BE Sem VIII ETRX Elective CBGS

Robotics

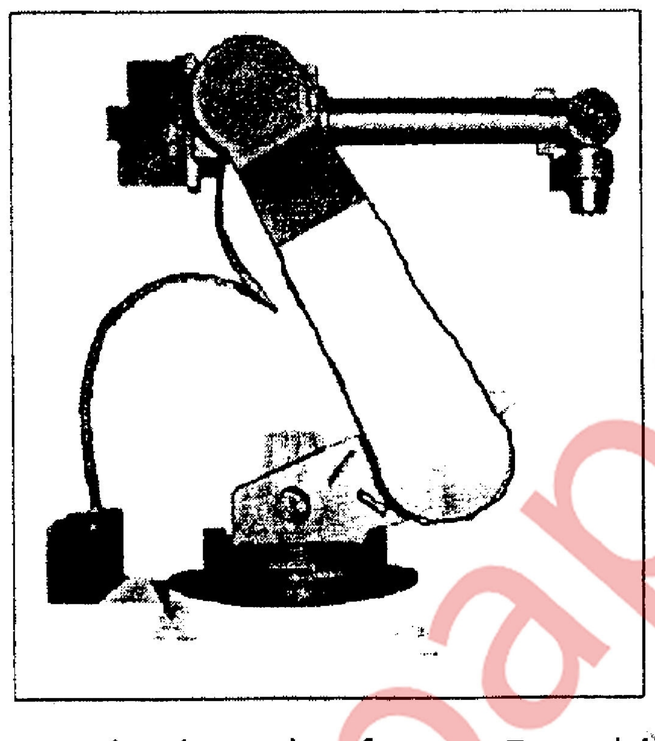
QP CODE : 732400

(3 Hours) [Total Marks: 80]

N. B.: 1. Question No. 1 is compulsory.
2. Attempt any three questions from the remaining five questions.
3. Assume suitable data if necessary.
4. Figures to the right indicate full marks.

Q.1. Answer following questions in brief.

a 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 below. (05)



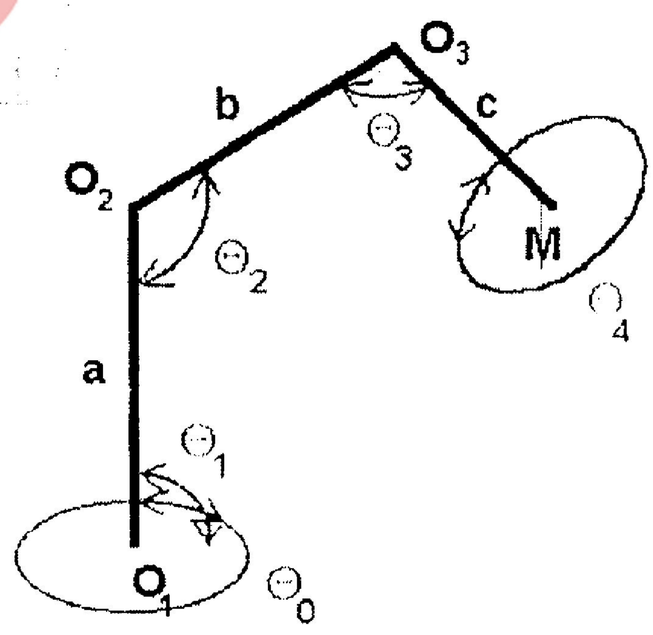
b A point $P(7,3,1)^T$ is attached to the frame F and is subjected to following transformations. Find the coordinates of the point relative to reference frame at the conclusion of transformations. (05)

i Rotation of 90^0 about the z-axis
ii Followed by a rotation of 90^0 about y-axis
iii Followed by a translation 0f [4,-3,7]

c What is potential function? How it is used for navigation of robot? (05)

d What is thresholding? Explain with suitable example. (05)

Q.2. a A 3-DOF robot arm has been designed for applying paint on flat walls, as shown below. (15)



- Assign coordinate frame as necessary based on the D-H representation.
- Write parameter table.

