Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015

Subject Code: 2714702 **Date: 04/01/2016**

Subject Name: Advance Control Systems

Time:2:30 pm to 5:00 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)** A unity feedback type-2 system with open loop transfer function **07**

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

It is desired to compensate the system so as to meet the following transient response specifications:
Settling time, ts ≤ 4 sec
Peak overshoot for step input ≤ 20%.
Design a suitable lead compensator to satisfy the above specification.

(b) Discuss the compensation technique of cascade lag compensator using root locus plot. **07**

Q.2 **(a)** A unity feedback system with open loop transfer function **07**

$$G(s) = \frac{k}{s^2(s+1.5)}$$

is to be compensated to meet the following specifications:
Settling time, ts = 4 sec
Peak overshoot for step input= 20%
Design a suitable double lead cascade compensator for the above specification.

(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 the damping ratio of the dominant closed-loop poles is 0.6.For this value of k, determine the velocity error constant Kv.

OR

(b) Consider a plant with transfer function **07**

$$G(s)=\frac{4}{s(s+0.5)}$$

Design a suitable lag-lead compensator system to meet the following specifications:
Damping ratio = 0.5
Undamped natural frequency =5 rad/sec
Velocity error constant = 80 $\sec^{-1}$.

Q.3 **(a)** Design a cascade compensation for a system whose transfer function is **07**

$$G(s) = \frac{k}{s(1+0.1s)(1+0.001s)}$$

To satisfy the following requirement:
Phase margin ≥ 45

Velocity constant Kv=1000 $\sec^{-1}$.

(b) Design a suitable lag compensating network for **07**

$$G(s) = \frac{k}{s(s+2)(s+20)}$$

to meet the following specification.

Kv=20 $\sec^{-1}$

P.M.≥ 35.

OR

Q.3 **(a)** Find the z-transform of the following function **07**

1.f(t)= e^{at}

2.f(t)=sin wt.

(b) Find the inverse z-transform and number sequence for the function **07**

$F(z) = \dfrac{0.632z}{z^2 - 1.368z + 0.368}$ given that sampling time T=1 sec.

Q.4 **(a)** Consider the following matrix **07**

$$\overset{o}{X} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}, x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

Find the state transition matrix, also determine x(t).

(b) Check the controllability and observability of the equation **07**

$$\overset{o}{X}(t) = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r(t)$$

OR

Q.4 **(a)** A system is characterized by the equation **07**

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

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

(b) A system is described by the matrices **07**

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

Determine the transfer function.

Q.5 **(a)** Describe the some common types of Non-linearities. **07**

(b) Derive the Describing function for Saturation. **07**

OR

Q.5 **(a)** Draw the phase trajectory of second order system with damping ratio, ζ=0.5 and wn=1 rad/sec for unit step input using method of isoclines. **07**

(b) Explain the Direct method of Lyapunov for stability analysis. **07**

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