

Reg No.: _____

Name: _____

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

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| 1 | a) List any <i>three</i> 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 <i>five</i> 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

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| 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.

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