BE Sem 8, Choice based, C- Scheme, R 2019-20, May 2025
Date - 19/5/2025, Branch- INFT

Time: (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 applications of robots. **(5)**
(b) Show that the fundamental rotation and translation matrices associated with the unit vectors commute. **(5)**
(c) Derive the matrix for differential transformations of a frame. **(5)**
(d) Explain any one robot programming language like AL, VAL, RAIL, etc. **(5)**

2. (a) Define Robotics. Explain the classification of Robots in detail. **(10)**
(b) Compare and contrast Hydraulic, Electric, and Pneumatic Actuating Systems. **(10)**

3. (a) A point $P(2, 4, 5)^T$ 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 180 degrees about the x-axis.
2. Followed by a rotation of 90 degrees about the z-axis.
3. Followed by a translation of [-2, 6, -4].

(b) Explain BUG1, BUG2 and Tangent BUG algorithms and compare them in brief. **(10)**

4. (a) Explain Denavit-Hartenberg (D-H) algorithm. **(10)**
(b) Explain the concept of robot motion planning. **(10)**

5. (a) Explain the characteristics of any two position sensors listed below. **(10)**
1. Potentiometers
2. Encoders
3. Linear Variable Differential Transformers (LVDT)

(b) Explain Inverse Jacobian in detail. **(10)**

6. (a) The Jacobian of a robot at a particular time is given. Calculate the linear and angular differential motions of the robot's hand frame for the given joint differential motions. **(10)**

$$J = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \quad D_\theta = \begin{bmatrix} 0.2 \\ 0.1 \\ -0.2 \\ 0.3 \\ 0 \\ 0.1 \end{bmatrix}$$

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