Chapter 17
Engineering Electric Circuits: AC Electric Circuits
17.1 Alternating Current in a Resistor Homework # 145

This is a copy of Homework #116 titled "Alternating Current" in "Chapter 14-DC Electric Circuits".

I

01. An ac voltage supply with a peak voltage of 180 V is applied across a 480-Ω resistor.
    a.) What is the value of the peak current in the resistor?
    b.) What is the value of the rms current in the resistor?

02. What is the peak current in a 2.80-kΩ resistor connected to a 240-V ac power source?

03. Determine the resistance of the following 120-V_{rms} light bulbs.
    a.) 40.0 W b.) 60.0 W c.) 75.0 W d.) 100 W

II

04. What is the peak current passing through a 100-W light bulb connected to a 120-V ac line?

05. If the peak value of alternating current passing through a 1250-W electric device is 4.25 A, what is the rms voltage across it?

06. What is the maximum instantaneous value of the power dissipated by a 75.0-W light bulb?

07. A 15.0-Ω heater coil is connected to a 240-V ac line.
    a.) What is the average power used by this coil?
    b.) What is the maximum value of the instantaneous power?
    c.) What is the minimum value of the instantaneous power?

ANSWERS: **01.** a.) 0.375 A b.) 0.265 A **02.** 0.121 A **03.** a.) 360 Ω b.) 240 Ω c.) 192 Ω d.) 144 Ω
04. 1.18 A **05.** 416 V **06.** 150 W **07.** a.) 3840 W b.) 7680 W c.) 0 W

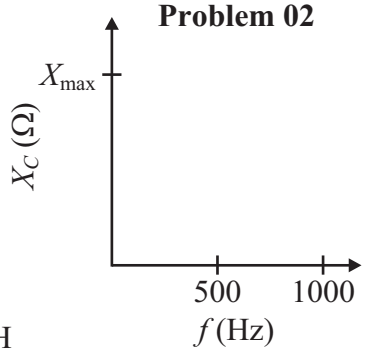
Chapter 17
Engineering Electric Circuits: AC Electric Circuits
17.2 Alternating Current in Inductors and Capacitors Homework # 146

I

01. At what frequency will a _____?
    a.) 97.5-μF capacitor have a reactance of 35.0 Ω
    b.) 626-mH inductor have a reactance of 1.85 kΩ?

02. On the coordinate axes to the right, sketch a graph of reactance of a 10.0-μF capacitor as a function of frequency from 10.0 to 1000.0 Hz. What is X_{max} for this range?

Problem 02



03. On the coordinate axes to the right and below, sketch a graph of reactance of a 10.0-mH inductor as a function of frequency from 10.0 to 1000.0 Hz. What is X_{max} for this range?

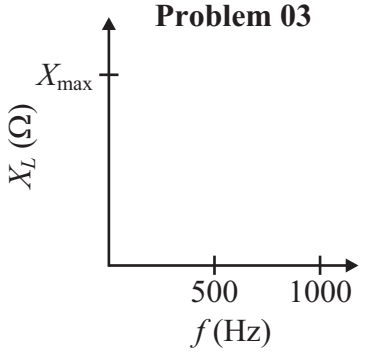
II

04. At what frequency would the reactance of a 10.0-mH inductor equal that of a 100.0-μF capacitor?

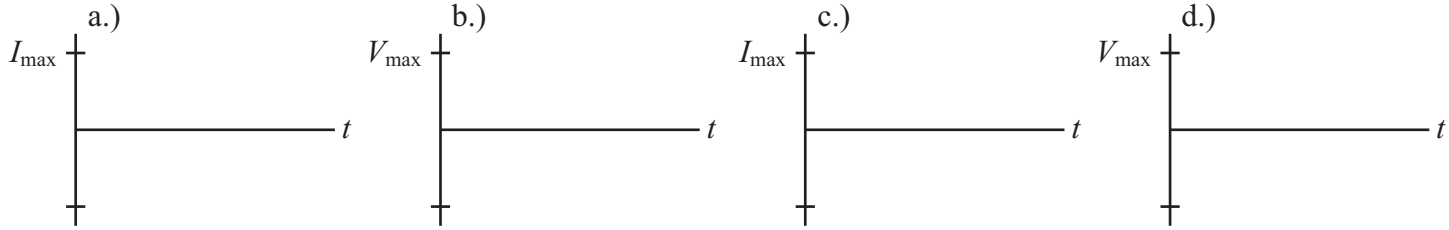
05. A coil draws 2.25 A of current from a 120-V ac power supply operating at 60.0 Hz. What is the inductance of this coil?

