PHYS 102: General Physics 2 | KOÇ UNIVERSITY | Spring Semester 2013

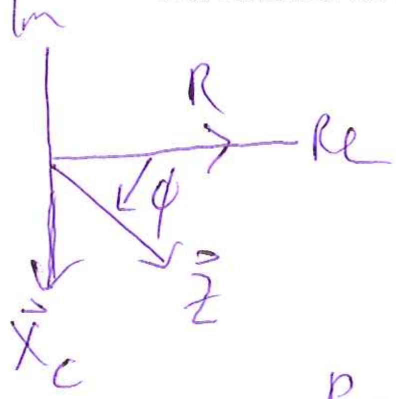
College of Sciences

Section 1 | Quiz 12 | 16 May 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A circuit consists of a resistor and acapacitor in series with an ac source that supplies an rms voltage 240 V. At the frequency of the source the reactance of the capacitor is 50.0 Ω. The rms current in the circuit is 3.0A. What is the average power supplied by the source?



$Z = [R^2 + X_C^2]^{1/2}$

$P_{av} = V_{rms} I_{rms} \cos\phi$ ($\cos\phi = R/Z$)

$P_{av} = 0.78 \times (240V)(3A)$

$P_{av} = 562.05$ Watt

$Z = \frac{V_{rms}}{I_{rms}} = \frac{240V}{3A} = 80\,\Omega$

$R = [Z^2 - X_C^2]^{1/2}$

$R = 62.45\,\Omega$

$\cos\phi = \frac{62.45}{80} = 0.78$

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Section 5 **Quiz 12** **16 May 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An L-R-C series circuit has R=300 Ω. At the frequency of the source, the inductor has reactance $X_L = 900\Omega$ and the capacitor has reactance $X_C = 500\Omega$ The amplitude of the voltage across the inductor is 450 V. $= V_L$

(a) What is the amplitude of the voltage across the resistor?
(b) What is the amplitude of the voltage across the capacitor?
(c) What is the amplitude of the voltage across the source?
(d) What is the rate at which the source is delivering electrical energy to the circuit?

a) $I = \frac{V_L}{X_L} = \frac{450V}{900\Omega} = \boxed{0.5A}$; $V_R = IR = (0.5A)\times(300\Omega)$ $\boxed{V_R = 150V}$

b) $V_C = IX_C = (0.5A)\times(500\Omega) = \boxed{250V = V_C}$

c) $Z = \left[R^2 + (X_L - X_C)^2\right]^{1/2} = \left\{100\cdot\left[9+16\right]^{1/2}\right\}\Omega = 500\Omega = Z$

$V = IZ = (0.5A)(500\Omega) = 250V$

d) $P_{av} = I_{rms}^2 R = \frac{1}{2}(0.5A)^2(300\Omega) = 37.5$ Watt

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Section 6 **Quiz 12** **16 May 2013**

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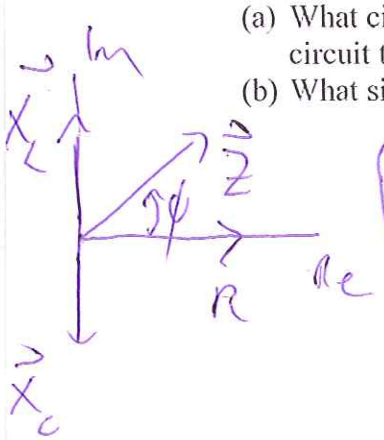
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A series circuit has an impedance of 60.0 Ω and a power factor of 0.7 at 50.0 Hz. The source voltage lags the current. (For $\cos\phi = 0.7 \rightarrow \phi = 45^o \rightarrow \tan 45^o = 1$)

(a) What circuit element, an inductor or a capacitor, should be placed in series with the circuit to raise its power factor?

(b) What size element will raise the power factor to unity?



Power Factor $= \frac{R}{Z} = \cos\phi$ → $X_L > X_C$ at $t=0$

a) Voltage lags ⇒ $\phi > 0$ so in order to increase power factor, we should reduce Z.

– to reduce Z ($\phi > 0$), we should add X_C to balance X_L ($> X_C$).

b) if $X_L = X_C \Rightarrow Z = R \Rightarrow \boxed{\cos\phi = 1}$

we need to add X_C in such a way that $\phi = 0$.

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Section 2 **Quiz 12** **16 May 2013**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An L-R-C series circuit has C=5.0 μF, L=500 mH, and source voltage amplitude V=60.0 V. The source is operated at the resonance frequency of the circuit. If the voltage across the capacitor has amplitude 80.0 V, what is the value of R for the resistor in the circuit?

