Benha University
Faculty of Engineering (Shoubra)
Electrical Engineering Department

3rd year (Comps) -1st Semester
Mid-Term Exam - 1 Hour
Automatic Control (12/11/2015)

==

1. A controlled system described by the differential equation: $y''(t)+3y'(t)+2y(t)=e^{-3t}$

[a] Find the solution of that system if *y(t)* and *x(t)* are the system output and input respectively and the initial condition are: $y'(0)=y(0)=0$.

[b] Find the final value of *y(t).*

2. Find the loop equations for the circuit shown in Fig. (1). Then draw the block diagram using these loop equations.

3. Reduce the system shown in Fig. (2) to a single transfer function.

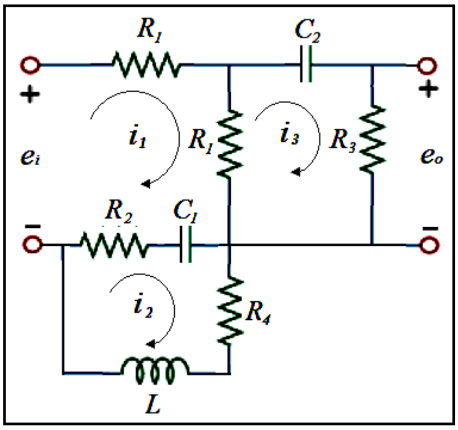


Fig. (1)

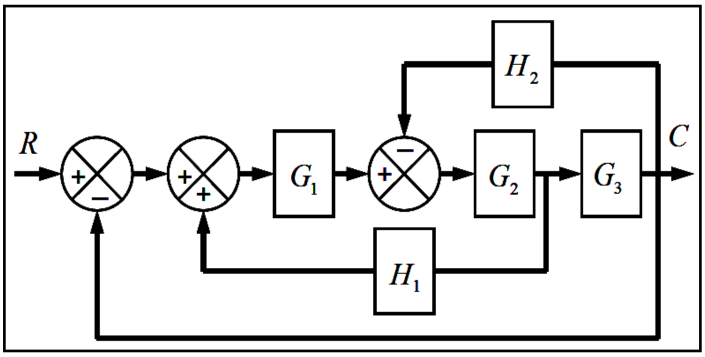


Fig. (2)

===

Answer

1. [a] $y''(t) + 3y'(t) + 2y(t) = e^{-3t}$

$$[S^2Y(s) - S\,y(0) - y'(0)] + 3[SY(s) - y(0)] + 2Y(s) = \frac{1}{S+3} \quad \text{........... if } y'(0) = y(0) = 0$$

$$\therefore\ S^2Y(s) + 3SY(s) + 2Y(s) = \frac{1}{S+3} \quad \rightarrow Y(s) = \frac{1}{(S^2+3S+2)(S+3)} = \frac{1}{(S+1)(S+2)(S+3)}$$

$$\therefore\ Y(s) = \frac{1}{(S+1)(S+2)(S+3)} = \frac{A}{S+1} + \frac{B}{S+2} + \frac{C}{S+3}$$

<u>First</u> : mutiply both sides by $(S+1)$ *and lets S go to* $-1 \quad \rightarrow \ \therefore A = \frac{1}{2}$

<u>Second</u> : mutiply both sides by $(S+2)$ *and lets S go to* $-2 \rightarrow \ \therefore B = -1$

<u>Third</u> : mutiply both sides by $(S+3)$ *and lets S go to* $-3 \quad \rightarrow \ \therefore C = \frac{1}{2}$

$$\therefore\ Y(s) = \frac{1}{(S+1)(S+2)(S+3)} = \frac{A}{S+1} + \frac{B}{S+2} + \frac{C}{S+3} = \frac{\frac{1}{2}}{S+1} + \frac{-1}{S+2} + \frac{\frac{1}{2}}{S+3}$$

$$\therefore y(t) = \tfrac{1}{2}e^{-t} - e^{-2t} + \tfrac{1}{2}e^{-3t}$$

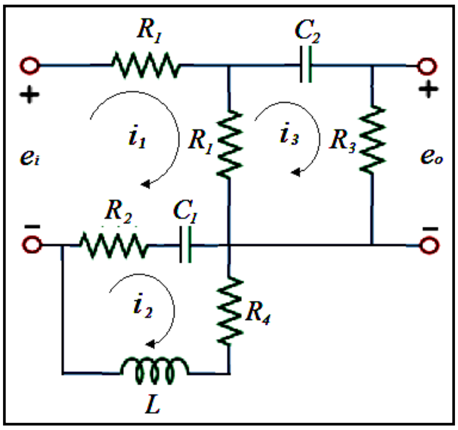
[b] $\lim_{t\to\infty} y(t) = \lim_{S\to 0} SY(s) = \lim_{S\to 0} \frac{S}{(S+1)(S+2)(S+3)} = 0$