06. A capacitor draws 2.25 A of current from a 120-V ac power supply operating at 60.0 Hz. What is the capacitance of this capacitor?

Problem 03

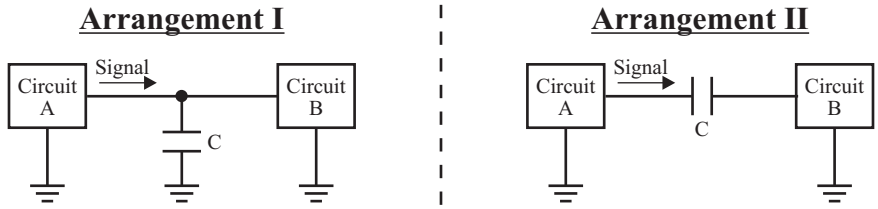


07. For each of the following circuits, use the coordinate axes below to construct the graph indicated.
    a.) A 35.0-mH inductor is wired to a 120-V ac power supply operating at 60.0 Hz. Find I_{max} and graph I vs t.
    b.) A 35.0-mH inductor draws 7.50 A from an ac power supply operating at 60.0 Hz. Find V_{max} and graph V vs t.
    c.) A 35.0-μF capacitor is wired to a 120-V ac power supply operating at 60.0 Hz. Find I_{max} and graph I vs t.
    d.) A 35.0-μF capacitor draws 7.50 A from an ac power supply operating at 60.0 Hz. Find V_{max} and graph V vs t.



08. The diagrams below show two possible arrangements, I and II, for two circuits, A and B, and a capacitor. In both arrangements assume the capacitance of the capacitor is very large.
    a.) Which arrangement will allow an ac signal but not a dc signal from circuit A to B? Explain!!!
    b.) Which arrangement will allow a dc signal but not an ac signal from circuit A to B? Explain!!!

Problem 08



ANSWERS: **01.** a.) 46.6 Hz b.) 470 Hz **02.** 1592 Ω **03.** 62.8 Ω **04.** 159 Hz **05.** 0.141 H **06.** 49.7 μF
07. a.) 12.9 A b.) 140 V c.) 2.24 A d.) 804 V **08.** a.) Arrangement II b.) Arrangement I

Chapter 17
Engineering Electric Circuits: AC Electric Circuits
17.3 Phasors/LC and LRC Circuits Without a Generator Homework # 147

I

01. An LRC circuit is designed such that $V_L > V_C$.
    a.) Draw the resultant phasor diagram.
    b.) Draw the phase angle, δ, and indicate whether the emf of the circuit leads or lags the current by δ.
    c.) Describe how the phase angle, δ, can be calculated from V_R, V_L, and V_C.

02. An LRC circuit is designed such that $V_L < V_C$.
    a.) Draw the resultant phasor diagram.
    b.) Draw the phase angle, δ, and indicate whether the emf of the circuit leads or lags the current by δ.
    c.) Describe how the phase angle, δ, can be calculated from V_R, V_L, and V_C.

03. What is the period of oscillation of an LC circuit consisting of a 15.0-mH coil and a 150.0-μF capacitor?

04. An LC circuit, with a 65.0-μF capacitor, oscillates at a 60.0-Hz frequency. What is the inductance of the inductor?

05. Circuit 1 is an LC circuit that has an inductance of L_1 and a capacitance of C_1. Circuit 2, a second LC circuit, has an inductance of $L_2 = \frac{1}{2}L_1$ and a capacitance of $C_2 = 2C_1$, while a third LC circuit, Circuit 3, has an inductance of $L_3 = 2L_1$ and a capacitance of $C_3 = \frac{1}{2}C_1$.
    a.) Which circuit oscillates at the greatest frequency?
    b.) Which circuit oscillates at the least frequency?
    c.) If all capacitors are charged to the same voltage, which circuit would have the greatest I_{max}?
    d.) If all three circuits have the same I_{max}, which circuit will have the inductor that has the greatest voltage?

