Assignment 4 - Phasors 2

Sunday, March 6, 2016 10:29 AM

(10 pts)
Two "pure" elements (that is, either R, L, or C, each) are connected in series and when we apply the voltage v(t) then the current i(t) flows. Find the elements in the circuit. For the element that is not in the circuit, enter zero. $v(t) = 240\, sin(116\, t + 28^o) V$ and $i(t) = 14\, sin(116\, t + -14^o) A$.

Resistance calculated [ ] Ω

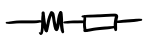
Inductance calculated [ ] mH

Capacitance calculated [ ] μF

$$\bar{Z} = \frac{\bar{V}}{\bar{I}} = \frac{\frac{240}{\sqrt{2}}\angle 28}{\frac{14}{\sqrt{2}}\angle -14} = (12.74, 11.47) = 17.14 \angle 42^\circ$$

(+)ive ∴ inductive

$X = \omega L$



$\boxed{R = 12.74}$ $L = \frac{X}{\omega} = \frac{11.47}{116} = \boxed{98\,mH}$ $\boxed{C = \emptyset}$

(10 pts)
Two "pure" elements (that is, either R, L, or C, each) are connected in parallel and when we apply the voltage v(t) then the current i(t) flows. Find the elements in the circuit. For the element that is not in the circuit, enter zero. $v(t) = 160\, sin(226\, t + 16^o) V$ and $i(t) = 14.5\, sin(226\, t + 40^o) A$.

Resistance calculated [ ] Ω

Inductance calculated [ ] mH

Capacitance calculated [ ] μF

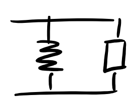
$$\bar{Z} = \frac{\bar{V}}{\bar{I}} = (10.08, -4.488) = 11.03 \angle -24$$

(-)ive ∴ capacitive

$\boxed{L = \emptyset}$

$$\bar{Z} = \frac{1}{\frac{1}{R} + \frac{1}{jX}} \rightarrow \frac{1}{\bar{Z}} = \frac{1}{R} + \frac{1}{jX}$$

$$\frac{1}{\bar{Z}} = (82.79, 36.86)\, m\mho$$



$\frac{1}{R} = 82.79\, m\mho \rightarrow \boxed{R = 12.079}$

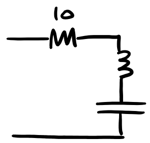
$\frac{1}{X} = 36.86\, m\mho$

$$X = \frac{1}{\omega C} \rightarrow C = \frac{1}{X\omega} = \frac{36.86\, m\mho}{226 \frac{rad}{s}} = \boxed{163.1\, \mu F}$$

(10 pts)
An RLC series circuit has a current which lags the applied voltage by 22 degrees. The voltage across the inductance has a maximum value which is twice the maximum value of the voltage across the capacitor and the voltage in the inductor L is $v(t) = 24\,sin(166\,t)V$.
If R = 10 ohms, determine the values of L and C.

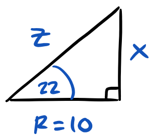
Inductance calculated [ ] mH

Capacitance calculated [ ] μF



$\bar{V} = \frac{24}{\sqrt{2}} \angle \phi$ $\quad \bar{I} = I \angle -22°$ $\quad \omega = 166 \frac{rad}{s}$

$Z \angle \theta_z = \frac{\frac{24}{\sqrt{2}} \angle \phi}{I \angle -22} \rightarrow \theta_z = \phi - (-22°) = 22°$



$\rightarrow X = 4.04$

$X = X_L - X_c \rightarrow 4.04 = X_L - X_c$ ①

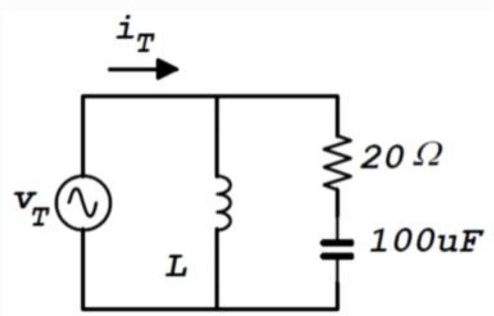
$2\bar{V}_c = \bar{V}_L \rightarrow 2X_c = X_L$ ② (same current)

$X_L = \omega L \rightarrow L = \frac{X_L}{\omega} = \frac{8.08}{166} = \boxed{48.7mH}$

$X_c = \frac{1}{\omega C} \rightarrow C = \frac{1}{X_c \omega} = \frac{1}{(4.04)166} = \boxed{1491 \mu F}$

(10 pts)
Find L in the parallel circuit below, if the applied voltage is equal to $v(t) = 27\,sin(282\,t)V$ and voltage and current are in phase, what is the value of L?

