

Time: 3 hours

Marks: 80

N.B.: (1) Question No. 1 is **Compulsory**.(2) Attempt any **three** questions out of the remaining **five**.

(3) Each question carries 20 marks and sub-question carry equal marks.

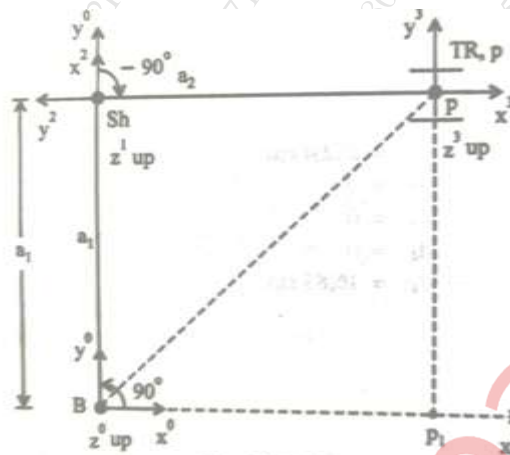
(4) Assume suitable data if required.

1. Solve **ANY FOUR** sub-questions from the following **(20)**
- (a) Explain with a neat sketch Kinematic diagram of a manipulator. **(5)**
- (b) Explain four kinematic parameters defined by D-H representation. **(5)**
- (c) 4-3-4 polynomials boundary conditions in a pick and place operation in time. **(5)**
- (d) Explain Perspective Transformation in detail **(5)**
- (e) Explain Run Length Encoding Algorithm in detail. **(5)**
2. (a) Explain Edge Detection Algorithm in detail. **(10)**
- (b) Explain Denavit-Hartenberg Algorithm in detail **(10)**
3. (a) Explain Generalized Voronoi Diagram in detail **(10)**
- (b) What are the template matching techniques? Explain Normalized Cross Correlation in detail for an image **(10)**
- $$\begin{bmatrix} 2 & 1 & 0 & 0 & 3 \\ 0 & 0 & 5 & 0 & 0 \\ 0 & 4 & 0 & 6 & 0 \\ 1 & 0 & 5 & 0 & 0 \end{bmatrix}$$
- For a mask/template
- $$\begin{bmatrix} 0 & 4 & 0 \\ 3 & 0 & 5 \\ 0 & 4 & 0 \end{bmatrix}$$
4. (a) A robot joint has to move from an initial angle of $\theta_0=30^\circ$ to the final value of $\theta_f=150^\circ$ in 5 seconds. Find the cubic polynomial to generate smooth trajectory for the joint. Assume zero velocity at the starting and ending of the path. What is maximum velocity and acceleration for this trajectory? **(10)**
- (b) Explain Fine Motion Planning in detail. **(10)**

- 5 (a) Explain Shrink operators, their usage and comment on convergence for the image given below (10)

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

- (b) For the three axis planer articulated robot shown in the figure, Find the joint variables q when the first two links form a right angled triangle, given TCV as $W(q) = \{a_2, a_1, d_3, 0, 0, 1\}^T$. (10)



6. Write short note on ANY TWO of the following. (20)

- (a) A* search Algorithm (10)
 (b) Tangent Bug Algorithm (10)
 (c) Fine motion planning (10)
