# GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– III (New) EXAMINATION – WINTER 2019

Subject Code: 3130905   **Date: 3/12/2019**
Subject Name: Control System Theory
Time: 02:30 PM TO 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.

		Marks

Q.1 **(a)** Define the following terms.   **03**
        (1) Control system(2) Plants (3) Process

(b) Explain transfer function and State advantages and Dis-advantages of transfer function.   **04**

(c) Solve the block diagram to find transfer function of the system shown in figure.   **07**
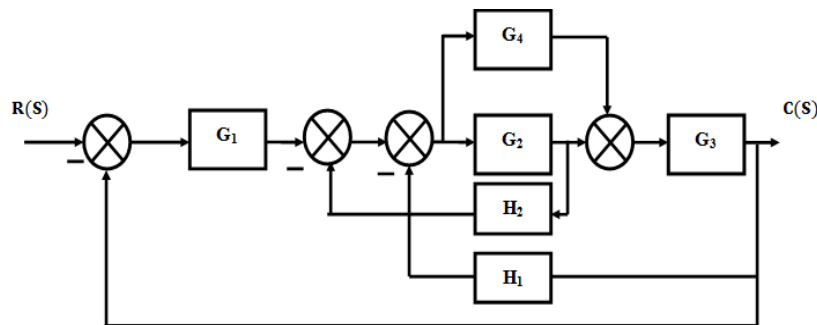
Q.2 **(a)** Explain Steady state Error.   **03**
(b) Compare Open loop Vs close loop control systems   **04**
(c) The characteristic equation of feedback control system is given by
    $s^4+20s^3+15s^2+2s+K=0$
    1) Calculate the range of K for the system to be stable.   **07**
    2) Can the system be marginally stable? If so, find the required value of k and frequency of sustained oscillation.
OR
(c) Write Nyquist contour and Nyquist stability criterion in brief.   **07**

Q.3 **(a)** Calculate damping ratio and Undamped natural frequency of oscillation for the open loop transfer function of a servo system with unity feedback system: $G(S) = \frac{10}{(S+2)(s+5)}$ **03**

(b) Explain Standard Test Signals used in control system   **04**
(c) Construct the root loci of open loop transfer function of the feedback control system given as $G(S)H(S) = \frac{k(S+3)}{s(s+2)}$ **07**
OR
Q.3 **(a)** Simplify the significance of proportional control.   **03**
(b) Define following terms with respect to second order system.
    1) Delay Time
    2) Rise Time   **04**
    3) Peak Time
    4) Steady state error

(c) Consider a lag-lead network defined by

$$Gc(s) = k \frac{(s + \frac{1}{T1})(s + \frac{1}{T2})}{(s + \frac{\beta}{T1})(s + \frac{1}{\beta T2})}$$

07

Show that at frequency ω_1, where $\omega_1 = \frac{1}{\sqrt{T_1 T_2}}$, the phase angle of

$Gc(j\omega)$ becomes zero.

Q.4 **(a)** Explain the effect of integral control action on system Performance.   03
(b) Explain relationship between time and frequency response.   04
(c) Explain step by step Procedure for Phase Lag Network.   07

OR

Q.4 **(a)** Explain the advantages of bode plot.   03
(b) Summarize types of compensation and explain any one.   04
(c) Explain the step by step procedure for obtaining bode plot.   07

Q.5 **(a)** Explain polar plots with a sketch of a simple example   03
(b) Decide that How stability can be ensured from Routh Table?   04
(c) Distinguish state variable approach verses the classical approach of transfer function for the analysis of control systems.   07

OR

Q.5 **(a)** Explain following terms. 1) State variable 2) State trajectory 3) State vector   03
(b) Define and explain following terms with respect to frequency response.
1) Gain Margin
2) Phase Margin
3) Gain Crossover frequency
4) Phase Crossover frequency   04

