SET - 1

Code No: 2420307

IV B. Tech II Semester Regular Examinations, April/May 2009
ROBOTICS
(Mechanical Engineering)

Time: 3 Hours **Max. Marks 80**

Answer any FIVE questions
All questions carry equal marks
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1. (a) What is industrial automation? Compare hard automation with soft automation. [8]
   (b) Describe the advanced technological features and applications of modern robots? [8]
2. (a) Briefly describe the various robot components. [10]
   (b) Define 'degrees of freedom'. How do you calculate the degrees of freedom of a robot manipulator? [6]
3. (a) Find the transformation matrices for the following operations on the point $4\hat{i}+9\hat{j}-3\hat{k}$. i) Rotate 45^o about x-axis and then translate 3 units along z-axis. ii) Translate -4 units along x-axis and rotate 60^o about x-axis. [8]
   (b) State and prove the properties of a rotation matrix. [8]
4. Obtain the kinematic equations using the homogeneous transformations for the spherical arm shown in Fig. 1. [16]

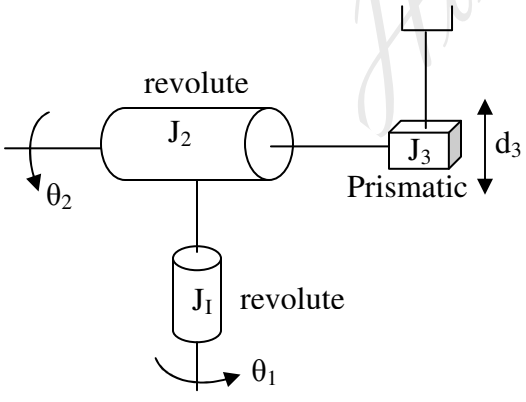

Fig. 1

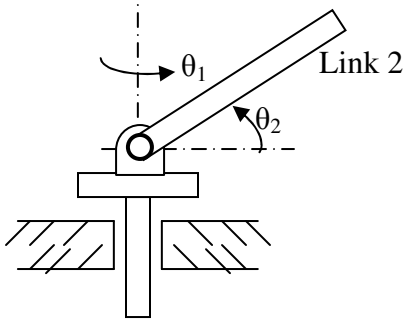

Fig. 2

SET - 1

Code No: 2420307

5. For the two-degree of freedom 2R manipulator shown in Fig. 2, assume that the inertia of the first moving link is negligible and that the second moving link is a slender homogeneous rod of mass 'm'. Obtain the dynamical equations of motion by recursive Newton-Euler method. [16]

6. The trajectory of a particular joint is specified as follows: path points in degrees are 10, 40, 30, and 15. The duration of these segments should be 3, 1, and 2 seconds, respectively. The magnitude of the default acceleration at all blend points is 40 degrees/second^2. Calculate all the segment velocities, blend times and linear times. [16]

7. (a) Explain the following hydraulic actuators with neat sketches [8]
   (i) Linear actuator (ii) rotary actuator
   (b) Write about the direct-current (dc) and alternating current (ac) tachometers.[8]

8. (a) What are the features and capabilities that an industrial robot must possess to perform arc welding? (8)
   (b) Discuss the applications of a robot in automated assembly operations? (10)

SET - 2

Code No: 2420307

IV B. Tech II Semester Regular Examinations, April/May 2009

ROBOTICS

(Mechanical Engineering)

Time: 3 Hours **Max. Marks 80**

Answer any FIVE questions

All questions carry equal marks

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1. (a) Give the classification of robots by coordinate system and describe the features of each type. [8]

   (b) Discuss the advantages and disadvantages of using the robots in industry.[8]

2. (a) Dicuss briefly about the grippers and give its classification. [8]

   (b) Show the degrees of freedom for the following joints with the help of neat sketches [8]

   (i) Prismatic joint

   (ii) Revolute joint

   (iii) Cylindrical joint

   (iv) Spherical joint

   (v) Planar joint

   (vi) Screw joint

3. (a) Determine a matrix T that represents a rotation of α angle about x- axis, followed by a translation of *b* units of distance along the z-axis, followed by a rotation of θ angle about the y-axis. [8]

