Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2023

Subject Code:3141708 Date:17-01-2024

Subject Name: Control 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 green engineering with suitable example.	**03**
	(b)	What is transfer function? Discuss properties, advantages, and disadvantages of it.	**04**
	(c)	What is control system? What are the different types of control systems? Compare open loop and closed-loop control system.	**07**
Q.2	**(a)**	Find Laplace transform of unit step and impulse signal.	**03**
	(b)	Compare Block diagram and Signal flow graph methods.	**04**
	(c)	Draw the equivalent mechanical system of the system shown in figure.1. Write the set of equilibrium equations for it and obtain electrical analogous circuits using i) F-V analogy ii) F-I analogy	**07**
		OR	
	(c)	What is an analogous system? Establish force-current and force-voltage analogy.	**07**
Q.3	**(a)**	Derive transfer function of field-controlled dc motor.	**03**
	(b)	Discuss standard Test signals used in control system.	**04**
	(c)	For the block diagram of figure.2, derive the open-loop and closed-loop transfer function by block diagram reduction technique.	**07**
		OR	
Q.3	**(a)**	Define: Frequency response, Root locus, Centroid.	**03**
	(b)	Derive the expression for peak time Tp for a second order control system subjected to a unit step input.	**04**
	(c)	Obtain the overall transfer function using Mason's gain formula for the signal flow graph shown in Figure.3.	**07**
Q.4	**(a)**	Explain bounded input bounded output (BIBO) stability.	**03**
	(b)	Define: (i) State (ii) State Variable (iii) State Vector.	**04**
	(c)	Sketch the root locus and determine the value of K for marginal stability. $G(s) = K / s (s+1) (s + 3)$.	**07**
		OR	
Q.4	**(a)**	What is Performance index? Define various performance indices for closed loop control system.	**03**
	(b)	Derive expression of K_P, K_V, K_A for Type '0' control system.	**04**
	(c)	The characteristic equation of a system is given by $S^6+3S^5+5S^4 + 9S^3 + 8S^2 + 6S + 4 = 0$. Investigate the stability of a system by means Routh-Hurwitz criterion.	**07**

Q.5	**(a)**	Derive unit step response of a first order system.	**03**
	(b)	Define the following terms 1) Gain cross over frequency 2) Phase cross over frequency 3) Gain Margin 4) Phase Margin.	**04**
	(c)	Sketch Bode plot of a unity feedback control system having transfer function, G(s) = 100(s+3) / s(s+1) (s+5).	**07**

OR

Q.5	**(a)**	Discuss Nyquist stability criterion.	**03**
	(b)	Sketch polar plot for the system with transfer function $G(s)H(s)$= 10/s (s + 2).	**04**
	(c)	Describe correlation between transfer function and state-space equations with suitable example.	**07**

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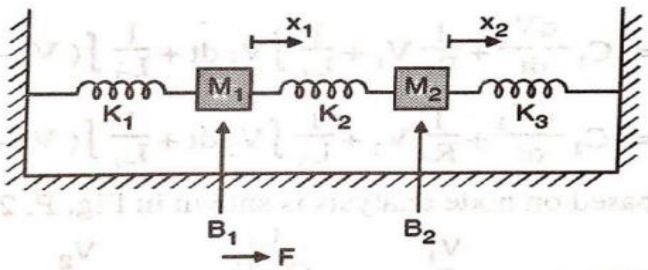

Figure.1

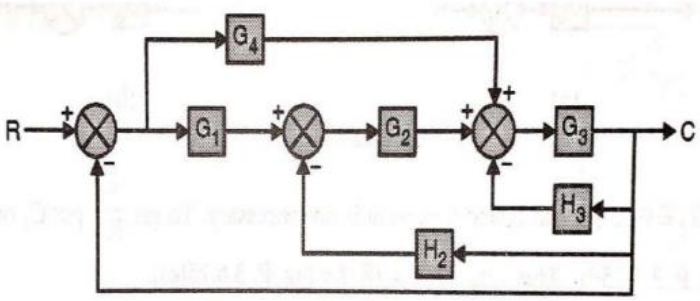

Figure.2

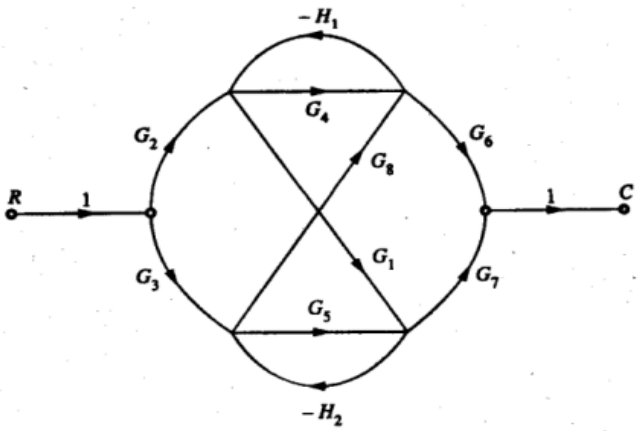

Figure.3