GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: MECHATRONICS
SUBJECT NAME: ROBOTIC ENGINEERING (Programme Elective-II)
SUBJECT CODE:37104704
M.E. 1st SEMESTER

Type of course: Engineering

Prerequisite: NA

Rationale: This subject deals with study of robot actuators, kinematics, dynamics and motion control of robotic manipulators which is useful for proper selection of robot manipulator.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hours	%Weightage
1	**General considerations of Robotic Manipulator** History of robot; Application of Robot, Geometric configurations, Work volumes and Degree of freedoms; Robot actuators and drives; Analysis of Robotic inaccuracies and resolutions.	08	19
2	**Kinematics of Robotic Manipulator** Service Index of different configurations; Position, velocity and acceleration analysis of various robot configuration, Jacobian, Homogeneous transformation; Direct Kinematic; Inverse Kinematics; D-H representation.	08	19
3	**Forces in Manipulators** Statics and dynamics of robot manipulator; Considerations of forces, Moments and torques for various basic robotic configurations; Joint torque and force calculation, Counter balancing systems	10	24
4	**Trajectory Generation** Basics of trajectory planning, Joint space vs. Cartesian space descriptions, Joint space trajectory planning, Cubic polynomials; Higher order polynomials; Linear function with parabolic blends; Numerical based on different motion trajectories, Cartesian space trajectories.	06	14
5	**Motion Control of Robotic manipulators** Robotic open and closed loop control systems, Second order systems, Non – linear closed loop equation of motion, Error controlled Robotic dynamics, Control of Single axis robotic arm, Generalized motion control laws for robotic manipulators, Common control system for industrial robots, simple	10	24

	robotic manipulator, Independent joint PID control, Independent joint PID control with effective joint inertia, Force control of robotic manipulator, Tracking error analysis, Coordinated movement		

Reference Books:

1. A Robot Engineering Textbook
   Mohsen Shahinpoor, Harper and Row, Publisher, New York
2. Mechanical Design of Robots
   Eugene I. Rivin, McGraw Hill Book Company, New York
3. Introductin to Robotics: Analysis, Control, Applications
   Saeed Niku, John Wiley & Sons
4. Introduction to Robotics
   S K Saha, Tata McGraw-Hill

Course Outcome:

After learning the course the students should be able to:

- Understand the workspace and degree of freedom of various robot configurations.
- Learn about forward and inverse kinematics of robotic manipulators.
- Calculate static and dynamic forces and torques of manipulator. This will help in selection of robotic actuators.
- Understand the trajectory generation of robotic manipulators.
- Select the various controllers of robotic manipulators.

List of Experiments:

1. Study of RCS-6 kit and study of drives, sensors, work volume of articulated robot.
2. Preparation of two configurations using RCS-6 kit.
3. Pick and Place configuration using six axis articulated robot.
4. Study of robot configurations (Cartesian and Polar) and work volume using MATLAB/Scilab software.
5. Determination and plotting of service index for Cartesian configuration using MATLAB/Scilab.
6. Determination of D-H parameters for 4 DOF robot manipulator using Roboanalyzer software and validation using MATLAB/Scilab software.
7. Determination of D-H parameters for6 DOF robot manipulator using Roboanalyzer software and validation using MATLAB/Scilab software.
8. Determination of joint variables for 3 DOF robot configuration using MATLAB/Scilab software.
9. Dynamic analysis of polar configuration using MATLAB/Scilab software.
10. Path and trajectory generation using MATLAB/Scilab software.
11. Motion control of robot manipulator.

Major Equipment:

Robot Kit, Any at least six axis Robot, MATLAB software

List of Open Source Software/learning website:

RoboAnalyzer, Scilab