Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III (New) EXAMINATION – WINTER 2019

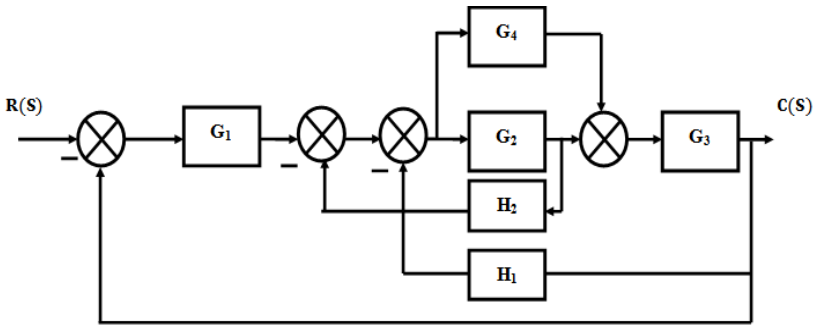
Subject Code: 3130905 Date: 3/12/2019

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. (1) Control system(2) Plants (3) Process	**03**
	(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. 2) Can the system be marginally stable? If so, find the required value of k and frequency of sustained oscillation.	**07**
		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 3) Peak Time 4) Steady state error	**04**

(c) Consider a lag-lead network defined by

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

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. **07**

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 **07**

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

$$c(t) = [1 \quad 0 \quad 0]x(t)$$

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Seat No.: _____ Enrolment No._____

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**

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2021

Subject Code:3130905 Date:02-03-2022

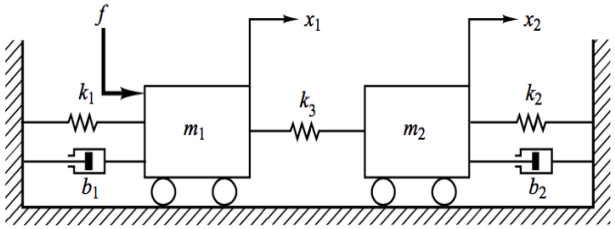
Subject Name:Control System Theory

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

Instructions:

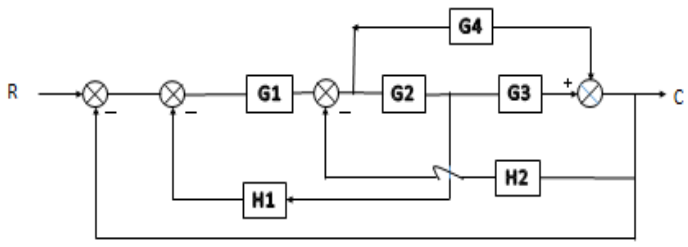
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			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 $S^5+4S^4+8S^3+8S^2+7S+4=0$ Predict stability of system by following R-H criterion.	**04**
	(c)	Sketch the Root locus for the open loop transfer function of unity feedback control system given by G(s) =K/S(S^2+6S+25).Also determine centroid and angle of departure.	**07**
Q.2	**(a)**	Find the closed loop transfer function, undamped natural frequency & 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.	**03**
	(b)	Discuss steady state error constants of the Type-0 system for a Ramp input.	**04**
	(c)	Evaluate the differential equation for the given system and convert from F to V and F to I electrical equation form.	**07**



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) = $\frac{80}{s(s+1)(s+20)}$.Make use of bode plot to measure gain margin and phase margin and identify stability of system.	**07**

OR

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**

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

$$Y = [1 \;\; 2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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**

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

$$Y = [1 \;\; 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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 (1) State (2) State Variable (3) State Space (4) Controller (5) Rise Time (6) Settling Time (7) Peak Time	**07**
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**

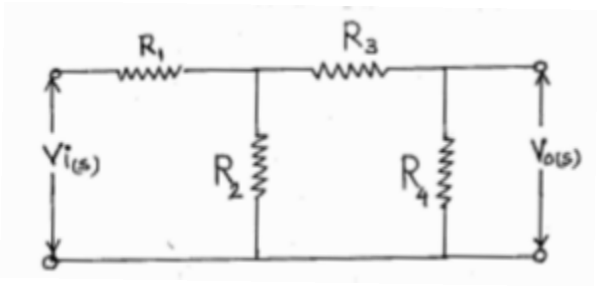

Fig. 1

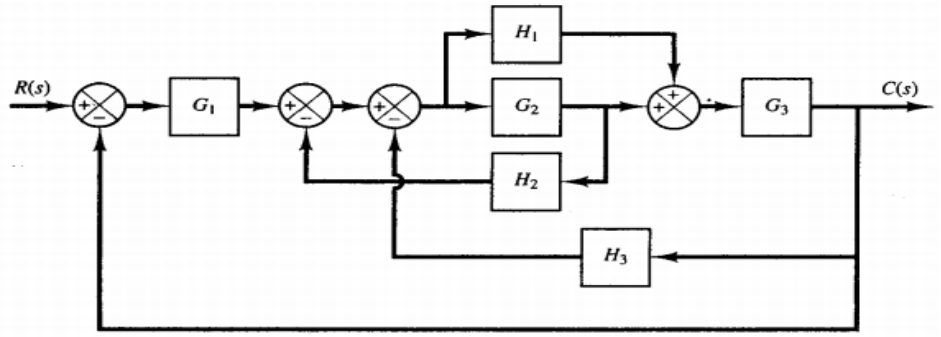

Fig. 2

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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**

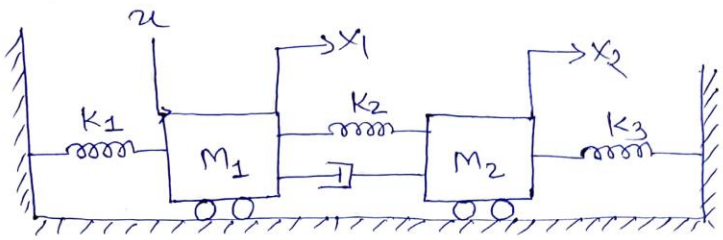

fig. 1

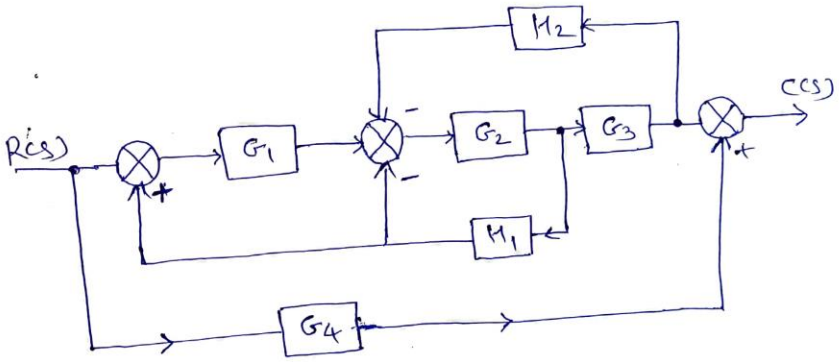

fig. 2

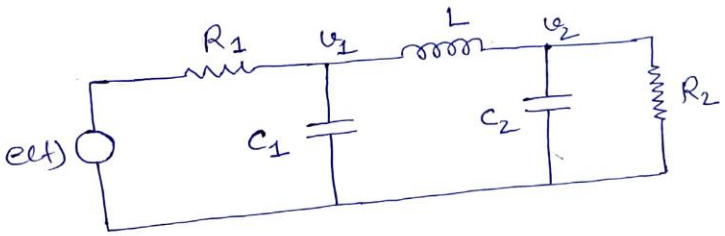

fig. 3

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