

22383

22223

3 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) Assume suitable data, if necessary.
 - (6) Use of Non-programmable Electronic Pocket Calculator is permissible.
 - (7) 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) Define a Robot.
 - b) Compare Kinematic model and Dynamic model (two points each)
 - c) What do you mean by the Jacobian matrix?
 - d) Define path and trajectory of a robot.
 - e) List out any four robot programming languages.
 - f) Define centripetal and tangential acceleration
 - g) Draw the symbol for
 - i) Revolute Joint
 - ii) Twisting Joint

P.T.O.

- 2. Attempt any THREE of the following:** **12**
- a) Explain Hydraulic Actuator with a diagram.
 - b) Explain any four switches of teach pendant.
 - c) Differentiate Joint space trajectory and Cartesian trajectory planning. (any four points)
 - d) Explain the various capabilities and limitations of the robot languages. (two points each)
- 3. Attempt any THREE of the following:** **12**
- a) Derive the inverse kinematics matrix equation of a 2R planer robot.
 - b) Draw the diagram for Magnetic Gripper and Vacuum Gripper.
 - c) Define work envelope? Draw work envelope for Cartesian coordinates.
 - d) Derive the manipulated Jacobian matrix (J) for cylindrical robot.
- 4. Attempt any THREE of the following:** **12**
- a) Compare Pneumatic and Electric Actuators. (any four points)
 - b) Find out the T[composite] matrix for the cylindrical coordinate system.
 - c) State the relationship between linear velocity and angular velocity.
 - d) Explain Walk-through programming method.
 - e) Derive the manipulated Jacobian matrix (J) of 3P robot.

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

- a) What are the safety measures taken w.r.t. Robots.
- b) Explain various capabilities and limitations of lead through programming methods.
- c) For a single slider crank mechanism, state the formula to calculate by analytical method.
 - i) Velocity of slider
 - ii) Acceleration of slider
 - iii) Angular velocity of connecting rod
 - iv) Angular acceleration of connecting rod.

Also state the meaning of each term.

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

- a) Derive the rotational operator matrix for ROT (Z, θ).
- b) Derive the homogeneous transformation matrix for SCARA robot.
- c) A frame $\{B\}$ is rotated about XU axis of the universal coordinate system by 45 degrees and translated along XU, YU, ZU by 1, 2 and 3 units respectively. Let the position of a point Q in $\{B\}$ is given by $[3.0 \ 2.0 \ 1.0]^T$. Determine ${}^U\bar{Q}$.
