EC532 - ROBOTICS DESIGN & CONTROL (Elective III)

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Course Objectives:

Mechatronic systems synergistically combine computer science, electrical engineering, and mechanical engineering. Robotics systems can be viewed as a subset of mechatronics that focuses on sophisticated control of moving devices.

The objective of this course is to expose students to the fundamentals of these systems. Over the course emphasis will be laid on topics like how to interface a computer with the real world, different types of sensors and their use, different types of actuators and their use, and forward and inverse kinematics of simple two link robotic manipulators.

Course Outcomes:

- To be able to understand basic concepts of robotics.
- Enhances practical applications of sensors and actuators in robotic systems.
- To be able to design and model robotic manipulator.
- To be able to design and develop dynamic control systems with related to robotics.

UNIT – I **(8 hours)**

Introduction

Brief History - Past, Present status and Future trends in robotics - Uses of robots – Robot Anatomy: Overview of Robot subsystems - Concept of Workspace - Mechanisms and Transmission - Types of Robots - Issues in Designing and Controlling Robots: Resolution, Repeatability, Accuracy and Compliance.

UNIT – II **(10 hours)**

Sensors and Actuators

End-Effectors: Different types of Grippers and Tools - Vacuum and other methods of gripping, Actuators: Pneumatic, Hydraulic and Electric Actuators – Sensors: Internal and External sensors - Position, Velocity and Acceleration Sensors - Proximity Sensors - Force Sensors - Laser range finder - Camera. Micro-controllers, DSP, Real time operating systems.

UNIT – III **(10 hours)**

Robot Kinematic

Positions, Orientations and Frames - Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic - D-H Representation - Forward and Inverse Kinematics of Six DOF Robot Arm - Robot Arm dynamics.

UNIT – IV **(10 hours)**

Control Design

Robot Control: Independent joint control - PD and PID feedback - Actuator models - Nonlinearity of Manipulator models - Issues in nonlinear control - Force feedback - Hybrid control - Motion planning and Obstacle avoidance: Road map methods, Graph search algorithms, Potential field methods - Robot languages -.Computer Control and Robot software.

UNIT - V **(7 hours)**

Introduction to Machine Vision

Robot Vision - Camera model and Perspective transformation - Image processing fundamentals for Robotic applications - Image acquisition and preprocessing - Segmentation and region characterization - object recognition by image matching and based on features - Problem of bin-picking - Futuristic topics in Robotics

TEXT BOOKS:

1.Groover M P, “Industrial Robotics”, Pearson Publications.
2.Mittal R K & Nagrath I J, “Robotics and Control”, Tata McGraw Hill Publications.
3.Ghosal A, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press.

REFERENCE BOOKS:

1. Fu K S, “Robotics”, McGraw Hill Publications
2. P. Coiffet and M. Chaironze, “An Introduction to Robot Technology”, Kogam Page Ltd. London,1983.
3. Richard D. Klafter, “Robotic Engineering”, Prentice Hall India Limited.
4. John J Craig, “Introduction to Robotics”, Pearson Education publications.
5. Mark W. Spong and M. Vidyasagar, “Robot Dynamics & Control”, John Wiley & Sons (ASIA) Pvt. Ltd.