

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-IV EXAMINATION – SUMMER 2025****Subject Code:3142003****Date:15-05-2025****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 the transient and steady state response of control system. | 03 |
| (b) State the merits and demerits of open-loop and closed-loop system. | 04 |
| (c) For the given mechanical translation System as shown in Fig. 1. Write the differential equations governing the system and represent in Force-Voltage analogy. | 07 |

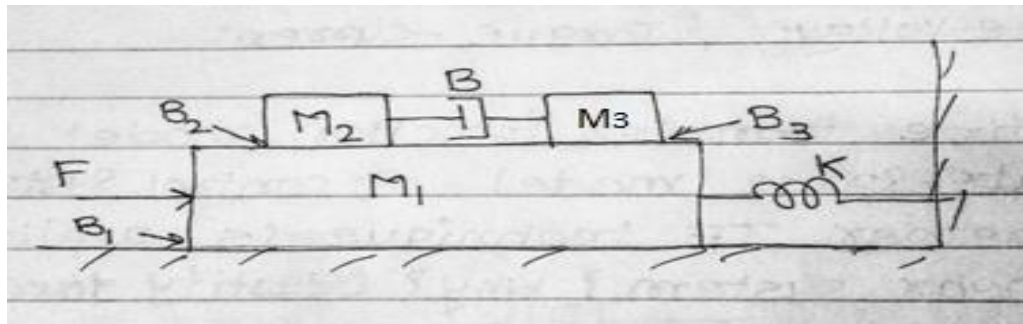


Fig. 1 (Q.1(c))

- | | |
|--|-----------|
| Q.2 (a) Write the rule for moving the summing point before the block. | 03 |
| (b) State the Masson's gain formula for the closed-loop system. | 04 |
| (c) A linear feedback control system has the block diagram shown in Fig. 2. Using block diagram reduction rules , obtain overall transfer function $C(s)/R(s)$. | 07 |

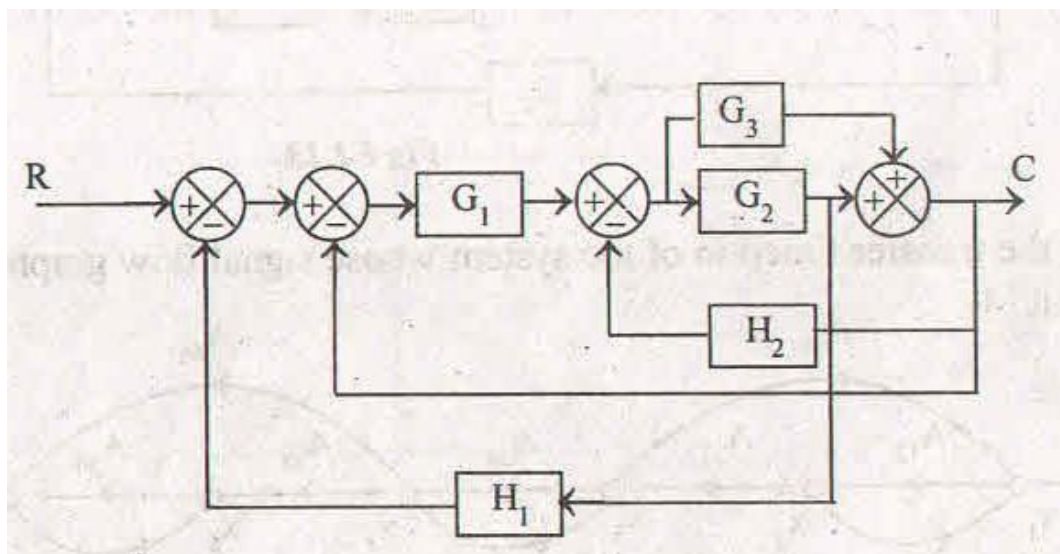


Fig. 2 (Q.2 (c))

OR

- | | |
|---|-----------|
| (c) For the signal flow graph shown in Fig. 3, using Masson's gain formula determine the overall transmission $C(s)/R(s)$. | 07 |
|---|-----------|