(c) Investigate Controllability and observability of the system

$$X(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix} u(t)$$

$$c(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x(t)$$

07

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GUJARAT TECHNOLOGICAL UNIVERSITY
BE- SEMESTER–III (NEW) EXAMINATION – WINTER 2020

Subject Code:3130905   **Date:05/03/2021**
Subject Name:Control System Theory
Time:10:30 AM TO 12:30 PM   **Total Marks:56**

Instructions:
1. Attempt any FOUR questions out of EIGHT questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

			MARKS
Q.1	**(a)**	Explain transfer function and write its advantages and dis advantages.	03
	(b)	Derive steady state error constants of the Type-1 system for a Step input.	04
	(c)	Describe the step by step procedure for reduction of Block diagram.	07
Q.2	**(a)**	Define: rise time, peak over shoot and settling time.	03
	(b)	Draw the step response of values of damping ration (i) $\zeta >1$ (ii) $\zeta=1$ (iii) $\zeta < 1$ (iv) $0<\zeta<1$	04
	(c)	Explain the requirements of an ideal control system.	07
Q.3	**(a)**	Write short note on marginally stable system	03
	(b)	How stability can be ensured from Routh Table?	04
	(c)	Explain Type 0, Type 1 and Type 2 control system. Derive equation for the steady state error of the Type 2 control system for step, ramp and parabolic input.	07
Q.4	**(a)**	Explain correlation between time domain and frequency domain	03
	(b)	State the advantages of bode plot	04
	(c)	Define the following terms: Gain margin, phase margin, bandwidth, resonant peak, resonant frequency and gain cross over frequency.	07
Q.5	**(a)**	Write the application of frequency response methods.	03
	(b)	Define Magnitude and angle criteria for the Root Locus analysis.	04
	(c)	State and explain nyquist stability criteria.	07
Q.6	**(a)**	Explain feedback control system	03
	(b)	Explain the effect of derivative control action on system performance.	04
	(c)	Write short note on PID controller.	07

Q.7 **(a)** List out types of compensation and explain any one   **03**

(b) How will you define controllability and observability of the system?   **04**

(c) Write steps to design Lag Compensator using Root Locus.   **07**

Q.8 **(a)** Define following terms. 1) State variable 2) State trajectory 3) State vector.   **03**

(b) Write difference between state space analysis and transfer function.   **04**

**(c)** How state space analysis method is different than classical methods. Explain in detail.   **07**

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GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2021

Subject Code:3130905   **Date:02-03-2022**
Subject Name:Control System Theory
Time:10:30 AM TO 01:00 PM   **Total Marks:70**
Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

		Marks
Q.1	**(a)** List out the difference between open loop and closed loop control system.	**03**
	(b) The Characteristic equation of a feedback control system is	**04**

$$S^5+4S^4+8S^3+8S^2+7S+4=0$$

Predict stability of system by following R-H criterion.

(c) Sketch the Root locus for the open loop transfer function of unity **07**
feedback control system given by $G(s) =K/S(S^2+6S+25)$.Also determine
centroid and angle of departure.

Q.2 **(a)** Find the closed loop transfer function, undamped natural frequency & **03**
damping ratio of the system whose system response is given by
$C(t)=1+0.2 e^{-60t} -1.2 e^{-10t}$ subjected to a unit step input.

(b) Discuss steady state error constants of the Type-0 system for a Ramp **04**
input.

(c) Evaluate the differential equation for the given system and convert from **07**
F to V and F to I electrical equation form.
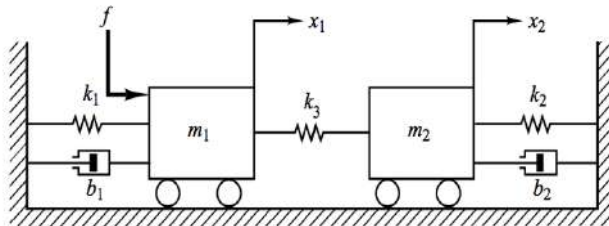
OR