A simple AC Steady State circuit, find the inductance.

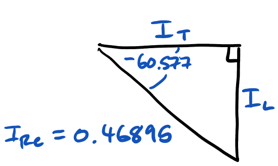


Inductance calculated [ ] mH

voltage and current in phase so
capacitance and inductance cancel
to be fully resistive

$\bar{I}_{RC} = \frac{\bar{V}_T}{\bar{Z}_{RC}} = \frac{\frac{27}{\sqrt{2}} \angle \phi}{20 + j\frac{10^6}{282 \cdot 100}} = 468.95 \angle -60.577 \text{ mA}$

$\bar{I}_L$ is purely inductive



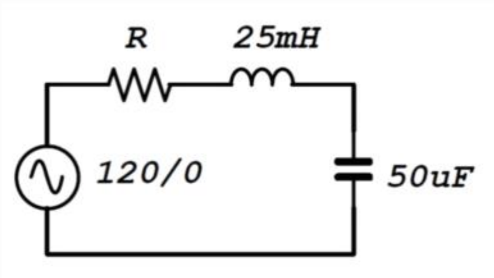
$\rightarrow \bar{I}_L = 0.408463 \angle 90$

$$\frac{\quad}{\overline{I_L}} = \frac{\quad \angle 44}{0.408463\angle 90} = -j46.741\,\Omega$$

$$L = \frac{X_L}{\omega} = \frac{46.741}{282} = \boxed{165.7\,mH}$$

(10 pts)
In the RLC circuit shown in Figure below, at a frequency 575 rad/sec, the current leads the voltage by 60 degrees. Find R and the maximum voltage across each circuit element.

The RLC circuit



Resistance calculated [ ] Ω

Voltage in resistor [ ] V

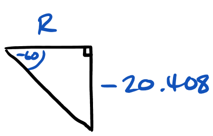
Voltage in inductor [ ] V

Voltage in capacitor [ ] V

$\overline{V} = 120\angle\phi \qquad \overline{I} = I\angle 60 \qquad \overline{Z} = \frac{\overline{V}}{\overline{I}} = Z\angle -60$

$X_c = \frac{1}{\omega C} = 34.783 \qquad X = X_L - X_c$

$X_L = \omega L = 14.375 \qquad \hookrightarrow X = -20.408$



$\rightarrow \boxed{R = 11.78\,\Omega}$

$$\overline{I_T} = \frac{\overline{V_T}}{\overline{Z_T}} = \frac{120\angle\phi}{11.78 - j20.408} = 5.0925\angle -60$$

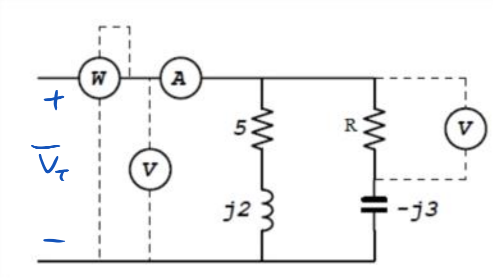
$V_R = \overline{I_T}R = \boxed{60\,\Omega}$

$V_c = \overline{I_T}\,\overline{Z_c} = \boxed{177.13\,\Omega}$

$V_L = \overline{I_T}\,\overline{Z_L} = \boxed{73.2\,\Omega}$

(10 pts)
The voltmeter connected to the 6.8 ohm resistor in the circuit below reads 80 volts. What are the readings of the ammeter, the wattmeter, and the voltmeter on the left.

The circuit



Voltmeter reading : V

Ammeter reading : A

Wattmeter reading : W

$$\bar{I}_c = \frac{\bar{V}_R}{R} = \frac{80\angle\emptyset}{6.8} = 11.765\angle\phi$$

$$\bar{V}_T = \bar{I}_c\bar{Z}_{Rc} = (11.765\angle\phi)(6.8, -3) = \boxed{87.44}\angle -23.8$$

