Register No.: …… Name: ……..

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH DEGREE EXAMINATION (Regular), FEBRUARY 2022

ROBOTICS AND AUTOMATION

(2021 Scheme)

Course Code : **21RA102**

Course Name: **Robotic System Configuration**

Max. Marks : **60** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Identify the robot configuration which gives a rectangular work envelope. Discuss the advantages of a rectangular work envelope.
2. Discuss the difference between forward and inverse kinematics.
3. Differentiate between joint space trajectory planning and cartesian space trajectory planning.
4. Discuss the concept of the state-space model of a 1 DOF robotic arm.
5. Examine the need for control in robotics. List the linear control schemes.
6. Identify the control scheme used in applications where a robot tool is in contact with the environment. Illustrate the answer with the help of a block diagram.
7. Illustrate the concept of robot vision and list the components of a vision system.
8. Explain the thresholding process of image segmentation.

PART B

(Answer one full question from each module, each question carries 6 marks)

MODULE I

9. a) A frame B was rotated about the x-axis by 90 degrees; then it was translated about the current a-axis by 3 inches before it was rotated about the z-axis by 90 degrees. Finally, it was translated about current o–axis by 5 inches.
(a) Write an equation that describes the motions.
(b) Estimate the final location of a point P=$[1,5,4]^T$ (attached to the mobile frame) relative to the reference frame. (4)

   b) Represent the fundamental rotation matrix for a rotation of θ^0 about z-axis. (2)

OR

10. a) Illustrate the anatomy of a typical robotic arm. List its parts. (4)

    b) Differentiate between reach and stroke of a robot manipulator. (2)

MODULE II

11. Examine the singularity conditions of a 2R planar manipulator. Discuss its physical significance. (6)

OR

12. Assess the coordinate frame assignment of the robotic arm shown in the Fig.1 using the DH method. (6)

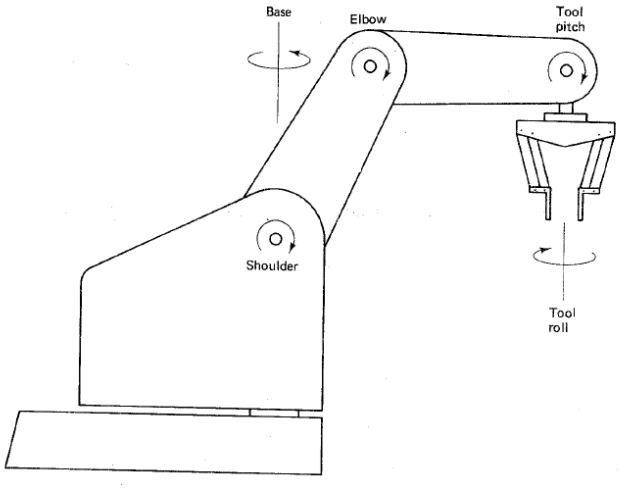

Fig.1

MODULE III

13. a) Discuss the importance of parabolic blend in a linear trajectory. (2)

b) Joint 1 of a 6-axis robot goes from the initial angle of θ_i=0° to the final angle of θ_f =70°in 5 seconds with a constant velocity of 10 rad/sec in the linear region. Find the necessary time for blending and plot the robot trajectory. (4)

OR

14. A robot is driven from an initial position through two intermediate points before it reaches its final destination using a 4-3-4 trajectory. The positions, velocities, and time duration for the three segments for one of the joints are below. Determine the trajectory equations and plot the position, velocity, and acceleration curves for the joint

θ_1 =20°, $\dot{\theta}_1$=0, $\ddot{\theta}_1$=0, T_{1i}=0 sec, T_{1f}=1 sec.
θ_2 =60°, T_{2i}= 0 sec, T_{2f}= 2 sec.
θ_3 =100°, T_{3i}= 0 sec, T_{3f}= 1 sec
θ_4 =40°, $\dot{\theta}_4$=0, $\ddot{\theta}_4$=0 (6)

MODULE IV

15. Calculate the expression for angular acceleration of the point P in Fig.2. Let the applied torque be equal to zero. Consider the moment of inertia of a uniform rod for calculations. (6)

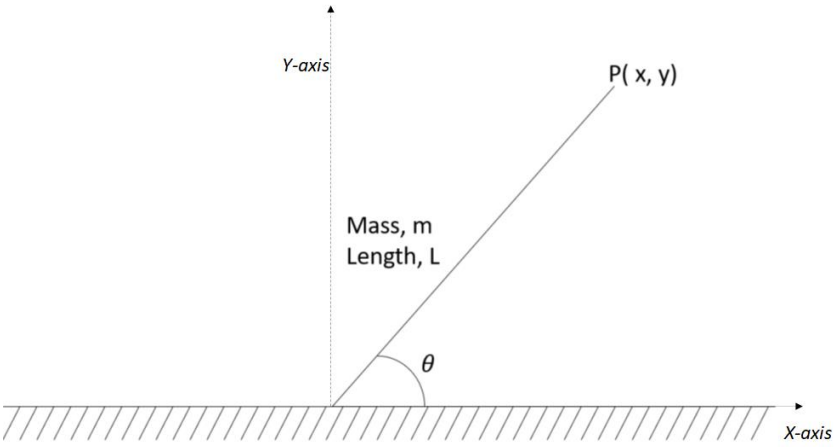

Fig.2

OR

16. Derive the equations for joint torques applied to a 2 DOF robotic arm using Euler Lagrange Equations. (6)

MODULE V

17. a) Discuss the concept of PD gravity control. (2)
    b) Derive the expression for the output of a PD gravity controller of 2 axes planar DOF arm. (4)

OR

18. With the help of a neat block diagram, explain the computed torque control for robot manipulators. (6)

MODULE VI

19. Describe the concept of camera image representation in robot vision. Discuss the equations governing the process. (6)

OR

20. a) Discuss the role of the robot in material handling operations. (2)
    b) Investigate the role of robots in automating a plastic molding process. Compare the use of robot with that of human labour. (4)

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