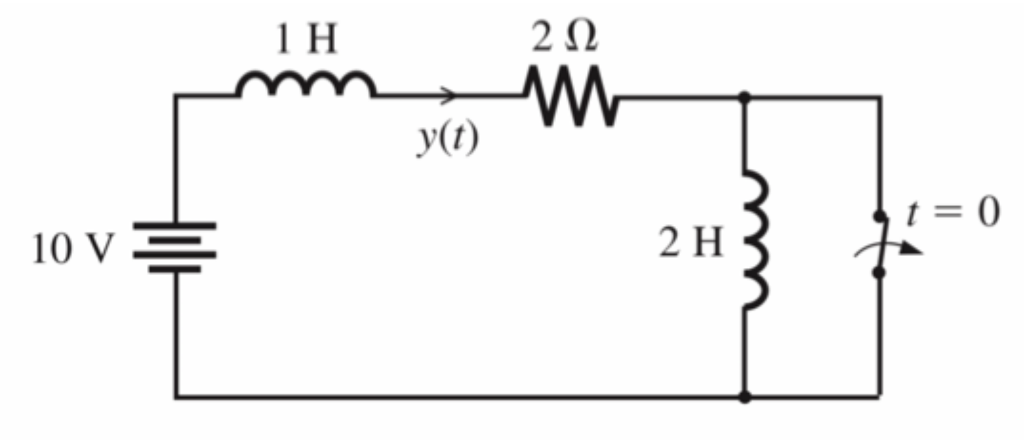
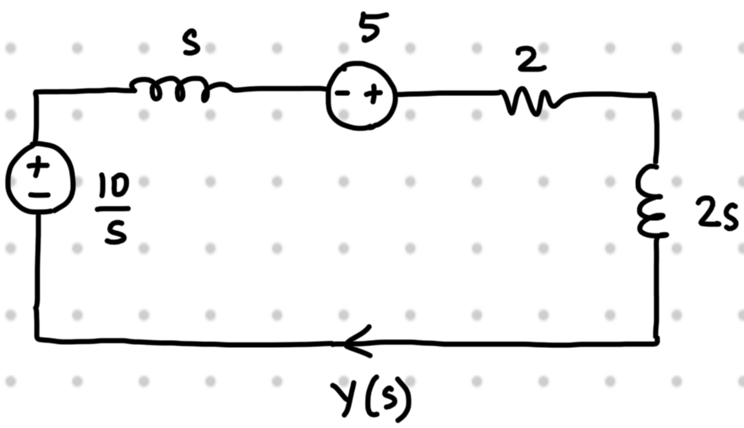
Q. The switch in the circuit shown below is closed for a long time and then opened instantaneously at $t = 0$. Find and sketch the current $y(t)$.



A. Before $t = 0$, inductor current $= 5A$

$\Rightarrow \; y(0) = 5A$

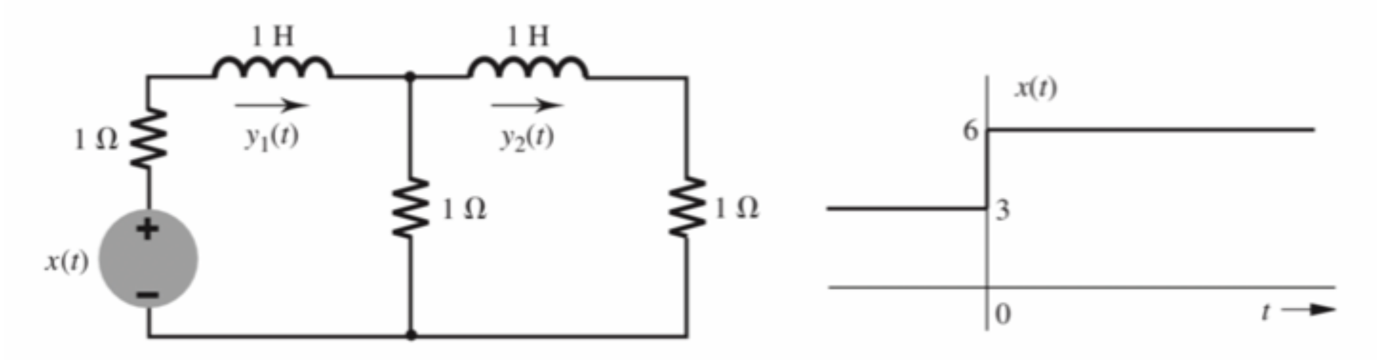
For $t \geq 0$,



$$Y(s) = \frac{\frac{10}{s} + 5}{3s + 2} = \frac{5}{3}\left[\frac{3}{s} - \frac{2}{s + 2/3}\right]$$

Hence, $y(t) = \left(5 - \frac{10}{3} e^{-2t/3}\right) u(t)$

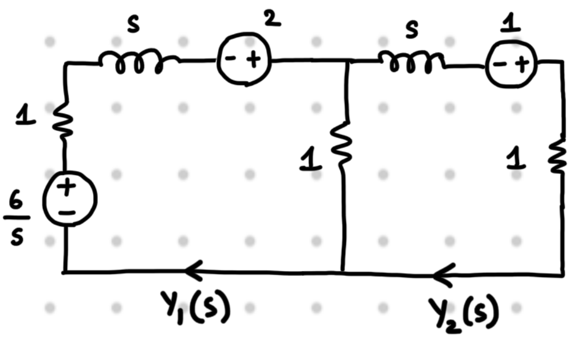
Q. Find the loop currents $y_1(t)$ and $y_2(t)$ for $t \geq 0$ in the circuit for the input $x(t)$ shown below.



