Reg. No.

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

SEVENTH SEMESTER B.TECH (INSTRUMENTATION AND CONTROL ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: ROBOTIC SYSTEMS AND CONTROL [ICE 425]

Time: 3 Hours   MAX. MARKS: 50

Instructions to Candidates:

❖ Answer **ANY FIVE FULL** questions.
❖ Missing data may be suitably assumed.

1A. Give a detail note on the various types of proximity sensors used in robots. **5**

1B. With neat diagrams, discuss about the various workspaces defined for robots. **5**

2A. Obtain the homogeneous transformation matrix for the given spherical arm shown in Fig. Q2A using DH representation **6**

2B. Explain the drawbacks of DH representation for forward kinematics. **4**

3A. For a 3 DOF manipulator shown in Fig.Q3A, the joint variables are $q = \theta_1, d_2, d_3, \theta_4$ .If the tool configuration matrix at a given instance is represented as ^0T_E, determine the magnitude of each joint variable. **6**

$$^0T_E = \begin{bmatrix} 0.5 & -0.866 & 0 & -84 \\ 0.866 & -0.5 & 0 & -48.5 \\ 0 & 0 & -1 & 105 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

3B. Illustrate the working of vacuum based grippers used in robots. Also highlight the merits and demerits of using such grippers. **4**

4A. Using Langrange method, obtain the equations of motion for a 2R manipulator mounted on ceiling, as shown in Fig.Q4A. **6**

4B. Give a brief note on: **4**
    (i) Feedforward control of Robots
    (ii) Stiffness control of a 1DOF Manipulator

5A. The trajectory of a particular joint of an n-DOF manipulator is specified from its initial point to final point, via an intermediate point, i.e. [15^0, 45^0, 30^0] respectively and the travel time (in seconds) for the three segments are [3, 2] respectively. If the constant acceleration is assumed as |55 deg/sec^2|, define the Motion-Time Law for the second segment. Assume the trajectory to be linear with parabolic blends. **6**

5B. Show that the overall differential transformations due to three differential rotations of about X, Y and Z axes, respectively, is independent of the order in which the rotations are made. **4**

6A. Give a brief account on: **10**
   (i) 'CMOS' and 'CCD' Technology based Vision sensors
   (ii) Hardware architecture for control system of an industrial robot
   (iii)Trilateration v/s Triangulation
   (iv) Set-Point Tracking of robots
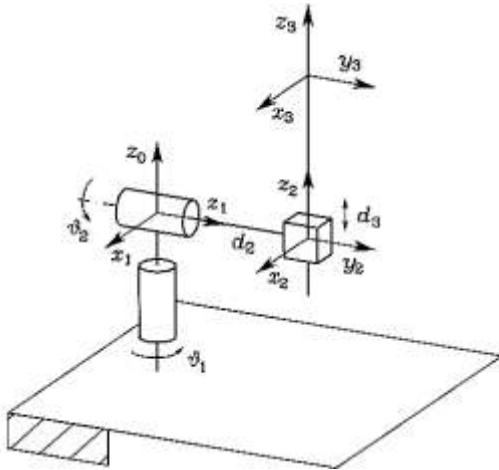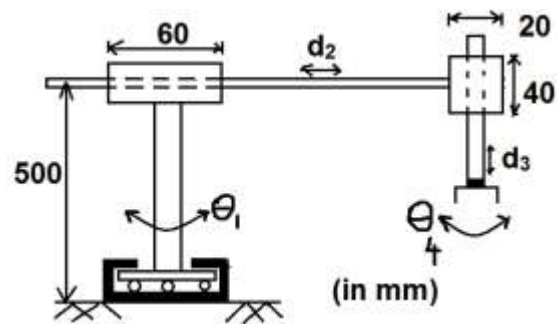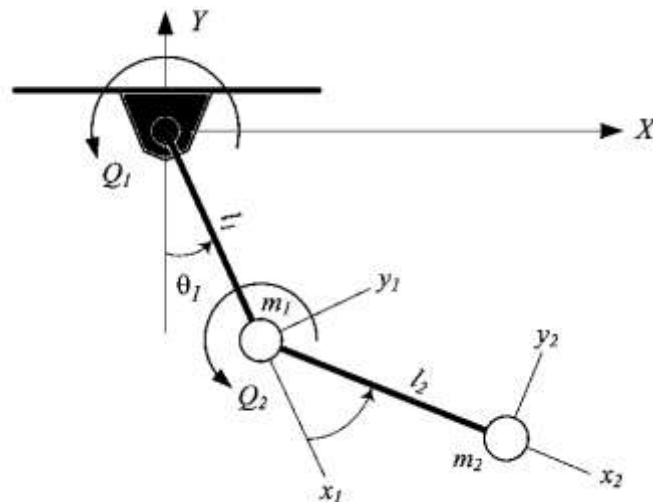   (v) Feedback linearization control architecture.

Fig.Q2A   Fig.Q3A

Fig.Q4A