

(3 Hours)

[Total Marks: 80]

N.B.: (1) Question No.1 is **Compulsory**.(2) Attempt **any three** questions from the **remaining** questions.(3) Assume **suitable** data wherever required but **justify** the same.(4) **Figures** to the **right** indicate **full marks**.(5) Answer each new question to be started on a **fresh page**.

1. (a) Define Robot. State the advantages and disadvantages of the robot. (5)
 (b) Explain Composite Homogeneous Transformations with suitable example. (5)
 (c) Derive the matrix for differential rotation about a general axis $\hat{k}$.
 (d) Explain any one robot programming language like AL, VAL, RAIL, etc. (5)
2. (a) Define Robotics. Explain in detail the specifications of robotic manipulators. (10)
 (b) Compare and contrast Hydraulic, Electric, and Pneumatic Actuating Systems. (10)
3. (a) A point $P(7,3,1)^T$ is attached to a frame and is subjected to the transformations described next. Find the coordinates of the point relative to the reference frame at the conclusion of transformations. (10)
 1. Rotation of 90 degrees about the z-axis.
 2. Followed by a rotation of 90 degrees about the y-axis.
 3. Followed by a translation of [4, -3, 7].
 (b) Explain BUG1, BUG2 and Tangent BUG algorithms and compare them in brief. (10)
4. (a) Carry out the Inverse Kinematics of 3-axis Planar Articulated Robot Arm (Mini-Drafter). (10)
 (b) Explain the concept of robot motion planning. (10)
5. (a) Explain the characteristics of any two proximity sensors listed below. (10)
 1. Magnetic Proximity Sensor
 2. Optical Proximity Sensor
 3. Ultrasonic Proximity Sensor
 (b) Explain Inverse Jacobian in detail. (10)
6. (a) Find the effect of differential rotations of 0.1 rad about the y-axis followed by a differential translation of [0.1, 0, 0.2] on the given frame B. (10)

$$B = \begin{bmatrix} 0 & 0 & 1 & 10 \\ 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- (b) Explain Lead-Through and Walk-Through Programming in detail. (10)
