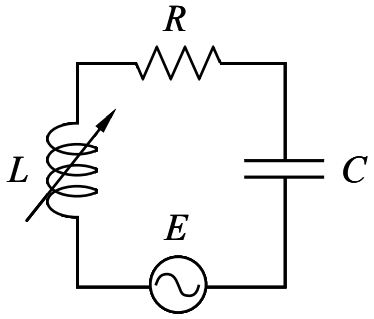
Name: _____ Sec. _____ **P212: Quiz 8A, Week 11**

In the RLC circuit shown at right, the resistance $R$ and capacitive reactance $X_C$ are set to the given values. The inductor is of variable magnitude (indicated by the diagonal arrow). The AC generator puts out a peak EMF of $\mathcal{E}_{max}$ = 120 V.



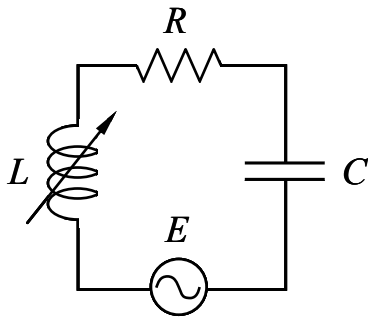

$R = 200\ \Omega$
$X_C = 400\ \Omega$
$E_{max} = 120$ V

1) If the inductance is set to $L$ = 300 μH, the circuit is in resonance. Given this information, calculate the capacitance $C$ of the circuit and the frequency ω of the generator. **[5]**

2) Leaving the frequency ω and peak voltage $\mathcal{E}_{max}$ of the AC generator unchanged, the variable inductor is now changed to $L$ = 200 μH. This puts the circuit off resonance. What is the phase angle $\phi$ of the generator EMF with respect to the current? **[4]**

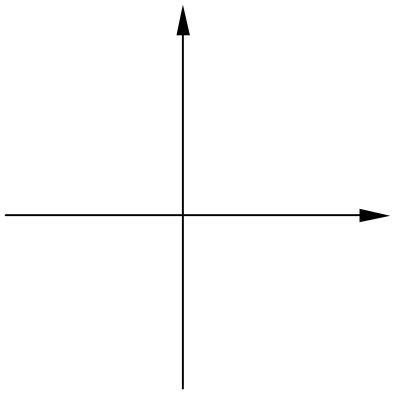
3) Does the generator EMF lead or lag the current when $L$ = 200 μH? Provide a brief but clear reason for your answer. **[3]**

4) What is the impedance $Z$ of the final circuit (with $L$ = 200 μH)? **[4]**




$R = 200\ \Omega$
$X_C = 400\ \Omega$
$E_{max} = 120\ V$

5) Draw the voltage phasor diagram ($\mathcal{E}$, $V_C$, $V_L$, $V_R$) for this final circuit, with the angles and lengths of the phasors indicated numerically. **[4]**



W11 Quiz 1

# Q8A

$X_C = 1/\omega C$. At Resonance, $X_L = \omega_{res} L = X_C = 400\Omega$.

1) So, $\omega_{res} = 400\Omega / 300\,\mu\text{H} = 1.33\times10^6$ rad/sec. (5)

$C = 1/\omega X_C = 1.88\,\text{nF}$

| | |
|---|---|
| Equation for $X_C$ | (1) |
| Equation for $X_L$ | (1) |
| Condition for resonance | (1) |
| Solution for $\omega_{res}$ | (1) |
| Solution for $C$ | (1) |
| Numerical errors | (-1, but only once per quiz) |

2) $X_L \Rightarrow \frac{200}{300}400\Omega = 267\Omega \Rightarrow X_L - X_C = -133\Omega$

$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right) = -33.6° = -0.59$ rad (4)

| | |
|---|---|
| Equation for $\phi$ | (2) |
| New $X_L$ | (1) |
| Answer | (1) |
| If $X_C$ changes | (-1) |
| Numerical errors | (-1, but only once per quiz) |

3) $V$ lags $I$, because $X_C > X_L$. Alternatively, because $\phi < 0$.
This can be said in words, or graphically.

| | |
|---|---|
| $V$ lags $I$ | (2) |
| Explanation | (1) |
| No credit w/o explanation.. | |

4) $|Z| = \sqrt{R^2 + (X_L - X_C)^2} = 240\Omega$ (4)

| | |
|---|---|
| Equation for $\|Z\|$ | (2) |
| Answer | (2) |
| Numerical errors | (-1, but only once per quiz) |
| Do not take off points for errors propagated from previous parts. | |

5) Magnitude of each $V_i$-phasor is $I_{max}X_i = (\mathcal{E}/Z)X_i = \frac{1}{2}X_i$.

| | |
|---|---|
| $\mathcal{E}$: 120 V, 33.6° below the +$x$-axis | (1) |
| $V_C$: ½400 = 200 $V$, down (along -$y$) | (1) |
| $V_L$: ½267 = 134 $V$, up (along +$y$) | (1) |
| $V_R$: ½200 = 100 $V$, to the right (along +$x$) | (1) |
| Equation for phasor magnitude | (2) |
| Each correct phasor | (½) |
| Numerical errors | (-1, but only once per quiz) |
| Do not take off points for errors propagated from previous parts. | |