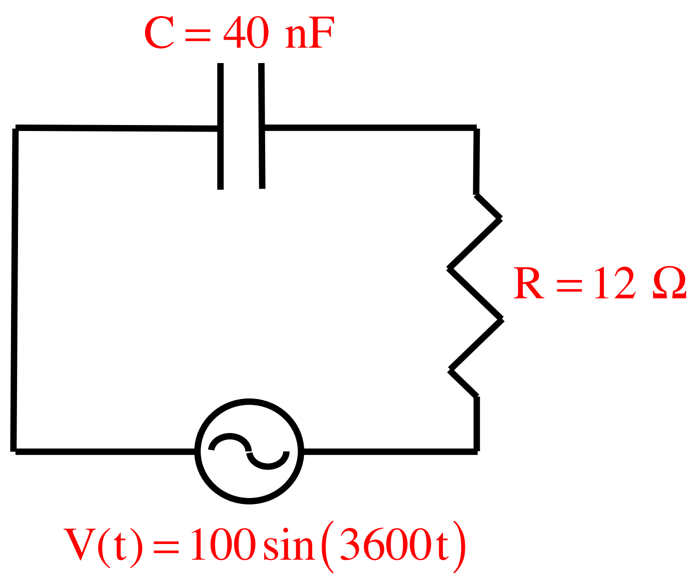
RC example problem

Consider the RC circuit shown to the right.



a.) What is the RMS value of the power supply?

b.) At what frequency is the power supply acting?

c.) What is the circuit's capacitive reactance?

d.) What is the circuit's impedance?

e.) What is the circuit's current?

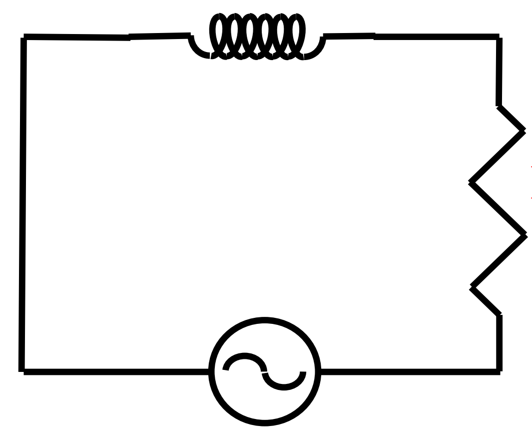
RL example problem

Consider the RL circuit shown to the right.

a.) What is the circuit's inductive reactance?

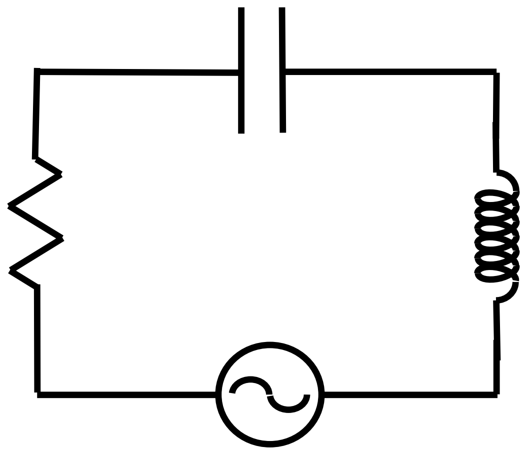
b.) What is the circuit's impedance?

c.) What is the circuit's current?



RLC example problem

Consider the RLC circuit shown to the right.



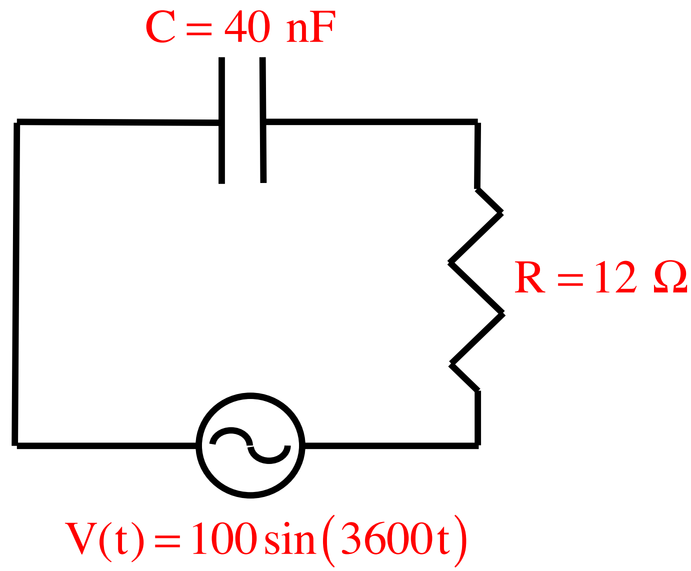
a.) What is the circuit's impedance?

b.) What is the circuit's current?

c.) What is the circuit's resonance frequency?

