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# SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

**FIFTH SEMESTER B.TECH DEGREE EXAMINATION (S),** FEBRUARY 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. Describe the features of PUMA robots.
2. Explain the characteristics of actuators in robots.
3. Explain screw transformations.
4. Explain how trajectory can be planned with via points
5. Explain about obstacle avoidance methods.
6. List the difference between joint space and cartesian space trajectory planning.
7. How will you compute the dynamic model of a 2 DOF planar manipulator?
8. Differentiate between linear and non linear control of robots.
9. How will you choose robotic configuration for a pick and place task?
10. Describe any three non-industrial applications of robots

## PART B

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

### MODULE I

11. a) How many degrees of freedom are required for a robotic manipulator to achieve any position (for the end effector) in 3D space? And how many more DOF required for achieving any orientation as well. (5)

    b) Explain the general features of wheeled, legged and aerial robots. (9)

**OR**

12. a) Distinguish between active and passive grippers. (6)

    b) Describe the various configurations of robotic manipulators with neat diagrams. (8)

## MODULE II

13. a) Find the new location of $P(1,2,3)^T$ relative to the reference frame after a rotation of $30^0$ about the Z - axis followed by a rotation of $60^0$ about the Y- axis (7)

b) Discuss relation between Joint and End Effector Velocities (7)

**OR**

14. a) Explain how DH algorithm is used to obtain the forward kinematic model of a robotic manipulator. (10)

b) Find the coordinates of point $P= (3,5,7)^T$ relative to the reference frame after a rotation of $30\ ^0$ about the z-axis. (4)

## MODULE III

15. a) It is desired to have the third joint of a 6-axis robot go from an initial angle of 20 degree to a final angle of 80 degree in 4 seconds. Calculate the coefficients for a third-order polynomial joint-space trajectory and plot the joint angles, velocities, and accelerations. The robot starts from rest, but should have a final velocity of 5 degree/sec (10)

b) Apply the A* algorithm to path planning of robots with a suitable example (4)

**OR**

16. a) Joint 1 of a 6 axis robot is to go from an initial angle of $\theta i=30^0$ to the final angle of $\theta_f=120^0$ in 4 seconds with a cruising velocity of $\omega_l=30°$/ sec. Find the necessary blending time for a trajectory with linear segments and parabolic blends and plot the joint positions, velocities and accelerations. (10)

b) Discuss how a circular trajectory is planned in cartesian space? (4)

## MODULE IV

17. a) Describe PD Control with Gravity Compensation using necessary sketches (4)

b) Model computed torque control using a block diagram and feedback control law. List its disadvantages. (10)

**OR**

18. a) Derive the dynamic model of a 1 DOF robot, including motor and gearbox (10)

b) Explain the concept of Single Axis PID Control with sketches? (4)

## MODULE V

19. a) Obtain the kinematic model of a differential driven mobile robot. (8)

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| | b) | Explain how robotic manipulators can be used for machining applications. | (6) |

**OR**

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| 20. | a) | Differentiate between locomotion and manipulation. | (6) |
| | b) | Explain how sensors work in robots and explain about different sensors. | (8) |

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