Seat No.: _____

Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016 Subject Code: 2734702

Subject Name: Robotic Engineering

Date:25/10/2016

Total Marks: 70

Instructions: 1. Attempt all questions.

Time:02:30 pm to 05:00 pm

- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q:1

(b)

A 3 DOF (RRP) manipulator arm is shown in the following figure, the 14 position and orientation of point P in Cartesian space is given by T. Determine all values of joint variables, that is, all solution to the inverse kinematic problem. The joint displacement allowed for three joints are:- $100^{\circ} < \theta_1 < 100^{\circ}, -30^{\circ} < \theta_2 < 70^{\circ}, \text{ and } 0.05 \text{ m} < d_3 < 0.5 \text{ m}.$ (L₁ and L₂ can be eliminated and d_3 is can be minimum for preparation of D H table)

$$\mathbf{T} = \begin{bmatrix} 0.354 & 0.866 & 0.354 & 0.106 \\ -0.612 & 0.500 & -0.612 & -0.184 \\ 0.707 & 0 & 0.707 & 0.212 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



- Explain different actuators used in robot with their advantages and 07 **O:2** (a) disadvantages.
 - 1. Explain the work volume of different robot configuration and 04 specific applications of each configuration.
 - 2. Discuss different sensors used in robots. 03

OR

07 **(b)** Explain the laws of robotics and robotics applications.

The second joint of a six axis robot is to go from an initial angle of 20° to **Q:3** (a) 07 an intermediate angle of 25° in 5 seconds and continue to its destination of

80° in another 5 seconds. Calculate the coefficient for third order polynomials in joint space. Plot the joint angles, velocities and accelerations. Assume that the joints stops at intermediate points.

(b) Explain the feedback control of a damped spring mass system with an 07 actuator.

OR

- Q:3 (a) First joint of six axis robot is to go from initial angle $\theta_i = 30^\circ$ to the final 07 angle $\theta_f = 120^\circ$ in 4 seconds with a cruising velocity $\omega_1 = 30^\circ$ / sec. Find the necessary blending time for trajectory with linear segments and parabolic blends and plot the joint trajectory with linear segments and parabolic blends and plot the joint positions, velocities and accelerations. 07
 - Discuss the force control of a robotic manipulator. **(b)**
- What do you understand by rigid and non-rigid manipulator structure? Q:4 14 Compare the forces required at joints of rigid and non-rigid manipulator structures.

OR

- Q:4 Derive the equations to determine torque requirement at various joints of 14 rigid three dimensional jointed manipulator.
- Derive a matrix to determine the coefficients of 4-3-4 trajectory. 07 Q:5 **(a)**
 - What do you understand by the service index of the robot configuration? 07 **(b)** Explain the variation of the service index in the workspace of the robot configuration.

OR

Q:5 Explain the block diagram and transfer function of a robotic link connected 14 to a DC motor through gear train. Also discuss the proportional, proportional and derivative and proportional, integral and derivative feedback controller for the above joint model.
