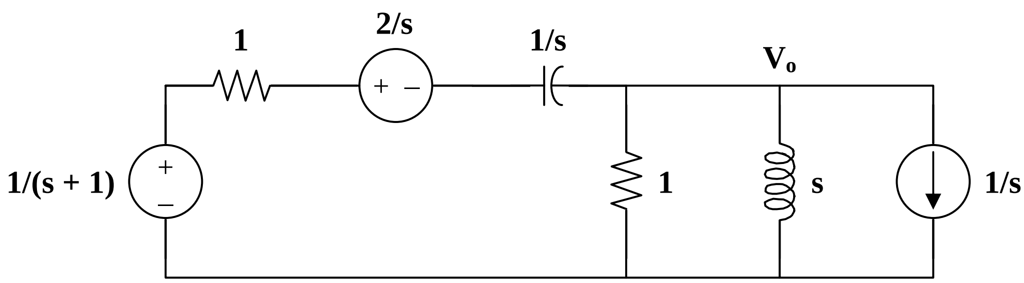
PROBLEM SET #8

Chapter 16, Solution 20.

We incorporate the initial conditions and transform the current source to a voltage source as shown.



At the main non-reference node, KCL gives

$$\frac{1/(s+1) - 2/s - V_o}{1 + 1/s} = \frac{V_o}{1} + \frac{V_o}{s} + \frac{1}{s}$$

$$\frac{s}{s+1} - 2 - s\,V_o = (s+1)(1+1/s)\,V_o + \frac{s+1}{s}$$

$$\frac{s}{s+1} - \frac{s+1}{s} - 2 = (2s + 2 + 1/s)\,V_o$$

$$V_o = \frac{-2s^2 - 4s - 1}{(s+1)(2s^2 + 2s + 1)}$$

$$V_o = \frac{-s - 2s - 0.5}{(s+1)(s^2 + s + 0.5)} = \frac{A}{s+1} + \frac{Bs + C}{s^2 + s + 0.5}$$

$$A = (s+1)\,V_o\Big|_{s=-1} = 1$$

$$-s^2 - 2s - 0.5 = A\,(s^2 + s + 0.5) + B\,(s^2 + s) + C\,(s+1)$$

Equating coefficients :

$$s^2: \quad -1 = A + B \longrightarrow B = -2$$

$$s^1: \quad -2 = A + B + C \longrightarrow C = -1$$

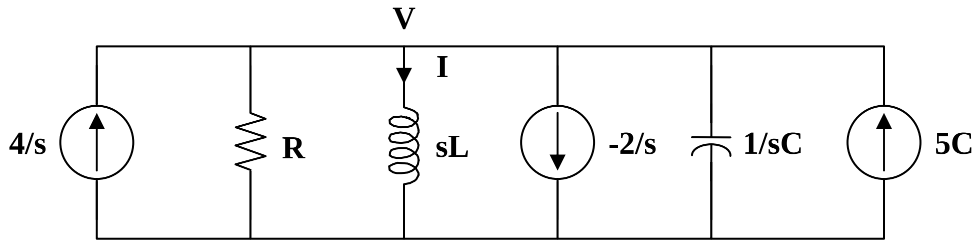
$$s^0: \quad -0.5 = 0.5A + C = 0.5 - 1 = -0.5$$

$$V_o = \frac{1}{s+1} - \frac{2s+1}{s^2 + s + 0.5} = \frac{1}{s+1} - \frac{2\,(s+0.5)}{(s+0.5)^2 + (0.5)^2}$$

$$v_o(t) = \underline{\left[\mathbf{e^{-t} - 2e^{-t/2}\cos(t/2)}\right]\mathbf{u(t)\ V}}$$

Chapter 16, Solution 23.

The s-domain form of the circuit with the initial conditions is shown below.



At the non-reference node,

$$\frac{4}{s} + \frac{2}{s} + 5C = \frac{V}{R} + \frac{V}{sL} + sCV$$

$$\frac{6 + 5sC}{s} = \frac{CV}{s}\left(s^2 + \frac{s}{RC} + \frac{1}{LC}\right)$$

$$V = \frac{5s + 6/C}{s^2 + s/RC + 1/LC}$$

But $\quad \dfrac{1}{RC} = \dfrac{1}{10/80} = 8, \qquad \dfrac{1}{LC} = \dfrac{1}{4/80} = 20$

$$V = \frac{5s + 480}{s^2 + 8s + 20} = \frac{5(s+4)}{(s+4)^2 + 2^2} + \frac{(230)(2)}{(s+4)^2 + 2^2}$$

$$v(t) = \underline{(5e^{-4t}\cos(2t) + 230e^{-4t}\sin(2t))u(t)\ \text{V}}$$

$$I = \frac{V}{sL} = \frac{5s + 480}{4s(s^2 + 8s + 20)}$$

$$I = \frac{1.25s + 120}{s(s^2 + 8s + 20)} = \frac{A}{s} + \frac{Bs + C}{s^2 + 8s + 20}$$

$A = 6, \qquad B = \text{-}6, \qquad C = \text{-}46.75$

$$I = \frac{6}{s} - \frac{6s + 46.75}{s^2 + 8s + 20} = \frac{6}{s} - \frac{6(s+4)}{(s+4)^2 + 2^2} - \frac{(11.375)(2)}{(s+4)^2 + 2^2}$$

$$i(t) = \underline{(6 - 6e^{-4t}\cos(2t) - 11.375e^{-4t}\sin(2t))u(t), \quad t > 0}$$