Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEMESTER– 7th EXAMINATION – SUMMER 2015

Subject Code: 172007 **Date:06/05/2015**

Subject Name: Modern Control System

Time: 02.30PM-05.00PM **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)** For the speed control system the plant model is derived as below. **07**

$\dot{x} = Ax + Bu$

A=$\begin{bmatrix} -1 & 1 \\ -1 & -10 \end{bmatrix}$; B=$\begin{bmatrix} 0 \\ 10 \end{bmatrix}$; C=[1 0].

Evalulate the response of this system to a unit step input under zero initial conditions.

(b) A feedback system has a closed loop transfer function **07**

$$\frac{Y(s)}{R(s)} = \frac{10(s+4)}{s(s+1)(s+3)}$$

Construct the state model for this system where the system matrix A is a diagonal matrix.

Q.2 **(a)** The open loop transfer function of the uncompensated system is **07**

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

It desired to compensate the system so as to meet the following transient response specifications

Damping ratio=0.707

Settling time, ts < 5 sec

Velocity error kv>=4.

Design a cascade lag compensator.

(b) Explain the design step required for the lag - lead compensator design using bode plot. **07**

OR

(b) Consider a Unity-feedback type-2 system with open loop transfer function. **07**

$$G(s) = \frac{k}{s2}$$

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

Settling time, <4sec,

Peak Overshoot for step input ≤20%

Find out gain K and write loop transfer function of cascade compensated sysem.

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

Consider a type-I unity feedback system with an open-loop transfer function.

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

It is desired to have the velocity error constant kv=10

Phase Margin of the system be at least 45deg.
Design a suitable cascade Lead compensator using bode plot for the above system.

(b) Given a z.o.h. in cascade with **07**

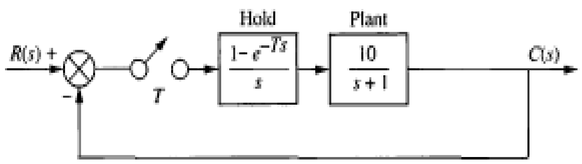
$$G(s) = \frac{(s+2)}{(s+1)}$$

find the sampled-data transfer function, *G(z)*, if the sampling time, *T*, is 0.5 second.

OR

Q.3 **(a)** Give difference between phase lead, phase lag and phase lag-lead Compensation. **07**

(b) Determine the range of sampling interval T that will make the system stable. **07**



Q.4 **(a)** Find the inverse *z*-transform sequence of the following function: **07**

1) $x(z) = \frac{z^2+z}{z^2-3z+4}$

2) $x(z) = \frac{z^2+z}{(z^2-1.13z+0.64)(z-0.5)}$

(b) **07**

A regulator system has plant

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

y=[1 0]x

Design a control law u= -kx. So that the closed-loop system has eigen values at -1.8 ±j2.4.

OR

Q.4 **(a)** Define controllability and observability for the second order system described by the following set of differential equations. **07**

$\dot{x}1(t) = -2x1(t) + 4x2(t)$
$\dot{x}2(t) = 2x1(t) - x2(t) + u(t)$

(b) Explain the stability analysis of sampled Data control system. **07**

Q.5 **(a)** Find the range of k for system stability using jury's stability criterion for the characteristic equation is given below, **07**

P(z)= $z^2 + (0.368k - 1.368)z + 0.368 + 0.264k = 0$

(b) Discuss the effect of adding a pole on shape of the root locus. Also discuss the effect of addition of a zero in reshaping the root locus. **07**

OR

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

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

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