Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – VII • EXAMINATION – WINTER 2012

Subject code: 171701 **Date: 26/12/2012**

Subject Name: Control System Design

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

Instructions:

1. **Attempt any five questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What is compensation? What are the different types of compensation? Explain lead compensation network in detail. **07**

(b) Derive z- Transform of given continuous signals with sampling time:

(i) $\frac{s}{s+\omega^2}$; Ts=T **03**

(ii) $\frac{s+2}{s^2+5s+6}$; Ts=1sec **04**

Q.2 **(a)** Define controllability and observability. Find both for second order system given by differential equation **07**

$$\ddot{y} + 2\dot{y} + y = \dot{u} + u$$

with x1=y, x2=$\dot{y}$ – u.

(b) The open loop transfer function of dc motor is $\frac{K}{s(s+2)(s+4)}$. Design suitable compensator for damping ratio=0.5 and ω_n = 3 rad/sec. **07**

OR

(b) For an aircraft position control system having open loop transfer function is $\frac{K}{s(s+3)(s+6)}$. Design suitable compensator for ω_n=2 rad/sec, damping ratio=0.5 and $K_v \geq 10$ sec^{-1}. **07**

Q.3 **(a)** A system has a plant transfer function $G_p(s)=\frac{4}{s+2}$. (i) Determine G(z) for $G_p(s)$ preceded a zero order hold with T=0.1 sec. (ii) Determine whether the digital system is stable. (iii) Plot the step response of G(z) for the first 5 samples. **07**

(b) Explain internal model design in detail for a step reference input. **07**

OR

Q.3 **(a)** Consider the system $G_p(s)=K/s^2$ with PD controller having transfer function (1+10s). For given system preceded by a zero order hold with T=1sec. (i) determine Z transform (ii) plot root locus (iii) determine value K for stability. **07**

(b) Explain the compensator design with integrated full-state feedback and observer. **07**

Q.4 **(a)** Define robust control system with system sensitivity. Explain how to analysis the robustness of the system. **07**

(b) A magnetically suspended steel ball described by A= $\begin{bmatrix} 0 & 1 \\ 3 & 0 \end{bmatrix}$, B=$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$. Design state feedback controller such that system have damping ratio=1 and t_s=2sec. **07**

OR

Q.4 **(a)** Explain the robust internal model control system. **07**

Q.4 **(b)** A second order system given by A= $\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$, B=$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$. Design optimal feedback controlled system using ricatti equation for Q= $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$, R=[1]. **07**

Q.5 **(a)** A unity feedback control system has an open-loop transfer function of $G(s)=K/s^2$. Design a lead compensator such that $K_a=1$ and PM$\geq 45^o$. **10**

(b) How to find out stability of system with uncertain parameters? **04**

OR

Q.5 The open loop transfer function of a robot position control system is $G(s)=\frac{3}{s(s+1)(0.5s+1)}$. Design a lag compensator such that PM$\geq 45^o$. **14**

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