



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code:3720917

ROBOTICS

Semester II

Type of course: Program Elective

Prerequisite: Zeal to learn the subject

Rationale: To provide comprehensive knowledge of robotic configurations, kinematics, singularity, dynamics, Trajectory planning, and control of robot manipulators.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Topic	Hours
1	Introduction: Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.	05
2	Robot Grippers: Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.	06
3	Drives and control systems: Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.	09
4	Kinematics: Transformation matrices and their arithmetic, link and joint description, Denavit – Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:- Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations	07
5	Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation. Robot Programming: - Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.	06



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6	Modeling and Simulation for manufacturing Plant Automation: Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics	10
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References:

1. Robotics control, sensing, vision and intelligence, K S Fu, R C Gonzalez, CSG Lee, Tata McGraw Hill Edition 2008
2. Introduction to robotics, John J Craig, Pearson/Prentice Hall, 2005, Third edition
3. Introduction to Robotics: Analysis, Control, Applications , Saeed Niku, John Wiley & Sons
4. Introduction to Robotics, S K Saha, Tata McGraw-Hill
5. Robotics and control, R K Mittal, I J Nagrath, Tata McGraw Hill 2003
6. A Robot Engineering Textbook , Mohsen Shahinpoor, Harper and Row, Publisher, New York
7. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
8. Industrial Automation: W.P. David, John Wiley and Sons.

Course Outcome:

On completion of this course:

Sr. No.	Course Outcome	Percentage weightage
CO-1	Students will be able to synthesize various configuration of Robot with different joints for required degrees of freedom.	25%
CO-2	Students will be able to understand fundamentals of Robot control system and automation.	25%
CO-3	Students will be able to apply the concept of DH convention for forward and inverse kinematics of robot and understand dynamics of robot.	30%
CO-4	Students will be able to understand automation in industry with recent trends in Robotics.	20%

List of Experiments:

1. Synthesize the robotic configuration for specific degrees of freedom as given by instructor
2. Direct kinematics implementation for open/closed loop robotic configurations
3. Inverse kinematics implementation for open/closed loop robotic configurations
4. Coding/simulation of direct kinematics for open/closed loop configurations along with work space generation using high end software
5. Formulation of DH parameters of robot configuration and its simulation using open source software
6. Lagrangian formulation of the given configuration along with its coding/ validation using simulation software
7. Newtonian formulation of the given configuration along with its coding/ validation using simulation software
8. Design of trajectory for a specific task as given by instructor
9. Simulation/ performance of a trajectory planning of a robot
10. Simulation/performance on the control of open kinematic architecture



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Major Equipment:

- Robot kits
- MATLAB/ High end Simulation software for mechanisms/robots

List of Open source software/learning website:

- <http://www.roboanalyzer.com/>