GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3154102
Semester – V
Subject Name: Principles of Robotics

Type of course: Professional Core Course

Prerequisite: None

Rationale: Principles of Robotics is fundamental course for robotics and Automation engineers to understand principle of robot. This course is essential for Kinematics of motion and kinematics- SCARA robots, Wrist and arm singularity.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Basic Concepts:-** Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and controlissues- Various manipulators – Sensors - work cell - Programming languages.	9
2	**Direct And Inverse Kinematics:-** Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution	13
3	**Manipulator Differential Motion And Statics:-** Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse - Wrist and arm singularity - Static analysis - Force and moment Balance.	9
4	**Path Planning:-** Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.	9
5	**Dynamics And Control:-** Lagrangian mechanics- 2 DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.	12

Suggested Specification table with Marks (Theory): (For BE only)

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Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20%	25%	20%	26%	8%	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.

Course Outcomes: After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	To introduce the functional elements of Robotics	17%
CO-2	To impart knowledge on the direct and inverse kinematics	25%
CO-3	To introduce the manipulator differential motion and control	17%
CO-4	To educate on various path planning techniques	17%
CO-5	To introduce the dynamics and control of manipulators	24%

List of Experiments:

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world Coordinate system.
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place.
5. Robot programming and simulation for Colour identification.
6. Robot programming and simulation for Shape identification.
7. Robot programming and simulation for machining.
8. Robot programming and simulation for writing practice.
9. Robot programming and simulation for any industrial process (Packaging, Assembly)
10. Robot programming and simulation for multi process.

Major Equipment:

1. 1DOF “Rconfiguration”robot.
2. 2DOF “Rconfiguration”robot.
3. Workstation for robotic arm.

List of Open Source Software/learning website:

- ROS (Microsoft Robotics Studio, Orocos)