B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Control System Engineering

P. Pages : 4 **NIR/KW/18/3480**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Compare open loop and close loop control system with example. **6**

b) Determine transfer function $\frac{X_1(s)}{F(s)}$ of translational mechanical system show in fig. 1 (b). **8**

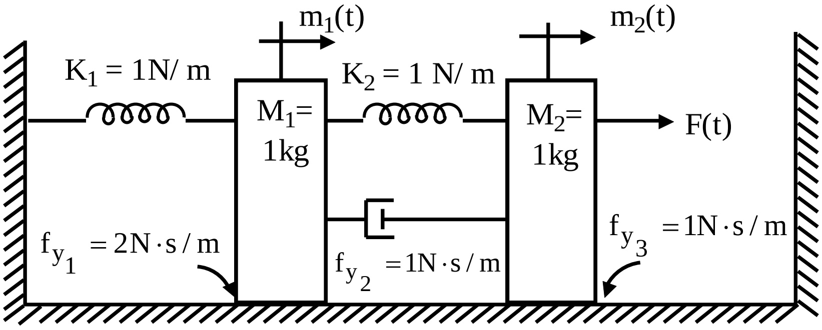


Fig. 1. b

OR

2. a) Determine Transfer function of an electrical network shown in fig. 2-a. **7**

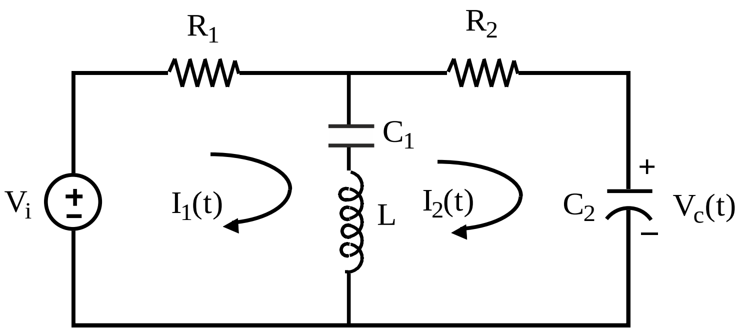


Fig. 2 - a

b) Determine transfer function of Rotational Geared mechanical system shown in fig. 2 – b **7**

$$T.F. = \frac{\theta_2(s)}{T(s)} = ?$$

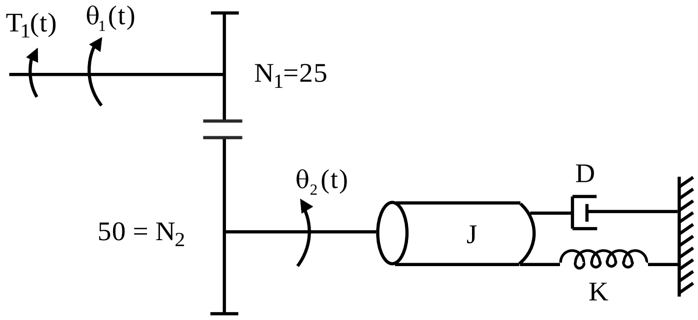


Fig. 2 - b

3. For a system represented by block diagram as shown in fig. 3. Determine transfer function using. **13**

i) Block diagram Algebra and

ii) Mason's gain formula (SFG)

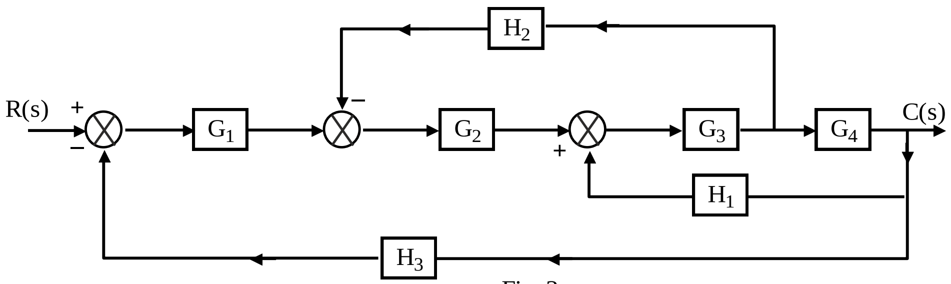


Fig. 3

OR

4. a) Convert the electrical network shown in fig. 4a in to equivalent signal flow graph and determine T.F. $V_0(s)/V_i(s)$ using Mason's gain formula. **6**

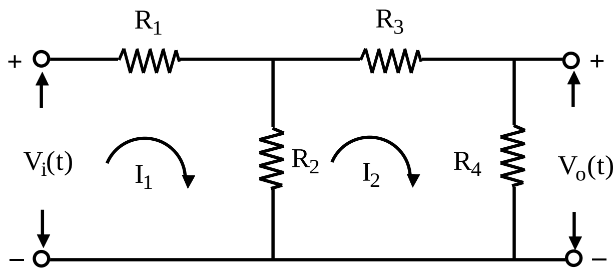


Fig. 4 - a

b) Determine T.F. $\frac{C(s)}{R(s)}$ of signal flow graph shown in fig. 4 b. **7**

