B.E. Instrumentation Engineering (Model Curriculum) Semester - IV

IN403M - Automatic Control System

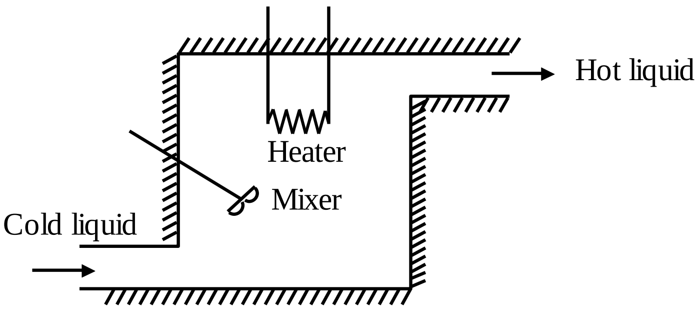
P. Pages : 4 **GUG/S/23/14016**

Time : Three Hours Max. Marks : 80

Notes :
1. Same answer book must be used for each section.
2. All questions carry marks as indicated.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Discuss open loop and closed loop control system with example in detail. **8**

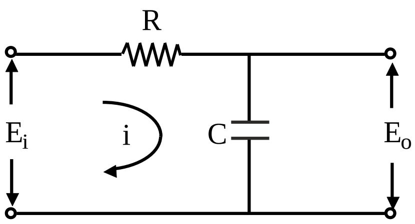
b) Do the mathematical modelling of the thermal system shown in figure and find its transfer function. **8**



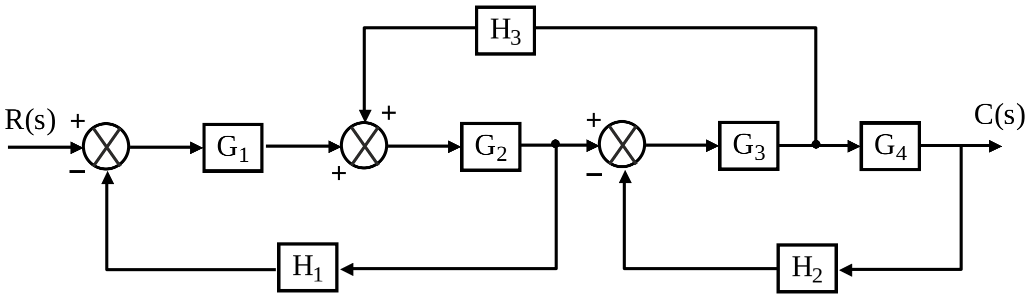
OR

2. a) Give the classification of control systems in detail. **8**

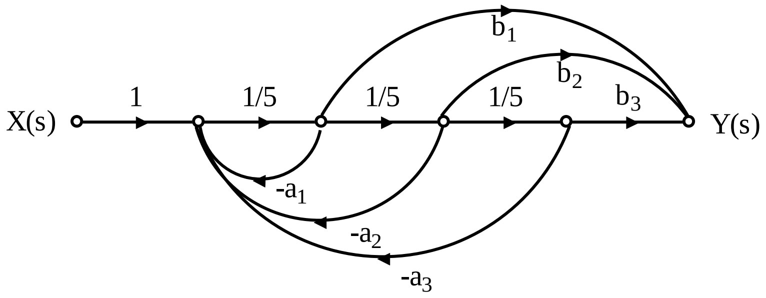
b) Find the transfer function of given electrical network. **8**



3. a) Find transfer function C(s)/R(s) by block diagram reduction technique. **8**



b) Find the transfer function Y(s)/X(s) for given SFG using Masson's gain formula. **8**



