Subject Code: 01CA0303

Subject Name: Robotics Engineering

M.Tech. II Year – (Sem-3) CAD/CAM

Type of course: Program Elective

Prerequisite: Kinematics, Control Engineering

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

Teaching and Examination Scheme:

Teaching Scheme (Hours)			Credits	Evaluation Scheme					Total Marks
				Theory Marks			Practical Marks		
Theory	Tutorial	Practical		ESE (E)	IA	CSE	Viva (V)	Term Work (TW)	
3	---	2	5	50	30	20	25	25	150

Course outcome

Students will be able to

1. Synthesize various configuration with different joints for required degrees of freedom
2. Understand the various approaches to write position as well as motion equations for open and closed loop configurations
3. Apply the concept of DH convention for forward and inverse kinematics
4. Know the role of friction models and control strategies for various tasks performed by robots

Sr. No	Topic	Lectures	Weightage
1	**General considerations of Robotic Manipulator** Robot anatomy; Feasible configurations of kinematic chains with prismatic, revolute, cylindrical and spherical joints. Degree of freedoms; Homogeneous transformation; Generalized rotations, Description of robotic pose, Orientation with RPY and Euler angles (Forward and inverse formulations)	**05**	**10%**
2	**Kinematics of Robotic Manipulators** Direct Kinematics, Inverse Kinematics for open and closed architectures; D-H representation; Work space analysis, Singularity analysis, Performance measurement indices (Condition number, reciprocal condition number, Manipubality index, GCI, GPI, GSI)	**10**	**25%**
3	**Dynamic Analysis of Robotic Manipulators** Considerations of forces, moments and torques for robotic configurations; Dynamics formulations using Newtonian, Lagrangian and Hamiltonian principle, Properties of dynamic equations	**09**	**25%**

4	**Trajectory Generation** Path and Trajectory, Joint space versus Cartesian space trajectories, Higher order polynomials; Linear function with parabolic blends; numerical based on different motion trajectories.	**06**	**10%**
5	**Introduction to grippers, sensors and actuators** Types of grippers, Properties of grippers, Types of sensors along with working principle, sensor properties, Translational and rotary actuators and their selection.	**04**	**10%**
6	**Motion Control of Robotic manipulators** Robotic open and closed loop control systems, Second order systems, Non – linear closed loop equation of motion, Different friction models, Control	**10**	**20%**

Distribution of Theory Marks

R Level	U Level	A Level	N Level	E Level	C Level
10	10	20	15	25	20

Legends: R: Remembrance**; U:** Understanding**; A:** Application, **N:** Analyze**,** and **E:** Evaluate

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

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