(c) Evaluate overall transfer function for the system shown in Figure below. **07**
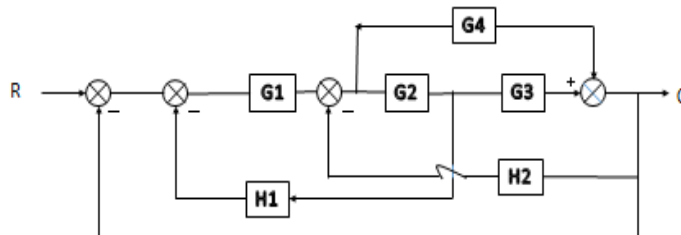
Q.3 **(a)** Define polar plot with a sketch of simple example. **03**
(b) Summarize limitations of frequency domain approach. **04**
(c) A unity feedback control system has $G(s) = \dfrac{80}{s(s+1)(s+20)}$.Make use of **07**
bode plot to measure gain margin and phase margin and identify stability
of system.

Q.3 **(a)** Define the following terms with respect to frequency response (i) Gain Margin (ii) Phase Margin (iii) Gain cross-over frequency. **03**

(b) State and explain nyquist stability criteria. **04**

(c) The open loop transfer function of a system is, **07**

$$G(S) = 800(S+2)/(S^2(S+10)(S+40))$$

Sketch the bode plot and comment on stability.

Q.4 **(a)** Define compensation. List out different types of compensations. **03**

(b) Demonstrate transfer function of lead network. **04**

(c) Explain PID controller. **07**

OR

Q.4 **(a)** State limitations and effects of Lag compensator. **03**

(b) Discuss advantages of frequency domain design. **04**

(c) Explain the design of lag lead compensator using root locus. **07**

Q.5 **(a)** List out different types of controller and need of controller. **03**

(b) Compute the state transition matrix for the state model whose matrix A is given by **04**

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

(c) Solve transfer function from the given state space model. **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

OR

Q.5 **(a)** Define Derivative controller. Mention two drawbacks of derivative action. **03**

(b) Discuss properties of state transition matrix. **04**

(c) A linear time invariant system is described by the following state variable model. **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Test for Controllability and Observability of the system.

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Seat No.: _____   Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–III (NEW) EXAMINATION – SUMMER 2021

Subject Code:3130905   **Date:06/10/2021**

Subject Name:Control System Theory

Time:10:30 AM TO 01:00 PM   **Total Marks:70**

Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Explain transfer function and write its advantages and disadvantages.	**03**
	(b)	Determine the transfer function of given network in Fig. 1	**04**
	(c)	Define Following Terms	**07**

    (1) State   (2) State Variable   (3) State Space
    (4) Controller   (5) Rise Time   (6) Settling Time   (7) Peak Time

Q.2	**(a)**	Explain Standard Test Signals used in control system.	**03**
	(b)	By means of Routh criterion, determine the range of K for stability of the system described by characteristic equation, $$s^3 + 8s^2 + 2s + 4K = 0$$	**04**
	(c)	Determine the overall transfer function for the system using block diagram reduction rules whose block diagram is shown in Fig.- 2.	**07**

OR

	(c)	Describe Correlation between transfer function and state-space equations with suitable examples.	**07**
Q.3	**(a)**	Write short note on PID controller.	**03**
	(b)	Using Routh's test, determine the stability of a system whose characteristic equation is given by $$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0.$$	**04**
	(c)	Derive an expression for peak time, t_p in terms of natural frequency ω_n and damping ratio ζ for a second order control system.	**07**

OR

Q.3	**(a)**	Differentiate between the order and type of a system with an illustrative example.	**03**
	(b)	Explain the nature of Bode plot for (i) Simple pole and (ii) Simple zero	**04**
	(c)	Derive the expressions for resonant peak M_r and resonant frequency ω_r for a second order system in terms of δ and ω_n.	**07**
Q.4	**(a)**	Explain Nyquist contour in brief.	**03**
	(b)	Derive the expressions for different static error coefficients.	**04**
	(c)	A system is characterized by the equation $$\frac{Y(s)}{U(s)} = \frac{1}{S^3 + 5s^2 + 8s + 2}$$ Represent given transfer function into state-space.	**07**

