[This question paper contains 4 printed pages.]

*Your Roll No.* .....

**3236** **J**

**MECTA**

COMPUTER TECHNOLOGY AND APPLICATIONS .

Paper—CS.652

Robotics and Automation Theory

*Time* : 3 *Hours* *Maximum Marks* : 100

*(Write your Roll No. on the top immediately on receipt of this question paper.)*

*Question No.* 1 *is compulsory.*

*Attempt any other* ***four*** *full questions from the remaining questions.*

*Assume missing data, if any.*

*Use of graph sheets permitted.*

1. (a) Explain in detail the convention used in DENAVIT-HEARTENBERG representation for solving kinematics problems of a series of links and joints. 10

   (b) With neat sketch explain the following configuration of robots : 10

   (i) Cartesian

   (ii) Cylindrical

[P. T. O.

(iii) Polar

(iv) Articulated joint arm.

2. (a) Explain the six d.o.f. motion of a standard robot. 6

(b) Differentiate between Open loop and Closed loop robotic system. 6

(c) Explain in detail the classification of various grippers and tools used in robots. Give one example for a gripper and one example for tool as end effector, with neat sketch. 8

3. (a) With block diagrams explain the function of following directional control valves : 6

(i) 2-way directional control valve.

(ii) 4-way directional control valve.

(b) Explain proportional control system of servo control mode with circuit diagram. Also explain steady-state error due to proportional control. 6

(c) A point $M[8, -4, 7]^T$ is attached to frame is subjected to the following tansformation. Determine the co-ordinate of the point relative to the reference frame at the conclusion of the transformation : 8

(i) Rotation of 45° about X-axis;

(ii) followed by translation of [2, 3, – 4];

(iii) followed by rotation of 90° about Z-axis.

4. (a) Derive the expression for R-P-Y angles rotation. 8

(b) Derive the expression for differential operator [Δ]. 6

(c) Prove that in the case of differential rotation :

$R_{ot}\ (\delta x,\ x)\ *\ R_{ot}\ (\delta y,\ y) = R_{ot}\ (\delta y,\ y)\ *\ R_{ot}\ (\delta x,\ x)$ 6

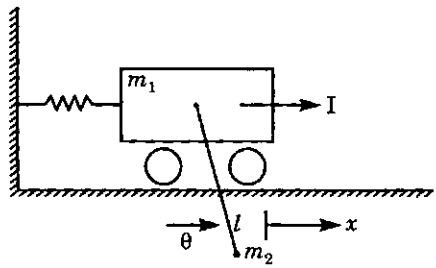
5. (a) Differentiate between Joint space and Cartesian space trajectory planning. 8

(b) It is desired to have the first joint of a six-axis robot to go from initial angle of 30° to a final angle of 75° in 5 secs. Using third order polynomial, calculate the joint angles at 1, 2, 3 and 4 secs. Plot the graph of :

(i) Position v/s Time.

(ii) Velocity v/s Time (iii) Acceleration v/s time. 12

6. (a) Derive the equation of motion for the system shown in fig. : 12



(b) Sketch and explain with application example the following illumination techniques used in machine vision : 8

(i) Diffuse lighting approach.

(ii) Structured lighting approach.

(iii) Back lighting approach.

(iv) Directional lighting approach.

7. Write short notes on the following : $4 \times 5 = 20$

(i) Tactile sensors.

(ii) Control system of robots.

(iii) Image processing.

(iv) Technical features of robots.

(v) Application of robots.