II

06. A 2500 pF capacitor is charged to 60.0 V and then connected, via two wires, to a 40.0-mH inductor. The two plates of the capacitor are separated by 2.00 mm of air and each plate has an area of 0.565 m^2. The length of the inductor is 10.00 cm and the coils have a radius of 1.00 cm.
    a.) What is the total charge stored on the capacitor before it is connected to the inductor?
    b.) How much electric energy is stored in the capacitor before it is connected to the inductor?
    c.) What is the electric energy density of the capacitor before it is connected to the inductor?
    d.) What is the electric field strength in the capacitor before it is connected to the inductor?
    e.) What is the maximum magnetic energy stored in the inductor after its connection to the capacitor?
    f.) What is the maximum magnetic energy density of the inductor after its connection to the capacitor?
    g.) What is the maximum magnetic field strength in the inductor after its connection to the capacitor?
    h.) What is the frequency of oscillation in the circuit?
    i.) What is the maximum current in the circuit?
    j.) Write an equation that describes the charge on the capacitor as a function of time in this circuit and graph Q vs t.
    k.) Write an equation that describes the current in this circuit as a function of time and graph I vs t.
    l.) Graph Q and I as a function of time if a small resistor is connected in series with the capacitor and inductor in the circuit. (Note: The resistance of the wire that is coiled to make the inductor could serve as this resistor.)

ANSWERS: **01.** b.) ε leads I c.) $\tan\delta = \frac{V_L - V_C}{V_R}$ **02.** b.) ε lags I c.) $\tan\delta = \frac{V_C - V_L}{V_R}$ **03.** 9.42 ms
04. 0.108 H **05.** a.) none b.) none c.) Circuit 2 d.) Circuit 3 **06.** a.) 0.150 μC b.) 4.50 μJ c.) 3.98 mJ/m^3
06. d.) 3.00×10^4 V/m e.) 4.50 μJ f.) 0.143 J/m^3 g.) 6.00×10^{-4} T h.) 1.59×10^4 Hz ($\omega = 1.00 \times 10^5$ rad/s)
06. i.) 0.015 A j.) $Q = (1.50 \times 10^{-7})\cos(1.00 \times 10^5 t)$ k.) $I = -(0.0150)\sin(1.00 \times 10^5 t)$

Chapter 17
Engineering Electric Circuits: AC Electric Circuits
17.4 LRC Circuits With a Generator/Resonance Homework # 148

I

01. An AC generator that has a maximum emf of 30.0 V and an angular frequency of 300.0 rad/s is connected in series with a 34.8-μF capacitor and a 95.0-Ω resistor.
    a.) What is the impedance? b.) What is the power factor?
    c.) What is the rms current? d.) What is the average power supplied?

02. A coil can be treated as a resistance in series with an inductor. A coil with a resistance of 80.0 Ω and an inductance of 0.350 H is connected to a 120-V, 60.0-Hz ac line.
    a.) What is the impedance? b.) What is the power factor?
    c.) What is the rms current? d.) What is the average power supplied?

03. A series LCR consists of a 50.0-mH inductor, a 50.0-μF capacitor and a 50.0-Ω resistor driven by a 50.0-V generator with a variable resistor, ω.
    a.) What is the resonant angular frequency ω_o?
    b.) Find X_L, X_C, Z, I_{rms}, the phase angle, δ, and the power factor at ω_o.
    c.) Find X_L, X_C, Z, I_{rms}, the phase angle, δ, and the power factor when ω = 3000 rad/s.