1.) RC circuit:

Consider the RC circuit shown to the right.



a.) What is the RMS value of the power supply?

$$V_{RMS} = .707V_o$$
$$= .707(100 \text{ volts})$$
$$= 70.7 \text{ volts}$$

b.) At what frequency is the power supply acting?

$$2\pi\nu = 3600$$
$$= 573 \text{ Hz}$$

c.) What is the circuit's capacitive reactance?

$$X_C = \frac{1}{2\pi\nu C}$$
$$= \frac{1}{2\pi(573 \text{ Hz})(40\text{x}10^{-9} \text{ F})}$$
$$= 6.94\text{x}10^{3} \ \Omega$$

1.) RC circuit (con' t) :

d.) What is the circuit' s impedance?

$$Z = \left[\left(R + \cancelto{0}{r_L}\right)^2 + \left(\cancelto{0}{X_L} - X_C\right)^2 \right]^{1/2}$$

$$= \left[\left(12\ \Omega + 0\right)^2 + \left(-6.94\text{x}10^3\right)^2 \right]^{1/2}$$

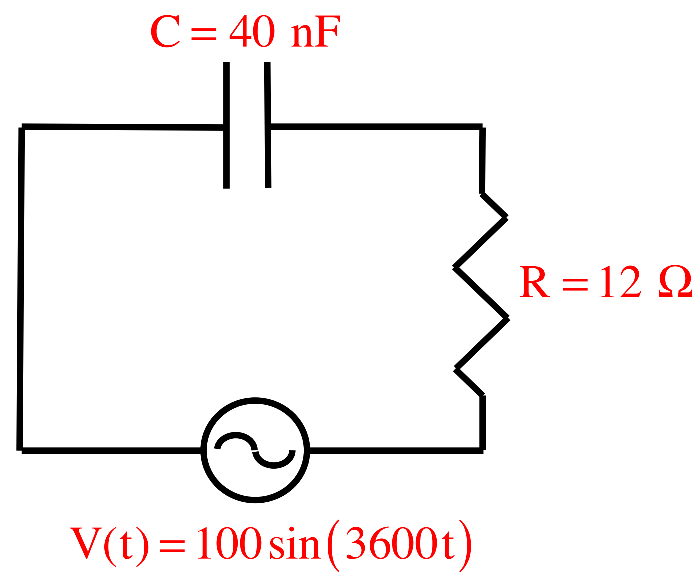
$$= 6.94\text{x}10^3\ \Omega$$

e.) What is the circuit' s current?

$$i_{RMS} = \frac{V_{RMS}}{Z}$$

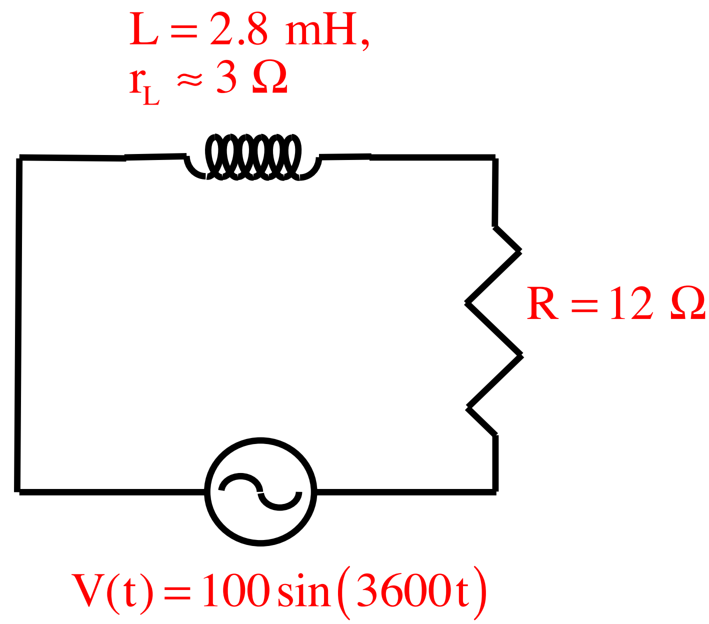
$$= \frac{(70.7\ \text{V})}{(6.94\text{x}10^3\ \Omega)}$$

$$= 1.02\text{x}10^{-2}\ \text{A}$$



2.) RL circuit:

