Homework: Ch. 23

1. True/False: Mutual induction occurs when the magnetic field produced by the current flowing through a coil is used to induce a current in another coil.

2. When a capacitor is used in an alternating current circuit, the current in the capacitor is related to the voltage across the capacitor by its capacitive reactance, which depends on the capacitance of the capacitor and the frequency of the generator. Which one of the following statements correctly describes the relationship between the capacitive reactance and the frequency?
    a. The capacitive reactance is directly proportional to the frequency.
    b. The capacitive reactance is directly proportional to the square of the frequency.
    c. The capacitive reactance is inversely proportional to the frequency.
    d. The capacitive reactance is inversely proportional to the square of the frequency.
    e. The capacitive reactance is directly proportional to the square root of the frequency.

3. When an inductor is used in an alternating current circuit, the current in the inductor is related to the voltage across the inductor by its inductive reactance, which depends on the inductance of the inductor and the frequency of the generator. Which one of the following statements correctly describes the relationship between the inductive reactance and the frequency?
    a. The inductive reactance is directly proportional to the frequency.
    b. The inductive reactance is directly proportional to the square of the frequency.
    c. The inductive reactance is inversely proportional to the frequency.
    d. The inductive reactance is inversely proportional to the square of the frequency.
    e. The inductive reactance is directly proportional to the square root of the frequency.

4. An alternating current is set up in an LRC circuit. For which of the following circuit elements are the current and voltage in phase?
    a. inductor only
    b. resistor only
    c. capacitor only
    d. resistor and capacitor only
    e. inductor, resistor, and capacitor

5. An alternating current is set up in an LRC circuit. For which of the following circuit elements does the current lead the voltage by 90°?
    a. inductor only
    b. resistor only
    c. capacitor only
    d. resistor and capacitor only
    e. inductor, resistor, and capacitor

6. An alternating current is set up in an LRC circuit. For which of the following circuit elements does the voltage lead the current by 90°?
    a. inductor only
    b. resistor only
    c. capacitor only
    d. resistor and capacitor only
    e. inductor, resistor, and capacitor

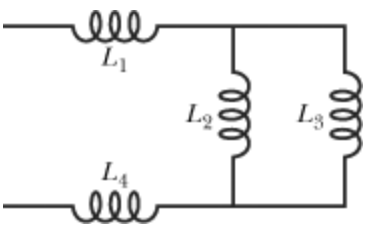
7. A small loop of area 6.8 mm^2 is placed inside a long solenoid that has 854 turns/cm and carries a sinusoidally varying current *i* of amplitude 1.28 A and angular frequency 212 rad/s. The central axes of the loop and solenoid coincide. What is the magnitude of the emf induced in the loop?

8. One hundred turns of (insulated) copper wire are wrapped around a wooden cylindrical core of cross-sectional area 1.20×10^{-3} m^2. The two ends of the wire are connected to a resistor. The total resistance in the circuit is 13.0 Ω. If an externally applied uniform longitudinal magnetic field in the core changes from 1.60 T in one direction to 1.60 T in the opposite direction, how much charge flows through a point in the circuit during the change?

9. The current in an *RL* circuit drops from 1.0 A to 10 mA in the first second following removal of the battery from the circuit. If *L* is 10 H, find the resistance *R* in the circuit.

10. A loop antenna of area 2.00 cm^2 and resistance 5.21 μΩ is perpendicular to a uniform magnetic field of magnitude 17.0 μT. The field magnitude drops to zero in 2.96 ms. How much thermal energy is produced in the loop by the change in field?

11. The inductor arrangement in the figure below, with L_1 = 30.0 mH, L_2 = 50.0 mH, L_3 = 20.0 mH, and L_4 = 15.0 mH, is to be connected to a varying current source. What is the equivalent inductance of the arrangement?



12. An *LC* oscillator consists of an inductor with inductance $L = 500\ \mu$ H and a capacitor with capacitance $C = 20.0\ \mu$ F. What are the frequency and period of the oscillations?

13. A driven *RLC* circuit has an inductor with inductance $L = 2.00 \times 10^{-6}$ H, a capacitor with capacitance $C = 3.00 \times 10^{-6}$ F, and a resistor with resistance $R = 1.20\ \Omega$. The amplitude of the driving emf is set at $\varepsilon_m = 40.0$ V. If the circuit is driven at the resonant angular frequency $\omega = 20.0$ rad/s, what are the reactances and the amplitude of the current?

14. Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate 15.0 A/s, the emf in coil 1 is 25.0 mV.
    a. What is their mutual inductance?
    b. When coil 2 has no current and coil 1 has a current of 3.60 A, what is the flux linkage in coil 2?

15. An oscillating LC circuit has a current of 150 μA, potential difference amplitude of 0.550 V, and a capacitance of 215 μF.
    a. What is the maximum energy stored in the inductor
    b. What is its inductance?
    c. What is the period of oscillation?

16. A series RLC circuit has $R = 10.00\ \Omega$, $L = 100.0$ mH, $C = 25.0$ μF, $\mathcal{E}_m = 25.0$ V, and driving frequency of 210.0 Hz.
    a. What is the impedance of this circuit?
    b. What is the amplitude of currents I_{rms} in the circuit?
    c. What is the power factor $cos\ \Phi$?
    d. At what value of the angular frequency ω_d will the current have its maximum amplitude? Justify your answer.