

Note:

1. Question No.1 is compulsory.
2. Attempt any **Three** questions from remaining.
3. Assume suitable data if required.
4. Illustrate your answers with sketches wherever necessary.

Q1) Attempt **any Four** from the following

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| (a) Explain different types of joints used in robotics. | 05M |
| (b) Explain powered lead through programming.           | 05M |
| (c) Explain features of Welding Robot.                  | 05M |
| (d) Briefly explain sensors used in robotics.           | 05M |
| (e) Explain robot Anatomy with neat sketch.             | 05M |

Q2)(a) The following frame definitions are given as known 10M

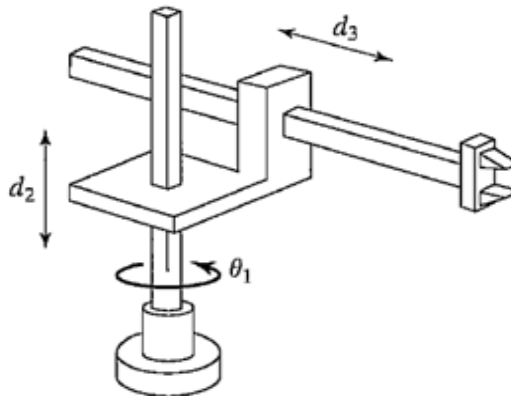
$${}^U_A T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 11.0 \\ 0.500 & 0.866 & 0.000 & -1.0 \\ 0.000 & 0.000 & 1.000 & 8.0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad {}^B_A T = \begin{bmatrix} 1.000 & 0.000 & 0.000 & 0.0 \\ 0.000 & 0.866 & -0.500 & 10.0 \\ 0.000 & 0.500 & 0.866 & -20.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^C_U T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & -3.0 \\ 0.433 & 0.750 & -0.500 & -3.0 \\ 0.250 & 0.433 & 0.866 & 3.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Draw a frame diagram to show their arrangement qualitatively, and solve for  ${}^B_C T$ .

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| (b) Explain future applications of robots with suitable example. | 10M |
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Q3)(a) For the following robot: 10M



- i) Assign the coordinate frame based on the D-H representation.
- ii) Determine all the D-H parameters.
- iii) Write all the joint/link matrix.
- iv) Write the combined  ${}^{Tool}T_{Base}$  matrix.

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|---|-----|
| (b) Explain types of training needed and maintenance required for robotics application. | 10M |
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- Q4)(a) Explain different types of classical controllers used in robotics. 10M
- (b) Justify use of industrial robot in place of human for continuous arc welding. 10M
- Q5)(a) Explain effects of industrial robots on economic costs and direct labour. 10M
- (b) Write a textual programming for the robot to pick up parts from an incoming conveyor and deposit them on pallet. The pallet has four rows 40 mm apart and five columns 50 mm apart. The plane of pallet is assumed to be parallel to the xy plane. The objects to pick up are 25 mm tall. 10M
- Q6)(a) What are AS/RS and its elements? Explain its types. 10M
- (b) Explain the steps that a company can follow in order to implement robotic system in its operation. 10M
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