314334

Instructions –   (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1.   **Attempt any FIVE of the following :**   **10**

a) State Asimov's laws of robot.

b) Name the types of robot arm configurations.

c) Define Centroids and centre of gravity.

d) Define :

i)   Forward dynamics

ii)   Inverse dynamics

e) Write the expression of the Elementary rotation matrix about the Y axis.

f) Define :

i)   Forward kinematics

ii)   Inverse kinematics

g) State any two differences between Continuous Path Motion and Point to point Motion.

P.T.O.

Marks

2. Attempt any THREE of the following :   **12**

a) State any four safety measures while working with robots.

b) State the steps involved in Forward position analysis.

c) Name Denavit - Hartenberg parameters. Define them.

d) Differentiate Joint space trajectory and Cartesian trajectory planning. (Any four)

3. Attempt any THREE of the following :   **12**

a) Define Force. State the Characteristics of Force.

b) A frame B is rotated about the X axis of the Universal coordinate system by 90 degrees followed by translation by 4, 0, 2 units along X, Y and Z axis of the Universal coordinate system. Find out HTM.

c) A 2 DOF serial manipulator with the links having lengths of L_1 and L_2 has the joint angles represented by θ_1 and θ_2. The end-effector's coordinates are represented by (X, Y) where

$X = L_1 \cos\theta_1 + L_2\cos(\theta_1 + \theta_2)$

$Y = L_1 \sin\theta_1 + L_2 \sin(\theta_1 + \theta_2)$

Find out the Jacobian matrix for the given configuration.

d) Compare Kinematic model and Dynamic model (Any four points)

4. Attempt any THREE of the following :   **12**

a) Describe the concept of equilibrium of forces. State its conditions.

b) State the role of sensors in Robotics. Name any two sensors in robotics.

c) Define :

     i) Linear Velocity

     ii) Linear Displacement

     iii) Linear Acceleration

     iv) Angular Acceleration.

d) Describe Lagrange- Euler method and state it's equation of motion in dynamics.

e) Derive the rotational operator matrix for ROT (Z, θ)

5. **Attempt any TWO of the following :** **12**

a) Derive the forward kinematics matrix equation of a 2R planar robot.

b) State the DH parameters for SCARA robot and derive the transformation matrix of each frame.

c) Determine the magnitude of the forces P and Q for the below force system to be in Equilibrium.
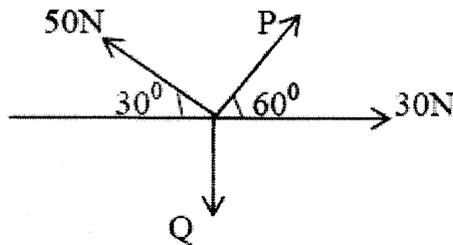
6. **Attempt any TWO of the following :** **12**

a) Draw the block diagram of the Robotic system. Explain each block.

b) Describe the Jacobian matrix with the equation.

c) A frame {B} is rotated about X axis of the universal coordinate system by 45 degrees and translated along Xu, Yu and Zu by 1, 2, and 3 units, respectively. Let the position of a point Q in {B} is given by $[3\ 2\ 1]^T$. Determine $\overline{Q}_U$.

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