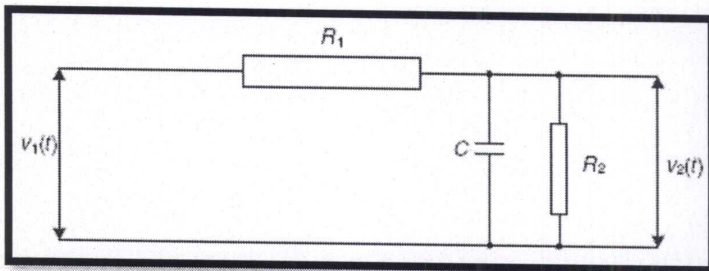


Question No. 1**10 Marks**

- A. Determine the transfer function relating $V_2(s)$ and $V_1(s)$
- B. When $C = 2 \mu F$ and $R_1 = R_2 = 1 M\Omega$. Determine the steady state gain K and time constant τ
- C. Find an expression for the unit step response



$$A. \frac{V_1 - V_2}{R_1} = \frac{V_2}{1/sC} + \frac{V_2}{R_2}$$

$$\frac{V_1 - V_2}{R_1} = CSV_2 + \frac{V_2}{R_2}$$

$$\frac{V_1}{R_1} = \frac{R_1 + R_2 + R_1 R_2 CS}{R_1 R_2} V_2$$

$$\therefore \frac{V_2}{V_1} = \frac{R_2}{R_1 + R_2 + R_1 R_2 CS}$$

$$B. \frac{V_2}{V_1} = \frac{1}{2 + 2s}$$

$$\frac{V_2}{V_1} = \frac{0.5}{1 + s}$$

$$K = \text{steady state} = 0.5$$

$$\tau = \text{tau} = \text{time constant} = 1$$

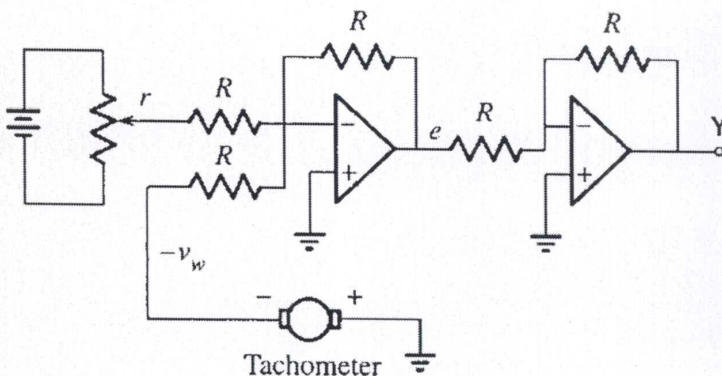
$$C. V_2 = \frac{0.5}{s(1 + s)}$$

$$V_2 = \frac{0.5}{s} - \frac{0.5}{1 + s}$$

$$V_2(t) = 0.5(1 - e^{-t})$$

Question No. 2**10 Marks**

Obtain the equation that relates the output voltage $Y(s)$ to $r(s)$ and $v_w(s)$

1st op-amp

$$\frac{r}{R} - \frac{v_w}{R} = \frac{-e}{R}$$

$$e = -(r - v_w)$$

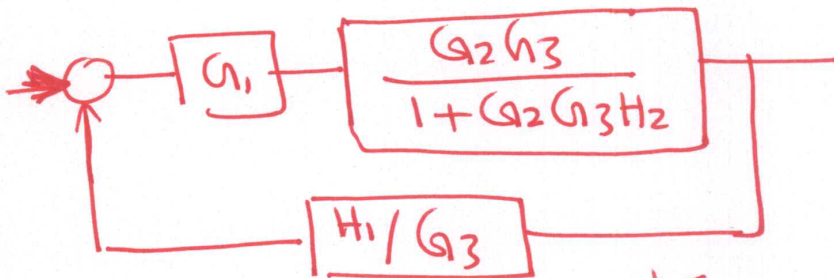
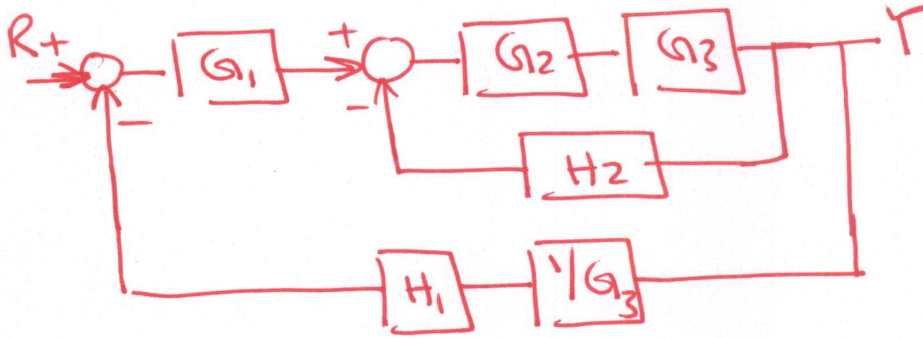
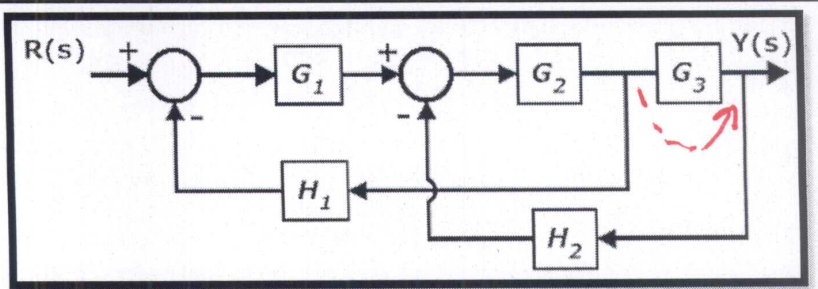
2nd op-amp

$$\frac{e}{R} = \frac{-Y}{R}$$

$$Y = -e \Rightarrow Y = r - v_w$$

Question No. 3
10 Marks

Use Block diagram reduction to find transfer function $\frac{Y(s)}{R(s)}$



$$\frac{Y}{R} = \frac{G_1 G_2 G_3}{(1 + G_2 G_3 H_2) + G_1 G_2 H_1}$$

Question No. 4
10 Marks

Obtain the unit-step response of the following system:

$$\frac{C(s)}{R(s)} = \frac{10}{s^2 + 4s + 4}$$

$$C(s) = \frac{10}{s(s+2)^2}$$

$$C = \frac{0.25}{s} - \frac{0.5}{(s+2)^2} - \frac{0.25}{s+2}$$

$$C(t) = 0.25 - 0.5te^{-2t} - 0.25e^{-2t}$$

$$C(t) = 0.25 - 0.5te^{-2t} - 0.25e^{-2t}$$