Time :- 3 Hours **Maximum Marks :- 80**

Note:
1. Question number one is compulsory.
2. Solve any 3 out of remaining five questions.
3. Figures to the right indicates full marks.
4. Assume suitable data wherever necessary.

Q.1 Answer any four (20 Marks)
(a) Explain any five robot specifications / characteristics with their appropriate units.
(b) Define 'direct kinematics' & 'inverse kinematics'.
(c) Define the terms 'path' & 'trajectory'. What is the difference between them?
(d) With a neat sketch explain a Generalized Voronoi Diagram (GVD).
(e) Describe corner point detection in robotic vision.

Q.2 (a) Develop the Denavit-Hartenberg (D-H) representation of a four axis SCARA robot and obtain an expression for the arm matrix. (10 Marks)

(b) Using inverse kinematics, derive the expressions for the joint angle variables (θ_1, θ_2, θ_3) for the three-link planar robotic arm manipulator as shown in Fig. 2.1 as below :- (10 Marks)

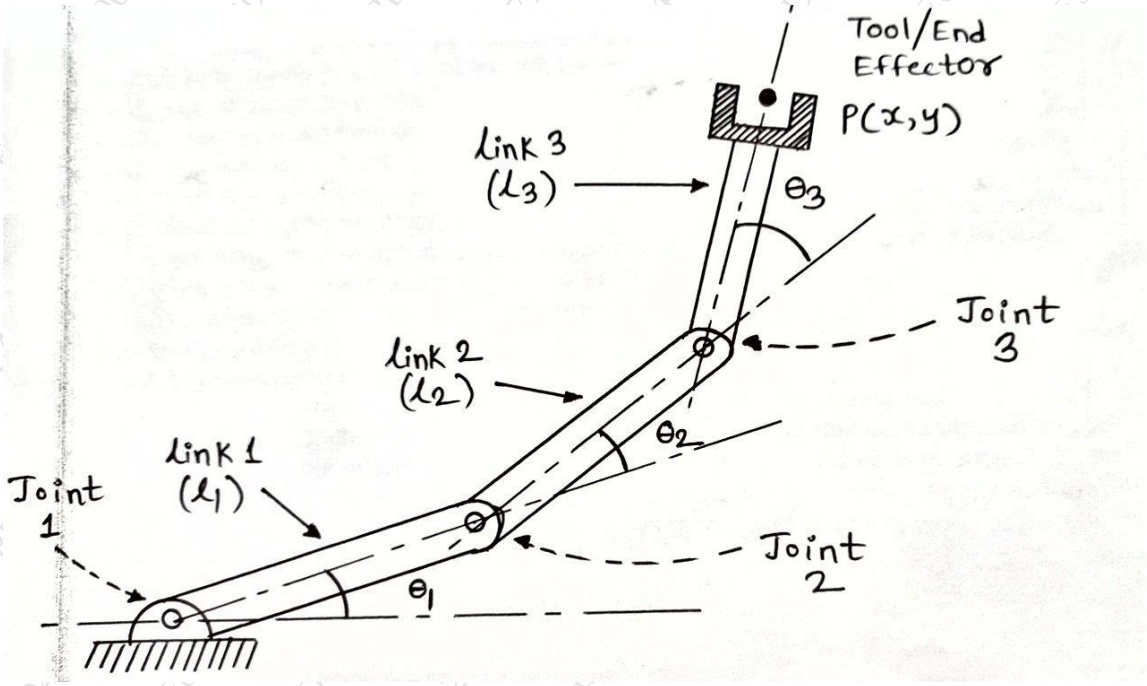


Fig. 2.1 – Two link planar robotic manipulator arm for Q.2 (b)

Q.3 (a) In detail, classify different types of robots based on :- (10 Marks)
(i) The drive technology used
(ii) The work envelope geometry
(iii) The motion control methods

(b) In detail, explain linear interpolated motion with parabolic blends with suitable sketches & appropriate mathematical expressions as necessary. (10 Marks)

7D7D52416FDCFE073E3E44000940CF8F

Q. 4 (a) Develop the direct kinematics solution for 2 axis planar robot as shown in Fig. 4.1 below in order to compute the tool/end effector position (P) given as P(x, y) :- (10 Marks)

