ROBOT ANALYSIS AND CONTROL

Course Code: 15ME2208

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Course Outcomes:

At the end of the course, the student will be able to

CO1: Identify the degree of freedom in a manipulator and analyze the design for manipulator.

CO2: Demonstrate critical awareness and evaluation of current research in order to apply analytical techniques for solving the kinematics of a robot manipulator.

CO3: Apply analytical techniques for solving the dynamics of a robot manipulator.

CO4: Demonstrate a comprehensive understanding and critical evaluation of the application of PID control for automation.

CO5: Select an appropriate robotic system for a given application and discuss the limitations of such a system.

UNIT-I (10-Lectures)

Introduction to Robotics: Evaluation of robots, Progressive advancements in Robots – first, second, third and fourth generations, Robot Anatomy – links, joints and their notations, degree of freedom in manipulator, Arm and wrist configurations, End effectors and their considerations.

Coordinate frames, Transformation of vectors, Inverting a homogeneous transform and fundamentals of rotation matrices.

UNIT-II (10-Lectures)

Robot Kinematics: Direct Kinematic Model – Description of links and joints, Kinematic modelling of the manipulator, Denavit – Hartenberg notation, Kinematic relationship between adjacent links, Manipulator transformation matrix.

Inverse Kinematic Model – manipulator workspace, Solvability of inverse kinematic models.

Manipulator Jacobian, Jacobian inverse and its singularities for wrist and arm.

UNIT-III (10-Lectures)

Robot Dynamics: Dynamic model for 2 DOF manipulator, Lagrange – Euler formulation, Newton – Euler formulation, Inverse dynamics.
Trajectory Planning – Joint space techniques and Cartesian space techniques.

UNIT–IV (10-Lectures)

Control of Manipulators: Manipulator control problem, Characteristics of second order linear systems, Joint actuators, PD and PID control schemes, Force control of robotic manipulators, Hybrid position/force control and Impedance force/torque control.
Robotic Sensors: Sensors in robotics – Status sensors, Environmental sensors, Quality control sensors, Safety sensors, Workcell control sensors, Kinds of sensors used in Industrial robot – Acoustic sensors, Optic sensors, Pneumatic sensors, Force/Torque sensors and Optical encoders.

UNIT-V (10-Lectures)

Robotic vision: Process of imaging, Architecture of robotic vision system, Image acquisition, Image representation, Image processing.
Robot applications: Industrial applications – Material handling, Processing applications, Assembly and Inspection applications, Non Industrial applications.

TEXT BOOKS:

1. Nagrath and Mittal, "*Robotics and Control*", Tata McGraw-Hill, 2003, 24th Reprint, New Delhi, 2014.

REFERENCES:

1. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Ordrey, "*Industrial Robotics*", Tata McGraw-Hill, New Delhi, 2012.

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