

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : This question paper carries five sections. Attempt any five questions selecting at least one question each from section A, B, C and D. Section E is compulsory. Assume any suitable missing data if any. Use of non-programmable calculator is allowed.

SECTION - A

1. (a) Discuss the various elements of the automation. (3)
- (b) Define the term 'automation'. Discuss the key differences between hard automation and soft automation in terms of design flexibility, production volume, and system adaptability. (7)
2. (a) Describe the working principle of a pneumatic manipulator. How does compressed air generate motion in such systems? (6)
- (b) Enlist the desirable features of the pneumatic manipulators. (4)

SECTION - B

3. Classify the robots according to the coordinates of motion with a sketch and explain the features of each type. (10)
4. (a) What are the key components of a motion control system? Explain their functions. (6)

- (b) Explain the concept of interpolation in motion control. (4)

SECTION - C

5. (a) A spatial 3 DOF spraying robot has been designed as illustrated in Fig. 1. (i) Create the DH parameter table for the robot and (ii) Obtain the final transformation matrices by using direct kinematic analysis. (5)

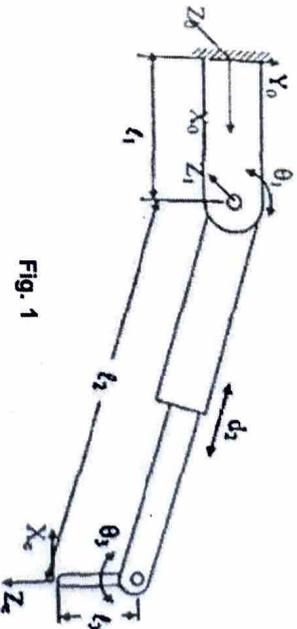


Fig. 1

- (b) Explain DH convention briefly to write down general homogeneous transformation matrix. (5)
6. (a) A frame is represented by $F = \begin{bmatrix} ? & 0 & ? & 3 \\ 0.5 & ? & ? & 9 \\ 0 & ? & ? & 7 \\ 0 & 0 & 0 & 1 \end{bmatrix}$. Find the missing values using properties of the frame. (3)
- (b) The co-ordinates of a point r_{abc} is given by $(7, 5, 3)^T$ which is rotated about the OX-axis of the reference frame OXYZ, by angle of 60° . Determine the co-ordinates of the point r_{xyz} . (3)
- (c) Discuss the Roll, Pitch, Yaw (RPY) angles. (4)

[P.T.O.]

SECTION - D

7. (a) Derive the inverse kinematics equations for a SCARA robot with two rotational joints and one prismatic joint. Show all the necessary steps. (7)

- (b) Calculate the inverse of the following transformation:

$$T = \begin{bmatrix} \frac{\sqrt{3}}{2} & -1 & 0 & 5 \\ 2 & 2 & 0 & 5 \\ 1 & \frac{\sqrt{3}}{2} & 0 & 4 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (3)$$

8. (a) Explain the payback method used in economic analysis and illustrate it with an appropriate example. (5)
- (b) Discuss two applications of the robots in processing operations. (5)

SECTION - E (Compulsory)

9. Briefly explain:
- (a) Work envelop
 - (b) Equivalent uniform annual cost method
 - (c) Roll Motion
 - (d) Manipulator
 - (e) Screw transformation
 - (f) Laws of robotics
 - (g) Disadvantages of automation
 - (h) Degree of freedom
 - (i) Continuous Path motion trajectory in robotics
 - (j) Five-axis articulated robot
- (10×2=20)