   (b) Find the transformation matrices for the following operations on the point $-4\hat{i}+8\hat{j}+5\hat{k}$. i) Rotate 45^{o} about x-axis and then translate -5 units along y-axis. ii) Translate 7 units along y-axis and rotate 60^{o} about x-axis. [8]

4. A spatial 3-R manipulator is shown in Fig. 1. Obtain the D-H parameters and the kinematic equations. [16]

SET - 2

Code No: 2420307

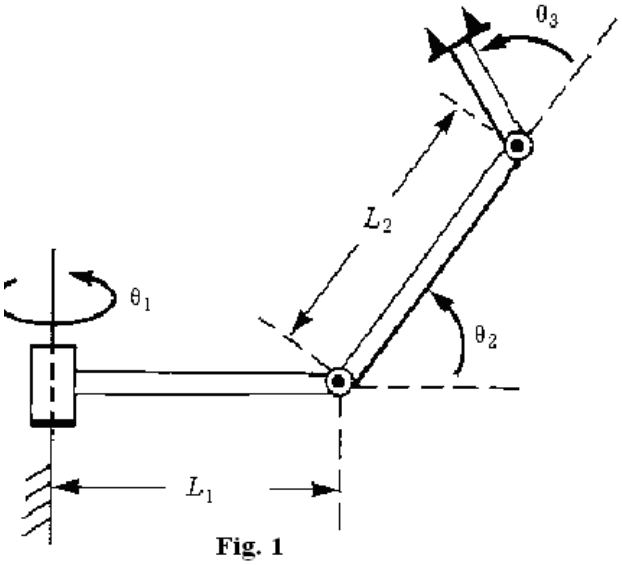

Fig. 1

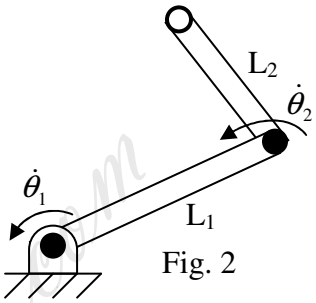

Fig. 2

5. A two-link planar arm is shown in Fig. 2. Calculate the velocity of the tip of the arm as a function of joint rates. [16]

6. (a) Compute the time law q(t) for a joint trajectory with velocity profile of the type $\dot{q}(t) = a(1-\cos(\alpha t))$ from q(0) = 0 to q(2) = 4. [8]

   (b) The values for the joint variables are: q(0) =0, q(2) =2, q(4) =3. Compute the cubic interpolating spline with zero initial and final velocities andaccelerations.[8]

7. (a) Give a brief classification of actuators used in robots. [8]

   (b) Explain the principal features of different position sensors. [8]

8. (a) What are the general considerations in robot material handling? Explain? [8]

   (b) What are technical and economic problems encountered in applying robots to arc welding? [8]

SET - 3

Code No: 2420307

IV B. Tech II Semester Regular Examinations, April/May 2009
ROBOTICS
(Mechanical Engineering)

Time: 3 Hours **Max. Marks 80**

Answer any FIVE questions
All questions carry equal marks
****

1. (a) Give the classification of robots based on control system and describe their characteristic features. [8]
   (b) Describe the present day industrial applications of robots. [8]

2. (a) Explain the selection criteria of end-effectors in robotics. [8]
   (b) Describe the common types of robot arms. [8]

3. (a) Determine the homogeneous transformation matrix to represent the following the sequence of operations:
   (i) rotation of 45^o about x-axis
   (ii) translation of 6 units along x- axis
   (iii) translation of –3 units along z-axis
   (iv) rotation of 30^o about y-axis [8]
   (b) Find the rotation matrix corresponding to the set of Euler angles ZYZ and solve the inverse problem to determine the set of Euler angles corresponding to a given rotation matrix $R = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$ [8]

4. Find the direct kinematics equation of the four-link closed chain planar arm shown in Fig. 1. The two links connected by the prismatic joint are orthogonal to each other.[16]

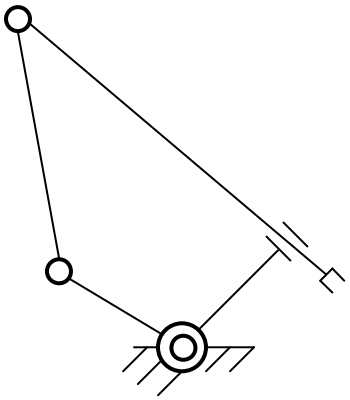

Fig. 1

5. Determine the 3x3 jacobian that calculates linear velocity of the tool tip from the three joint rates for the manipulator shown in Fig. 2. [16]

