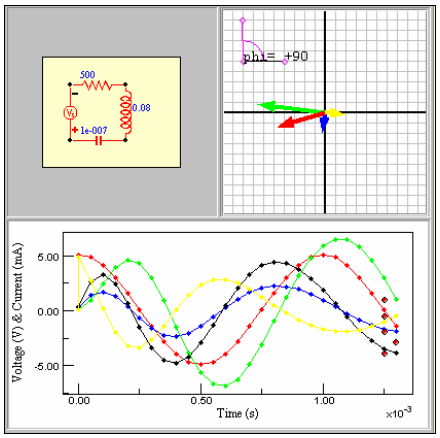
Worksheet for Exploration 31.6: RLC Circuits and Phasors



Assume an ideal power supply. The graph shows the voltage as a function of time across the source **(red)**, the resistor **(blue)**, the capacitor **(green)** and the inductor **(yellow)**, as well as the current through the circuit **(black) (voltage is given in volts, current is given in milliamperes, angles are given in degrees, and time is given in seconds)**. Restart.

From the vectors on the phasor diagram, we can develop a connection between the peak (or rms) voltage and the peak (or rms) current, where $V_0 = I_0 Z$ and the phase difference between the voltage and current is given by φ. On the phasor diagram, V_0 (**the source voltage-red**) is the vector sum of the three voltage vectors (**resistor-blue**, **inductor-yellow** and **capacitor-green**) and φ is the angle between V_0 and the resistor phasor (since resistor current and voltage are in phase). The y components of the phasor vectors are the voltages across the various circuit elements. See Illustrations 31.6 and 31.7 as well as Exploration 31.5.

a. Explain the phase difference between the blue, yellow and green vectors in the phasor animation.

b. Pick a frequency and pause the animation. Verify that the red vector is the vector sum of the other three vectors.

c. Pick a frequency and measure φ on the phasor diagram using the pink protractor.

Frequency = _____

i. Current phasor is in phase with the resistor voltage phasor. Why?

ii. Phase shift (angle between current (resistor voltage) and source voltage) = _____

d. Explain how you can tell that the phasor animation matches the voltage and current versus time graph for the circuit.

e. Also measure the phase angle on the voltage and current graphs. To measure the phase angle, since one period ($1/f$) represents a phase shift of 2π, measure the time difference between the peaks of the voltage and current plots and divide by the period.

T (period) = _____

t_1 = Time at a maximum of voltage = _____

t_2 = Time at nearest maximum of current = _____

φ = phase shift=$2\pi*(t_1-t_2)/T$ = _____

f. Measure Z for this same frequency ($Z = V_0 / I_0$). Check your answers by using the equations for impedance and the phase shift between the voltage and the current, $Z = (R^2 + (\omega L - 1/\omega C)^2)^{1/2}$ and $\cos\varphi = R / Z$.

Frequency = _____

V_{rms} = _____ I_{rms} = _____

$Z = V_0/I_0 = V_{rms}/I_{rms}$ = _____

Comparison with $R \cos \varphi$ = _____

and $(R^2 + (\omega L - 1/\omega C)^2)^{1/2}$ = _____