2123

B. E. (Mechanical Engineering)
Fifth Semester
MEC-503: Robotics

Time allowed: 3 Hours

Max. Marks: 50

NOTE: *Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Unit.*

x-x-x

I.   Attempt the following:-

a) What is the Jacobian matrix in robotics, and how is it used in the context of robotic manipulators?

b) How do sensors contribute to the functionality of robots in various applications?

c) What is a tactile robot sensor?

d) How does a robotic arm differ from a human arm?

e) What is the role of actuators in a robotic system?   (5x2)

UNIT - I

II.   Explain in detail the convention used for affixing frames to links in robotics.   (10)

III.   Consider a 3-DOF robotic manipulator with rotational joints. The lengths of the robot links are as follows: $l_1 = 0.2$ m, $l_2 = 0.3$ m and $l_3 = 0.1$ m. The joint angles are given as 30, 45 and -60 degrees respectively. Calculate the end-effector position using the Denavit-Hartenberg (DH) parameters and forward kinematics equations. Provide the transformation matrices for each joint, and then compute the overall transformation matrix from the base to the end-effector. Finally, obtain the end-effector coordinates in the base frame.   (10)

IV.   How' does the Jacobian relate to the mapping between joint velocities and end-effector velocities in a robotic system? Additionally, discuss the role of the Jacobian in the context of robot manipulability and singularities.   (10)

P.T.O.

UNIT - II

V. Consider a 2-DOF robotic manipulator, the robot needs to move from an initial configuration 30 and 60 degrees to a final configuration of 120 and 30 degrees over a period of 5 seconds. Implement linear interpolation to generate a trajectory for the robot to move smoothly from the initial to the final configuration. Calculate the joint angles, velocity and acceleration at each time step (e.g., every 1 second) using linear interpolation. (10)

VI. What are different robot actuators? Give a comprehensive description of each type using schematic diagrams. (10)

VII. Discuss potential challenges or limitations of the linear control approach for the robotic system. (10)

x-x-x