Total No. of Questions : 8]

SEAT No. :

PA-1606

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[5926]-233

T.E. (Robotics and Automation Engineering)

ROBOT KINEMATICS AND DYNAMICS

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

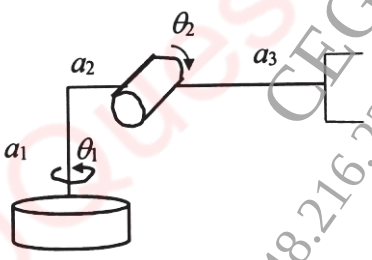
Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Neat diagrams must be drawn wherever necessary.***
2) ***Figures to the right side indicate full marks.***
3) ***Use of Calculator is allowed.***
4) ***Assume Suitable data if necessary.***

Q1) a) Explain the steps of steepest descent algorithm to solve inverse kinematics problem. **[6]**

b) For the robot shown in Figure, use inverse kinematics to obtain the joint parameters θ_1 and θ_2 to bring the robot end effector to the position (23, 16, -10). Consider a_1 = 20 cm, a_2 = 10 cm, a_3 = 35 cm. **[12]**



OR

Q2) a) Determine the gradient of a function $3.x_1^2.x_2 - 5x_2 + 8$ at $x_1 = 2$ and $x_2 = 1$. **[4]**

b) Perform one iteration of pattern search method to minimize $x_1x_2 + 2.x_1^2 - 5$. Consider initial solution as (1, 1) and increment of 0.5. **[10]**

c) What are the input and output parameters for inverse kinematics of SCARA robot? **[4]**

P.T.O.

Q3) a) What are criteria for selection of appropriate actuator for grippers? **[6]**

b) A pneumatic gripper has a cylinder of piston diameter 30 mm and required stroke length is 65 mm. If the gripper force is 425 N, determine the motor power required in HP if it runs with 80 rpm. **[6]**

c) Write short note on: Vacuum grippers. **[6]**

OR

Q4) a) A mechanical gripper having two fingers is used to hold the part weighing 8 kg. The coefficient of friction between the fingers and the part surface is 0.15. The g factor to be used in force calculations should be 3.0. Compute the required gripper force. **[6]**

b) Following data operates for an electromagnetic gripper: **[6]**

- Number of turns of coil = 150
- Average length of each turn of coil = 4 cm
- Permeability of core = 2000
- Magnetic path length = 10 cm
- Operating Current = 1.2 amp

Calculate the maximum retention force.

c) Explain with suitable example the concept of reconfigurable grippers. **[6]**

Q5) a) A robot arm with revolute joint follows cubic polynomial $25+2.109\,t^2-0.175.t^3$. Determine the final angular position of the arm and the time taken by the arm to move from initial position to final position. **[9]**

b) What is inverse robot dynamics? What are input and output parameters for inverse dynamics? **[8]**

OR

Q6) a) For the robot link the gripper force (N) = [0, – 65, 0], mass of the link = 20 Kg, Angular velocity of link (ω) = 5 rad/s, Angular acceleration of link = –12 rad/s^2, Length of link = 1.5 m with CG located at 0.5 m from joint. Determine the resultant joint reaction force in base co-ordinate system for angular position of 50°. **[12]**

b) Explain Lagrangian formulation for manipulator dynamics. **[5]**

Q7) a) Why is balancing of rotating parts necessary for high speed engines? Discuss how a single revolving mass is balanced by two masses revolving in different planes. **[7]**

b) Write a short note on primary balancing and secondary balancing. **[10]**

OR

Q8) a) Discuss the balancing of V-engines. **[7]**

b) A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. **[10]**

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