Code No. M0324 /R07 **R07** **Set No.1**

IV B.Tech I Semester Supplementary Examinations, February/March, 2011

ROBOTICS

(Mechanical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Write the Asimov's laws of robotics. [4]
   (b) Explain how automation and robotics are related. [5]
   (c) Explain the classification of robots by coordinate system. [7]

2. (a) Describe the degrees of freedom associated with the four common robot configurations with help schematic diagrams. [8]
   (b) Differentiate between hydraulic and pneumatic drive systems used in robots [8]

3. (a) Find the rotation matrix that represents the rotation of ∅ angle about the vector $\bar{r} = [1, 1, 1]^{T.}$ [8]
   (b) Find a homogeneous transformation matrix that represents a rotation of '∝' angle about the OX axis, followed by a translation of '*a*' units along the OX axis, followed by a translation of '*d*' units along the OZ axis, followed by a rotation of 'θ' angle about the OZ axis. [8]

4. Obtain D-H parameters for a three link planer arm shown in Fig.1. Determine the direct kinematics equation.

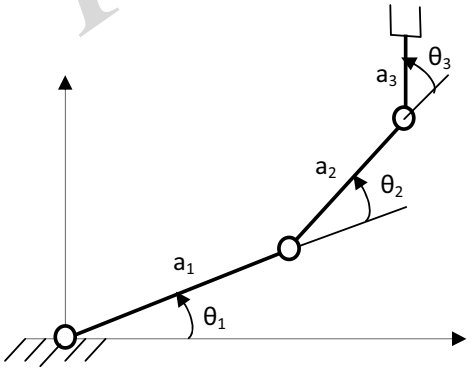

Fig. 1

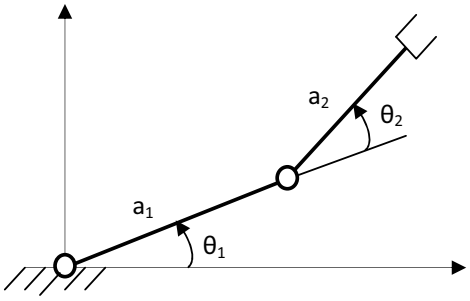

Fig. 2

Code No. M0324 /R07 **R07** **Set No.1**

5. (a) What is a Jacobian ? [4]
   (b) Compute the Jacobian for a two link planar arm shown in Fig. 2. [12]

6. (a) A point to point robot with a revolute joint moving with velocity of 15 deg/sec , traverses from an initial position of 12^0 to a final position of 60 deg/sec. Determine the position and velocity at the end of 1,2 and 3 seconds. The range of initial and final position is covered in 6 seconds with a finite acceleration of 8 deg/sec^2. [8]
   (b) Explain different methods of Robot programming. [8]

7. (a) Explain the working principle of a stepper motor used in robots [8]
   (b) Differentiate between absolute and incremental encoders. [8]

8. (a) What are the general considerations in robot material handling? Explain? [8]
   (b) What are the desirable features of a robot for successful machine tool load/unload applications? [8]

Code No. M0324 /R07 **R07** **Set No.2**

IV B.Tech I Semester Supplementary Examinations, February/March,2011

ROBOTICS

(Mechanical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

*****

1. (a) Explain the classification of industrial robots according to their control Systems. [8]
   (b) Explain the following with examples.
   (i) Fixed automation. [4+4]
   (ii) Flexible automation.