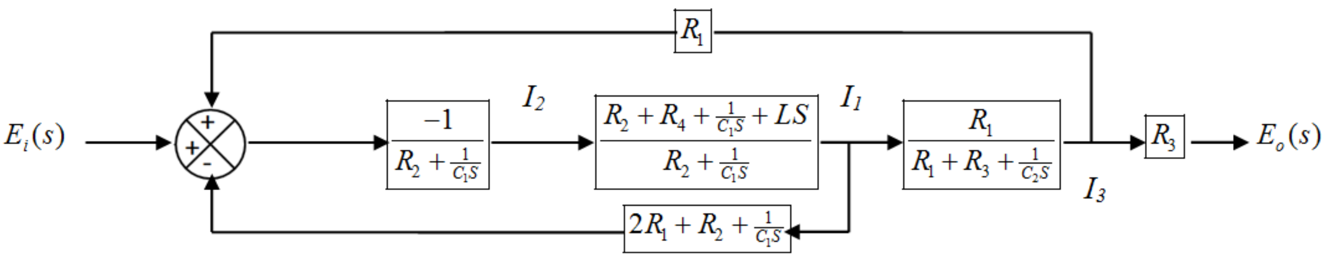
2. $E_i(s) = I_1(s)[2R_1 + R_2 + \frac{1}{C_1S}] - I_2(s)[R_2 + \frac{1}{C_1S}] - I_3(s)R_1$

$$0 = I_3(s)[R_1 + R_3 + \frac{1}{C_2S}] - I_1(s)R_1$$

$$0 = I_2(s)[R_2 + R_4 + \frac{1}{C_1S} + LS] - I_1(s)[R_2 + \frac{1}{C_1S}]$$

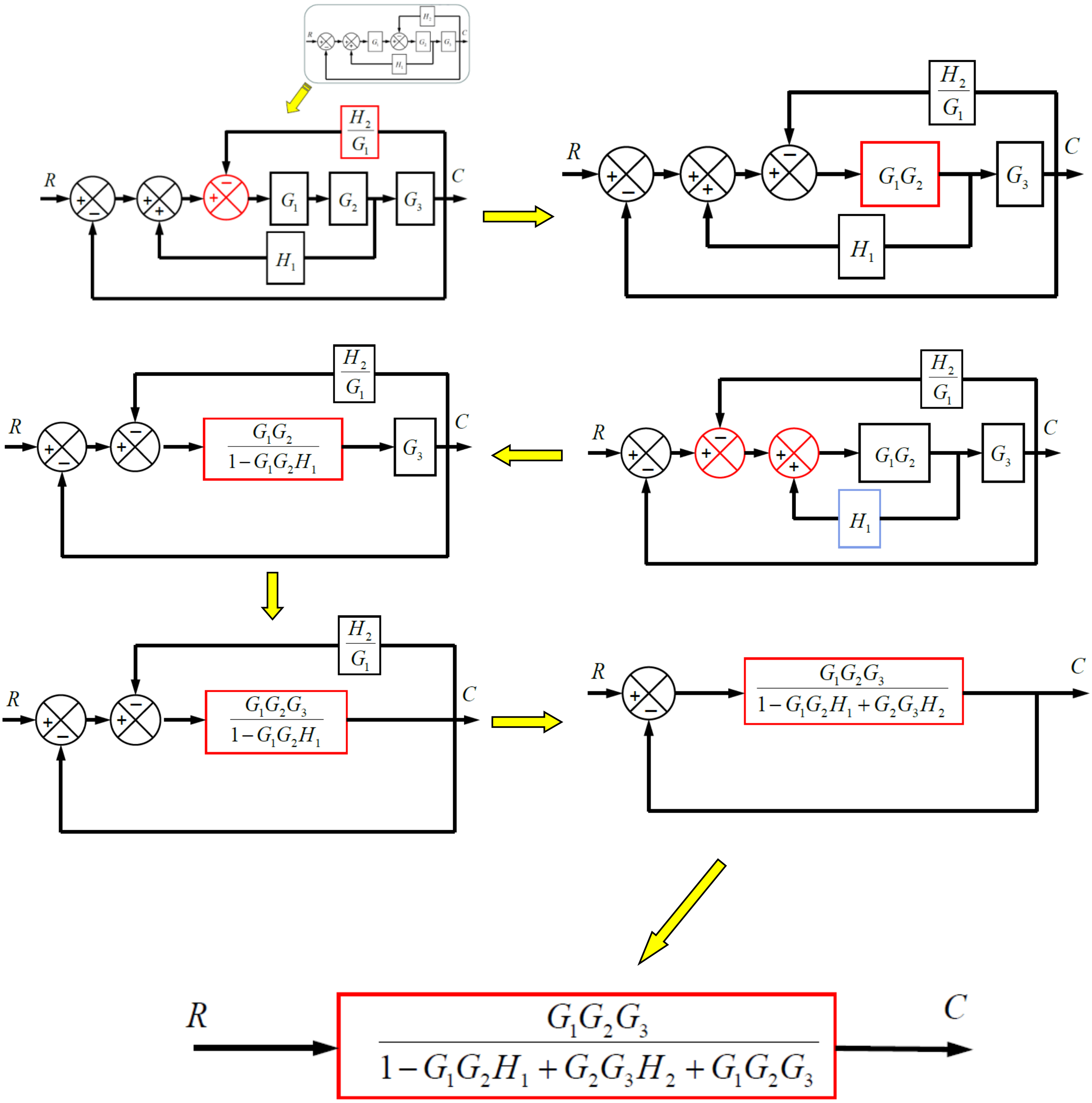
$$E_o(s) = I_3(s)R_3$$





==

3.


R
C
G_1
G_2
G_3
H_1
$\frac{H_2}{G_1}$
G_1G_2
$\frac{G_1G_2}{1-G_1G_2H_1}$
$\frac{G_1G_2G_3}{1-G_1G_2H_1}$
$\frac{G_1G_2G_3}{1-G_1G_2H_1+G_2G_3H_2}$
$\frac{G_1G_2G_3}{1-G_1G_2H_1+G_2G_3H_2+G_1G_2G_3}$