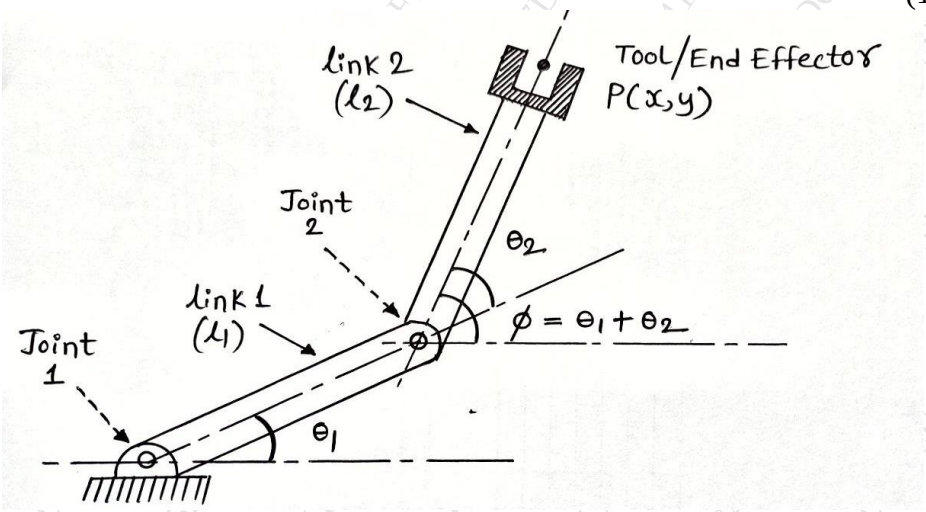


Fig. 4.1 – Planar 2 axes robotic manipulator arm for Q.4 (a)

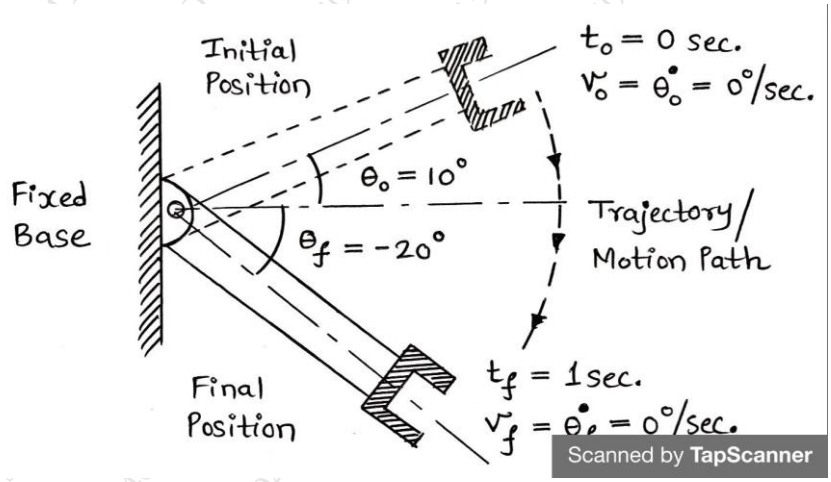
(b) What is image segmentation in robot vision? Explain thresholding & region labeling. (10 Marks)

Q. 5 (a) Describe the task planning simulation problem & explain with neat sketch or case study. (10 Marks)

(b) Explain robot programming languages and its classification. (10 Marks)

Q. 6 (a) Explain kinematic parameters in robotics with a neat sketch. Describe normal, approach & sliding vectors with a neat sketch for the tool or the end-effector. (10 Marks)

(b) Evaluate the trajectory profile of position, velocity & acceleration for a 1 DOF planar robotic manipulator as shown in Fig. 6.1 below such that the initial angular position $\theta_o = 10°$ & final angular position $\theta_f = -20°$ with a 1 second movement from point A to point B ($t_o = 0$ & $t_f = 1$ sec.). Assume velocities at each points are zero ($v_o = v_f = 0$ °/sec.) (10 Marks)



Scanned by TapScanner

Fig. 6.1 – 1 DOF Planar Robotic Manipulator for Q.3

****

7D7D52416FDCFE073E3E44000940CF8F