B.E. Mechanical Engineering Sixth Semester

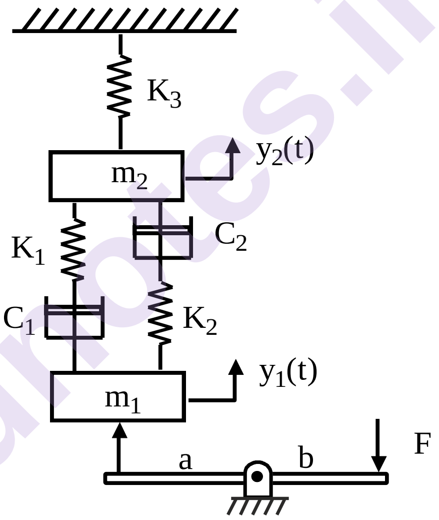
ME601 - Control System Engineering

P. Pages : 3 **GUG/W/18/1712**

Time : Three Hours Max. Marks : 80

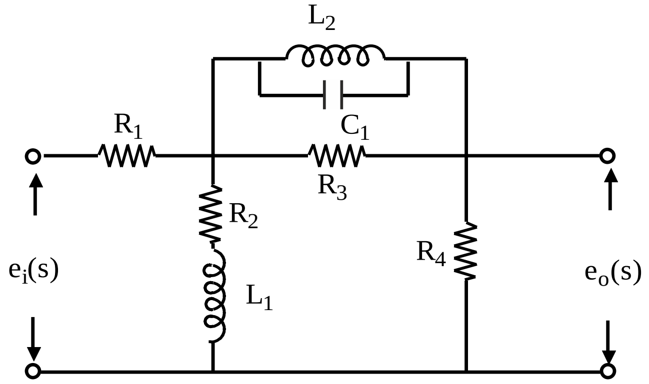
Notes :
1. All questions carry marks as indicated.
2. Solve Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q.6, Q. 7 or Q. 8, Q.9 or Q.10.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
7. Use of polar plot, semi-log paper, graph paper is permitted.

