

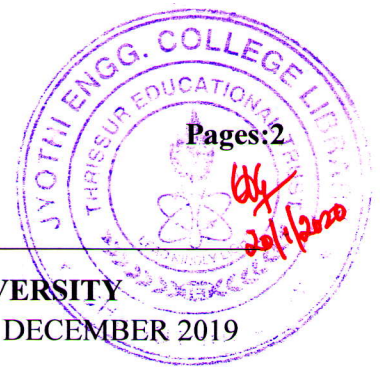
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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

Course Code: EC368

Course Name: Robotics

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks

Marks

- 1 a) List any *three* important milestones in the development of the field of robotics. (3)
- b) Define the following robot specifications: (a) Payload (b) Reach (4)
- c) With suitable diagrams, explain the working principle of (i) Tachometer (ii) Strain gauge-based force-torque sensor. (8)
- 2 a) Identify *five* applications of non-industrial robots. (5)
- b) Compare between hydraulic and pneumatic drive systems. (10)
- 3 a) Explain the classification of robotic joints with illustrations. (10)
- b) How can microprocessors be used in speed and direction control of electric motors? (5)

PART B

Answer any two full questions, each carries 15 marks

- 4 a) What are the functions of a robotic vision system? List two applications where vision systems can be employed in robots. (5)
- b) A homogenous transformation matrix can be used to represent rigid motion. Explain. (5)
- c) Derive the generalized rotation matrix used to represent rigid motion due to a spherical wrist, in terms of its joint angles. (5)
- 5 a) An object in space executes the following sequence of motions: (7)
 - (i) Rotation of 30° about the world z-axis
 - (ii) Translation of 3 unit along current y-axis
 - (iii) Rotation of 45° about world x-axis
 - (iv) Translation of 6 units along current x-axis.

Find the relationship between the world frame and the resultant object frame. Also determine the coordinates of a point in the world frame, if it is described by $[1 \ 5 \ 2]^T$ in the object frame.

- b) Describe the steps in frame assignment using D-H convention for a cylindrical (8)

robot configuration (without any wrist attached).

- 6 a) What is a rotation matrix? List *three* properties of rotation matrices. (5)
- b) A homogenous transformation matrix describing the end-effector frame with respect to the base frame is provided for a robot with articulated configuration, fitted with a spherical wrist. The displacement of the end-effector from the wrist centre is also given. Explain how the closed form solution to the inverse kinematics problem can be determined. (10)

PART C

Answer any two full questions, each carries 20 marks

- 7 a) What is a singularity in the context of velocity kinematics? Explain its significance. (5)
- b) Explain the concept used in Lagrangian mechanics. (5)
- c) Write a VAL program to pick five identical objects from the same pick-up point and place them at five locations spaced 8 units apart along a straight line, in succession. Let the first point be located 10 units away from the pick-up point along the same straight line. List the assumptions made. (8)
- 8 a) Derive the Jacobian used to describe the relationship between the velocities (linear and angular) of the tip and the joint velocities of a spherical manipulator. It may be assumed that there is no wrist attached to the robot. (10)
- b) Explain the classification of Robot Languages. (10)
- 9 a) What is a PID controller? How can it be used in robot actuation and control? (10)
- b) Describe any *four* industrial applications of robots in material handling and assembly. (10)