SET - 3

Code No: 2420307

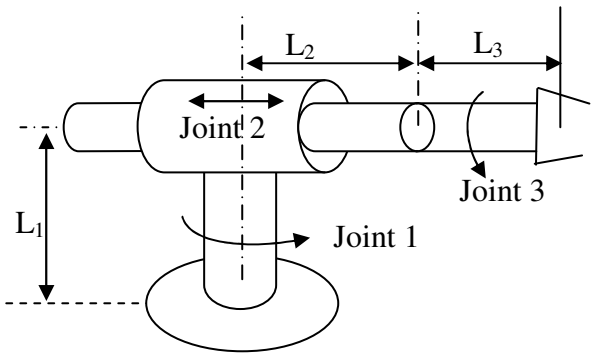

Fig. 2

6. (a) Compute the time law q(t) for a joint trajectory with velocity profile of the type $\dot{q}(t) = k \cos(\alpha t)$ from $q(0) = 0$ to $q(2) = 3$. [8]
   (b) Explain different methods used in robot programming for defining positions in space. [8]

7. (a) Explain the operating principle of stepper motor used in robots. [8]
   (b) What is a resolver? Explain its operating principle. [8]

8. (a) Discuss the considerations to be made while designing for robotic assembly. [8]
   (b) Explain the robotic contact arc welding sensor system? [8]

SET - 4

Code No: 2420307

IV B. Tech II Semester Regular Examinations, April/May 2009
ROBOTICS
(Mechanical Engineering)

Time: 3 Hours **Max. Marks 80**

Answer any FIVE questions
All questions carry equal marks
****

1. (a) Give the classification of robots by coordinate system and describe the features of each type. [8]

   (b) Describe the present day industrial applications of robots. [8]

2. (a) Describe the degrees of freedom of a robot wrist with the help of a neat sketch. [8]
   (b) Describe the common types of robot arms. [8]

3. (a) Find the rotation matrix corresponding to the set of Euler angles ZYX [6]
   (b) Compute the rotation matrix to represent a rotation of 90^o about an arbitrary vector $\hat{a} = 20\,\hat{i} - 15\hat{j} + 20\hat{k}$. [6]
   (c) Verify that a rotation matrix R_k that describes the elementary rotation, θ about an axis $\boldsymbol{k}$ follows the property, $R_k(-\theta) = R_k(\theta)$. [4]

4. Solve the inverse kinematics for the two-link arm shown in fig. 1. [16]

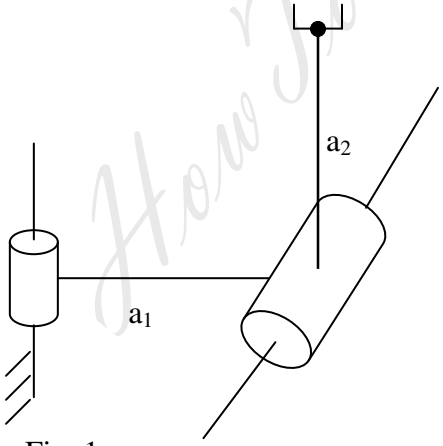

Fig. 1

5. (a) Find the inertia matrix of a right cylinder of homogeneous density with respect to a frame with origin at the center of mass of the body. Given the radius and the length of the cylinder as 'a' and 'L'. [6]

   (b) Obtain expressions for the linear and angular accelerations of a link *i*. [10]

Code No: 2420307

SET - 4

6. (a) Explain the differences between robot programming and traditional programming. [8]

   (b) A single cubic trajectory is given by $\theta(t) = 10 + 90\,t^2 - 40\,t^3$ and is used over a time interval from $t = 0$ to $t = 2$ seconds. What are the starting and final positions, velocities and accelerations? [8]

7. (a) Explain the characteristic features of pneumatic actuators used in robots. [8]

   (b) Differentiate between incremental and absolute encoders. [8]

8. (a) What are the general considerations in robot material handling? Explain? [8]

   (b) Explain how robotics can be applied to inspection automation? [8]