Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- VIIth SEMESTER–EXAMINATION – MAY/JUNE- 2012

Subject code: 171701 Date: 24/05/2012

Subject Name: Control System Design

Time: 02:30 pm – 05:00 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 pseudo-QFT method for robust controller design. **07**

(b) With necessary equations write a note on observer design. **07**

Q.2 **(a)** Find the z-transform and ROC of the signal **07**

$x(n) = [7(2^n) - 4(5^n)]u(n)$

(b) Consider a process given by **07**

$\dot{x} = Ax + Bu$ and $y = cx$

Where $A = \begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$; Design a controller using internal model design to track a step input.

OR

(b) Discuss importance of robust control system and sensitivity of controlled system. **07**

Q.3 **(a)** **07**

A process is given by $G(s) = \dfrac{1}{(s+1)^2}$. If cascade controller $G_c(S)=1$ then steady state error is 50% and settling time (2% tolerance band) is 3.2 second for a step input. Optimum coefficients of the characteristic equation for ITAE are given by equation $s^3 + 1.75\omega_n s^2 + 2.15\omega_n^2 s + \omega_n^3$ .Design PID controller to obtain an optimum ITAE performance for a step input and a settling time less than 0.5 second.

(b) Write a note on the role of digital computers in control system design and application **07**

OR

Q.3 **(a)** Describe optimal control system with control energy considerations. **07**

(b) With example discuss design of digital controllers using root locus in the z-plane. **07**

Q.4 **(a)** Check the controllability of the system given with state matrices as **07**

$$A = \begin{bmatrix} 1 & 1 & 0 \\ 3 & 0 & 1 \\ -6 & 11 & 5 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 9 & 2 \end{bmatrix}$$

(b) Find the transfer function for the system matrices given as **07**

$$A = \begin{bmatrix} -4 & -1 \\ 3 & -1 \end{bmatrix}, B = \begin{bmatrix} 2 \\ 5 \end{bmatrix}, C = \begin{bmatrix} 1 & 2 \end{bmatrix}$$

OR

Q.4 **(a)** Check the observability of the system given with state matrices as **07**

$$A=\begin{bmatrix}3 & 6 & 0\\ 3 & 2 & 1\\ 4 & 1 & 3\end{bmatrix},\ B=\begin{bmatrix}7\\ 6\\ 5\end{bmatrix}, C=\begin{bmatrix}0 & 0 & 1\end{bmatrix}$$

(b) Define state variable and state model. If a system has one input, one output and three states, find out the dimensions of the various matrices of the state model. **07**

Q.5 Design a suitable compensator in frequency domain for unity feedback system to meet following performance specifications. **14**
Settling time Kv $\geq$5 Sec^{-1} , phase margin $\geq 42^{o}$, W_b=1.02 rad/sec

$$G(s)=\frac{0.25K}{s(s+1)(0.25s+1)}$$

OR

Q.5 Design a suitable compensator in time domain for the system defined by **14**

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

Satisfying specifications like

Settling time $\leq$ 3 sec (5% tolerance band)

Peak Overshoot for step input $\leq$ 20%

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