

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

General Instructions :

1. Use appropriate graph sheets for solving Bode plot and Root locus problems.
2. Assume any missing data.

Answer ALL Questions

(10 X 10 = 100 Marks)

1.
 - a) Build a control system that will automatically adjust a bike's radio volume as the noise generated by the bike changes. The noise generated by the bike increases with speed. As the noise increases, the system increases the volume of the radio. Assume that the amount of noise can be represented by a voltage generated by the speedometer cable, and a dc voltage controls the radio's volume. If the dc voltage represents the desired volume disturbed by the motorcycle noise, draw the functional block diagram of the automatic volume control system, showing the input transducer, the volume control circuit, and the speed transducer as blocks. Also show the following signals: the desired volume as an input, the actual volume as an output, and voltages representing speed, desired volume, and actual volume.
 - b) A temperature control system operates by sensing the difference between the thermostat setting and the actual temperature and then opening a fuel valve an amount proportional to this difference. Draw a functional closed-loop block diagram identifying the input and output transducers, the controller, and the plant. Further, identify the input and output signals of all subsystems described.
2. Using Alembert's principle, determine the transfer function $\frac{X_2(s)}{F(s)}$ for the following mechanical translational system as shown in Fig. 1 and draw its force-current analogous system.

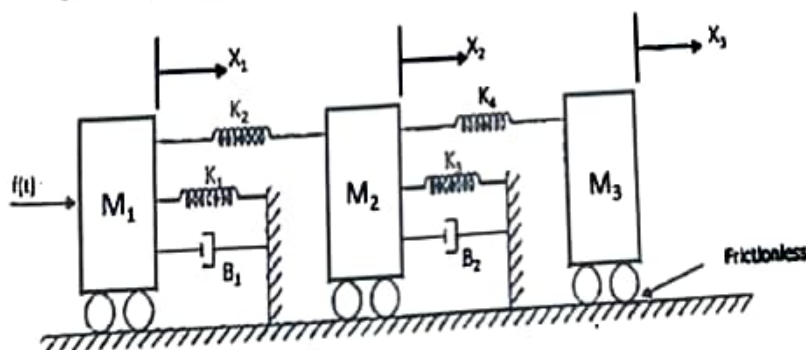


Fig. 1

- 3.(a) Determine the transfer function $\frac{C(s)}{R(s)}$ for the following system using the block diagram reduction technique as shown in Fig. 2.

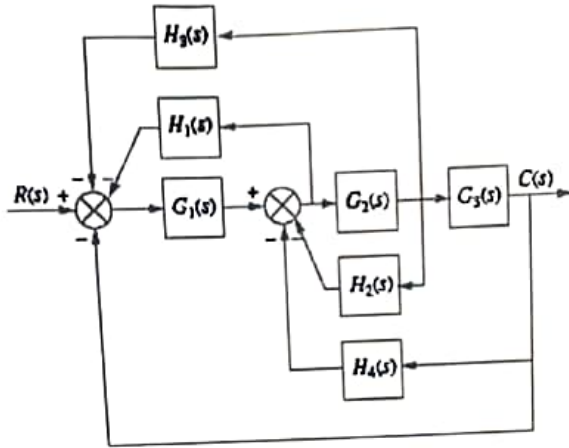


Fig. 2

OR

- 3.(b) Determine the transfer function $\frac{C(s)}{R(s)}$ for the signal flow graph as shown in Fig.3 using Mason's gain formula.

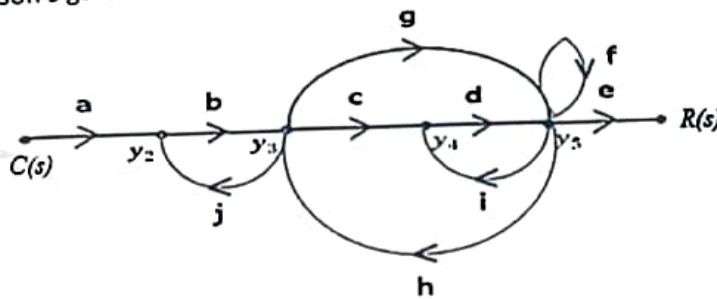


Fig. 3

4. For a unity feedback control system, where $G(s) = \frac{5000}{s(s+75)}$. (a) Determine the system type, expected percentage overshoot, settling time, for a unit step input signal. (b) Determine the steady state error for the following input $5u(t)$, $5tu(t)$, and $5t^2u(t)$.
5. The unit-step response of a linear control system is shown in Fig. 4. Find the transfer function of a second-order prototype system model.

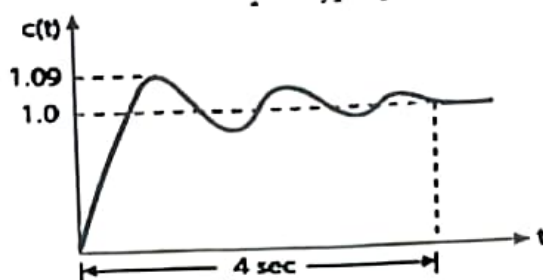


Fig. 4

- 6.(a) Sketch the root locus for a system having an open-loop transfer function given by $G(s)H(s) = \frac{K}{s(s+4)(s^2+2s+2)}$. Determine the following:

- The breakaway and break-in points.
- The intersection of the root locus with $j\omega$ axis.
- The angle of departure/arrival.

OR

- 6.(b) Sketch the root locus for a system having an open-loop transfer function given by $G(s)H(s) = \frac{K(s^2+4s+20)}{(s+4)(s+2)}$. Determine the following:

- The breakaway and break-in points.
- The intersection of the root locus with $j\omega$ axis.
- The angle of departure/arrival.

7. Sketch the Bode plot for the unity feedback system, whose open loop transfer function is given by $G(s)H(s) = \frac{20}{s(1+3s)(1+4s)}$. Determine the following:

- Gain crossover frequency
- Phase crossover frequency
- Gain Margin and Phase Margin
- Comment on the stability of the system.

8. A unity feedback control system with an open loop transfer function,

$$G(s) = \frac{50}{s(1+\frac{1}{s})(s+1)}$$

Design a PI controller so that the phase margin of the system is 35° at a frequency of 1.2 rad/sec.

9. For a given open-loop transfer function $G(s) = \frac{20}{s(1+0.25s)(1+0.17s)}$. Design suitable lead compensation so that phase margin is $\geq 40^\circ$ and velocity error constant $K_v = 20$.

10. Test the controllability and observability for the following state model representation

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 2 \\ -2 & -3 & 0 \\ 0 & 2 & 3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u, y = [1 \quad 0 \quad 0] \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

=== K/L/TX ===