Solution of EECS 300 Test 10 F08

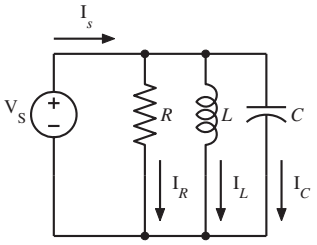
1. In the circuit below let $V_s = 20\angle 0°\ \text{V}$, $R = 2\ \text{k}\Omega$, $L = 0.5\ \text{H}$ and $C = 400\ \text{nF}$ with $\omega = 5000\ \text{rad/s}$.

   (a) The magnitude and angle of the phasor current I_R.

   (b) The magnitude and angle of the phasor current I_L.

   (c) The magnitude and angle of the phasor current I_C.

   (d) The magnitude and angle of the phasor current I_s.



$$I_R = \frac{20\angle 0°\ \text{V}}{2000\Omega} = 10\angle 0°\ \text{mA}$$

$$I_L = \frac{20\angle 0°\ \text{V}}{j(5000\ \text{rad/s})(0.5\ \text{H})} = -j8\ \text{mA} = 8\angle -90°\ \text{mA}$$

$$I_C = (20\angle 0°\ \text{V})(j(5000\ \text{rad/s})(400\ \text{nF})) = j40\ \text{mA} = 40\angle 90°\ \text{mA}$$

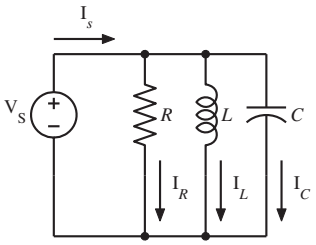
$$I_s = I_R + I_L + I_C = (10\angle 0° + 8\angle -90° + 40\angle 90°)\ \text{mA} = (10 + j32)\ \text{mA} = 33.53\angle 72.65°\ \text{mA}$$

(continued on next page)

   (e) Is the source current leading or lagging the source voltage?

   (e) The power being delivered by the voltage source at time $t = 10\ \text{ms}$.

   (f) The energy stored in the capacitor at time $t = 10\ \text{ms}$.



The source current leads the source voltage by 72.65°.

$$p_s(t) = v_s(t)\,i_s(t) = \left[20\cos(5000t)\ \text{V}\right]\left[33.53\cos(5000t + 72.65°)\ \text{mA}\right]$$

$$p_s(t) = 0.6706\cos(5000t)\cos(5000t + 72.65°)\ \text{W}$$

$$p_s(10\ \text{ms}) = 0.6706\cos(50)\cos(50 + 1.268)\ \text{W} = 0.3483\ \text{W}$$

$$e_C(t) = (1/2)C\,v_C^2(t) = (1/2)(400\ \text{nF})\left[20^2\cos^2(5000t)\ \text{V}^2\right]$$

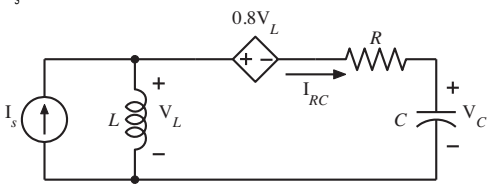
$$e_C(10\ \text{ms}) = (1/2)(400\ \text{nF})\left[400\cos^2(50)\ \text{V}^2\right] = 74.49\ \mu\text{J}$$

2. In the circuit below $R = 10\ \text{k}\Omega$, $L = 50\ \text{mH}$ and $C = 600\ \text{pF}$ with $\omega = 100{,}000\ \text{rad/s}$ and $\mathbf{I}_{RC} = 1\angle 0°\ \text{A}$.

(a) Find the magnitude and angle of the phasor voltage $\mathbf{V}_C$.

(b) Find the magnitude and angle of the phasor voltage $\mathbf{V}_L$.

(c) Find the magnitude and angle of the phasor current $\mathbf{I}_s$.



$$\mathbf{V}_C = \mathbf{I}_{RC}\frac{1}{j\omega C} = \left(1\angle 0°\ \text{A}\right)\frac{1}{j\left(100{,}000\ \text{rad/s}\right)\left(600\times 10^{-12}\ \text{F}\right)} = -j16667\ \text{V} = 16{,}667\angle -90°\ \text{V}$$

$$-\mathbf{V}_L + 0.8\mathbf{V}_L + \left(1\angle 0°\ \text{A}\right)\left(10{,}000\ \Omega\right) + 16{,}667\angle -90°\ \text{V} = 0$$

$$-0.2\mathbf{V}_L = \left(-10{,}000 - 16{,}667\angle -90°\right)\text{V} \Rightarrow \mathbf{V}_L = \frac{-10{,}000 - 16{,}667\angle -90°}{-0.2}\ \text{V} = 97{,}184\angle -59.04°\ \text{V}$$

$$\mathbf{I}_L = \frac{\mathbf{V}_L}{j\omega L} = \frac{97{,}184\angle -59.04°\ \text{V}}{j\left(100{,}000\ \text{rad/s}\right)\left(50\ \text{mH}\right)} = 19.44\angle -149.04°\ \text{A}\ \ \text{(flowing downward)}$$

$$\mathbf{I}_s = \mathbf{I}_{RC} + \mathbf{I}_L = \left(1\angle 0° + 19.44\angle -149.04°\right)\ \text{A} = 18.586\angle -147.45°\ \text{A}$$

Solution of EECS 300 Test 10 F08

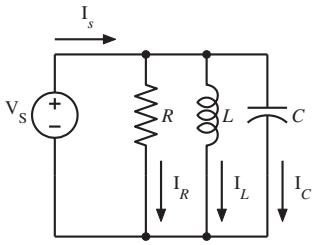
1. In the circuit below let $V_s = 20\angle 0°\ \text{V}$, $R = 2\ \text{k}\Omega$, $L = 0.5\ \text{H}$ and $C = 400\ \text{nF}$ with $\omega = 3000\ \text{rad/s}$.