04. FM radio stations are assigned carrier waves by the FCC in the range of 88.0 to 108.0 MHz. A radio receiver is a series LCR circuit with a variable capacitor so that it can resonate with any carrier wave frequency in this range. A particular radio has a 1.50-μH inductor.
    a.) What is the range of capacitances necessary to cover this range of frequencies?

For parts b.) and c.), assume the radio is tuned to 104.6 MHz and Δf = 0.05 MHz.

    b.) What is the capacitance? c.) What is the Q factor?

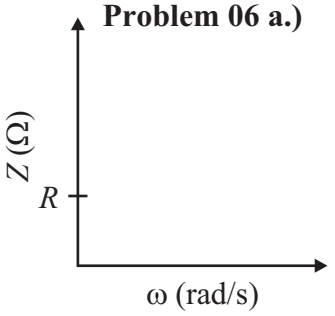
II

05. In the circuit shown to the right, the variable frequency ac generator produces an rms voltage of 120 V when operated at 60.0 Hz. Assume transient effects have had sufficient time to decay so steady state conditions exist.
    a.) What is the rms current in the circuit? b.) Find the rms voltage across AB.
    c.) Find the rms voltage across BC. d.) Find the rms voltage across CD.
    e.) Find the rms voltage across AC. f.) Find the rms voltage across BD.
    g.) What is the maximum energy stored in the capacitor?
    h.) What is the maximum energy stored in the inductor?
    i.) What is the resonant angular frequency of this circuit?
    j.) What is the average power supplied to the circuit by the generator?
    k.) What is the average power consumed by the resistor?

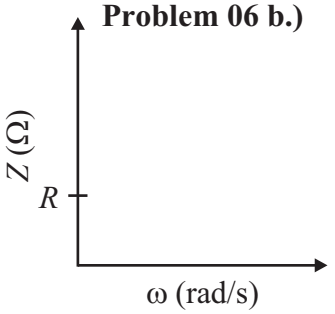
III

06. On the graphs above and to the right sketch a graph of Z versus ω for a series _____ circuit. (Hint: Use a spreadsheet program with the values R = 100 Ω, L = 0.250 H, C = 50.0 μF, and f ranging from 10 Hz to 200 Hz.)
    a.) LR b.) RC c.) LRC

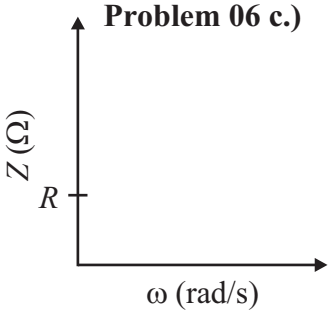
Problem 06 a.)



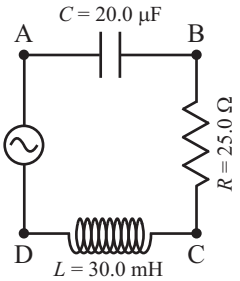
Problem 06 b.)



Problem 06 c.)



Problem 05



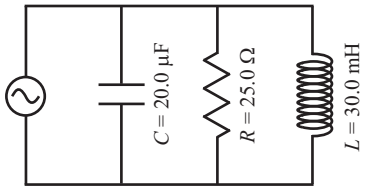
ANSWERS: **01.** a.) 135 Ω b.) 0.704 c.) 0.157 A d.) 2.35 W **02.** a.) 154 Ω b.) 0.518 c.) 0.778 A
02. d.) 48.4 W **03.** a.) 632 rad/s b.) X_L = 31.6 Ω, X_C = 31.6 Ω, Z = 50.0 Ω, I_{rms} = 1.00 A, δ = 0, cos δ = 1
03. c.) X_L = 150 Ω, X_C = 6.67 Ω, Z = 152 Ω, I_{rms} = 0.329 A, δ = 70.8°, cos δ = 0.329 **04.** a.) 2.18-1.45 pF
04. b.) 1.54 pF c.) 2092 **06.** a.) 0.969 A b.) 128 V c.) 24.2 V d.) 11.0 V e.) 131 V f.) 26.6 V
06. g.) 330 mJ h.) 28.2 mJ i.) 1291 rad/s j.) 23.5 W k.) 23.5 W

