Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH DEGREE EXAMINATION (Regular), DECEMBER 2023

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. Explain the joint configuration of a three-axis SCARA robot with the help of a diagram.
2. Examine the coordinate frame assignment procedure for a new joint of a robotic arm.
3. Describe the advantage of using a cubic polynomial in joint-space trajectory planning.
4. Identify the significance of dynamic analysis in a robotic arm.
5. State the conditions where a linear control scheme can be implemented in a manipulator.
6. Differentiate between impedance control and PD gravity control.
7. Describe the concept of point-to-point motion of an industrial manipulator.
8. Summarize the need for camera calibration in robot vision.

PART B

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

MODULE I

9. a) Identify the coordinates of point $P=[10\ 10\ 10]^T$ relative to the reference frame after a rotation of 30 degrees about the z-axis. (3)

   b) Evaluate the new location of point $P_M= [1\ 2\ 3]^T$ relative to the reference frame after a rotation of 30 degrees about the z-axis followed by 60 degrees about the y-axis. All the operations are with respect to the fixed frame. (3)

OR

10. a) Explain the classification of robot joints. (3)

    b) Differentiate between cartesian robots and spherical robots. (3)

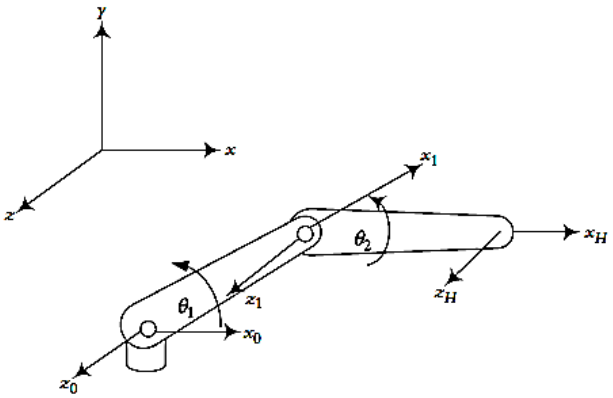
MODULE II

11. a) Examine the nature of solutions for an inverse kinematic problem. (3)

b) Differentiate between a reachable workspace and a dexterous workspace. (3)

OR

12. Evaluate the arm matrix of the robotic arm shown in the figure below. (6)



MODULE III

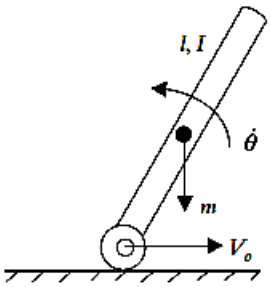
13. Joint 1 of a 6-axis robot is to go from an initial angle of 30 degrees to the final angle of 120 degrees in 4 seconds with a cruising velocity of 30 degrees/sec. Find the necessary blending time for a trajectory with linear segments and parabolic blends and plot the joint positions, velocities, and accelerations. (6)

OR

14. The second joint of a 6-axis robot is to go from an initial angle of 20 degrees to an intermediate angle of 80 degrees in 5 seconds and continue to its destination of 25 in another 5 seconds. Calculate the coefficients for third-order polynomials in joint space. Plot the joint angles, velocities, and accelerations. Assume the joint stops at intermediate points. (6)

MODULE IV

15. Evaluate the kinetic energy of the link shown below with shown parameters. (6)



OR

16. a) Classify the types of robot dynamics. (2)
b) Examine the dynamic analysis of the single-axis PID controller. (4)

MODULE V

17. a) With the help of a block diagram, explain the working of computed torque control. (4)
b) List the advantages of computed torque control. (2)

OR

18. a) Illustrate the working of impedance control with the help of a block diagram. (4)
b) List two applications that use impedance control. (2)

MODULE VI

19. a) Summarize the role of robots in automating welding and molding processes. (4)
b) List four industrial operations where humans can perform better than robots. (2)

OR

20. a) Identify the process of image segmentation for robotic vision. (3)
b) Illustrate the edge detection concept in robotic vision. (3)

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