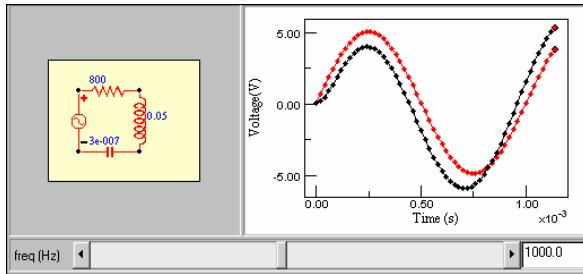# Worksheet for Exploration 31.4: Phase Angle and Power

Assume an ideal power supply. The graph shows the voltage **(red)** as a function of time across the source and the current **(black)** through the circuit **(voltage is given in volts, current is given in milliamperes, and time is given in seconds)**. (Note: the initial current versus time graphs are not centered about 0 because of the initial state of the capacitor and inductor.) Restart.

To calculate the power dissipated by an RLC series circuit you can not simply use $I_{rms}V_{rms}$ because the power supply current and voltage are not in phase (unlike with a purely resistive load). This is due to the different phase shifts between voltage and current associated with the capacitors and inductors (the current through all elements must be the same so the voltages across each are phase shifted from each other, see Illustrations 31.4 and 31.5). Here the equations for calculating power are

$$P = I_{rms}^2 R = I_{rms}V_{rms}\cos\varphi = I_{rms}^2 Z\cos\varphi,$$

where Z is the impedance of the series circuit (V_{rms}/I_{rms})and φ is the phase shift between current and voltage defined as ($\omega = 2\pi f$)

$$Z = (R^2 + (\omega L - 1/\omega C)^2)^{1/2} \quad \text{and} \quad \cos\varphi = R/Z.$$

a. Pick a frequency value. Find the impedance from V_{rms}/I_{rms} .

Frequency = _____

V_{rms} = _____

I_{rms} = _____

Z = _____

b. Compare this value with the calculated value found using the equation above.

R = _____

L = _____

C = _____

$\omega = 2\pi f$ = _____

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

c. Calculate the phase shift.

   i. $\cos\varphi = R/Z$ so $\varphi =$

d. Compare this calculated value with the value of phase shift measured directly from the graph. 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 (the time between the peaks of the voltage or the current) to find the percentage of 2π by which the current is shifted.

   T (period) = _____

   t_1 = Time at a maximum of voltage = _____

   t_2 = Time at nearest maximum of current = _____

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

e. What is the power dissipated?