

PHYS 51W Workshop. March 4 – 10

These problems are associated with Chapters 31 and 32, Alternating current and electromagnetic waves.

1. The voltage in a wall socket is described by the equation $V = V_o \cos(\omega t)$. The rms voltage is 220 volts, and the frequency is 60 Hz.

- a. What is the voltage amplitude V_o ? What is the average voltage?
- b. What is the angular frequency ω ?
- c. If this voltage is applied to a toaster which has a resistance of 50 ohms, what is the rms current? The maximum current? The average current?

2. A power supply oscillates at 60 Hz. The rms voltage is 100 V.

- a. Suppose the power supply is connected to a 100Ω resistor. What is the maximum current through the resistor? What is the rms current? Suppose that the voltage across the resistor is a maximum. How long would you have to wait until the next maximum in current occurred?
- b. Suppose that the power supply is connected to a 0.025 H inductor. What is the reactance? What is the maximum current through the inductor. What is the rms current? Suppose the voltage across the resistor is a maximum. How long would you have to wait until the next maximum in the current occurred?
- c. Suppose that the power supply is connected to a $5.0 \mu\text{F}$ capacitor. What is the reactance? What is the rms current? What is the maximum current through the capacitor? Suppose the voltage across the resistor is a maximum. How long would you have to wait until the next maximum in the current occurred?

3. A capacitor has a reactance of 100Ω at a frequency of 100 Hz. What is its capacitance? An inductor has a reactance of 100Ω at a frequency of 100 Hz. What is the inductance? If the frequency doubles, what is the new reactance of each?

4. A $100\ \Omega$ resistor, a $5.0\ \mu\text{F}$ Capacitor, and a $0.25\ \text{H}$ inductor are connected in series. The frequency of the current through each is $60\ \text{Hz}$.

- a. What is the total ~~reactance~~^{impedance} of this circuit?
- b. At what frequency is the ~~reactance~~^{impedance} of the circuit a minimum?
- c. At what frequencies is the ~~reactance~~^{impedance} of the circuit twice the minimum reactance.
- d. Determine the phase angle for this LRC circuit at $60\ \text{Hz}$; when the reactance is a minimum; when the reactance is twice the minimum reactance.

5. You have a $100\ \Omega$ resistor, a $0.200\ \text{H}$ inductor, and a $2.50\ \mu\text{F}$ capacitor connected in series with a variable voltage source whose amplitude is $5.00\ \text{V}$.

- a. At what frequency is the current through this circuit a maximum? What is the current amplitude then? The rms current then?
- b. Double the frequency you determined in page a. Find the current amplitude through the circuit for this new frequency. Find the voltage amplitude across each of the three devices. Does the voltage lead or lag the current? What is the phase angle?
- c. for the previous two parts of the problem, determine the power dissipated in the circuit.

6. A series circuit consists of $50\ \Omega$ resistor, a $0.100\ \text{H}$ inductor, and a $2.00\ \mu\text{F}$ capacitor. The frequency of the circuit is $50\ \text{Hz}$ and the voltage amplitude is $3.5\ \text{volts}$.

- a. What is the average power delivered to the resistor? To the capacitor? To the inductor?
- b. How would your answers change if the frequency doubled? If the voltage amplitude doubled?

7. In an LRC series circuit are a $50\ \Omega$ resistor, a $0.200\ \text{H}$ inductor, and a $0.400\ \mu\text{F}$ capacitor are in series with an ac voltage source.

- a. What is the resonance frequency of this circuit?
- b. The maximum voltage the capacitor can withstand is 50 volts. What is the maximum voltage amplitude of the voltage source if this maximum capacitor voltage is not to be exceeded?