Total No. of Questions : 8]

SEAT No. :

P425

[Total No. of Pages : 3

[6003]-522
T.E. (Robotics and Automation)
ROBOT KINEMATICS AND DYNAMICS
(2019 Pattern) (Semester - I) (311503 (A))

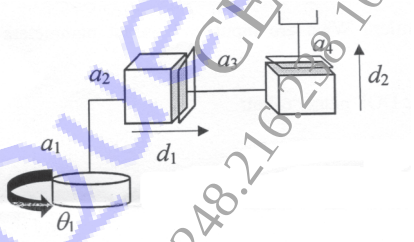
Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q7 or Q.8.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) Draw flowchart and explain the steps of pattern search algorithm for solving inverse kinematics problems. **[6]**

b) For the robot shown in Figure, use inverse kinematics to obtain the joint parameters θ_1, d_1 and d_2 to bring the robot end effector to the position (37.9, 45.2, 46). Consider a_1 = 30 cm, a_2 = 15 cm, a_3 = 40 cm, a_4 = 10 cm. **[12]**



OR

Q2) a) What is inverse kinematics problem? Explain various approaches to solve inverse kinematics problem. **[6]**

b) In a genetic algorithm, calculate the value of $z = 3x_1^2.x_2 - 5x_2 + 10$ if the coded values of x_1 and x_2 are 10011 and 00101 respectively. Consider $3 \le x_1 \le 6$ and $1 \le x_2 \le 5$. **[6]**

c) What is the gradient of a function? What is its significance? **[6]**

P.T.O.

Q3) a) Explain the principle of working of electromagnetic grippers. What are advantages and disadvantages of using these grippers? **[8]**

b) A mechanical gripper having two fingers is used to hold the part weighing 5 kg. The coefficient of friction between the fingers and the part surface is 0.25. The g factor to be used in force calculations should be 3.0. Compute the required gripper force. **[6]**

c) What are the limitations of friction based grippers? **[4]**

OR

Q4) a) A vacuum gripper is used to hold a part having mass 100 kg. Determine the number of suction cups required if the applied pressure is 0.9 bar, Coefficient of friction between part and cup surface is 0.35 and the diameter of each vacuum cup is 80 mm. **[6]**

b) Write short note on: Mechanical grippers. **[6]**

c) Explain the principal of working of acoustic sensor to measure the distance of the object from the gripper. **[6]**

Q5) a) Determine the angular position, angular velocity, and angular acceleration of a robot arm with revolute joint at t =4 seconds if it rotates from 20° to 65° in 10 seconds. **[9]**

b) Explain Lagrangian formulation for manipulator dynamics. **[8]**

OR

Q6) a) What is forward robot dynamics? What are input and output parameters for forward dynamics? **[5]**

b) Following data operates for a 2 DOF planer robot: **[8]**

- Length of link 1=0.5 m
- Length of link 2=0.3 m
- Mass of link 1=1.5 kg
- Mass of link 2=1.2 kg
- Angular position of link 1=30°
- Angular position of link 1=65°

If the links are of rectangular cross section with negligible width and height, determine the inertia tensor of link 1 in the base co-ordinate system.

c) Explain the Recursive Newton-Euler algorithm to derive manipulators dynamic equations of motion. **[4]**

Q7) a) Explain clearly the terms 'static balancing' and 'dynamic balancing'. State the necessary conditions to achieve them. **[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) How the different masses rotating in different planes are balanced? **[8]**

b) Four masses m_1, m_2, m_3 and m_4 are 100 kg, 200 kg,160 kg and 170 kg respectively. The corresponding radii of ratation are 0.25 m, 0.16 m, 0.30 m and 0.32 m respectively and the angles between successive masses are 30°, 45° and 125°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. **[9]**