



Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree (R, S) Examination November 2024 (2019 Scheme)

Course Code: RAT 301**Course Name: INTRODUCTION TO ROBOTICS**

Max. Marks: 100

Duration: 3 Hours

PART A*(Answer all questions; each question carries 3 marks)*

Marks

- | | | |
|----|--|---|
| 1 | Explain degrees of freedom of robots with an example. | 3 |
| 2 | Differentiate between servo and non-servo control robots. | 3 |
| 3 | Write the three rotation matrixes about x, y, z axis. | 3 |
| 4 | Distinguish between forward and inverse kinematics. | 3 |
| 5 | Explain the principle behind cubic polynomial trajectory planning. | 3 |
| 6 | Compare joint space and Cartesian space trajectory planning. | 3 |
| 7 | Write down the equations for force and torque in terms of the Lagrangian. | 3 |
| 8 | Draw the schematic diagram of a robot control system. | 3 |
| 9 | Summarise any two non-industrial applications of robots. | 3 |
| 10 | Explain the working principle of any one type of accelerometer with a diagram. | 3 |

PART B*(Answer one full question from each module, each question carries 14 marks)***Module -1**

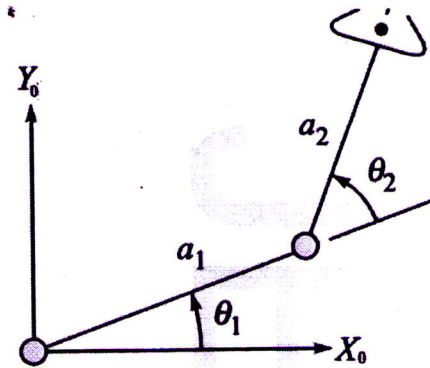
- | | | |
|----|--|----|
| 11 | a) Describe with a diagram robot anatomy in detail. | 10 |
| | b) Explain with a diagram a gripper that can be used to handle large flat objects of any type of material. | 4 |

OR

- | | | |
|----|---|----|
| 12 | a) Describe mechanical grippers and magnetic grippers with neat diagrams. | 10 |
| | b) Explain the advantages and disadvantages of electric drives. | 4 |

Module -2

- | | | |
|----|---|----|
| 13 | a) Obtain the D-H parameter table and arm equation for a 2-link planar robot given in the figure below. | 10 |
|----|---|----|



- b) Explain the screw transformation with necessary equations. 4

OR

- 14 a) A point $p(7,3,1)^T$ is attached to a mobile frame F_{noa} and is subjected to the following transformations. Find the coordinates of the point relative to the reference frame. 8

1. Rotation of 90° about the z-axis,
2. Followed by a rotation of 90° about the y-axis,
3. Followed by a translation of $[4, -3, 7]$.

- b) Explain the general properties of solutions to the inverse kinematics problem of a manipulator. 6

Module -3

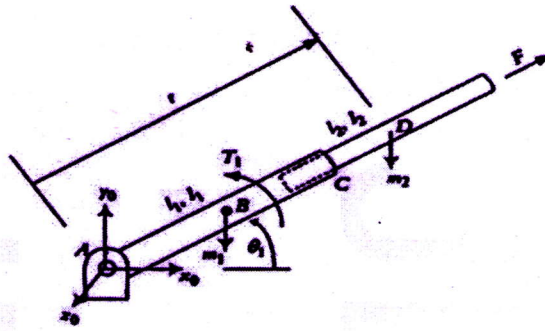
- 15 a) The second joint of a SCARA robot must move from 20° to 60° in 5 sec. Find the coefficients of the cubic polynomial to interpolate a smooth trajectory. Also obtain the position, velocity, and acceleration profiles. 9
- b) Summarize with a neat diagram the principle of artificial potential field method in robot navigation with obstacle avoidance. 5

OR

- 16 a) Describe the A* algorithm with a suitable example. 9
- b) Explain with a diagram trajectory planning using via points. 5

Module -4

- 17 a) Develop the dynamic model of a 2 DOF polar arm shown in the figure below. 10

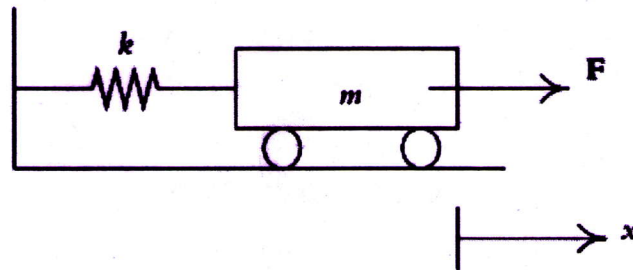


b) Draw the block diagram of a PD Gravity Controller. 4

OR

18 a) Explain the working of a single axis PID controller with necessary block diagrams. Also derive its closed loop transfer function. 8

b) Derive the dynamic equation of a single degree of freedom system given in the figure below 6



Module -5

- 19 a) Summarize the application of any three types of sensors in robotics. 6
b) Derive the forward kinematic model of a differential drive robot. 8

OR

- 20 a) Explain the application of robots in material handling and welding with specification of the robots used for these applications. 8
b) Explain the terms dynamic range, resolution and linearity with reference to sensors. 6
