

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2017

Subject Code: 2150909

Date: 16/11/2017

Subject Name: Control System Engineering

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.

		MARKS
Q.1	(a) Define Open-loop and Closed-loop systems. Mention their merits and demerits.	03
	(b) Derive the transfer function of a system from the state space.	04
	(c) Determine the overall transfer function for the system using block diagram reduction rules whose block diagram is shown in Fig.- 1.	07
Q.2	(a) Define the transfer function of the system. What are the limitations of the transfer function approach?	03
	(b) Explain Standard Test Signals used in control system.	04
	(c) Obtain the overall transfer function using Mason's gain formula for the signal flow graph shown in Fig. 2.	07
	OR	
	(c) Derive overall transfer function of armature controller DC motor.	07
Q.3	(a) If the two closed loop poles are located at $-1+j1$ and $-1-j1$ respectively, find the damping ratio of the system.	03
	(b) Using Routh's test, determine the stability of a system whose characteristic equation is given by $s^5 + 2s^4 + 24s^3 + 48s^2 - 25s - 50 = 0$. Also find the roots of this equation.	04
	(c) Write the differential equations for the mechanical system shown in Fig. 3. Also obtain an analogous electrical circuit based on force-current analogy.	07
	OR	
Q.3	(a) For the unity feedback control system with $G(s) = \frac{K(s+15)}{s(s+2)(s+3)}$. Determine the range of K for stability using Routh-Hurwitz criterion.	03
	(b) The open-loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(1+ST)}$. By what factor should the amplifier gain K be multiplied so that the damping ratio is increased from 0.25 to 0.75?	04
	(c) Derive an expression for the time response of a second-order control system subjected to a unit step input.	07
Q.4	(a) Draw the underdamped system response for unit step input and mention it's time response specifications on the same.	03
	(b) Consider a system with open-loop transfer function as $G(s)H(s) = \frac{10}{s}$, obtain its polar plot.	04
	(c) The transfer function of a unity feedback control system is given by $G(s) = \frac{K}{s(s+2)(s+4)}$. Construct the root locus and determine the value of K for sustained oscillations in output.	07

OR

- Q.4

(a)

The unit step input is applied to the open loop transfer function with a unity feedback control system $G(s) = \frac{10(s+1)(s+4)}{(s+2)(s+10)}$. Find the steady state error.

03
- (b)

Derive the 2nd order closed loop transfer function $G_{CL}(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

04
- (c)

Derive an expression for rise time, t_r in terms of natural frequency ω_n and damping ratio ζ for a second order control system subjected to a unit step input.

07
- Q.5

(a)

Explain the significance of dead-time transfer function $e^{-j\omega T}$ in a closed-loop and its effect on system stability.

03
- (b)

Explain Nyquist contour in brief and Nyquist stability criterion.

04
- (c)

Draw the Bode plot for a system having $G(s)H(s) = \frac{100}{s(s+1)(s+2)}$. Find Gain Margin and Phase Margin.

07

OR

- Q.5

(a)

What is compensation? What are the different types of compensations?

03
- (b)

Define the following terms with respect to frequency response (i) Gain Margin (ii) Phase Margin (iii) Gain cross-over frequency (iv) Phase cross-over Frequency.

04
- (c)

Using Nyquist criterion, examine the closed-loop stability of a system whose open-loop transfer function is given by $G(s)H(s) = \frac{50}{(s+1)(s+2)}$.

07

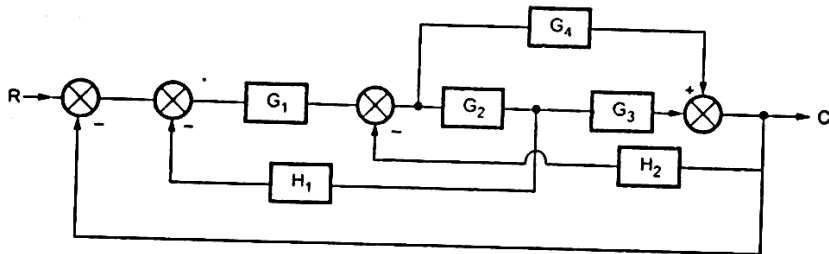


Fig. 1

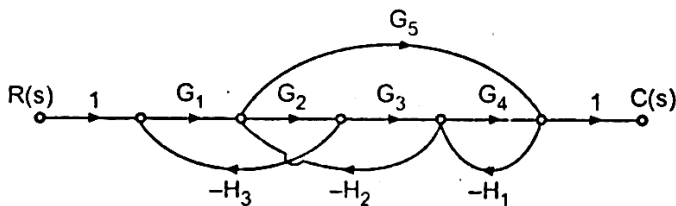


Fig. 2

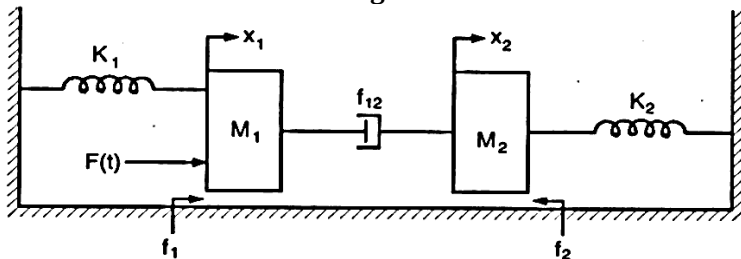


Fig. 3
