Code: 17MEMD2T4

PVP 17

I M.Tech - II Semester – Regular Examinations – AUGUST 2018

ADVANCED ROBOTICS
(MACHINE DESIGN)

Duration: 3 hours Max. Marks: 60

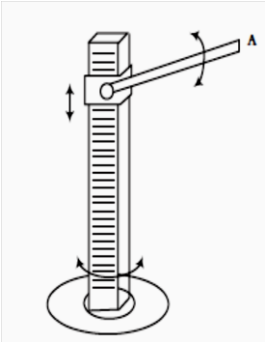
Answer the following questions.

1.a) Incise a short note on the following with neat sketches.
i)Rectangular configuration ii) Spherical configuration. 5 M

b) For the following frame, find the values of the missing elements and complete the matrix representation of the frame: 5 M

$$F = \begin{bmatrix} ? & 0 & ? & 5 \\ 0.707 & ? & ? & 3 \\ ? & ? & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

c) Draw the approximate workspace for the following robot. Assume the dimensions of the base and other parts of the structure of the robot are as shown. 5 M



(OR)

2. a) Illustrate different joints used in robots. 5 M

b) A frame F has been moved 10 units along the y-axis and 5 units along the z-axis of the reference frame. Find the new location of the frame. 4 M

$$F = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 5 \\ 0.369 & 0.819 & 0.439 & 3 \\ -0.766 & 0 & 0.643 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

c) A frame B was rotated about the x-axis by 90^o, then it was translated about the current a-axis 3 inches before it was rotated about the z-axis 90^0. Finally, it was translated about current o–axis 5 inches. 6 M

i) Write an equation that describes the motions.

ii) Find the final location of a point p $(1,5,4)^T$ attached to the frame relative to the reference frame.

3. a) The desired final position and orientation of the hand of a Cartesian-RPY robot is given below. Find the necessary RPY angles and displacements. 10 M

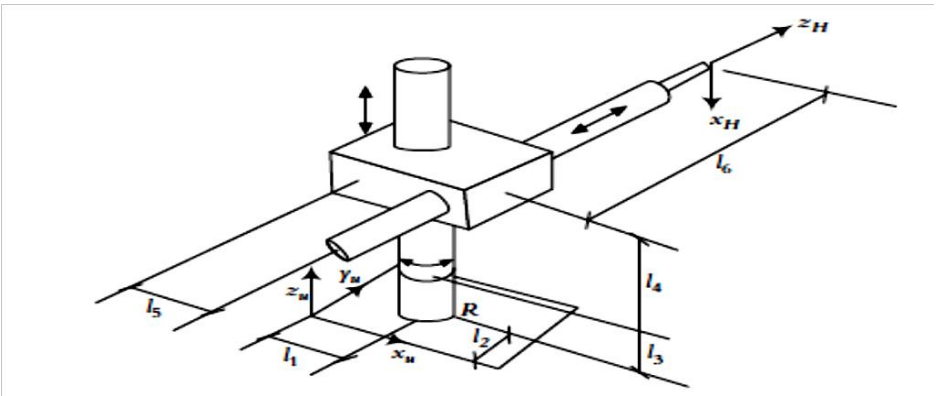
$${}^R T_p = \begin{bmatrix} n_x & o_x & a_x & p_x \\ n_y & o_y & a_y & p_y \\ n_z & o_z & a_z & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0.354 & -0.674 & 0.649 & 4.33 \\ 0.505 & 0.722 & 0.475 & 2.50 \\ -0.788 & 0.160 & 0.595 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

b) Calculate the inverse of the following transformation matrices: 5 M

$$T_1 = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 2 \\ 0.369 & 0.819 & 0.439 & 5 \\ -0.766 & 0 & 0.643 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \text{ and } T_2 = \begin{bmatrix} 0.92 & 0 & 0.39 & 5 \\ 0 & 1 & 0 & 6 \\ -0.39 & 0 & 0.92 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(OR)

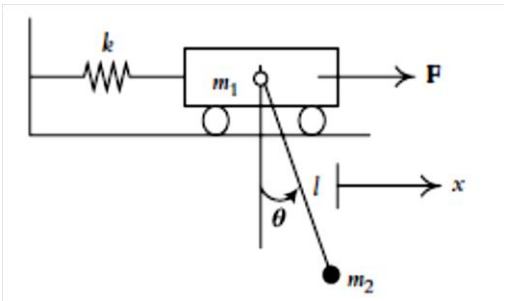
4. a) A 3-DOF robot arm has been designed for applying paint on flat walls, as shown. (i) Assign the coordinate frames as necessary based on the D-H representation. (ii) Fill out the parameters table. (iii) Find the ${}^{U}T_{H}$ matrix. 10 M



b) As a result of applying a set of differential motions to frame T shown, it has changed an amount dT as shown. Find the magnitude of the differential changes made (dx; dy; dz; δx; δy; δz) and the differential operator with respect to frame T. 5 M

$$T = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 0 & 1 & 3 \\ 0 & -1 & 0 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad dT = \begin{bmatrix} 0 & -0.1 & -0.1 & 0.6 \\ 0.1 & 0 & 0 & 0.5 \\ -0.1 & 0 & 0 & -0.5 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

5. a) Derive the equations of motion for the 2-DOF system shown in Figure. 7 M



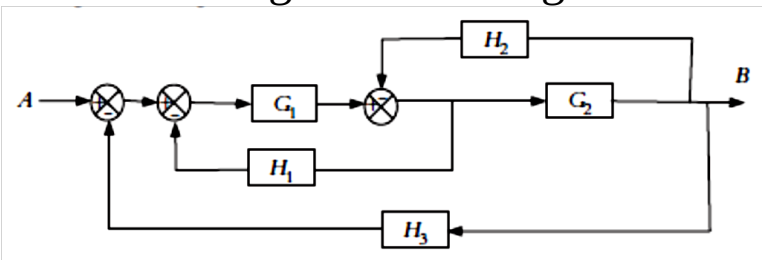
b) It is desired to have the first joint of a 6-axis robot go from initial angle of 30^0 to a final angle of 75^0 in 5 seconds. Using a third-order polynomial, calculate the joint angle at 1, 2, 3, and 4 seconds. 8 M

(OR)

6. a) The third joint of a 5 DOF manipulator is at the start of the cycle. It is to be moved by an angle of 90^0 in 5 seconds. Find the cubic trajectory for the specified motion. Plot position, velocity and acceleration profiles for the motion assuming it is starting from rest and comes to rest at the destination. 8 M

b) Joint 1 of a 6-axis robot is to go from an initial angle of $\theta_i = 30^0$ to the final angle of $\theta_f = 120^o$ in 4 seconds with a cruising velocity of $\omega_1 = 30^0$/sec. Find the necessary blending time for a trajectory with linear segments and parabolic blends and plot the joint positions, velocities, and accelerations. 7 M

7.a) Simplify the block diagram of the Figure shown below. 7 M



b) Brief out about Electric Motors, Servo motors and stepped motors. 8 M

(OR)

8. a) Differentiate hydraulic, electrical and pneumatic actuating systems in robots. 7 M

b) Brief out Sensor characteristics in view of robotics. 8 M