

Total No. of Questions : 8]

SEAT No. :

PE2701

[Total No. of Pages : 2

[6583]-251

T.E. (Robotics and Automation)

ROBOT KINEMATICS AND DYNAMICS

(2019 Pattern) (Semester - V) (311503A)

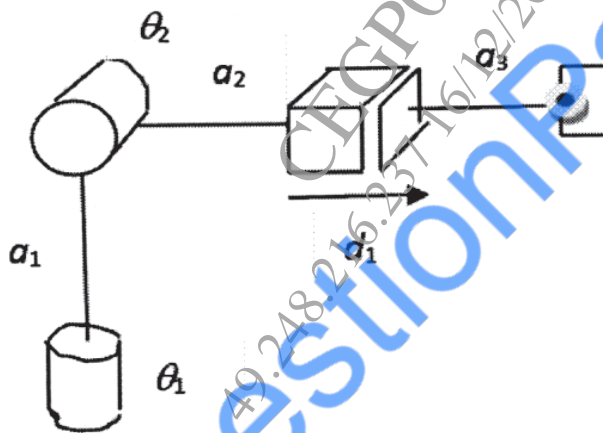
Time : 2 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.
- 2) Neat diagrams must be drawn wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of calculator is allowed.
- 5) Assume suitable data if necessary.

- Q1) a) What is inverse kinematics problem? What are advantages of using metaheuristic methods over numerical methods to solve inverse kinematics problems? [6]
- b) For the kinematic diagram of robot as shown in Fig., Obtain the values of joint parameters θ_1 , θ_2 , and d to bring the end effector to position (1.00, 1.10, -1.50). The link lengths are: $a_1=2.5$, $a_2=2$, $a_3=1.25$. [12]



OR

- Q2) a) Explain the steps of steepest descent algorithm to solve inverse kinematics problems. [8]
- b) Genetic algorithm is to be used to minimize the function $z = 3xy + x^2y$ such that $2 \leq x, y \leq 6$. Perform the following: [10]
- i) Generate initial population of 5 solutions in binary coded form with string length as 4.
 - ii) Obtain the decoded values.
 - iii) Convert decoded values into actual values of variables.
 - iv) Obtain the values of objective function z .

P.T.O.

- Q3)** a) Explain the design consideration of electromagnetic grippers. [8]
 b) A vacuum gripper is to be designed to handle flat plate glass in an automobile windshield plant. Each plate weighs 175 N. A single suction cup will be used, and the diameter of the suction cup is 125 mm. Determine the negative pressure required to lift each plate. Use a safety factor of 2 in your calculations. [6]
 c) What are the advantages and limitations of mechanical grippers? [4]

OR

- Q4)** a) Explain the design aspects of pneumatic grippers. [6]
 b) What are various criteria for selection of grippers in robotics applications? [6]
 c) A magnet with 1,000 turns and a cross-sectional area of 0.5 m^2 is operated with 10 amperes of current, 1.5 meters from a piece of metal. [6]

- Q5)** a) What is robot dynamics? What is its significance? [8]
 b) A robot arm with revolute joint is stationary at $\theta = 25^\circ$. It is required to move it to $\theta = 70^\circ$ in 8 seconds. Find the coefficients of cubic polynomial that accomplishes this motion and brings the manipulator to rest at goal point. Hence determine the angular position, angular velocity, and angular acceleration at $t = 3$ seconds. [9]

OR

- Q6)** a) What is gradient of a function? What is its significance? Determine the gradient of a function : [5]
 $4x_1x_2 - 2x_2^2 + 12$ at $x_1 = 3$ and $x_2 = 2$
 b) For a single rotary manipulator link, the gripper force is $= [0, -30 \text{ N}, 0]$, mass of the link $= 30 \text{ Kg}$, Angular velocity of link (ω) $= 6 \text{ rad/s}$, Angular acceleration of link $= -18 \text{ rad/s}^2$, Length of link $= 2 \text{ m}$ with CG located at 0.8 m from joint. Determine the resultant joint reaction force in base co-ordinate system for angular position of 40° . [12]

- Q7)** a) Discuss the balancing of V-engines. [7]
 b) Define the following terms: [10]
 i) Swaying Couple
 ii) Hammer blow
 iii) Tractive force
 iv) Primary balancing
 v) Secondary balancing

OR

- Q8)** a) What is balancing? What are types of balancing? [8]
 b) A circular disc mounted on a shaft carries three attached masses of 4 kg, 3 kg, and 2.5 kg at radial distances of 75 mm, 85 mm and 50 mm and at the angular positions of 45° , 135° and 240° respectively. The angular positions are measured counter-clockwise from the reference line along the x-axis. Determine the amount of the counter mass at a radial distance of 75 mm required for the static balance. [9]

