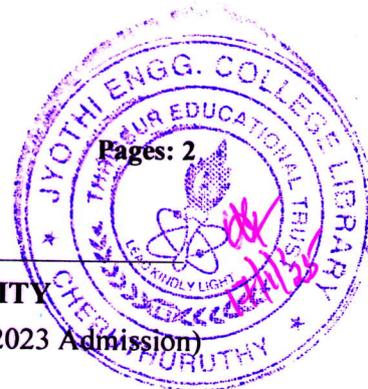


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Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech (Minor) Degree Examination December 2024 (2023 Admission)

Course Code: RAT 281

Course Name: BASICS OF ROBOTICS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks

- | | Marks |
|--|-------|
| 1. Identify the degrees of freedom of a rigid body in space. | (3) |
| 2. Define the terms robot and robotics. | (3) |
| 3. Distinguish between internal sensors and external sensors. | (3) |
| 4. List out the advantages of electric actuators. | (3) |
| 5. Distinguish between mechanical and magnetic grippers. | (3) |
| 6. Distinguish between cartesian robot and articulated robot. | (3) |
| 7. Write down the fundamental rotation matrix about Z-axis of a coordinate frame.
Compute the fundamental rotation matrix if the frame is rotated by an angle 30° about Z-axis of reference frame. | (3) |
| 8. Classify the trajectory planning techniques in robotics. | (3) |
| 9. Explain the closed loop controller block diagram of a feedback system. | (3) |
| 10. Distinguish between forward dynamics and inverse dynamics. | (3) |

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

- | | |
|--|------|
| 11. a. What are the factors that need to be considered while selecting a robot for a particular application? | (10) |
| b. What are the roles of robots in industrial applications? | (4) |
| 12. a. What are the physical components of a robotic arm? Classify the types of robotic joints. | (10) |
| b. What are the differences between open kinematic chain and closed kinematic chain? | (4) |

Module 2

13. a. Explain why the vision sensors are classified as external sensors. Discuss the role of vision sensors in robotics? (8)
- b. How we can measure the acceleration of a robot joint? (6)
14. a. With the help of block diagram illustrate how an actuator system works. Explain the role of each component. (7)
- b. Explain the working of a DC servo motor with the help of a block diagram. Discuss the importance of feedback control. (7)

Module 3

15. a. Classify robots based on configuration. Assess the advantages and disadvantages of each configuration. (14)
16. a. Identify the role of mechanical grippers as end effectors. Discuss the working of frictional grippers. (8)
- b. Assess the criteria for selecting a suitable gripper for a specific applications. (6)

Module 4

17. a. Explain the steps involved in developing a composite homogeneous transformation matrix (HTM). (7)
- b. $P^M = [1 \ 1 \ 1 \ 1]^T$ represents the homogeneous coordinates of a point in mobile coordinate frame M. Suppose that initially the mobile coordinate frame is coincident with fixed coordinate frame F. If we rotate the mobile frame by 45° about X-axis of the fixed frame, compute the homogeneous coordinates of the point P^F with respect to fixed frame. (7)
18. a. Assess the equation for cubic polynomial trajectory of a robotic joint. Investigate how the polynomial coefficients are computed, if the velocities at the beginning and at the end of the motion segment are zero. (8)
- b. Investigate the reason behind implementing parabolic blends to linear joint trajectories. (6)

Module 5

19. Explain the concept closed loop system of a robotic joint with PID controller and a DC motor. Discuss the equations of PID controller and DC motor. (14)
20. a. Investigate the importance of dynamic modelling of robotic arm. (5)
- b. Illustrate the Euler Lagrange formulation for the dynamic analysis of robotic arm with an example. (9)