$X_L(w_R) \equiv X_C(w_R) \rightarrow w_R = [L \cdot C]^{-1/2} = [(500\times10^{-3} H)\cdot(5\times10^{-6} F)]^{-1/2}$

$w_R = 632.46\ rad/s$ $\rightarrow X_L(w_R) = w_R L = (632.46\ rad/s)\cdot(500\times10^{-3} H)$

$= X_L(w_R) = 316.23\ \Omega$

$I(w_R) = \dfrac{V_C(w_R)}{X_C(w_R)} = \dfrac{80V}{316.23\ \Omega} = 0.253A$

$Z(w_R) = R \rightarrow R = \dfrac{V}{I(w_R)} = \dfrac{60V}{0.253A} = 237.17\ \Omega$

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Section 3 Quiz 12 16 May 2013

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

In the L-R-C series circuit, L= 160 mH and C=4μF. The voltage amplitude of the source is 120 V.

(a) What is the resonance angular frequency of the circuit?

(b) When the source operates at the resonance angular frequency, the current amplitudein the circuit is 1.0 A. What is the resistance R of the resistor?

(c) At the resonance angular frequency, what are the peak voltages across the inductor, the capacitor, and the resistor?

a) if $w = w_R \Rightarrow (X_L(w_R) - X_C(w_R)) = w_R L - 1/w_R C = 0 \rightarrow w_R = \frac{1}{\sqrt{LC}}$

$\rightarrow w_R = [(160\times10^{-3} H)\cdot(4\times10^{-6} F)]^{-1/2} = (1.25\times10^3)\ rad/s$

b) $Z(w = w_R) \equiv R \rightarrow Z = V/I \rightarrow R = \frac{V(w_R)}{I(w_R)} = \frac{120V}{1A} = 120\Omega$

c) $V_L(w_R) = I(w_R) X_L(w_R) = I(w_R)\cdot[w_R L] = [1A \times (1.25\times10^3\ rad/s) \times (160\times10^{-3} H)]$

$V_L(w_R) = 200V$; $X_L(w_R) = X_C(w_R)$ & $V_C = I X_C \Rightarrow V_C = 200V$

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Section 4 — Quiz 12 — 16 May 2013

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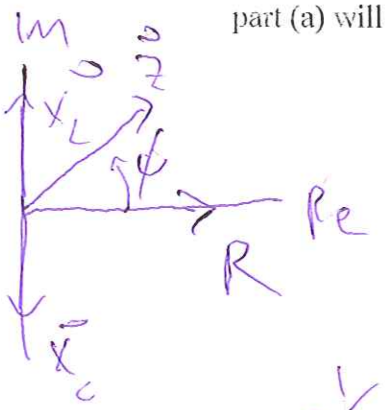
Name: **Student ID:** **Signature:**

$w = 2\pi f$

An L-R-C series circuit consists of 4 Ω resistor, a 11μF capacitor, a 3 mH inductor, and an ac voltage source of voltage amplitude 6 V operating at 1000 Hz. (Take π=3)

(a) Find the current amplitude and the voltage amplitudes across the inductor, the resistor, and the capacitor. Why can the voltage amplitudes add up more than 6 V?

(b) If the frequency is now doubled, but nothing else is changed, which of the quantities in part (a) will change? Find the new values for those that do change.



a) $X_L = wL = (10^3\ 1/s)\cdot(3\times10^{-3}\ H)\cdot(2\cdot 3\ rad)$ (2π)

$X_L = 6\ \Omega$

$X_C = [wC]^{-1} = [(6\times10^3\ rad/s)\cdot(11\times10^{-6}\ C)]^{-1}$

$X_C \cong 15\ \Omega$

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

$= [16 + 81]^{1/2}\ \Omega$

$Z = 9.85\ \Omega$

$Z \sim 10\ \Omega$

$I = V/Z = \frac{6V}{10\Omega} = 0.6A = I$

$V_L = IX_L = 3.6V$; $V_C = IX_C = 9V$; $V_R = IR = 2.4V$

b) $w' = 2w$

$X_L' = 2X_L = 12\ \Omega$

$X_C' = \frac{1}{2}X_C = 7.5\ \Omega$

$Z' = 6\ \Omega \rightarrow I' = \frac{6V}{6\Omega} = 1A$

$V_L' = I'X_L' = 12V$ ⇐ increased

$V_C' = I'X_C' = 7.5V$ ⇐ decreased

$V_R' = I'R = 4V$ ⇐ increased