OR

Q.4	**(a)**	For an underdamped, critically damped and overdamped control systems, state the values or range of values of damping ratio.	**03**
	(b)	What is polar plot? Describe the steps to construct the polar plot.	**04**
	(c)	Draw the root locus plot for a system having open-loop transfer function	**07**

$$G(s)H(s) = \frac{k}{s(s+1)(s+3)}$$

Q.5 **(a)** Define the following terms with respect to frequency response (i) Gain Margin (ii) Phase Margin (iii) Gain cross-over frequency   **03**

(b) Determine the transfer function from the data given below: **04**

$$A = \begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = [1 \quad 1], D = 0$$

(c) Explain in detail the steps to design a lead compensator   **07**

OR

Q.5 **(a)** List advantages and disadvantages of a lag compensator   **03**
(b) Write steps to design Lag Compensator using Root Locus.   **04**
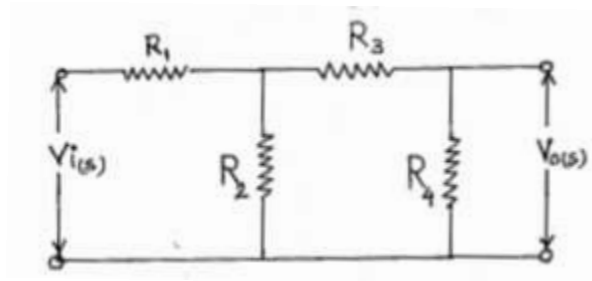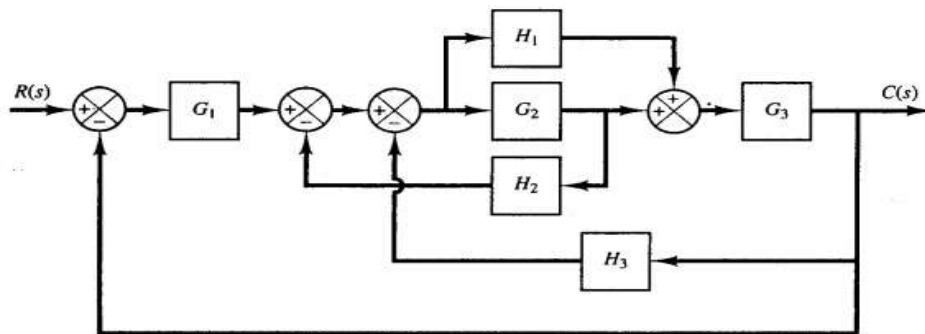**(c)** Explain bode plot of Lag-Lead compensator.   **07**

Fig. 1

Fig. 2

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Seat No.: _____   Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– III (NEW) EXAMINATION – SUMMER 2022

Subject Code:3130905   **Date:18-07-2022**
Subject Name:Control System Theory
Time:02:30 PM TO 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.**
4. **Simple and non-programmable scientific calculators are allowed.**

