<table>
<tr><td colspan="3">Devi Ahilya Vishwavidyalaya, Indore, India
Institute of Engineering & Technology</td><td colspan="4">III Year B. Tech (Mechanical Engineering)
(Full Time)</td></tr>
<tr><td>Course Code & Name</td><td colspan="6">Instructions Hours per Semester and Credits</td></tr>
<tr><td rowspan="2">6RMPE2: Introduction to Robotics</td><td colspan="2">Classroom Instruction (CI)</td><td>Lab Instruction (LI)</td><td>Term Work (TW) and Self Learning (SL)</td><td>Total no. of Hours Per semester</td><td>Total Credits (Total Hours/30)</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>TW+SL</td><td rowspan="2">120</td><td rowspan="2">4</td></tr>
<tr><td>20</td><td>10</td><td>20</td><td>70</td></tr>
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Course Learning Objectives:

1. Introduce fundamentals of robotics, automation, and intelligent systems.
2. Develop understanding of robot kinematics, dynamics, and control.
3. Familiarize students with sensors, actuators, and programming environments.
4. Expose students to AI-driven robotics, human–robot collaboration, and Industry 4.0 applications.
5. Enable students to design, simulate, and analyze robotic systems for industrial and societal applications.

Prerequisite(s): Computer Programing and Hardware Knowledge.

COURSE CONTENT

UNIT-I

Foundations of Robotics: History, scope, and applications of robotics. Classification of robots (industrial, service, humanoid). Coordinate systems, DOF, and basic components. Robotics in Industry 4.0 and smart manufacturing.

UNIT-II

Components & Hardware: End-effectors and grippers: design, selection, applications. Actuators: electric, hydraulic, pneumatic, and emerging soft actuators. Sensors: vision, tactile, force, IMU, LiDAR. Cybersecurity and safety in robotic systems.

UNIT-III

Kinematics & Dynamics: Direct and inverse kinematics. Homogeneous transformations, Denavit–Hartenberg representation. Robot arm configurations. Lagrange–Euler formulation, energy methods, motion equations.

UNIT-IV

Control & Programming: Point-to-point and continuous path control. Feedback devices: encoder, resolver, LVDT. Adaptive and AI-based control. Programming: ROS 2, Roboanalyzer, Python, simulation tools (Gazebo, Webots). Vision-Language-Action (VLA) models for robotic autonomy.

UNIT-V

Applications & Emerging Trends: Industrial applications: welding, assembly, inspection, logistics. Humanoid robotics and human–robot collaboration. Robotics in healthcare, agriculture, and defence. Ethical and societal implications of robotics. Future directions: generative AI, autonomous learning, IT/OT convergence.

List of Lab/Practical Assignments:

1. Introduction to Robotic Arm Configuration:
   a. Identify joints, links, and DOF.
   b. Demonstrate workspace and reach envelope.
2. Forward Kinematics Demonstration:
   a. Calculate end-effector position for given joint angles.
   b. Verify using actual arm movement.
3. Inverse Kinematics Exercise:
   a. Program the arm to reach a specific Cartesian point.
   b. Compare theoretical vs. experimental accuracy.
4. To perform Gripper Operations:
   a. Study the different types of grippers.
   b. Compare parallel, suction, and adaptive grippers.
   c. Pick-and-place objects of varying shapes/sizes/colors.
   d. Perform Palletisation work.
   e. Perform Metal and Non-Metal Sorting.
   f. Perform name tracing and curve tracing operation.
   g. Use of Poka- Yoka Mechanism.
5. Force/Torque Sensing Practical: Demonstrate compliance control.
6. Offline Programming in Simulation Software (RoboAnalyzer)
   a. Introduction to RoboAnalyzer and Virtual Models of Industrial Robots
   b. Understanding Coordinate Frames and Transformations.
   c. Forward and Inverse Kinematics of Robots.
   d. Kinematics of MTAB Mini Robot.
   e. Workspace Analysis of a 6 axis Robot.
   f. Inverse and Forward Dynamics of Robots.
   g. Creating Robot Joint Trajectories.
   h. Writing a Welding Profile using a Virtual Robot.
7. Online Programming with Python/ROS 2:
   a. Write scripts for automated pick-and-place.
   b. Integrate sensor feedback for adaptive control.
8. Manual Jogging & Teach Pendant Operation:
   a. Move the arm using teach pendant/manual controls.
   b. Record and replay simple motions.
9. To Study the Flexible Manufacturing System.
10. PLC programming for Metal and Non-Metal/Color/Shape/Size etc.

Books Recommended:

[1]. Saha, S.K. “Introduction to Robotics,” 2e, Tata McGraw-Hill, New Delhi, 2014
[2]. Fu K. S., Robotics (Control, Sensing, Vision and Intelligence), McGraw-Hill, 4e, 2003.
[3]. Schilling R. J., Fundamental of Robotics, Prentice Hall, 1990.
[4]. Wesley, Sryda E., Industrial Robots: Computer interfacing and Control, Prentice Hall, 1985.
[5]. Groover M.P., Industrial Robotics Technology Programming and Applications, McGraw-Hill, 1986.
[6]. Asada and Slotine, Robot Analysis and Control, John Wiley and Sons, 1986.
[7]. Recent IEEE/ACM papers on AI-driven robotics and humanoid systems.

Course Outcomes	After completion of the course, students will be able to:
CO1	Understand fundamentals of robotics and automation.
CO2	Apply kinematics and dynamics to robotic systems.
CO3	Program and simulate robots using modern platforms.
CO4	Integrate sensors and actuators for intelligent control.
CO5	Evaluate ethical, safety, and industrial aspects of robotics.

CO-PO-PSO Mapping

Course Name: Introduction to Robotics Course Code: 6RMPE2

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
6RMPE2. CO1	3	2	-	-	-	-	2	-	-	-	-	3	3	3
6RMPE2. CO2	3	3	2	-	1	-	2	-	-	-	-	3	3	2
6RMPE2. CO3	3	2	3	1	2	-	2	-	-	-	-	3	3	2
6RMPE2. CO4	3	3	2	2	2	-	3	-	-	-	-	3	3	2
6RMPE2. CO5	2	3	2	1	2	-	3	1	-	-	-	3	3	3