[Total Marks: 80]

(3 Hours)

N.B.   (1) Question No. 1 is compulsory.

   (2) Attempt any three questions from remaining.

   (3) All questions carry equal marks.

   (4) Assume suitable data wherever necessary.

1. Answer any **four** of the following:

(a) Explain why inverse kinematic solution is not unique for generic robots.   5

(b) Define joint and link parameters.   5

(c) Differentiate between the robots direct and inverse dynamics problem.   5

(d)Explain Reach and Stroke of a robot.   5

(e) Define pixel function, shrink operator and swell operator.   5

2. a) Find the position of the tool tip of the Adept one robot when the joint variables are   10

$$q= [\; \frac{\pi}{4} \; ,-\frac{\pi}{3} \; ,120, \; \frac{\pi}{2} \;]^{T}$$

Given d= [877, 0.0, d3, 200]^{T} mm and a= [425, 375, 0.0, 0.0]^{T} mm.

   b) Obtain the inverse kinematics analysis of a 3 axis planar articulated robot   10

3. a) Formulate the dynamic model of a simple one axis robot.   10

   b) Consider a 3 axis planar articulated robot. The tool configuration function   10

   of this robot is as follows:

$$W(q) = \begin{bmatrix} a1c1 + a2c12 \\ a1s1 + a2s12 \\ d3 \\ 0 \\ 0 \\ \exp(\frac{q3}{\pi}) \end{bmatrix}$$ Find the tool configuration Jacobian matrix V (q).

4. a) Explain robot motion planning using Bug 1 and Bug 2 algorithm. 10

 b) What is a GVD? Sketch all the GVD's resulting due to the basic 10

   interactions of the obstacle .Derive the necessary equations.

5 .a) What are moments of an image? How the moments are used in the 10

   shape analysis of objects?

 b) Explain the 4 point minimal PNP trajectory for pick and place 10

   of objects by using a robot manipulator.

6 . Write short notes on any **four** of the following: 20

   (a) Potential functions.

   (b) Wave front planner.

   (c)Template matching.

   (d)Cartesian space trajectory

   (e)Edge detection