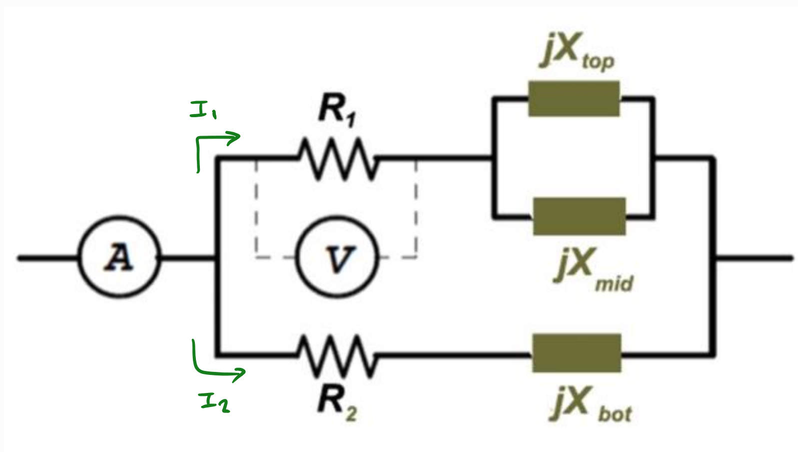
$$\bar{I}_L = \frac{\bar{V}_T}{\bar{Z}_{RL}} = \frac{87.44\angle -23.8}{5+j2} = 16.237\angle -45.6$$

$$\bar{I}_T = \bar{I}_c + \bar{I}_L = \boxed{25.872}\angle -26.642$$

$$S = \bar{V}_T\bar{I}_T = \boxed{2.262}\angle -50.44 \text{ kVA}$$

(10 pts)
In the circuit below, the ammeter reads 33 A. What is the reading of the voltmeter. The values of the elements are $R_1 = 5\ \Omega$, $R_2 = 3\ \Omega$, $X_{top} = 13\ \Omega$, $X_{mid} = 0\ \Omega$, $X_{bot} = 8\ \Omega$. The "reactors" in the boxes can be either inductors or capacitors, just look at the sign of their impedances.

The circuit



Voltmeter reading : ____ V

$\bar{I}_T = 33 \angle \phi$ $\qquad$ $\bar{Z}_1 = R_1 + jX_{top} // jX_{mid} = 5\Omega$

$$\bar{I}_1 = \bar{I}_T \frac{\bar{Z}_2}{\bar{Z}_1 + \bar{Z}_2} = 33 \frac{3+j8}{8+j8} = 24.921 \angle 24.44$$

$$\bar{V}_1 = \bar{I}_1 R_1 = \boxed{124.61} \angle 24.44$$

(10 pts)
The voltage and current in a two element series circuit are $v(t) = 130\,sin(64\,t)\ V\ \ and\ \ i(t) = 29\,sin(64\,t - -16^o)\ A$. What percentage change in the resistance will result in a maximum current of $14.5A$, and what is the phase shift of this new current?

Resistance change : $\%$

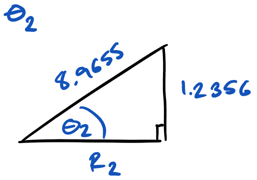
Phase shift : ^{o}

$\bar{V}_1 = 130/\sqrt{2} \angle \phi$ $\qquad$ $\bar{I}_1 = 29/\sqrt{2} \angle 16°$

$$\bar{Z}_1 = \frac{\bar{V}_1}{\bar{I}_1} = 4.48 \angle 16° = 4.309 - j1.2356$$

keeping same reactance b/c only modifying resistance

$$\bar{Z}_2 = \frac{130/\sqrt{2} \angle \phi}{14.5/\sqrt{2} \angle \theta_2} = 8.9655 \angle -\theta_2 = R_2 - j1.2356$$



$\rightarrow$ $R_2 = 8.87994$

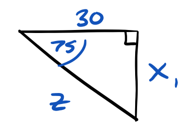
$\theta_2 = 7.92155°$

$$\%\ change = \frac{X_f - X_i}{X_i} = \frac{R_2 - R_1}{R_1} = \frac{8.87994 - 4.309}{4.309} = \boxed{106\%}$$

phase shift = $\theta_i - \theta_f = 16 - 7.92155 = \boxed{8.08^\circ}$

(10 pts)
An RC series circuit with R=30 ohm, has an impedance with an angle -75 degrees at 480 Hz. At what frequency will the absolute value of the impedance of the circuit be two times of that at 480 Hz?

New frequency: Hz

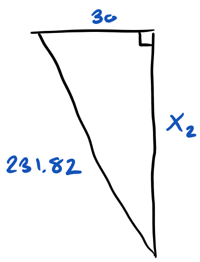


$\rightarrow Z_1 = 115.91$

$Z_2 = 2Z_1 = 231.82$

$X_1 = 111.96 = \frac{1}{\omega C}$

$\hookrightarrow C = \frac{1}{111.96(2\pi 480)} = 2.9615\mu F$



$\rightarrow X_2 = 229.87 = \frac{1}{\omega_2 C}$

$\hookrightarrow f_2 = \frac{1}{229.87(2.9615\mu F)2\pi}$

$= \boxed{233\,Hz}$