

314334

24225

03 Hours / 70 Marks

Seat No.

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- Instructions* – (1) All Questions are *Compulsory*.
(2) Answer each next main Question on a new page.
(3) Illustrate your answers with neat sketches wherever necessary.
(4) Figures to the right indicate full marks.
(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: 10
- a) State Asimov's laws of robotics.
 - b) Define Force and give its S.I. unit.
 - c) Define Kinematics and Dynamics.
 - d) State the conditions for equilibrium of forces.
 - e) Define motion planning in robotics.
 - f) State any two significances and uses of the Jacobian matrix.
 - g) Give elementary rotation matrix formula about X axis and Y axis.
2. Attempt any THREE of the following: 12
- a) Mention the Bureau of Indian Standards (BIS) for safety in robotics (Any Four points)
 - b) Define centre of gravity. State how it differs from centroid.
 - c) Form the table of DH parameter of SCARA Robot.
 - d) Describe Lagrange - Euler method and state its equation of motion in dynamics.

P.T.O.

- 3. Attempt any THREE of the following:** **12**
- a) Derive homogenous transformation matrix of 2R Planar robot of each frame.
 - b) Compare point to point and continuous path motion (Four points)
 - c) Define:
 - i) Linear Velocity
 - ii) Linear acceleration
 - iii) Angular Velocity
 - iv) Angular Acceleration
 - d) Mention the type of joints with diagram. (Any Four)
- 4. Attempt any THREE of the following:** **12**
- a) State the characteristics of a force.
 - b) Differentiate between kinematics and dynamics. (Any Four points)
 - c) State the Rules of DH parameter (Any Four points)
 - d) Describe Jacobian matrix in robotics. State its equation.
 - e) A frame B is rotated about the X axis of the Universal coordinate system by 90 degrees without translation. Let the position of a point Q in B is given by $[10 \ 2 \ 8]^T$. Find out \bar{Q}_u .
- 5. Attempt any TWO of the following:** **12**
- a) Classify and describe the robot arm configurations with label diagram (Any Four)
 - b) Differentiate between different types of force systems.
 - c) Derive Forward Position analysis of 2P Planar Robot.

6. Attempt any TWO of the following:**12**

- a) Derive the rotational operator matrix for ROT (Z, θ)
 - b) A 2 DOF serial manipulator with the links having lengths of L_1 and L_2 has the joint angles θ_1 and θ_2 . The end effector coordinates are X and Y where
$$X = L_1 \cos \theta_1 + L_2 \cos (\theta_1 + \theta_2)$$
$$Y = L_1 \sin \theta_1 + L_2 \sin (\theta_1 + \theta_2)$$
Find out the Jacobian Matrix for the given configuration.
 - c) Differentiate between Joint Space Planning and Cartesian Space Planning.
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