Chapter 17
Engineering Electric Circuits: AC Electric Circuits
17.5 LRC Circuits With a Generator/Rectification and Amplification — Homework # 149

II

07. In the circuit shown to the right, the variable frequency ac generator produces an rms voltage of 120 V when operated at 60.0 Hz. Assume steady state conditions.
    a.) Find the rms current that leaves the generator.
    b.) Find the rms current through the capacitor.
    c.) Find the rms current through the resistor.
    d.) Find the rms current through the inductor.
    e.) What is the phase angle, δ?
    f.) What is the maximum energy stored in the capacitor?
    g.) What is the maximum energy stored in the inductor?
    h.) What is the resonant frequency of this circuit ?
    i.) What is the minimum rms current for the resonant frequency?

Problem 07



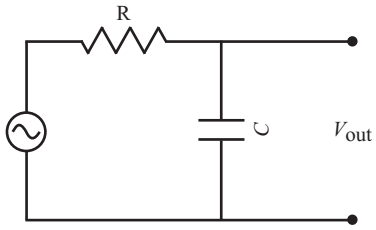
Rectification & Amplification

I

08. The maximum output current from a rectification circuit is 3.00 A. What is the rms current if the circuit is a _____ rectifier? a.) full-wave b.) half-wave

09. In the circuit shown to the right, the variable frequency ac generator produces an rms voltage of 120 V, while $R = 25.0\ \Omega$ and $C = 20\ \mu F$.
    a.) What is the capacitive reactance when the frequency is 10.0 Hz?
    b.) What is the impedance of the circuit when the frequency is 10.0 Hz?
    c.) What is the rms current when the frequency is 10.0 Hz?
    d.) What is the output rms voltage when the frequency is 10.0 Hz?
    e.) What is the capacitive reactance when the frequency is 10,000.0 Hz?
    f.) What is the impedance of the circuit when the frequency is 10,000.0 Hz?
    g.) What is the rms current when the frequency is 10,000.0 Hz?
    h.) What is the output rms voltage when the frequency is 10,000.0 Hz?
    i.) Why is this called a low-pass filter?

Problems 09 and 10



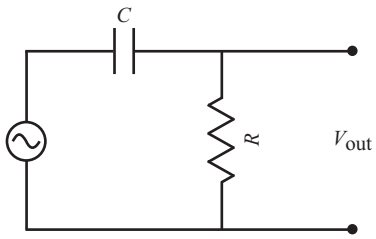
II

10. For the circuit shown above and to the right, write an equation that describes output rms voltage, $V_{out\ rms}$, as a function or $V_{in\ rms}$, R, C, and ω.

11. In the circuit shown to the right, the variable frequency ac generator produces an rms voltage of 120 V, while $R = 25.0\ \Omega$ and $C = 20\ \mu F$. What is the output voltage when the frequency of the generator is _____?
    a.) 10.0 Hz b.) 10,000.0 Hz
    c.) Why is this called a high-pass filter?

12. For the circuit shown to the right, write an equation that describes output rms voltage, $V_{out\ rms}$, as a function or $V_{in\ rms}$, R, C, and ω.

Problems 11 and 12



ANSWERS: **07.** a.) 10.8 A b.) 0.905 A c.) 4.80 A d.) 10.6 A e.) 63.7° f.) 0.144 J g.) 1.69 J
07. h.) 205 Hz i.) 4.80 A **08.** a.) 2.12 A b.) 1.06 A
09. a.) 796 Ω b.) 796 Ω c.) 0.151 A d.) 119.9 V e.) 0.796 Ω f.) 25.0 Ω g.) 4.80 A h.) 3.82 V
10. $V_{out\ rms} = \dfrac{V_{in\ rms}}{\sqrt{\omega^2 C^2 R^2 + 1}}$ **11.** a.) 3.76 V b.) 119.9 V **12.** $V_{out\ rms} = \dfrac{V_{in\ rms}(\omega CR)}{\sqrt{\omega^2 C^2 R^2 + 1}}$