Course Type	Course Code	Name of Course	L	T	P	Credit
DE	OMED627	Industrial Robotics: Theories for Implementation	3	0	0	3

Prerequisite
UG Level: Mathematics and Basic Engineering Mechanics
Course Objectives
• To introduce the fundamental concepts, components, and applications of industrial robotic systems. • To develop an understanding of robot actuators, sensors, kinematics, dynamics, calibration, and control. • To familiarize students with industrial robot installation, commissioning, safety, and programming. • To enable students to analyze, model, and evaluate the performance of robotic manipulators used in modern manufacturing and automation. • To prepare students for advanced studies and industrial applications in robotics and automation.
Learning Outcomes
Upon successful completion of this course, students will: • Understand the anatomy, classification, specifications, and applications of industrial robots. • Analyze and select robot actuators, drives, and sensors using manufacturers' technical datasheets. • Determine the degrees of freedom, kinematic relationships, and workspace characteristics of robot manipulators. • Perform forward and inverse kinematic analyses and evaluate robot Jacobians and singularities. • Understand robot installation, calibration, commissioning, and performance evaluation procedures. • Apply principles of robot statics, dynamics, and control to industrial robotic systems. • Understand industrial robot safety standards, workspace monitoring, and basic robot programming concepts.

Unit No.	Topics to be Covered	No of Lecture Videos	Video Time (Minutes)	Learning outcome
1	Introduction: Robot definition, applications, industrial robot anatomy, robot classifications, technical specifications, serial and parallel robots.	5	188	Understanding of industrial robot structures, classifications, and applications.
2	Electrical Actuators and Drives: DC motors, stepper motors, BLDC motors, AC servo motors, servo drives, controllers, interfaces, motor selection, interpretation of technical datasheets.	5	237	Ability to identify and select suitable actuators and drives for robotic applications.
3	Robot Sensors and Interfaces: Contact and non-contact sensors; position, velocity, acceleration, proximity, and	5	199	Understanding of sensing technologies and sensor selection for robotic systems.

	force sensors; sensor characteristics and technical datasheets.			
4	Grubler-Kutzbach Criterion, Degrees of Freedom, Homogeneous Transformations, Denavit-Hartenberg Parameters, Forward Kinematics.	5	213	Ability to model robot geometry and determine end-effector position and orientation.
5	Inverse Kinematics, Differential Motion, Velocity and Acceleration Analysis, Jacobian Matrix, Singularity Analysis.	5	218	Ability to solve inverse kinematics and analyze robot motion and singularities.
6	Industrial Robot Installation and Commissioning, Robot Mastering, Tool Center Point Calibration, Orientation Calibration Methods.	4	137	Understanding of practical robot setup and calibration procedures.
7	Robot System Calibration: Fixed tool calibration, workpiece calibration, work-surface calibration, linear rail systems, rotary turntables.	3	129	Ability to understand industrial calibration techniques for robotic cells.
8	Robot Statics: Link forces and moments, recursive formulation, gravity compensation, force and velocity ellipsoids.	3	87	Understanding of force transmission and static analysis of manipulators.
9	Robot Dynamics: Euler-Lagrange formulation, Newton-Euler formulation.	4	140	Understanding of dynamic modeling and analysis of robot manipulators.
10	Load Data Calibration, Payload Identification, Repeatability Tests, ISO 9283:1998 Performance Evaluation.	3	101	Understanding of robot performance assessment and industrial standards.
11	Robot Control: Transfer functions, state-space representation, feedback control systems, PID control, gain tuning.	5	241	Understanding of robotic joint control and controller design principles.
12	Workspace and Operator Safety, Safety Functions, Workspace Monitoring, Safety Devices, Standards and Regulations, Introduction to Industrial Robot Programming.	2	87	Understanding of industrial robot safety requirements and programming fundamentals.
		49	1977	

Text Book:

1. S. K. Saha, *Introduction to Robotics*, 2nd Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2008.
2. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd Edition, Pearson Education, 2008.

References:

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, 2nd Edition, Wiley India, 2020.
2. *Technical specification sheets and product manuals* of KUKA, ABB, FANUC, and YASKAWA industrial robots.

Web link of the course: https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_me143