Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – WINTER 2013

Subject Code: 171701 Date: 26-11-2013

Subject Name: Control System Design

Time: 10:30 TO 01:00 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)** Define the following terms with respect to control system in brief. **07**

1) Prefilter 2) Deadbeat Response 3) Sampled Data
4) Linear Quadratic Regulator 5) Internal Model Design
6) Root sensitivity 7) Multiplicative Perturbation

(b) Discuss the system having uncertainty (uncertain coefficients), with suitable example / derivation. Comments on Results. **07**

Q.2 **(a)** Develop the state model for Cart and Inverted pendulum system. Choose cart position, velocity and pendulum angular position and velocity as state variable and cart position as output. (Make necessary assumption and mention it.) **07**

If following are the system parameters(as per usual meaning):

$\ell = 0.098$ m , $g = 9.8$ m/s^2, $m = 0.825$ kg , $M = 8.085$ kg

Then find T.F. and roots of system. Comments on results/stability

(b) Check the Controllability for system for Que 2(a).Comments on results. Design full state feedback control system for settling time $t_{ss}<10$ sec and low overshoot. Comments on results. **07**

OR

(b) Check the Observability of the system for Que 2(a). Comments on results. Design Observer (estimation error) for settling time $t_{ss}< 0.5$ sec and minimum overshoot. Comments on results. **07**

Q.3 **(a)** Find the State model for the open loop System given below as state equation. Determine the constant for optimality k_1 & k_2, so that for the feedback Optimal Control, the Integral Performance Index (J) for the system is minimized. $\dot{x}_1 = x2$; $\dot{x}2 = u$ (t). Assume $k_2 = 1$ and Initial Condition is $X^T(0) = [1\ 0]$. Comments on results. **07**

(b) Define state variable and state model. If a system has two inputs, one output and three states, find out the dimensions of the various matrices of the state model. Explain the need of diagonalisation technique. **07**

OR

Q.3 **(a)** Design a suitable compensator using Root locus for the system defined by as below. Draw the both -compensated and uncompensated root locus. **07**

$$G(s) = \frac{k}{s^2}$$

Which satisfy following specifications

Settling time ≤ 4 sec (2% tolerance band)

Peak Overshoot for step input 20%.

Also find RC network for compensator.

(b) State an Ackermann's formula. Show the Computation of State Controllability and Observability using it. What is its limitation? **07**

Q.4 **(a)** Design a suitable compensator using Bode plot for unity feedback system to **07**

meet following performance specifications. Phase margin $\geq 35^0$

$$G(s) = \frac{10}{s^2(0.2s+1)}$$

Also find RC network for compensator. Draw the both -compensated and uncompensated bode plot.

(b) Find the unit impulse response for the first four sampling instants. **07**

For the system given by $Y(z) = \frac{z^3 + 2z^2 + 1}{z^3 - 1.5z^2 + 0.5z}$

Also try to make a generalized form of output in terms of time/sample.

OR

Q.4 **(a)** Draw the Root locus and comments on stability for generalized digital feedback control system with digital controller. For that assume D (z) = 1, Open loop plant T.F. is $Gp(s) = \frac{1}{s^2}$, Sampling time T = 1.73 sec. Comments on results. **07**

(b) Explain the implementation of digital (PID, PD and PI) controllers with necessary steps. **07**

Q.5 **(a)** Check the Robustness of control system of having right hand side Zero. Comments on results. Suggest the remedies. **07**

(b) State the Computer (MatLab) commands used for State variable analysis with syntax/code and its related outputs. Mention appropriate comments also. **07**

OR

Q.5 **(a)** What do you mean by ZOH? Why and where it is used? Write the Computer (MatLab) code for the same. State the assumptions required if any. **07**

(b) What do you mean by Eigen value and Eigen Vector? What is the role of its in State Variable Analysis? **07**

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