2. (a) What is an end effector of robot? [3]
   (b) Describe different types of grippers. [8]
   (c) Give the line diagrams of (i) Articulated robot (ii) SCARA. [5]

3. (a) If $a_{xyz} = [4,3,2]^T$, $b_{xyz} = [6,2,4]^T$, are the co-ordinates of two points with respect to the reference frame OXYZ, determine the corresponding points with respect to the rotated OUVW mobile frame if it has been rotated 60^0 about the OZ axis. [8]
   (b) A matrix is to be determined that represents a rotation of $\propto$ angle about the OX axis, followed by a translation of '*b*' units along the rotated OV axis [8]

4. Obtain D-H Parameters for the spherical arm shown in Fig. 1 and determine the direct Kinematics equations. [16]

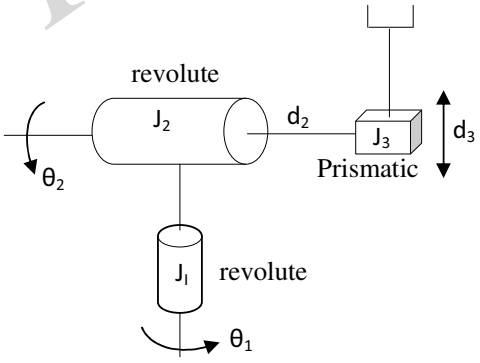

Fig. 1

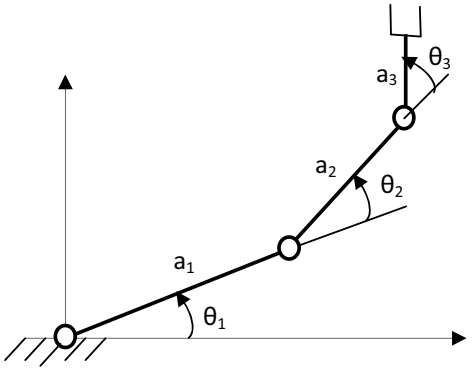

Fig. 2

Code No. M0324 /R07 **R07** **Set No.2**

5. Compute the Jacobian for 3-link planar arm shown in Fig. 2.

6. (a) Compute the time law q(t) for a joint trajectory with velocity profile of the type $\dot{q}(t) = k\sin(\alpha t)$ from q(0) = to q(3) = 4 [8]
   (b) What are the capabilities and limitations of lead through programming methods? [8]

7. (a) Explain about electric servomotors employed in robots. [8]
   (b) Discuss about velocity transducers. [8]

8. (a) Explain the requirements of a robot for spray-coating applications? [8]
   (b) Explain the robotic arc- sensing systems? [8]

Code No. M0324 /R07 **R07** **Set No.3**

IV B.Tech I Semester Supplementary Examinations, February/March,2011

ROBOTICS

(Mechanical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

*****

1. (a) Give the definition of an industrial provided by RIA. [4]
   (b) Differentiate between fixed automation and programmable automation automation. [6]
   (c) Enumerate the industrial applications of robot [6]

2. (a) Explain the basic components of a robot. [8]
   (b) Discuss the factors to be considered in the selection of grippers. [8]

3. (a) List the properties of rotation matrices. [8]
   (b) A mobile body reference frame OABC is rotated 45^0 about OY axis of the fixed base reference frame OXYZ. If $P_{xyz} = [2,4,6]^T$ and $Q_{xyz} = [359]^T$ are the coordinates with respect to OXYZ frame, determine coordinates of P and Q with respect to the OABC frame. [8]