   (a) The magnitude and angle of the phasor current I_R.

   (b) The magnitude and angle of the phasor current I_L.

   (c) The magnitude and angle of the phasor current I_C.

   (d) The magnitude and angle of the phasor current I_s.



$$I_R = \frac{20\angle 0°\ \text{V}}{2000\Omega} = 10\angle 0°\ \text{mA}$$

$$I_L = \frac{20\angle 0°\ \text{V}}{j\left(3000\ \text{rad/s}\right)\left(0.5\ \text{H}\right)} = -j13.3\ \text{mA} = 13.3\angle -90°\ \text{mA}$$

$$I_C = \left(20\angle 0°\ \text{V}\right)\left(j\left(3000\ \text{rad/s}\right)\left(400\ \text{nF}\right)\right) = j24\ \text{mA} = 24\angle 90°\ \text{mA}$$

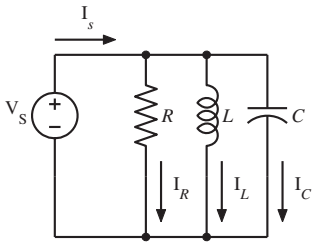
$$I_s = I_R + I_L + I_C = \left(10\angle 0° + 13.3\angle -90° + 24\angle 90°\right)\ \text{mA} = \left(10 + j10.7\right)\ \text{mA} = 14.65\angle 46.94°\ \text{mA}$$

(continued on next page)

   (e) Is the source current leading or lagging the source voltage?

   (e) The power being delivered by the voltage source at time $t = 10\ \text{ms}$.

   (f) The energy stored in the capacitor at time $t = 10\ \text{ms}$.



The source current leads the source voltage by 46.94°.

$$p_s(t) = v_s(t)\,i_s(t) = \left[20\cos(3000t)\ \text{V}\right]\left[14.65\cos(3000t + 46.94°)\ \text{mA}\right]$$

$$p_s(t) = 0.293\cos(3000t)\cos(3000t + 46.94°)\ \text{W}$$

$$p_s(10\ \text{ms}) = 0.293\cos(30)\cos(30 + 0.819)\ \text{W} = 0.0374\ \text{W}$$

$$e_C(t) = (1/2)C\,v_C^2(t) = (1/2)(400\ \text{nF})\left[20^2\cos^2(3000t)\ \text{V}^2\right]$$

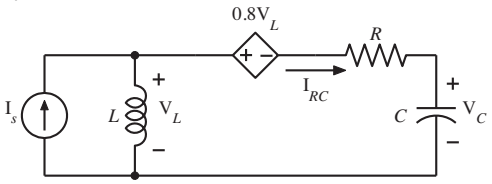
$$e_C(10\ \text{ms}) = (1/2)(400\ \text{nF})\left[400\cos^2(30)\ \text{V}^2\right] = 1.904\ \mu\text{J}$$

2. In the circuit below $R = 10\ \text{k}\Omega$, $L = 50\ \text{mH}$ and $C = 600\ \text{pF}$ with $\omega = 200{,}000\ \text{rad/s}$ and $\mathbf{I}_{RC} = 1\angle 0°\ \text{A}$.

(a) Find the magnitude and angle of the phasor voltage $\mathbf{V}_C$.

(b) Find the magnitude and angle of the phasor voltage $\mathbf{V}_L$.

(c) Find the magnitude and angle of the phasor current $\mathbf{I}_s$.



$$\mathbf{V}_C = \mathbf{I}_{RC}\frac{1}{j\omega C} = \left(1\angle 0°\ \text{A}\right)\frac{1}{j\left(200{,}000\ \text{rad/s}\right)\left(600\times 10^{-12}\ \text{F}\right)} = -j8333\ \text{V} = 8{,}333\angle -90°\ \text{V}$$

$$-\mathbf{V}_L + 0.8\,\mathbf{V}_L + \left(1\angle 0°\ \text{A}\right)\left(10{,}000\ \Omega\right) + 8{,}333\angle -90°\ \text{V} = 0$$

$$-0.2\,\mathbf{V}_L = \left(-10{,}000 - 8{,}333\angle -90°\ \right)\text{V} \Rightarrow \mathbf{V}_L = \frac{-10{,}000 - 8{,}333\angle -90°}{-0.2}\ \text{V} = 65084\angle -39.8°\ \text{V}$$

$$\mathbf{I}_L = \frac{\mathbf{V}_L}{j\omega L} = \frac{65084\angle -39.8°\ \text{V}}{j\left(200{,}000\ \text{rad/s}\right)\left(50\ \text{mH}\right)} = 6.508\angle -129.8°\ \text{A}\ \ \text{(flowing downward)}$$

$$\mathbf{I}_s = \mathbf{I}_{RC} + \mathbf{I}_L = \left(1\angle 0° + 6.508\angle -129.8°\right)\ \text{A} = 5.92\angle -122.35°\ \text{A}$$