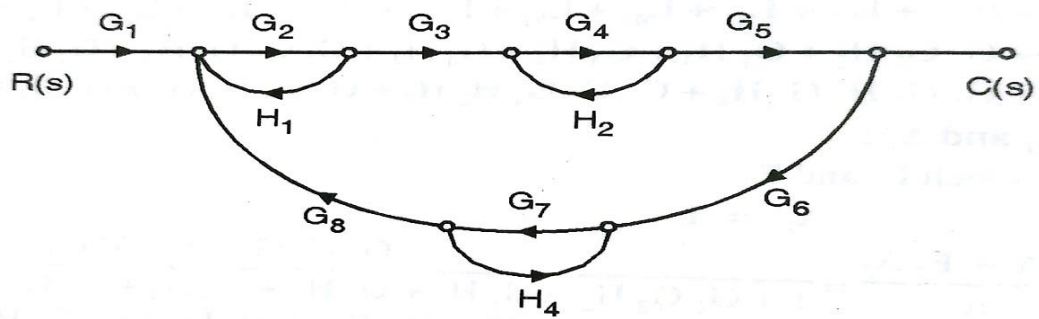


Fig. 3(OR – Q.2(c))

- Q.3 (a)** Define order, pole, and zero of a closed loop control system. **03**
(b) State difference between absolute and relative stability. **04**
(c) A unity feedback closed loop control system is given by differential equation **07**

$$\frac{d^2 y(t)}{dt^2} + 4 \frac{dy(t)}{dt} + 8y(t) = 8x(t); \text{ where } y(t) = \text{Output}$$

and $x(t) = \text{Input}$.

- (a)** Draw the block diagram for closed loop system.
(b) What is the characteristic equation of the system?
(c) Find out damping ratio and natural frequency of oscillation?
(d) Discuss the nature of the system.
(e) Determine and sketch the transient response for unit step input.
Find out the time domain specifications: rise time, peak time, settling time, Maximum overshoot.

OR

- Q.3 (a)** Define Routh's stability criterion. **03**
(b) Construct Routh array and determine the stability of the system whose characteristic **04**
equation is $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$.
(c) Find the position, velocity and acceleration error constants, for a unity feedback control **07**
system has the open loop transfer function $G(s) = 10(s+2)/s^2(s+1)$.

- Q.4 (a)** Define and explain following terms with respect to root locus **03**
(i) Centroid (ii) Breakaway point (iii) Angle of departure
(b) With suitable example explain how relative stability can determine from Nyquist Plot? **04**
(c) Sketch the root locus of the system whose open-loop transfer function is **07**
 $G(s) = \frac{K}{s(s+2)(s+4)}$. Find the values of K so that the damping ratio of the closed-loop
system is 0.5.

OR

- Q.4 (a)** What do you understand by absolute stability and relative stability? Which method **03**
indicates what type of stability?
(b) What is polar plot? Draw the polar plot for type 0 and 1 system. **04**
(c) The open-loop transfer function of a unity feedback control system is given as **07**

$$G(s)H(s) = \frac{(s+2)}{(s+1)(s-1)}$$

Determine the closed-loop system stability by applying Nyquist criterion.

- Q.5 (a)** What is compensation? Why compensation required? **03**
(b) Define Gain Margin and Phase Margin with respect to frequency response (bode) plot. **04**

- (c) Sketch the Bode Plot and determine the Phase Margin (at Gain Crossover frequency) and Gain Margin (at Phase Crossover frequency) for the open loop transfer function. **07**

$$G(s) = \frac{10}{s(1 + 0.4s)(1 + 0.1s)}$$

OR

- Q.5 (a)** State difference between phase-lag and phase-lead system. **03**

- (b) Draw the frequency response for the phase-lead network, which is utilized for compensation. **04**

- (c) Design a lead compensator for a unity feedback control system with open-loop transfer **07**

function is given by $G(s) = \frac{K}{s(s+1)(s+5)}$ to meet the following specifications:

- (i) Phase Margin is $\geq 20^\circ$ (ii) Velocity error constant (K_v) ≥ 50

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