Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – SUMMER • 2014

Subject Code: 172007 Date: 31-05-2014

Subject Name: Modern Control System

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)** Consider a unity feedback type-I system with open loop transfer function **07**

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

It is desired to design a cascade lead compensator such that the dominant closed-loop poles provide a damping ratio =0.5 and have undamped natural frequency wn=4 rad/sec.

(b) The controlled plant of a unity-feedback system is **07**

$$G(s) = \frac{k}{s(s+10)(s+20)}$$

Determine the value of K so that damping ratio of the dominant closed-loop poles is 0.6.For this value of K, determine the velocity error constant Kv.

It is desired to increase Kv by a factor of 10.It is also desired to keep the damping ratio of the dominant closed-loop poles at 0.6.

Design a suitable cascade lag compensator to realize the given objective.

Q.2 **(a)** Consider a plant with transfer function **07**

$$G(s) = \frac{k}{s(s+0.5)}$$

We design a feedback system to meet the following specifications:

1.Damping ratio of dominant closed-loop poles,=0.5

2. Undamped natural frequency, wn=5 rad/sec.

3. Velocity error constant =80 $\sec^{-1}$.

Design a suitable lag-lead compensator to satisfy the above specification.

(b) Controlled plant of a unity-feedback system is **07**

$$G(s) = \frac{k}{s(s+1)(s+5)}$$

It is desired to compensate the system so as to meet the following specification:

Damping ratio of dominant roots=0.45

Undamped natural frequency =3.5 rad/sec.

Velocity error constant = 30 $\sec^{-1}$

Design a cascade lag-lead compensator to meet these objectives.

OR

(b) Discuss the compensation characteristic of cascade lead and lag compensators using root locus method. **07**

Q.3 **(a)** Consider a type-1 unity feedback system with an open loop transfer function **07**

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

It is desired to have the velocity error constant Kv=10.

Phase margin of the be 45^0

Design a lead compensator to meet the above specification.

(b) Consider a unity feedback type-1 system with open loop transfer function **07**

$$G(s) = \frac{k}{s(s+1)(s+4)}$$

The system is to be compensated to meet the following specification.
Velocity error constant Kv=5
Peak overshoot Mp=25%
Settling time ts=10 sec.
Design a suitable lag compensator using bode method.

OR

Q.3 **(a)** Discuss the compensation characteristic of cascade lag compensator. **07**

(b) Explain the design steps of cascade lag-lead compensator using bode plot method. **07**

Q.4 **(a)** Define controllability of the system find that the system is state controllable or not? **07**

$$\begin{bmatrix} \dot{x1} \\ \dot{x2} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u \, .$$

(b) Find the solution of state equation by inverse laplace transform techniques. **07**

OR

Q.4 **(a)** Obtain the response y(t) for the following system. **07**

$$\begin{bmatrix} \dot{x1} \\ \dot{x2} \end{bmatrix} = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} x + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad 0] x$$

where u is the unit step input.

(b) Explain the block diagram of sampled control system. **07**

Q.5 **(a)** Explain the pole placement technique using state feedback controller. **07**

(b) A regulator system has the plant **07**

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

Design a control law u=-kx so that the closed loop system has eigenvalues at $-1.8 \pm j2.4$.

OR

Q.5 **(a)** Explain the z-transform of the following function. **07**

(i)F(t)=sin wt,(ii) F(t)=cos wt,(iii) F(t)= e^{-at} cos *wt*

(b) Explain the process of mapping from s-plain to z-plain in sampled data control system. **07**

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