

Name:

Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2023

Course: Advanced Robotics
Program: B.Tech Mechatronics
Course Code: MECH3046

Semester : V
Time : 03 hrs.
Max. Marks: 100

Instructions:

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	List the parameters for a robotic link for kinematic modeling.	4	CO1
Q 2	State the significance of Jacobian computation in robotics system.	4	CO1
Q 3	List out the description of force control tasks of a manipulator for the scrapping paint from aa glass plane.	4	CO2
Q 4	Explain the joint space versus Cartesian space trajectory planning for the smooth operation of the manipulator.	4	CO2
Q 5	Define the adaptive control system for controlling the robotic arm in the unknown environment.	4	CO2

SECTION B
(4Qx10M= 40 Marks)

Q 6	For a robot controller it is proposed to implement partitioned proportional integral control strategy (PPI). Develop the block diagram and mathematical model for PPI controller.	10	CO3
Q 7	For a three –degree of freedom, cylindrical manipulator, design a linear trajectory with parabolic blends. The initial position of the end – effector is expressed by the homogeneous matrix T_s and the goal position by T_g as $T_s = \begin{bmatrix} 0 & 1 & 0 & 200 \\ 1 & 0 & 0 & 100 \\ 0 & 0 & -1 & -100 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad T_g = \begin{bmatrix} 1 & 0 & 0 & -50 \\ 0 & -1 & 0 & 200 \\ 0 & 0 & 0 & 400 \\ 0 & 0 & 0 & 1 \end{bmatrix}$	10	CO3
Q 8	Determine the equations of polynomials for the three segments of a point-to-point trajectory between two points if a 3-5-3 trajectory plan is used.	10	CO3
Q 9	For the to link planar manipulator, the first link as is twice as long as the second link ($L_1 = 2L_2$). Sketch the reachable workspace of the manipulator if the joint ranges limits are	10	CO4

$$0 < \theta_1 < 170^\circ,$$

$$-90^\circ < \theta_2 < 110^\circ$$

OR

Show that for a 3R planar manipulator having link lengths as L_1, L_2 and L_3 with $(L_1 + L_2) > L_3$, the Reachable Workspace(RWS) is a circle with radius $r_{RWS} = (L_1 + L_2 + L_3)$ and dexterity workspace (DWS) is a circle with radius $r_{DWS} = (L_1 + L_2 - L_3)$

SECTION-C
(2Qx20M=40 Marks)

Q 10 Determine the singularities of the 3-DOF articulated arm configuration as shown in figure 1.

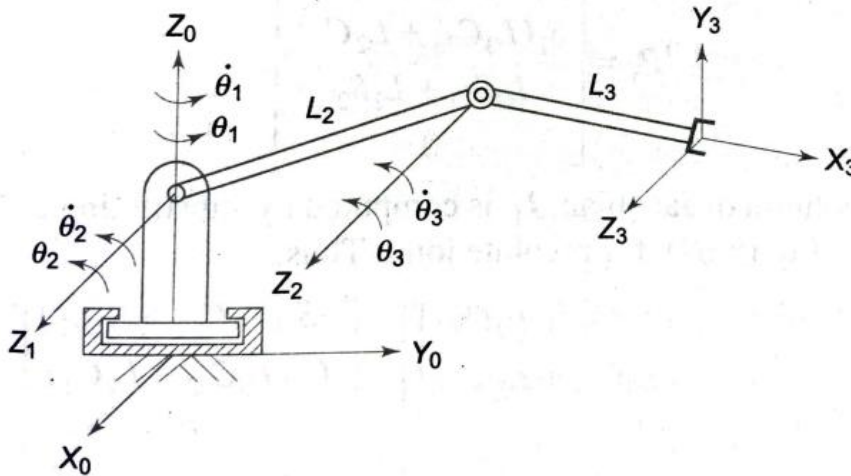


Figure.1

20

CO4

Q 11 For the 2-DOF planar revolute arm, assuming both the links of unit length, determine the (a) configuration singularities and (b) joint velocities in terms of end-point velocities.

OR

Derive the mathematical expression for computing the Jacobian of n-DOF manipulator.

20

CO4