GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III-EXAMINATION - WINTER 2015

Subject code: 2734702

Subject Name: Robotics Engineering

Time: 2:30 PM to 5:00 PM

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- **Q.1** What do you understand by robot configuration? Explain 2P, 2PR, 3R 07 (a) configuration with a suitable sketch.
 - Define the following: (i) Spatial resolution (ii) Accuracy (iii) Repeatability **(b)** 07 (iv) Robotic Inaccuracies.
- Q.2 **(a)** Derive the homogeneous transformation matrix by Considering the effect of 07 a translation in the x, y, z directions by -1, -1, -1, respectively, followed successively by $a + 30^{\circ}$ rotation about the X-axis, and $a + 45^{\circ}$ rotation about Y- axis on the homogeneous coordinate position vector [3211].
 - For the given configuration construct: (a) Set of Robotic frames (b) Table **(b)** 07 for Joint parameters (c) The components of ${}^{0}T_{4}$ matrices.



OR

Explain Direct and inverse Kinematics with a suitable example. 07 **(b)**

- Q.3 Find the force and torque acting on each joints for an *n*-Degree of freedom 07 (a) manipulator with the help of a free body diagram.
 - For the 2- Degree of freedom manipulator determine the dynamic model 07 **(b)** using a suitable method.

Total Marks: 70

Date: 04/12/2015

Q.3 (a) A 3-DOF articulated arm (as shown in figure) applies a force F with its endeffector. Determine the torques required at the joints to maintain static equilibrium.



- (b) Explain Newton- Euler formulation for determining the joint torque for all 07 the joints actuators of an *n*-DOF manipulator.
- Q.4 (a) The second joint of a SCARA manipulator is required to move from $\Theta_2 = 07$ 30° to 150° in 5 seconds. Find the cubic polynomial to generate the smooth trajectory for the joint. What is the maximum velocity and acceleration?
 - (b) Describe the classification of robotic control system. Explain any one in 07 brief.

OR

- **Q.4** (a) The trajectory of a particular joint of an n- DOF manipulator is specified 07 with two via points(Four path points) as $\mathbf{q}^{j} = [15^{\circ} 40^{\circ} 30^{\circ} 15^{\circ}]$ and the travel time for the three segments in seconds are $[3.0 \ 2.0 \ 3.0]$, respectively. If the constant acceleration is assumed as 55 deg/ sec², calculate the blend time, linear segment time and constant velocity for each segment assuming a linear trajectory with parabolic blends.
 - (b) Differentiate between and open loop and closed loop control system. 07
- Q.5 (a) Describe basic controllers to develop a coordinated movement of an end 07 effector.
 - (b) Explain Proportional Derivative controller with a suitable example. 07
 - OR
- Q.5 (a) What do you understand by force control of robotic manipulators? Also 07 derive the force- Error equation for a Compliant arm.
 - (b) For the PID controller shown in the figure below present an analysis of the **07** satiability of the control algorithm.


