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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTER B.TECH DEGREE EXAMINATION (R,S), DECEMBER 2023
ROBOTICS AND AUTOMATION

(2020 SCHEME)

Course Code: 20RBT301

Course Name: **Introduction to Robotics**

Max. Marks: **100**   **Duration: 3 Hours**

PART A
(Answer all questions. Each question carries 3 marks)

1. List the features of SCARA robot.
2. Differentiate between active and passive grippers.
3. Define the pose of a rigid body.
4. Determine the rotation matrix, if frame {2} is rotated with respect to frame {1} by $60°$ about the Z-axis.
5. Differentiate between Joint space and Cartesian space trajectory planning
6. Illustrate how Point To Point path planning is different from Continuous Path planning.
7. Illustrate how important is Lagrange function in describing the system variables?
8. Are robotic manipulators nonlinear in nature? Justify.
9. List the technical specifications / characteristics of a spray-painting robot?
10. Differentiate between precision and accuracy in measurement .

PART B
(Answer one full question from each module, each question carries 14marks)

MODULE I

11. a) Describe the various configurations of robotic manipulators with neat diagrams   (8)
    b) Explain how useful are actuators in Industrial Robotics?   (6)

OR

12. a) Explain the classification of end effectors.   (8)
    b) Illustrate the general features of wheeled, legged and aerial robots.   (6)

MODULE II

13. a) A point p (7, 3, 1) ^{T} is attached to frame {1}. Determine the   (7)

coordinates of the point relative to the fixed frame as per following transformations i) Rotation of $90°$ about Z axis ii) Rotation of $90°$ about Y axis iii) A translation of [4,-3, 7].

b) Describe what do you understand by homogenous transformations? Discuss its importance in the modeling of manipulators. (7)

OR

14. a) Assume a unit vector $\hat{P} = [0\ 1\ 0]^T$ is moving with a moving co-ordinate frame {UVW} translated by 4 units along Z axis and rotated by an angle of π radians about the same axis of stationary reference co-ordinate frame {XYZ}. (i) Determine the homogenous screw transformation matrix (ii) Calculate its new position after the transformation. (7)

b) Illustrate how the D-H algorithm is used to obtain the forward kinematic model of robot manipulator. (7)

MODULE III

15. a) Apply A* algorithm to path planning of robots with a suitable example. (7)

b) The first joint of a 6-axis robot go from an initial angle of 30°to final angle of 75^0 in 5seconds. Determine the joint angles at 1,2,3,4 seconds using third order polynomial. (7)

OR

16. a) The second joint of a SCARA manipulator has been moved from Θ_2=30°to 150°in 5 seconds. Find the cubic polynomial to generate the smooth trajectory for the joint. What is the maximum velocity and acceleration for this trajectory? (7)

b) Derive an expression to calculate the blending time of linear response if parabolic sections are blended at the beginning and end of a motion. (7)

MODULE IV

17. a) Model the Computed Torque Control in manipulators with the help of block diagrams. (7)

b)

(7)
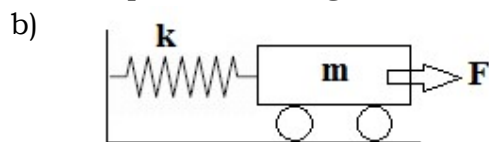
Determine the force-acceleration relationship for the 1-DoF system using Lagrangian mechanics. (Wheels have negligible inertia).

OR

18. a) With the help of a block diagram illustrate the concept of PD control with gravity compensation.   (7)

    b) Model the closed loop transfer function of a single axis PID control with necessary sketches.   (7)

MODULE V

19. a) Illustrate the concept of differentially driven robots with ketches.   (8)

    b) Describe how effectively robots can be used for applications in the Medical, Mining, Space.   (6)

OR

20. a) Describe the concept of precise control of peg in hole assembly using force guided robots.   (8)

    b) Describe how effectively robots can be used for applications in the Defense, Security, Domestic, and Entertainment.   (6)

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