4. Determine the D-H parameters for the parallelogram arm shown in Fig.1 and obtain the direct kinematics equation.

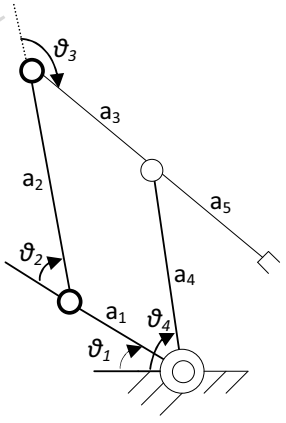

Fig. 1

Code No. M0324 /R07 **R07** **Set No.3**

5. Derive the dynamic equation of motion for a revolute–prismatic robot arm manipulator shown in Fig. 2

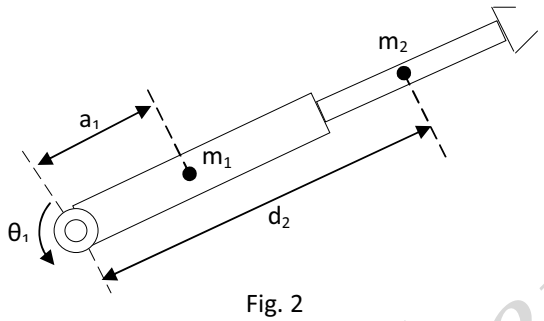

Fig. 2

6. (a) Given the values for the joint variable: q(0) = 0, q(2) =2 and q(4) =3, compute the two fifth order interpolating polynomials with continuous velocities and accelerations. [10+6]
   (b) Explain the WAIT, SIGNAL and DELAY commands used in robot programming.

7. (a) What are various position sensors used in robotic applications? Describe them. [10]
   (b) Differentiate between pneumatic and hydraulic actuators. [6]

8. (a) Discuss the considerations to be made while designing for robotic assembly. [8]
   (b) Discuss the advantages and benefits of robot arc welding. [8]

Code No. M0324 /R07 **R07** **Set No.4**

IV B.Tech I Semester Supplementary Examinations, February/March, 2011

ROBOTICS

(Mechanical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

*****

1. (a) What is the role a robot in industrial automation? Explain. [8]
   (b) Discuss about playback robots. [8]

2. (a) Define the degrees of freedom. Determine the number of degrees of freedom for a SCARA robot. [6]
   (b) List the advantages and disadvantages of electric drive system compared to hydraulic drive system used robots. [5]
   (c) Discuss about mechanical grippers. [5]

3. (a) A Vector P is rotated about Z axis by θ degrees and is subsequently rotated about X- axis by $\emptyset$ degrees. Give rotation matrix which accomplishes these rotations in the given order. [6]
   (b) Determine the axis of rotation and the angle of rotation about the same axis for the following rotation matrix. [4]

$$\begin{bmatrix} \frac{\sqrt{3}}{2} & 0 & 0.5 \\ 0 & 1 & 0 \\ -0.5 & 0 & \frac{\sqrt{3}}{2} \end{bmatrix}$$

   (c) Determine the homogeneous transformation matrix to represent a rotation of 60^0 about OX- axis and a translation of 10 units along the OB-axis of the mobile frame. [6]

Code No. M0324 /R07 **R07** **Set No.4**

4. Solve the direct kinematics problem for the cylindrical arm shown in Fig.1.

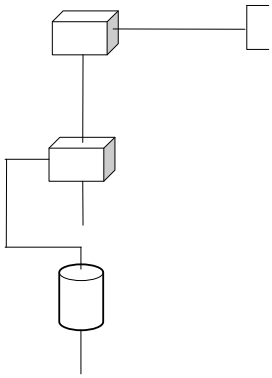

Fig. 1

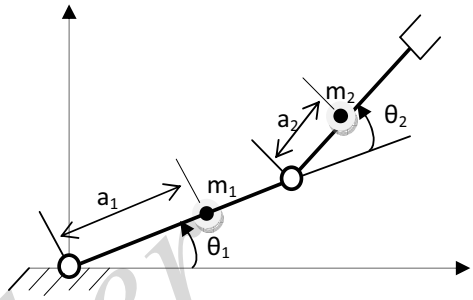

Fig. 2

5. Derive the dynamic equations for the two link manipulator shown in Fig.2. The lengths of the links 1 and 2 are L_1 and L_2 respectively. [16]

6. (a) What are the characteristics of robot task-level languages? Explain. [8]
   (b) A joint of a robot manipulator traverses from an initial position of 20^0 to a final position of 60^0 in 4 seconds. Assumming a fifth degree polynomial and a starting acceleration of 3deg/ sec^2, determine the acceleration at the end of 4 seconds. Take initial and final velocities as zero. [8]

7. Write short notes on [4x4]
   (a) Pneumatic actuators
   (b) Resolvers
   (c) Tachometers
   (d) Stepper motors

8. (a) Explain the requirements of a robot for spray-coating applications? [8+8]
   (b) Describe the problems encountered in the use of robots for arc welding applications?