Hill, 2003, 6th Reprint, 2007, New Delhi.

2. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Ordrey, "*Industrial Robotics*", Tata McGraw-Hill, New Delhi, 2008.

**REFERENCES:**

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "*Robot Modeling and Control*", John Wiley and Sons, 2006, New Delhi.

2. John J. Craig, "*Introduction to Robotics – Mechanics and Control*" , Pearson Education, 3rd Edition, 2005.

3. Saeed B. Niku, "*Introduction to Robotics: Analysis, Systems, Application*" , Pearson education, 2011.

4. S. K. Saha, "*Introduction to Robotics*" , McGraw-Hill Education India, New Delhi, 2008.

5. Tsuneo Yoshikawa, "*Fundamentals of Robotics: Analysis and Control*" , PHI, 2001.

6. Fu K.S, Gonzalez R.C., Lee C.S.G, "*Robotics - Control, Sensing, Vision and Intelligence*" , McGraw Hill International, 1987.

7. Robert J. Schilling, "*Fundamentals of Robotics*" , PHI India, 2000.