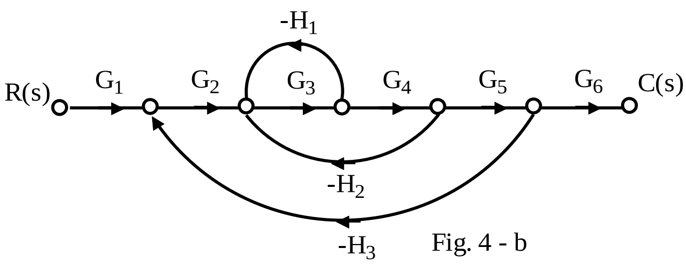


Fig. 4 - b

5. a) Determine steady – state errors for inputs of $5\mu(t), 5t\,\mu(t)$ and $5t^2\,\mu(t)$ given to system shown in fig. 5 a. The function $\mu(t)$ is unit step. **7**

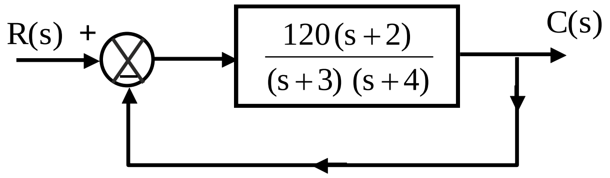


Fig. 5 - a

b) Derive expression for error coefficients and steady state error for step, ramp and parabolic inputs given to type <u>one</u> system. **6**

OR

6. a) For rotational mechanical system shown in fig. 6 – a. Determine 'J' and 'D' so that system yield 20% overshoot and settling time is 2 seconds. For step input of torque T(t). **8**

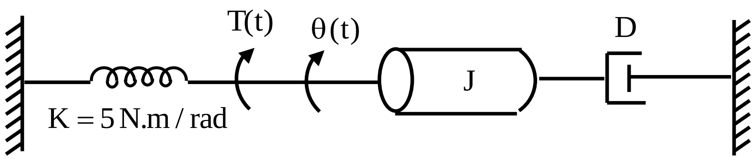
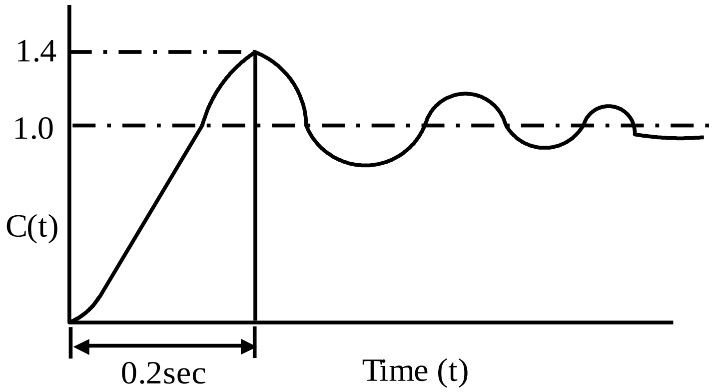


Fig. 6 - a

b) Experimental unit step response of 2nd order system with zero initial condition is shown in fig. 5 – b. Determine natural frequency, damping ratio and other transient specifications. **5**



7. a) Explain stable, unstable and marginally stable system with neat sketch. **6**

b) For the system having characteristic eq^n as **8**
$s^5 + s^4 + 2s^3 + 2s^2 + s + 1 = 0$
comment on stability using Routh's array.

OR

8. Sketch a Root Locus plot for system having **14**

$$G(s) \cdot H(s) = \frac{K(s+4)(s+5)}{(s+3)(s+1)}$$

9. Draw Bode plot for the system having **13**

$$G(s)\cdot H(s) = \frac{K}{s\left(1+\frac{s}{8}\right)\left(1+\frac{s}{40}\right)}$$

Determine value of gain K for

i) Gain margin = 20 db

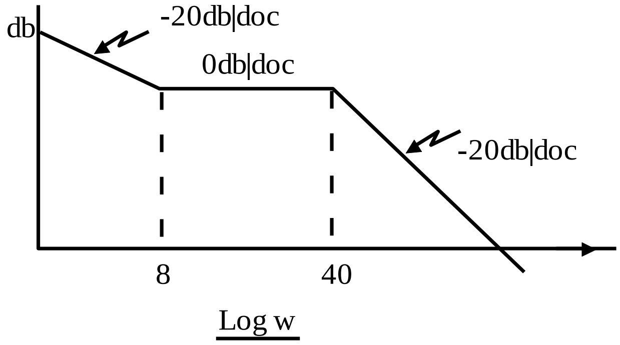
ii) Phase margin = 30º.

OR

10. a) Sketch polar plot for system having **8**

$$G(s)\cdot H(s) = \frac{5}{s(s+6)(s+8)(s+4)}$$

b) Obtain open loop T.F. using inverse Bode plot technique for gain plot shown in fig. 10 b. **5**



11. a) Construct a state space model for system having closed loop T.F. **7**

$$\frac{Y(s)}{\mu(s)} = \frac{10(s+4)}{s(s+1)(s+3)}$$

b) Find Transfer function of the following state model. **6**

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\\ \dot{X}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -2 & -4 & -7\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}\mu(t)$$

and $y(t) = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix}$

OR

12. Write short notes on the following : **13**

i) Phase Lead – Lag compensation.

ii) Effect of location of poles of second order system for under damped, overdamped and critically damp response.

iii) Controllability and observability.

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