

**Time: 3 Hours****Marks: 80**

Instructions for the Student

- 1) Question number 1 is compulsory
- 2) Attempt any three out of the remaining five questions.
- 3) Assume suitable data if necessary and justify the assumptions.
- 4) Figures to the right indicate full marks

Q1 Attempt the Following Questions (Any FOUR)

**20**

- a) Explain Template matching algorithms
- b) Describe Run Length Encoding (RLE) with example.
- c) Describe DH Algorithm or DH Representation of Robot
- d) Describe Repeatability, precision and accuracy of Robots
- e) Explain in brief Reactive Paradigm

Q2 a) Write a detailed note on role of sensors in Robots

**10**

- b) In a robotic setup, a camera is attached to the fifth link of a robot with six degrees of freedom. The camera observes an object and determines its frame relative to the camera's frame. Using the following information, determine the necessary motion the end effector has to make to get to the object:

$${}^5T_{\text{cam}} = \begin{bmatrix} 0 & 0 & -1 & 3 \\ 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad {}^5T_H = \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^{\text{cam}}T_{\text{obj}} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad {}^HT_E = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Q3 a) State the role of shrink and swell operators in robot vision. Differentiate between these operators with suitable examples.

**10**

b) Define Automation. Differentiate between soft and hard automation.

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Q4 a) Applications of Fuzzy logic in Robotics **10**

b) A point P (7, 3, 2) T is attached to a frame ( $\bar{n}$ ,  $\bar{o}$ ,  $\bar{a}$ ) and is subjected to the transformations described next. Find the coordinates of the point relative to the reference frame at the conclusion of transformations.

(i) Rotation of  $90^\circ$  about the z – axis

(ii) Followed by a rotation of  $90^\circ$  about the y-axis

(iii) Followed by a translation of [4, - 3, 7 ]

**10**

Q5 a) Explain classification of Robots based on various criteria. **10**

b) Explain BUG 1 algorithm and Compare it with BUG 2 algorithm **10**

Q6 Short notes on The Following **20**

a) Various types of work envelopes.

b) Trajectory planning

c) Differentiation between Hydraulic and Pneumatic Actuators

d) Robot as an expert system

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