(a) (b)

A. At $t = 0$, the steady state values of currents $y_1(t)$ and $y_2(t)$ are $y_1(0) = 2$ and $y_2(0) = 1$.

Hence, for $t \geq 0$,



$$(s+2)\,Y_1(s) - Y_2(s) = 2 + \frac{6}{s}$$

$$-Y_1(s) + (s+2)\,Y_2(s) = 1$$

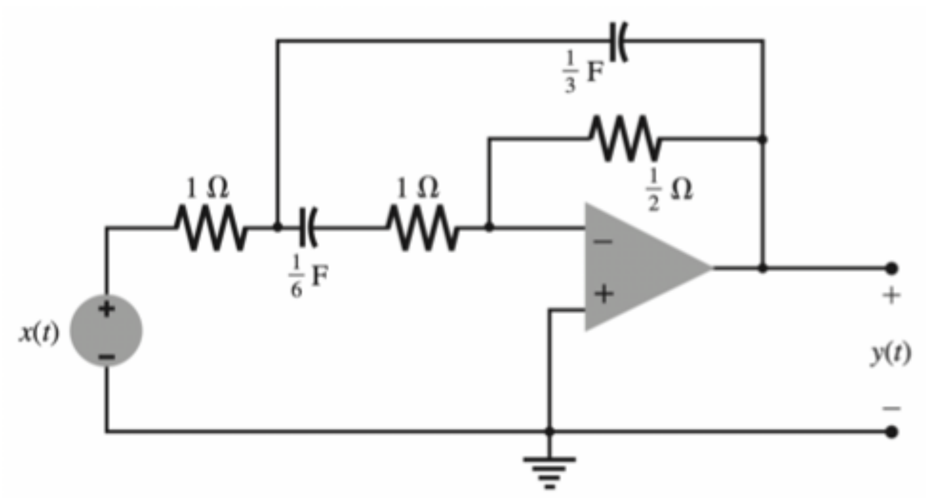
$$\Rightarrow Y_1(s) = \frac{2s^2 + 11s + 12}{s(s+1)(s+3)} = \frac{4}{s} - \frac{3/2}{s+1} - \frac{1/2}{s+3}$$

$$Y_2(s) = \frac{s^2 + 4s + 6}{s(s+1)(s+3)} = \frac{2}{s} - \frac{3/2}{s+1} + \frac{1/2}{s+3}$$

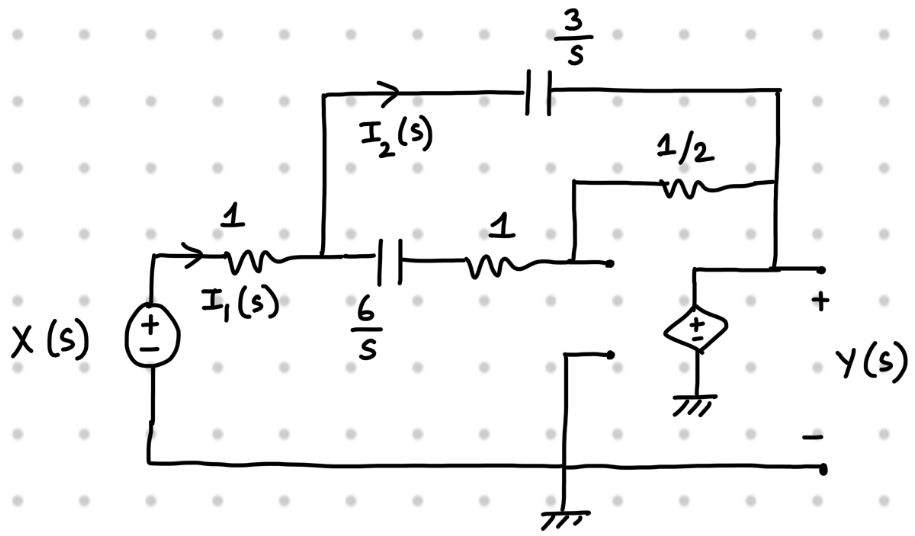
Hence, $$y_1(t) = \left(4 - \frac{3}{2}e^{-t} - \frac{1}{2}e^{-3t}\right)u(t)$$

$$y_2(t) = \left(2 - \frac{3}{2}e^{-t} + \frac{1}{2}e^{-3t}\right)u(t)$$

Q. For the op amp circuit shown below, find the transfer function $H(s)$ relating the output $y(t)$ to the input $x(t)$.



A. Transforming the circuit,



$$\left.\begin{aligned} X(s) &= I_1 + \left(\frac{6}{s} + 1\right)(I_1 - I_2) \\ 0 &= -\frac{3}{s} I_2 + \left(\frac{6}{s} + 1 + \frac{1}{2}\right)(I_1 - I_2) \end{aligned}\right\} \text{Solve}$$

With $Y(s) = -\frac{1}{2}\left[I_1 - I_2\right]$, $H(s) = \dfrac{-s}{s^2 + 8s + 12}$