Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VII • EXAMINATION – WINTER 2013**

**Subject Code: 172007 Date: 03-12-2013**

**Subject Name: Modern Control System**

**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)** Explain the design step required for the cascade lead compensator for the reshaping of the root locus. **07**

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

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

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

Settling time, $ts < 3\sec$

Peak overshoot for step input $\leq 20\%$

Design a suitable cascade lag compensator.

**Q.2** **(a)** Explain the design step required for the lead-lag compensator design of the root locus. **07**

**(b)** Consider a unity feedback system with plant transfer function is given by **07**

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

It is desired to have the Phase margin $\geq 60^\circ$ and

$K_v \geq 10$.

Design a suitable cascade Lag compensator for the above system.

**OR**

**(b)** Consider a system G(s) with negative unity feedback having transfer function G(s)= $\frac{10}{s(s+1)}$ **07**

Design a compensator such that closed loop system will satisfy following requirements.

1. Static velocity error constant=20 $\sec^{-1}$.

2.Phase margin= $50^\circ$

**Q.3** **(a)** A system is described by the following equation: **07**

$$\frac{y(s)}{U(s)} = \frac{20(4s+2)}{s^3+5s^2+8s+2}$$

Find its state input and output equation and express in matrix form.

**(b)** Derive the solution of state equation using infinite series method. **07**

**OR**

**Q.3** **(a)** A system is describe by the matrices: **07**

$$A=\begin{pmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{pmatrix}, b=\begin{bmatrix}0\\0\\1\end{bmatrix}$$

C=[1 2 0]

Determine the transfer function.

**(b)** A single input single output system is given by **07**

$$\dot{x}=\begin{pmatrix}-1 & 0 & 0\\ 0 & -2 & 0\\ 0 & 0 & -3\end{pmatrix}x(t)+\begin{bmatrix}1\\1\\0\end{bmatrix}u$$

Y=[1 0 2] x(t)

Test for controllability and Observability.

**Q.4** **(a)** Explain the generalized block diagram of sampled data control system and mention the function of each block. **07**

**(b)** Explain the jury's stability criterion with suitable example. **07**

**OR**

**Q.4** **(a)** Explain the stability analysis of sampled Data control system using mapping theorem. **07**

**(b)** Determine the z-transform of the function **07**

1. $F(s)=\dfrac{1}{s^2+2s+2}$, Assume sampling time=1 sec.

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

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

$$\dot{x}=Ax+bu$$

$$y=cx$$

Where $A=\begin{pmatrix}-3 & 2\\ 4 & -5\end{pmatrix}, b=\begin{bmatrix}1\\0\end{bmatrix}$, c=[0 1]

Compute k so that the Eigen values of (A-bk) are -4,-7.

**OR**

**Q.5** **(a)** Discuss the aspects taken into consideration while designing any control system **07**

**(b)** What is effect of adding zero in the reshaping of the root locus? **07**

**********