GUJARAT TECHNOLOGICAL UNIVERSITY
ME - SEMESTER–IV • EXAMINATION – SUMMER 2013

Subject Code: 742801   **Date: 14-05-2013**

Subject Name: Robotics and Control

Time: 10.30 am - 01.00 pm   **Total Marks: 70**

Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the types of reference frames attributed to the robot structure. **03**

(b) The base joint of the cylindrical robot is driven by a 12-bit memory converter **07**
and has a swing of 360^0. The radial axis is driven by an 8 bit memory converter,
and has a horizontal reach of 300 mm and a stroke of 200 mm. The vertical
motion has a drive of 0 bit memory converter with a vertical reach of 480 mm
and a stroke of 360 mm. Find the following
   1. Volume of the work envelope
   2. Radial resolution
   3. Vertical resolution
   4. Angular resolution
   5. Horizontal resolution
   6. Total resolution

(c) A point $P_{abc}= (2, 3, 4)^T$ has to be translated through a distance of +4 units along **04**
OX axis and -2 units along OZ axis. Determine the co-ordinates of the new
point P_{xyz} by homogeneous transformation.

Q.2 **(a)** Using L-E formulation determine the equation of motion for RP manipulator **07**
shown in fig

(b) The end effector of a manipulator is to exert a force   f=0i+0j+10k and a **07**
moment of m=0i+0j-100k. The position of the end effector is described by
matrix A

$$A= \begin{array}{cccc} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 10 \\ 0 & 0 & 0 & 1 \end{array}$$

Determine the equivalent moment and force at the wrist.

OR

(b) Explain the following and its importance as applied to robot arm. **07**
   1. Inertia terms
   2. Coupling inertia
   3. Centrifugal force
   4. Coriolis component
   5. Gravity term

Q.3 **(a)** Write the transfer function and block diagram for the following **07**
   1. Proportional control
   2. Derivative control
   3. Integral control

(b) Draw block diagram and obtain the transfer function that corresponds to spring **07**
mass damper system suspended from a fixed wall.

OR

Q.3 **(a)** The differential equation specifying the joint motion   a robotic manipulator is $3d^2y/dt^2+8dy/dt+5y=0$. Determine   **07**
           1. Setting time
           2. Delay time
           3. Peak overshoot

     (b) Derive kinematic equation for the elbow manipulator with co-ordinate frame diagram and kinematic parameter.   **07**

Q.4 **(a)** What is edge detection? Explain the procedure.   **07**
     (b) What is work space? Give the functional diagram with the workspace for the following   **07**
           1.PUMA
           2.SCARA

<div align="center">OR</div>

Q.4 **(a)** Derive with usual notations the expression for force exerted by the mechanical grippers in robotics.   **07**
     (b) Explain the steps involved in D-H convention.   **07**

Q.5 **(a)** Explain the illumination technique used in robot vision system.   **07**
     (b)   1. What is the function of encoder? What are the types of encoder?   **07**
           2. The maximum voltage range for a 8 bit capacity A/D converter is 18V. Calculate the quantization levels, quantization level spacing, quantization error.

<div align="center">OR</div>

Q.5 **(a)** What is quantization and i/p data reduction?   **07**
     (b) With neat sketches highlight the four common types of robot configuration.   **07**

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