

Lecture 03: Review of homework problems

Vijay Singh*

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Abstract

We will solve a couple of homework problems.

Problem 7.19

In the circuit of Figure 1, find the value of L such that $i(t)$ is in phase with $v_s(t)$.

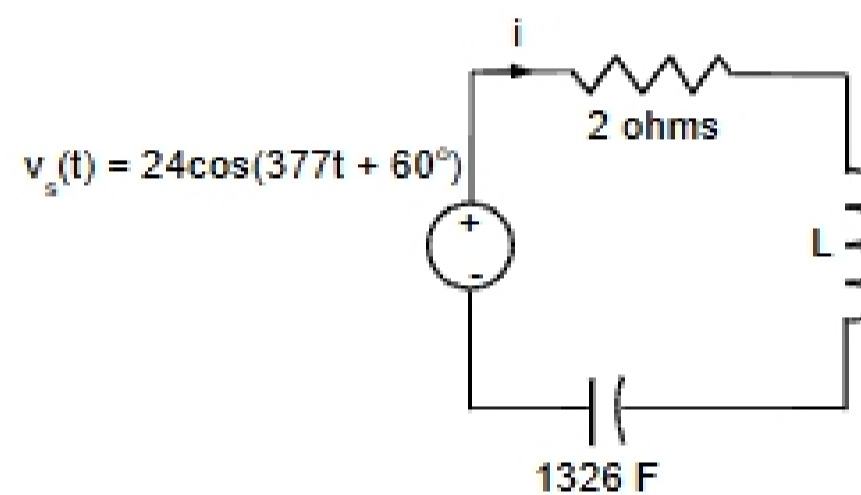


Figure 1: Circuit for problem 7-19.

Let I and V_s be the phasors that correspond to $i(t)$ and $v_s(t)$. In the frequency domain we can write

$$I = \frac{V_s}{R + (j\omega L + \frac{1}{j\omega C})}$$

For I and V_s to be in phase, $R + (j\omega L + \frac{1}{j\omega C})$ must be a real number. In other words, $j\omega L + \frac{1}{j\omega C}$ must be equal to zero, that is, $L = \frac{1}{\omega^2 C}$.

Thus,

$$L = \frac{1}{\omega^2 C} = \frac{1}{377^2 \times 1326 \times 10^{-6}} \text{ H.}$$

*Professor and Chairman, Department of Electrical & Computer Engineering, University of Kentucky, Lexington, KY, USA. E-mail: vsingh@engr.uky.edu Lecture presented on January 24, 2003. Typeset in L^AT_EX

Problem 7.33

In the circuit of Figure 2, find $v_o(t)$. Also, using a phasor diagram, show that $i_1(t) + i_2(t) = i_s(t)$.

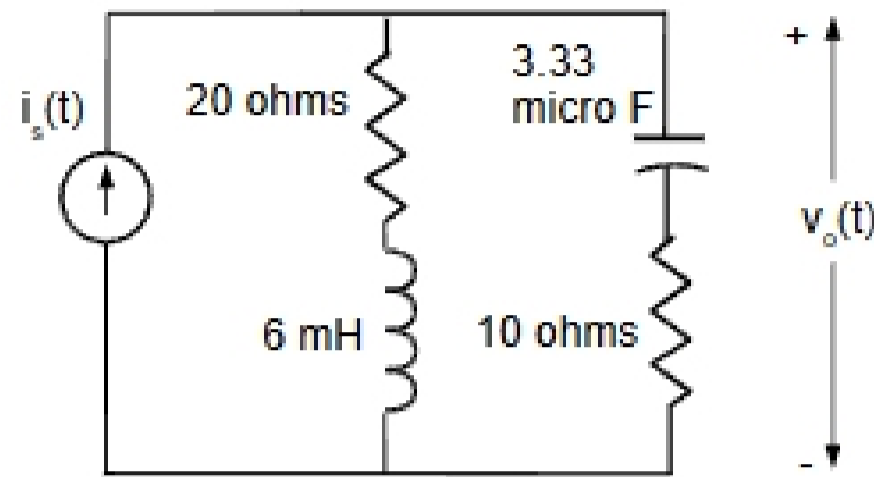


Figure 2: Time domain circuit.

The phasor circuit corresponding to the circuit of Figure 2 is shown in Figure 3.

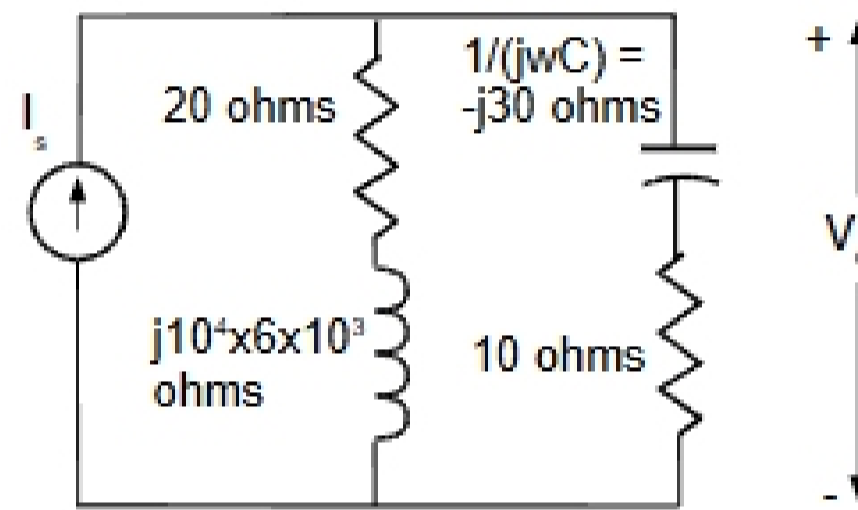


Figure 3: Frequency domain circuit.

