Electric Circuits II – Tutorial 05

#	Student ID	Student Name	Grade (10)
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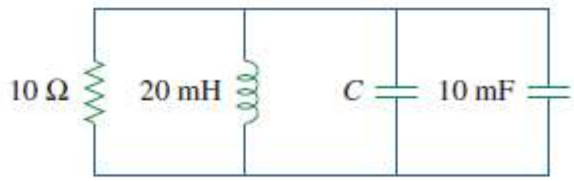
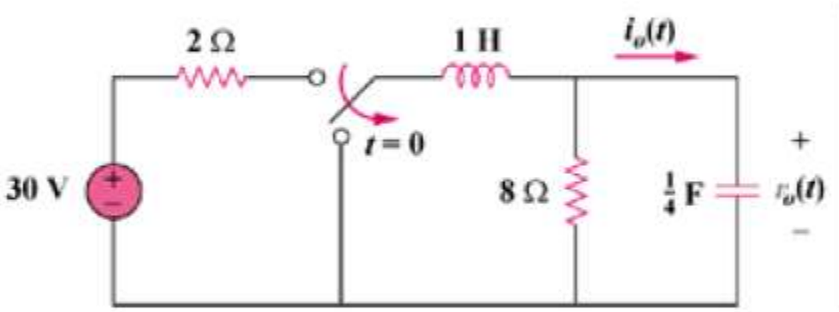
Q1	For the network in Fig. , what value of C is needed to make the response underdamped with unity damping factor ($\alpha = 1$)? 
Sol 1	Let $C_o = C + 0.01$. For a parallel RLC circuit, $$\alpha = 1/(2RC_o),\ \omega_o = 1/\sqrt{LC_o}$$ $$\alpha = 1 = 1/(2RC_o),\ \text{we then have } C_o = 1/(2R) = 1/20 = 50\text{ mF}$$ $$\omega_o = 1/\sqrt{0.02x0.05} = 141.42 > \alpha\ \text{(underdamped)}$$ $$C_o = C + 10\text{ mF} = 50\text{ mF or } C = \mathbf{40\ mF}$$

Q2

calculate $i_o(t)$ and $v_o(t)$ for $t > 0$.



Sol 2

In the circuit in Fig. 8.76, calculate $i_o(t)$ and $v_o(t)$ for $t>0$.

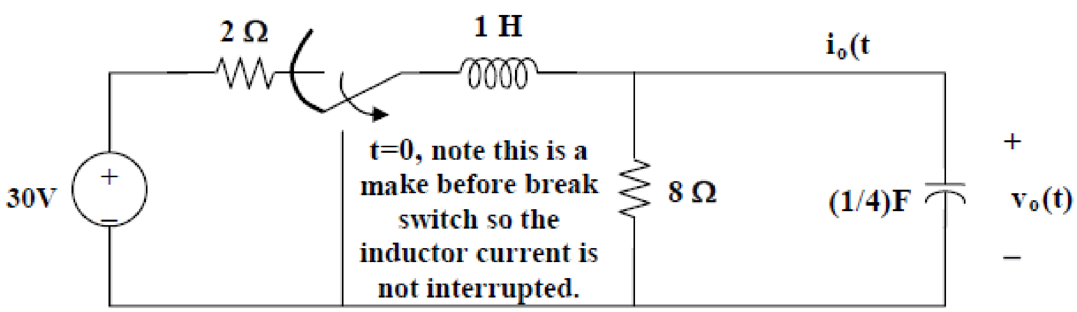


Figure 8.78 For Problem 8.25.

At $t = 0^-$, $v_o(0) = (8/(2 + 8)(30) = 24$

For $t > 0$, we have a source-free parallel RLC circuit.

$$\alpha = 1/(2RC) = ¼$$

$$\omega_o = 1/\sqrt{LC} = 1/\sqrt{1x1/4} = 2$$

Since α is less than ω_o, we have an under-damped response.

$$\omega_d = \sqrt{\omega_o^2 - \alpha^2} = \sqrt{4 - (1/16)} = 1.9843$$

$$v_o(t) = (A_1\cos\omega_d t + A_2\sin\omega_d t)e^{-\alpha t}$$

$$v_o(0) = 30(8/(2+8)) = 24 = A_1 \text{ and } i_o(t) = C(dv_o/dt) = 0 \text{ when } t = 0.$$

$$dv_o/dt = -\alpha(A_1\cos\omega_d t + A_2\sin\omega_d t)e^{-\alpha t} + (-\omega_d A_1\sin\omega_d t + \omega_d A_2\cos\omega_d t)e^{-\alpha t}$$

$$\text{at } t = 0, \text{ we get } dv_o(0)/dt = 0 = -\alpha A_1 + \omega_d A_2$$

Thus, $A_2 = (\alpha/\omega_d)A_1 = (1/4)(24)/1.9843 = 3.024$

$$v_o(t) = \mathbf{(24\cos 1.9843t + 3.024\sin 1.9843t)e^{-t/4}} \textbf{ volts}.$$

$$i_0(t) = C dv/dt = 0.25[-24(1.9843)\sin 1.9843t + 3.024(1.9843)\cos 1.9843t - 0.25(24\cos 1.9843t) - 0.25(3.024\sin 1.9843t)]e^{-t/4}$$
$$= \mathbf{[-12.095\sin 1.9843t]e^{-t/4}} \textbf{ A}.$$