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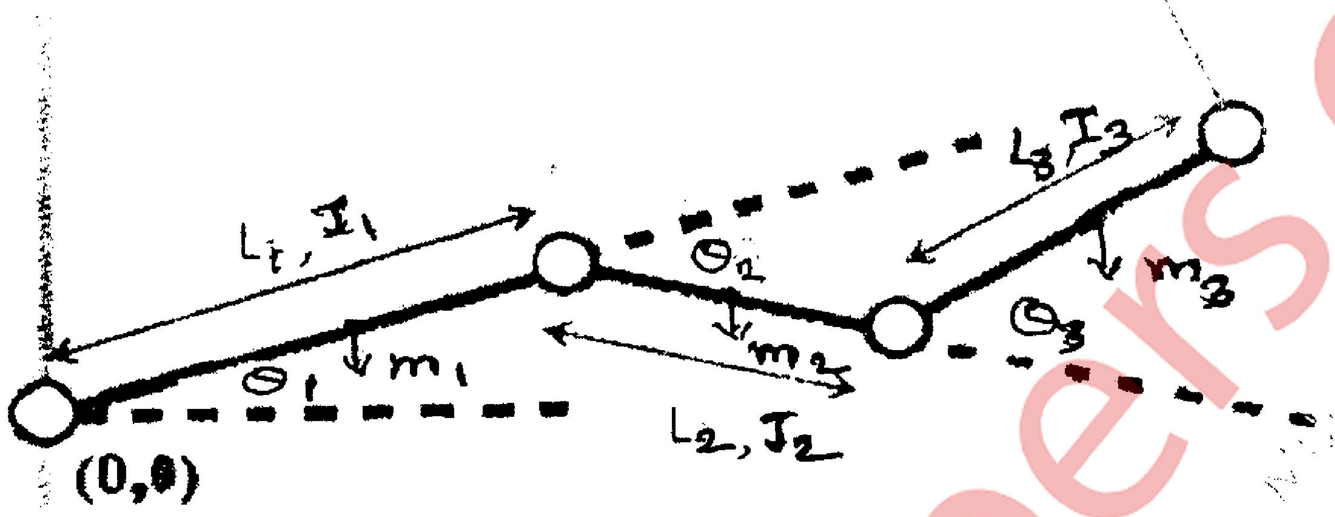
- Write all A matrices.
- Find the ${}^{U}T_{H}$ matrix.

b Define the following terms (05)
- Euler angles
- Articulated joints

Q.3. a Derive the equations of motion for the system shown below: (08)



b A camera is attached to the hand frame T_H of a robot as given. The corresponding inverse Jacobian of the robot at this location is also given. The robot makes a differential motion described as $D\Theta = [0.05 \quad 0 \quad -0.1 \quad 0 \quad 0.1 \quad 0.03]^T$. (12)

i Find which joints must make a differential motion, and by how much, in order to create the indicated differential motion

ii Find the change in the Hand frame

iii Find the new location of the camera after the differential motion

iv Find how much the differential motion should have been instead, if measured relative to Frame T_H, to move the robot to the same location as in part (iii)

$$T_H = \begin{bmatrix} 0 & 1 & 0 & 3 \\ 1 & 0 & 0 & 2 \\ 0 & 0 & -1 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad J^{-1} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 0 & -1 & 0 & 0 & 0 \\ 0 & -0.2 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Q.4. a Explain Tangent Bug algorithm and compare it with Bug2 algorithm. (10)

b Explain Brushfire algorithm. Discuss local minima problem. (10)

Q.5. a What is GVD? Explain sensor-based construction of GVD. (10)

b Explain how you will generate Cartesian-space trajectories. Give simple example. (10)

Q.6. Write short notes on

a Forward and Inverse kinematics (05)

b Langragian Mechanics (05)

c Visibility graph construction (05)

d Wave-front planner (05)

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