Total No. of Questions : 8]

SEAT No. :

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[6262]-318

T.E. (Robotics and Automation)

ROBOT KINEMATICS AND DYNAMICS

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

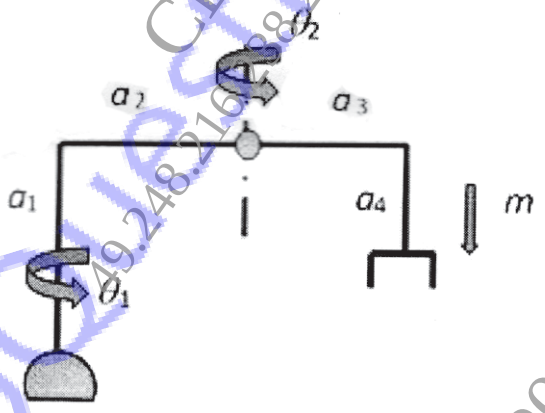
Time : 2½ Hours] *[Max. Marks : 70*

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) Explain steps of pattern search algorithm to solve inverse kinematics problems. **[6]**

b) For the kinematic diagram of a robot shown in Fig.. obtain the inverse kinematic equations for joint parameters θ_1, θ_2. and m to bring the end effector to position (1.70, 1.87, 1.70). The link lengths are: $a_1 = 2$, $a_2 = 1.5$, $a_3 = 1.2$, $a_4 = 0.1$. **[12]**



OR

Q2) a) Perform one iteration of a steepest descent algorithm to minimize function $f = 2x_1^2.x_2 - 6x_1$. Consider initial solution as: $x_1 = 1$, $x_2 = 1$. **[10]**

b) Explain Roulette wheel selection as a reproduction operator in genetic algorithm. **[8]**

P.T.O.

Q3) a) Obtain the gripper force to hold a part weighing 50 N using friction against two opposing fingers. The coefficient of friction between the fingers and the part surface is 0.2. **[8]**

b) A pneumatic gripper has a cylinder of piston diameter 15 mm and required stroke length is 540 mm. The gripper force is 200 N, Detemine the motor power required in HP if it runs with 40 rpm. **[6]**

c) What are the advantages and limitations of mechanical grippers? **[4]**

OR

Q4) a) Explain the design aspects of Electromagnetic grippers. **[6]**

b) What are various criteria for selection of grippers in robotics applications? **[6]**

c) Determine the number of suction cups required for a vacuum gripper shown in Figure, to hold a mass of 20 Kg. Consider diameter of cup to be 50 mm, applied pressure is of 0.7 bar and coefficient of friction between cup and work surface is 0.2. **[6]**

Q5) a) What is robot inverse dynamics? How it is useful in robot design? **[8]**

b) A robot arm with revolute joint is stationary at $\theta = 20°$. It is required to move it to $\theta = 50°$ in 6 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 $t = 2$ seconds. **[9]**

OR

Q6) a) Explain by means of an example the concept of dynamic equation of motion for a robot. **[5]**

b) For a planer robot having two prismatic joints as shown in figure, determine the force on each link at time $t = 3$ sec. considering the mass of the link 1 as 4 kg and mass of link 2 as 3 kg. The equation of Joint angle for link 1 is $q_1 = 0.3t^3 - 0.2t + 16$ and equation of Joint angle for link 2 is $q_2 = 0.1t^3 - 0.3t + 10$. **[12]**

Q7) a) Explain clearly the terms 'static balancing' and 'dynamic balancing'. State the necessary conditions to achieve them. **[9]**

b) Explain the method of balancing of different masses revolving in the same plane. **[8]**

OR

Q8) a) Write note on : Balancing machines. **[5]**

b) A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190°, both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine: **[12]**

i) The magnitude of the masses at A and D;

ii) The distance between planes A and D ; and

iii) The angular position of the mass at D.

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