Inductors and AC Circuits

Equations:

Energy stored in capacitor or inductor:

$$U_C = \frac{1}{2}\frac{Q^2}{C} \qquad U_L = \frac{1}{2}LI^2$$

Oscillating frequency of LC circuit:

$$(2\pi f)^2 = \frac{1}{LC}$$

Reactance of capacitor and inductor (AC):

$$X_C = \frac{1}{2\pi f C} \qquad X_L = 2\pi f L$$

f is frequency.

Impedance of LRC circuit (AC):

$$Z = \sqrt{(X_C - X_L)^2 + R^2}$$

Form for current... in LRC circuit (AC):**

$$I(t) = I_{max}\sin 2\pi f t \qquad \frac{\Delta I}{\Delta t} = 2\pi f I_{max}\cos 2\pi f t \qquad Q(t) = \frac{-1}{2\pi f} I_{max}\cos 2\pi f t$$

Form for voltage in LRC circuit (AC):**

$$V(t) = Z I_{max}\sin(2\pi f t + \phi) \qquad \tan\phi = \frac{X_L - X_C}{R}$$

Resonant condition for LRC circuit (AC):

$$X_C = X_L \qquad (2\pi f)^2 = \frac{1}{LC}$$

Ohm's Law for LRC circuits (AC):

$$\mathcal{E}_{max} = Z I_{max} \qquad \mathcal{E}_{rms} = Z I_{rms}$$

Root-mean-square (rms) currents and voltages (AC):

$$I_{rms} = I_{max}/\sqrt{2} \qquad \mathcal{E}_{rms} = \mathcal{E}_{max}/\sqrt{2}$$

Power dissipated in LRC circuits (AC):

$$P = I_{rms}^2 R$$

Assorted Facts:

1. Charge on capacitor can not change instantaneously if connected in series with resistor.
2. Current through circuit element can not change instantaneously if connected in series with inductor.
3. In steady state (DC) there is no current through a capacitor.
4. In steady state (DC) there is no voltage drop across an inductor.
5. Current through LRC element for fixed voltage is maximized when frequency is set to resonant condition (see above).

** These formulas will be used only for discussion purposes.