Ref. No.: Ex/PG/ME/T/1210F/2017

M.E. MECHANICAL AND AUTOMOBILE ENGINEERING FIRST YEAR SECOND SEMESTER – 2017
ROBOTICS AND AUTOMATION
Time: 3 hours **Full Marks: 100**

Answer any five questions

1. A robotic manipulator is shown in Fig. Q1. The joint variable vector of the manipulator is $q = [\pi/4 \quad -3\pi/4 \quad \pi/2 \quad \pi/4 \quad \pi]^T$. The link parameters are: $L_1 = 20,\ L_2 = L_3 = 150,\ L_5 = 30.$ Determine the position and orientation of the end-effector using Denavit-Hartenberg algorithm. Draw figure and construct Table showing link parameters. 20

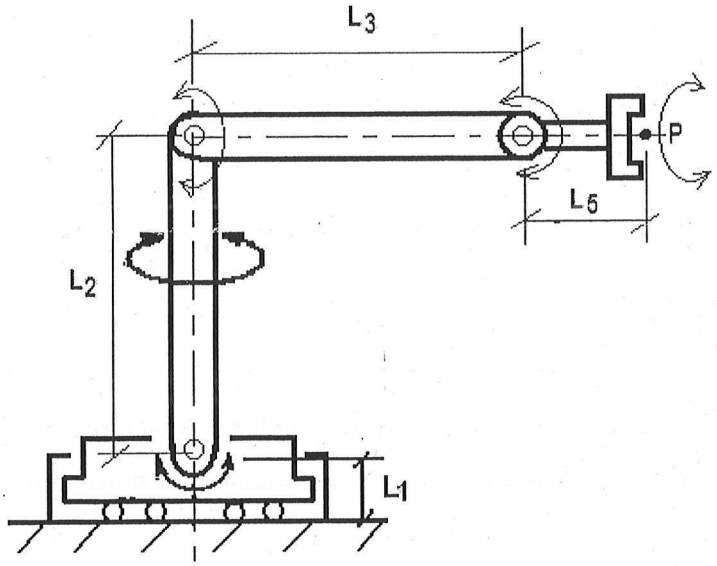

Fig. Q1

2. Trajectory of a robotic manipulator is required to design for the following conditions:

a) the manipulator starts from a finite value of displacement;

b) it ends at another finite value of displacement;

c) velocities at start and end to be zero;

d) accelerations at start and end to be zero;

e) jerks at start and end to be zero.

Select an appropriate polynomial and establish equations for determining the required polynomial coefficients. 20

3. (a) What is robot programming language?

(b) What are Lead-through method and textual robot language?

(c) Show move, speed control, wait and sensor operation commands used in VAL language. (d) What are first generation and second generation languages? What should be the features of future generation language? (3+3+8+6)

4. The Euler angle definition for a robotic manipulator is:

(i) the first coordinate frame is obtained by rotating about Z-axis by an angle ϕ, (ii) then rotating by an angle θ about Y-axis, and (iii) finally rotation by an angle ψ about X-axis. If the overall rotation matrix is given by

$${}^{0}T_{3} = \begin{bmatrix} 0.1 & 0.23 & 0.5 \\ 0.5 & 0.866 & 0.5 \\ 0.866 & 0.5 & 1 \end{bmatrix}, \text{ assuming } 0 < \theta < \pi.$$

Find the angles ϕ, θ, ψ by inverse kinematics approach. 20

5. (a) State industrial applications of robot. 5

(b) Describe an robot based arc welding process with particular reference to (i) constraints to overcome, (ii) requirements from the manipulator to deal with those constraints and (iii) sensors used for the purpose. (3X5)

6. Write notes on (any two): (10x2)

(a) Robot centred work-cell;

(b) Joint space planning for robot trajectory;

(c) Via-points and smoothness equations in connection with trajectory design.