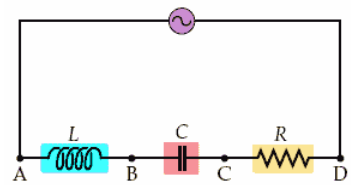
PHYSQ 126, Quiz 10
12 avril 2012

Walker #24.55

55. **Picture the Problem**: The figure shows a 2.50-Ω resistor, 0.300-mH inductor, and 0.100-μF capacitor connected in series with a 6.00-V, 60.0-kHz power supply.



Strategy: Calculate the rms voltage across each element by multiplying the reactance or resistance of that element by the rms current. To calculate the rms current, divide the rms voltage by the impedance of the entire circuit, given by equation 24-16.

Solution: 1. Calculate the capacitive reactance:

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi\left(60.0\text{ kHz}\right)0.100\,\mu\text{F}} = 26.53\ \Omega$$

2. Calculate the inductive reactance:

$$X_L = \omega L = 2\pi\left(60.0\text{ kHz}\right)\left(0.300\text{ mH}\right) = 113.1\ \Omega$$

3. Calculate the impedance:

$$Z = \sqrt{R^2 + \left(X_L - X_C\right)^2}$$
$$= \sqrt{\left(2.50\ \Omega\right)^2 + \left(113.1\ \Omega - 26.53\ \Omega\right)^2} = 86.61\ \Omega$$

3. Calculate the rms current:

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{Z} = \frac{6.00\text{ V}}{86.61\ \Omega} = 0.0693\text{ A}$$

4. (a) Multiply the current by the resistance:

$$V_{\text{rms,R}} = I_{\text{rms}}R = \left(0.0693\text{ A}\right)\left(2.50\ \Omega\right) = \boxed{0.173\text{ V}}$$

5. (b) Multiply the current by the inductive reactance:

$$V_{\text{rms},L} = I_{\text{rms}}X_L = \left(0.0693\text{ A}\right)\left(113.1\ \Omega\right) = \boxed{7.84\text{ V}}$$

6. (c) Multiply the current by the capacitive reactance:

$$V_{\text{rms,C}} = I_{\text{rms}}X_C = \left(0.0693\text{ A}\right)\left(26.53\ \Omega\right) = \boxed{1.84\text{ V}}$$

7. (d) The sum of the rms voltages across the circuit is greater than the rms voltage of the power source. Because the inductor and capacitor are out of phase with each other, they can produce large instantaneous voltages that nearly cancel each other. When all the voltages are added as phasors (as in figure 24-21), however, their sum equals exactly 6.00 V.

Insight: Note that the impedance is much higher in this problem than it was in problem 54, when the circuit was being driven at a frequency that is much closer to the resonance frequency of 29.1 kHz. Driving the circuit at too high a frequency creates a large "back" emf across the inductor and increases the inductive reactance, which in turn increases the impedance and decreases the current in the circuit.