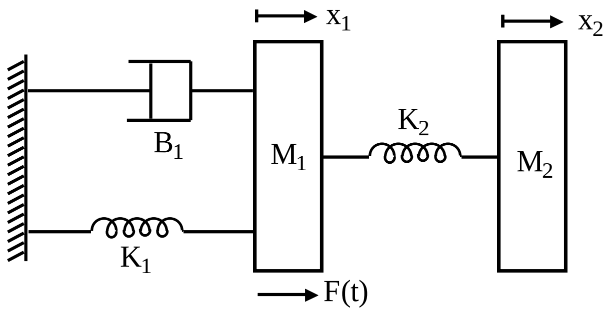
OR

4. a) For the mechanical system shown in figure **8**

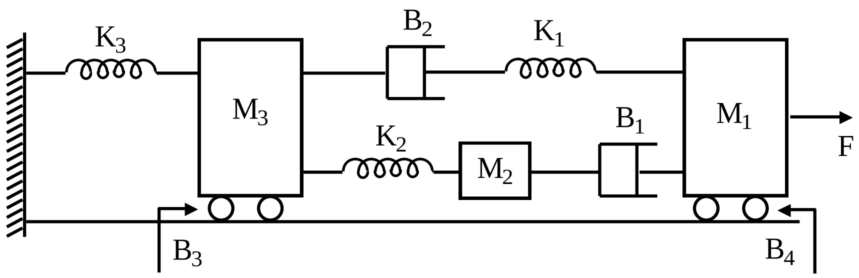
a) Draw the mechanical network

b) Write the differential equations of performance find $X_2(s)/F(s)$

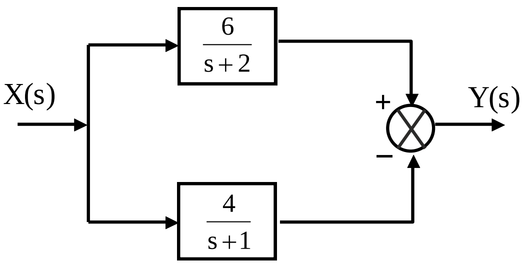
c) Draw the force voltage and force current analogous network



b) Find the system equation for given system. **8**



5. a) For the diagram shown, show that the transfer function $\dfrac{Y(s)}{X(s)}$ has zero in the right half of S-plane. Obtain response Y(t) when X(t) is unit step plot Y(t) w.r.t. X(t) **8**



b) Define all time response specification with neat sketch and write formula for each specification parameter. **8**

OR

6. a) Find the output response of second order underdamped system $(\xi < 1)$ to unit step input. **8**

b) A unity feedback system having **8**

$$G(s) = \frac{8(s+3)}{s^2(s^2+4s+8)(s^2+3s+12)}$$

$$H(s) = \frac{s+10}{s+1}$$

Find step, ramp & parabolic error constants. For arbitrary μp $r(t) = 5 + 2t + 3t^2$.

7. a) Write general rules for the construction of root loci. **8**

b) A feedback control system with loop gain $G(s)H(s) = \frac{k}{s(s+1)(s^2+2s+5)}$. **8**

Determine the value of k for critically stable system.

OR

8. a) The open loop transfer function of a unity feedback system is given by **8**

$$G(s) = \frac{k}{(s+2)(s+4)(s^2+6s+25)}$$

By applying Routh's criterion discuss the stability of closed loop system as a function of K. Determine value of K which will cause sustained oscillations in the system. What are the corresponding oscillation frequencies?

b) The open-loop transfer function of a unity feedback system is given by, **8**

$$G(s) = \frac{k}{(s+3)(s+5)(s^2+2s+2)}$$

Plot the root locus.

9. a) Control system has $GH = \frac{25(s+4)}{s(s+1)(s+10)}$ sketch the Bode plot and determine **8**

i) Gain Margin

ii) Phase Margin

iii) Stability of the system.

b) Draw the polar plot for the closed loop system having the following open loop transfer function and determine whether the system is stable or not, **8**

$$G(s)H(s) = \frac{100}{s(1+2s)(1+s)}$$

OR

10. a) Consider the following state equations **8**

$$\dot{x}_1 = x_2(t)$$
$$\dot{x}_2 = x_3(t)$$
$$\dot{x}_3 = -6x_1(t) - 11x_2(t) - 6x_3(t)$$
$$+6u(t),$$
$$y = x_1(t)$$

And determine the controllable canonical form.

b) Consider the system defined by **8**

$$\dot{x} = A_x + B_u$$
$$y = C_x$$

Where

$$A = \begin{bmatrix} -1 & 0 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix},$$

$$C = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$$

Transform the system equations into observable canonical form.

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