Robotics & Automation (404205)

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

Course Objectives:

- Describe the history and early beginnings of automated manufacturing & Robotics.
- Ability to recognize industrial control problems.
- Aims to Develop understanding Robotics Components.
- Apply creative approaches to practical applications, identify technological opportunities in robotics.
- An over view of technology of advanced topics such as CNC Machines, Human Robot Interaction.
- The ability to provide Automation solution.

Course Outcomes:
After successfully completing the course students will be able to

- Understand Need of Automation.
- Demonstrate use of engineering methods and problem solving towards design of the specified robot.
- Compare and contrast various mechanical systems, and the industrial application of robotic and automation.
- Identify prerequisites of Robotics for small industrial Applications.
- Describe Robot control & its applications.

Unit I : **Introduction to Automation** **6L**

Types of Automation; Architecture of Industrial Automation Systems, Advantages and limitations of Automation, Effects of modern developments in automation on global competitiveness.
Introduction of CNC Machines: Basics and need of CNC machines, NC, CNC and DNC (Direct NC) systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines.

Unit II : **Robotics** **6L**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems Hydraulic, Pneumatic and Electric system.

Unit III : **Robot Transformation, Sensors & End effectors** **6L**

Transformation types: 2D, 3D. Translation- Homogeneous coordinates multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors Robotic vision sensor-Force sensor-Light sensors, Pressure sensors End effectors : Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers- Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems

Unit IV : **Kinematics** **6L**

Rigid body Kinematics, Inverse Kinematics, Rotation matrix, Homogenous transformation matrix, Denavit - Hartenberg convention, Euler angles, RPY representation, Direct and inverse Kinematics for industrial robots for position and orientation Redundancy, Manipulator, Jacobian Joint, End effector, velocity – direct and inverse velocity analysis. Control: Individual joint computed torque.

Unit V : **Dynamics** **6L**

Lagrangian Dynamics, link inertia tensor and manipulator inertia tensor, Newton-Euler Dynamics of Robot, Newton-Euler formulation for RR & RP manipulators, Dynamics of systems of Interacting Rigid Bodies, D-H Convention, Trajectory planning for Flexible Robot, Cubic polynomial linear segments with parabolic blending, static force and moment transformation, solvability, stiffness, Singularities.

Unit VI : **Robot Control & Applications** **6L**

Control approaches: oscillatory based time varying control law, control law based on vector field orientation approach. Advanced strategies of control: conventional aerial vehicle, Bidirectional X4-flyer. Applications of Fuzzy Logic and Neural network in Robot Control, Neural controllers, Implementation of Fuzzy controllers: Trajectory tracking controller.

Applications of Robotic system: complex control system, vision system in complex control system. Human Robot Interaction: Architecture.

Text Books

1. Thomas R. Kurfess, _Robotics And Automation Handbook_, CRC Press, 2004, ISBN 0-8493-1804-1
2. Robotics: Appin Knowledge Solutions (Firm)_, Infinity Science Press , 2007, ISBN 978-1-934015-02-5
3. Robot Motion and Control (Recent Developments) by M.Thoma & M. Morari

Reference Books

1. J. Norberto Pires, Altino Loureiro and Gunnar Bölmsjo, _Welding Robots -Technology, System Issues and Applications_, Springer-Verlag 2006, ISBN-10:1852339535
2. Ben-Zion Sandler, _Robotics : Designing the Mechanisms for Automated Machinery_, 2nd ed. 1999 by Academic Press, ISBN 0-12-618520-4