The same power supply and resistor in an RL circuit is shown to the right (assuming the coil's resistance is zero).



a.) What is the circuit's inductive reactance?

$$X_L = 2\pi\nu L$$
$$= 2\pi(573\ \text{Hz})(2.8\text{x}10^{-3}\ \text{H})$$
$$= 10.0\ \Omega$$

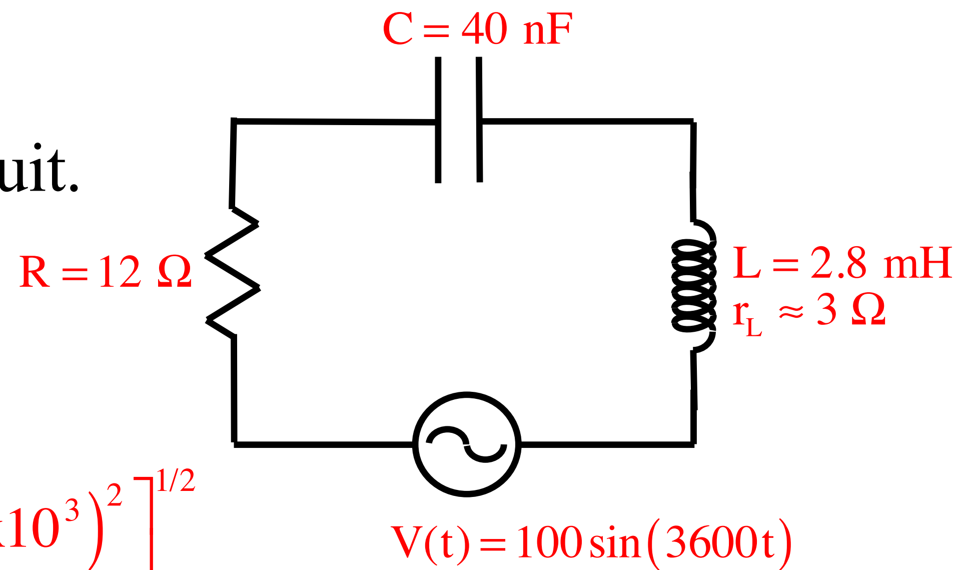
b.) What is the circuit's impedance?

$$Z = \left[(R + r_L)^2 + (X_L - \cancelto{0}{X_C})^2\right]^{1/2}$$
$$= \left[(12\ \Omega + 3\ \Omega)^2 + (10.0)^2\right]^{1/2}$$
$$= 18.0\ \Omega$$

c.) What is the circuit's current?

$$i_{RMS} = \frac{V_{RMS}}{Z}$$
$$= \frac{(70.7\ \text{V})}{(18\ \Omega)}$$
$$= 3.93\ \text{A}$$

3.) RLC circuit:



Now add a cap making an RLC circuit.

a.) What is the circuit' s impedance?

$$Z = \left[(R + r_L)^2 + (X_L - X_C)^2\right]^{1/2}$$

$$= \left[(12\ \Omega + 3\ \Omega)^2 + (10.0 - 6.94\text{x}10^3)^2\right]^{1/2}$$

$$= 6.93\text{x}10^3\ \Omega$$

b.) What is the circuit's resonance frequency?

$$\nu = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} = \frac{1}{2\pi}\sqrt{\frac{1}{(2.8\text{x}10^{-3}\text{H})(40\text{x}10^{-9}\text{F})}}$$

$$= 1.5\text{x}10^3\ \text{Hz}$$

c.) What is the circuit's current at the resonance frequency?

As the *inductive reactance* and *capacitive reactance* add to zero at resonance, the current will simply be due to the circuit's frequency independent resistor-like resistance, or:

$$i_{RMS} = \frac{V_{RMS}}{R_{net}} = \frac{(70.7\ \text{V})}{(15\ \Omega)}$$

$$= 4.71\ \text{A}$$