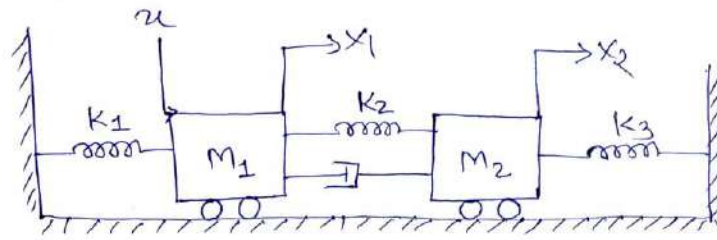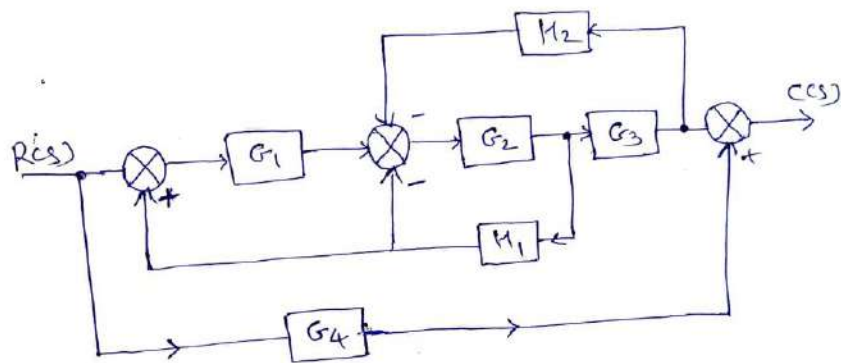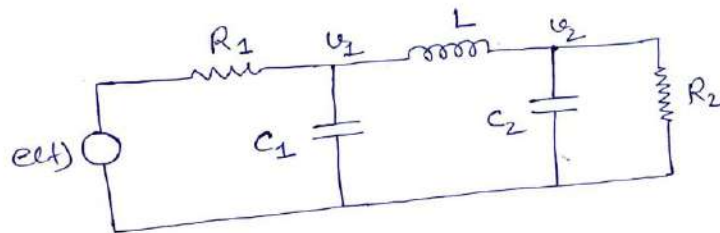|			
Q.1	**(a)**	Define control system and give classification of control systems.	**03**
	(b)	State advantages and dis advantages of transfer function.	**04**
	(c)	Explain closed loop control system with suitable example in detail.	**07**
Q.2	**(a)**	Define transfer function and state methods to find transfer function of control system.	**03**
	(b)	Prepare table showing analogous quantities of Electrical and mechanical translation systems for F-V and F-I analogy.	**04**
	(c)	Determine the transfer function for given mechanical system shown in fig 1 and draw equivalent electrical circuit for F-V analogy.	**07**
		OR	
	(c)	Draw schematic diagram of Field controlled D.C. Motor and derive it's transfer function.	**07**
Q.3	**(a)**	List out the different types of Controllers.	**03**
	(b)	Define the following terms related to signal flow graph: 1. Source node 2. Sink node 3. Chain node. 4. Dummy node.	**04**
	(c)	Evaluate overall transfer function of the system shown in fig.2 using block diagram reduction technique.	**07**
		OR	
Q.3	**(a)**	Define the terms: - 1. Delay Time 2. Rise Time 3. Peak overshoot.	**03**
	(b)	For a system having G(S) = 15/(S+1) (S+3) , H(S)= 1. Determine (i) Characteristic equation (ii) Damping Ratio (iii) Undamped frequency.	**04**
	(c)	With neat sketch explain all the time response specifications.	**07**
Q.4	**(a)**	A system has G(S) = 50 (1+0.1S)/S (S+20) (0.02S+1) calculate corner frequencies of the system.	**03**
	(b)	State limitations of frequency Response Analysis.	**04**
	(c)	Explain constructional rules for Root Locus Technique.	**07**
		OR	
Q.4	**(a)**	Write technical note of Gain margin or Phase margin.	**03**
	(b)	Predict stability of control system for given characteristic equation using R-H Criterion. $S^5 + S^4 + 24S^3 + 48S^2 - 25S - 5 = 0$	**04**
	(c)	State and explain Nyquist Stability Criteria.	**07**
Q.5	**(a)**	Explain effect of PD controller on second order system.	**03**
	(b)	Write characteristics of PI (Proportional + Integral) Mode.	**04**
	(c)	Explain the design of lag compensator using root locus.	**07**
		OR	
Q.5	**(a)**	Define the terms: 1. State variable 2. State vector 3. State space.	**03**
	(b)	State advantages of State Variable Analysis.	**04**

(c) Obtain state model for given electrical system shown in fig 3. **07**

fig. 1

fig. 2

fig. 3

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