COURSE CONTENT

INDUSTRIAL ROBOTICS

I Semester: M.Tech (CAD/CAM)

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
2414016	Advanced	3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisites: Kinematics of machinery

Course Overview:

This course introduces automation and robotics, covering robot anatomy, control systems, sensors, and power transmission. It explores manipulator kinematics, motion analysis, trajectory planning, and robot dynamics. Students learn about end effectors, machine vision, and image processing techniques. The course also includes robot programming, languages, and motion commands. Finally, it focuses on robot cell design, control systems, and industrial applications such as material handling, assembly, and inspection, preparing students for advanced robotic system implementation in manufacturing environments.

Course Objectives:

1. To demonstrate knowledge of different types of actuators used in robotic systems.
2. To analyze the position and velocity kinematics of a robot arm, implement in 2D.
3. To analyze sensor signals to implement real-time control algorithms.
4. To demonstrate knowledge of error propagation in electrical, mechanical and computational systems.
5. To construct, program, and test the operation of a robotic system to perform a specified task.

Course Outcomes: After Completion of the Course, Students should be able to

1. Understand the evolution, classification, structures and drives for robots.
2. Perform motion analysis through kinematic approach of manipulators.
3. Understand robot dynamics and machine vision for robotics.
4. Learn and write robot programming languages.
5. Expose the students to build a robot for any type of application.

UNIT-I:

Introduction: Automation and Robotics, Robot anatomy configuration, motions joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement.

Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

UNIT-II:

Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated &Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via

point, blending.

UNIT-III:

Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT-IV:

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT-V:

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller. Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

TEXT BOOKS:

1. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson
2. Industrial robotics by Mikell P.Groover, McGraw Hill.

REFERENCE BOOKS:

1. Industrial robotics by Mikell P.Groover, McGraw Hill
2. Robotics by K.S.Fu, McGraw Hill.
3. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson
4. Robot Analysis by Lung Wen Tsai, John Wiley & Sons
5. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York

ELECTRONIC RESOURCES:

1. https://nptel.ac.in/courses/112105319

MATERIALS ONLINE:

1. Course template
2. Definitions and terminology
3. Lecture notes
4. E-Learning Readiness Videos (ELRV)