(3 hours) [80M]

N. B 1 Question No. 1 is compulsory.
    2 Attempt any three questions from the remaining five questions.
    3 Assume suitable data if necessary.
    4 Figures to the right indicate full marks

Q.1 a Explain classification of Robots. (5M)
    b Explain with suitable example iterative processing. (5M)
    c Define Kinematic parameters. (5M)
    d Explain the term singularities. (5M)

Q.2 a Develop D.H algorithm for 4-axis SCARA robot, write its parameter table and find its arm matrix. (12M)
    b Let F= $\{f^1, f^2, f^3\}$ and M= $\{m^1, m^2, m^3\}$ be initially coincident fixed and mobile orthonormal coordinate frames, respectively. Suppose we perform a screw transformation along axis f^2 translating by $\lambda = 3$ and rotation by an angle of $\pi/2$. Find $[m^3]^F$ following the screw transformation, and determine the pitch of the screw. (8M)

Q.3 a With a suitable example explain differential motions of a frame with respect to (12M)
        1.Differential translation
        2.Differential rotation
        3.Differential transformations
    b (8M)
        Explain Jacobian matrix and calculate the linear and angular differential motions of the robot's hand frame for the given joint differential motions.

$$J = \begin{bmatrix} 2 & 0 & 0 & 0 & 1 & 0 \\ -1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad D_\Theta = \begin{bmatrix} 0 \\ 0.1 \\ -0.1 \\ 0 \\ 0 \\ 0.2 \end{bmatrix}$$

Q.4 a Give Comparison between Bug Algorithms. (10M)
    b Derive the dynamic equation of motion using Newton-Euler formulation. (10M)

Q.5 a Explain Joint-space versus Cartesian-Space Descriptions (10M)
    b What is Visibility graph? Explain algorithm to construct visibility graph. (10M)

Q.6   Write short note on   (20M)
   a. Template matching
   b. Path versus Trajectory
   c. Generalized Voronoi diagram
   d. Inverse Kinematic of Robot