$$\begin{aligned}
 V_o &= [(20 + j60) \parallel (10 - j30)] \times I_s \\
 &= \frac{(20 + j60)(10 - j30)}{(20 + j60) + (10 - j30)} \times I_s \\
 &= \frac{200 - j600 + j600 + 1800}{30(1 + j)} \times I_s \\
 &= \frac{2000}{30} \frac{1 - j}{1 + j} \\
 &= I_s \frac{100}{3} (1 - j) \\
 &= 0.3 \angle (-135^\circ) \times 33.33 \times \left(\frac{1}{\sqrt{2}} - j \frac{1}{\sqrt{2}} \right) \times \sqrt{2} \\
 &= 0.3 \angle (-135^\circ) \times 33.33 \sqrt{2} \angle (-45^\circ) \\
 &= 10\sqrt{2} \angle (-180^\circ) \\
 &= 14.14 \angle (-180^\circ)
 \end{aligned}$$

So,

$$v_o(t) = 14.14 \cos(10^4 t - 180^\circ) \text{ V.}$$

Finding I_1 and I_2 :

$$\begin{aligned}
 I_1 &= \frac{V_o}{20 + j60} = \frac{14.14\angle(-180^\circ)}{20(1 + j3)} = \frac{0.707\angle(-180^\circ)}{\sqrt{10}\angle(71.57^\circ)} \\
 &= \frac{0.707\angle(-180^\circ)}{3.16\angle(71.57^\circ)} \\
 &= 0.224\angle(-251.6^\circ)
 \end{aligned}$$

$$\begin{aligned}
 I_1 &= \frac{V_o}{10 - j30} = \frac{14.14\angle(-180^\circ)}{10(1 - j3)} = \frac{14.14\angle(-180^\circ)}{10 \times \sqrt{10}\angle(-71.57^\circ)} \\
 &= \frac{1.414\angle(-180^\circ)}{3.16\angle(-71.57^\circ)} \\
 &= 0.448\angle(-108.4^\circ)
 \end{aligned}$$

The phasor diagram showing $I_S = I_1 + I_2$ is shown in Figure 4.

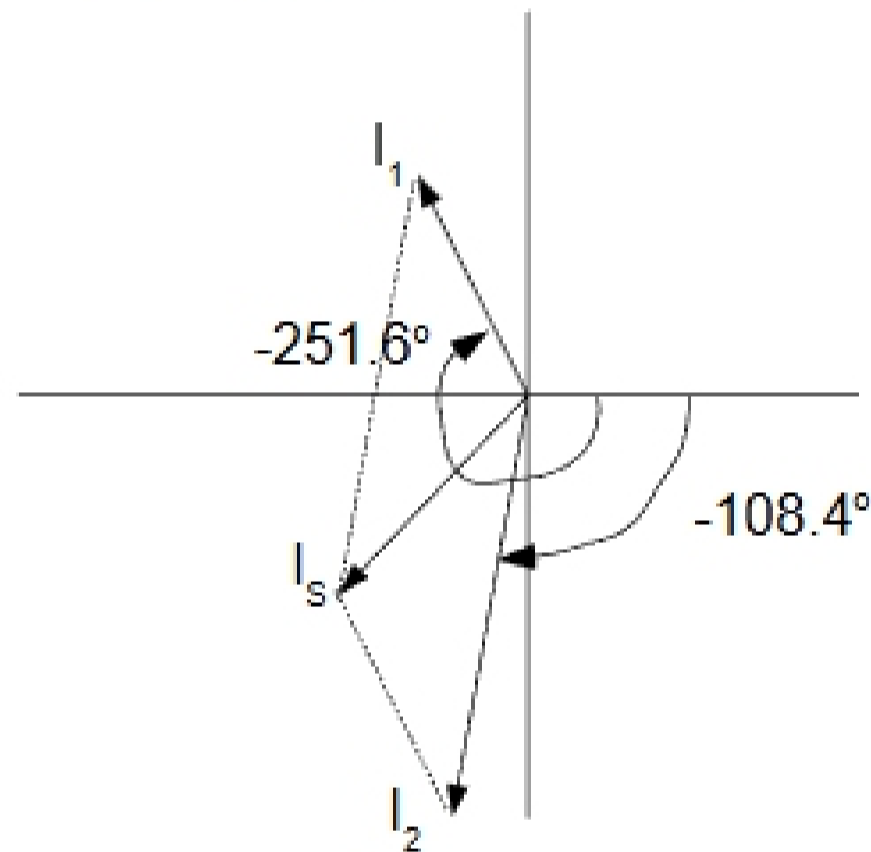


Figure 4: Phasor diagram.