1. a) Find transfer function of the following mechanical system. **8**



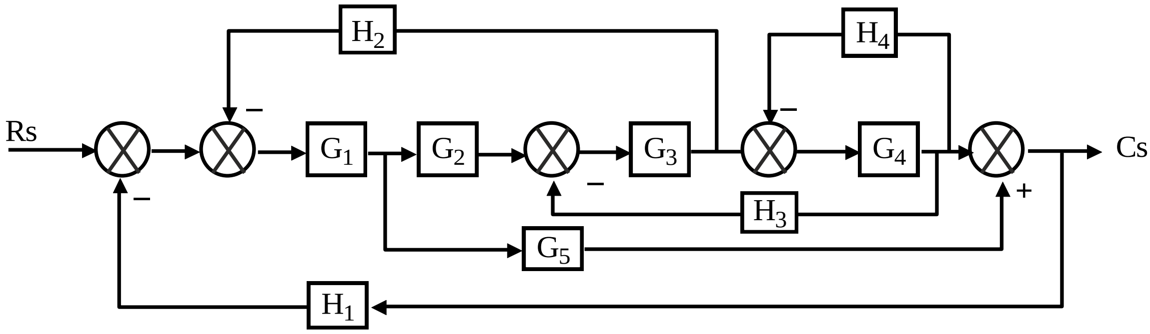
Find $\dfrac{Y_2(s)}{F(s)}$

b) Find transfer function $\dfrac{E_o(s)}{E_i(s)}$ for electrical system. **8**

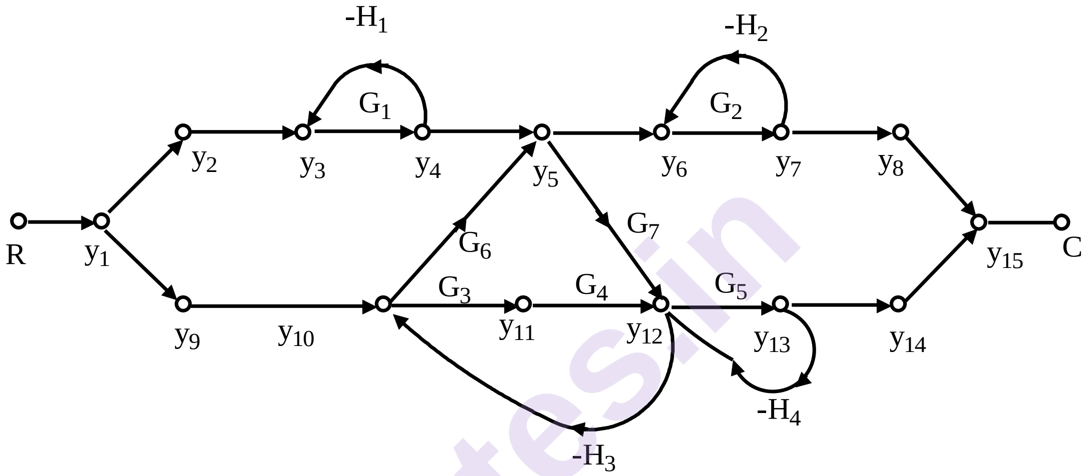


OR

2. a) Find transfer function of block diagram by block reduction method. **8**



b) Find transfer function of following signal flow graph. **8**



3. a) If response equation for second order system with step input is **7**

$$C(t) = 1 + \frac{e^{-\delta w_n t}}{\sqrt{1-\delta^2}} \sin\left(w_n \sqrt{1-\delta^2}\, t - \theta\right)$$

Then find maximum output equation (C_{max}) and peak time equation $(T_P \text{ or } T_{max})$.

b) A unity feedback system has **9**

$$G(s) = \frac{25}{s(s+6)}$$

Find T_r, T_p, T_s, C_{max}, maximum overshoot for a step of 10 units. Also find the value of C(t) at time t = 20% of T_s.

OR

4. a) A unity feedback system has $G(s) = \frac{36}{s^3(s+9)}$ **8**

Find steady state Error and Error constant value for a step, ramp and parabolic input of 5 units.

b) A system is described by the following equation. **8**

$$s^6 + 5s^5 + 6s^4 + 8s^3 + 7s^2 + 9s + k = 0$$

Find the range of 'k' for stability.

5. a) Draw a polar plot. Whose open loop transfer function **10**

$$GH(s) = \frac{10(s+4)}{s^2(s+1)\,(s^2+3s+9)}$$

b) Define open loop system and close loop system. Also state its merits and demerits. **6**

OR

6. Draw a Bode plot (Gain curve and phase curve with full scale) whose OLTF is **16**

$$GH(s) = \frac{400\,s^2 e^{-0.155}}{(s+1)\,(s+4)\,(s^2+8s+25)}$$

Also find :

i) Gain margin ii) Phase margin and

iii) Gain cross over frequency

7. a) Draw a Nyquist plot and state the stability of system. **13**

$$GH(s) = \frac{50\,(s-1)}{s^3(s+5)\,(s+1)}$$

b) Discuss briefly Nyquist stability criteria. **3**

OR

8. a) PID controller, discuss briefly. **8**

b) Write a state model for a system whose output equation is given by - **8**

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 10\frac{dy}{dt} + 25y(t) = 50\,u(t)$$

9. a) Construct a Root locus for a system whose OLTF is ; **13**

$$GH(s) = \frac{k(s+4)}{s(s+1)}$$

Also find the value of k at $\theta = 150^\circ$.

b) Define following terms : **3**

i) Relative stability ii) Marginal stability.

OR

10. a) Find transfer function equation of the following system whose state model is given as **6**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -4 & -8 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}_u \quad \text{and} \quad y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Find controllability and observability of the following state model. **10**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}_u \quad \text{and} \quad y = [1 \quad 0 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

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