Basic Electronics Part 30
by
Thomas Atchison, W5TV

We now consider a series circuit with a resistor, R, a capacitor, C, an inductor, L, and an AC source (Fig. 1)

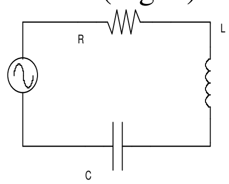


Fig. 1

Suppose that $R = 5000\ \Omega$. Recall that we could state a capacitance for C and an inductance for L, however, we would then need to know the frequency of the alternating current in order to calculate the capacitive reactance and the inductive reactance using formulas we have already discussed. Instead of doing this we will just stipulate the capacitive reactance as $X_C = 4{,}000\ \Omega$ and the inductive reactance as $X_L = 8{,}000\ \Omega$.

Referring back to our graphical representation of these quantities, we plot the resistance on a horizontal axis and the reactance on a vertical axis. Recall the inductive reactance is represented in the positive vertical direction (up) and the capacitive reactance is represented in the negative vertical direction (down) (see Fig. 2).

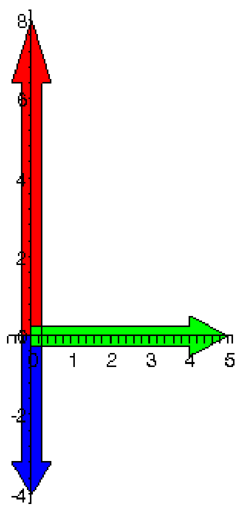


Fig. 2

Here the green arrow is resistance, the red arrow is inductive reactance, and the blue arrow is capacitive reactance. The scale is in thousands of ohms.

We can combine the reactance by taking $X_L = +8{,}000\ \Omega$ and $X_C = -4{,}000\ \Omega$. This gives us a total reactance of $X_{Total} = +4{,}000\ \Omega$. Since this is a positive reactance, it is considered inductive and is plotted upward as in Fig. 3.

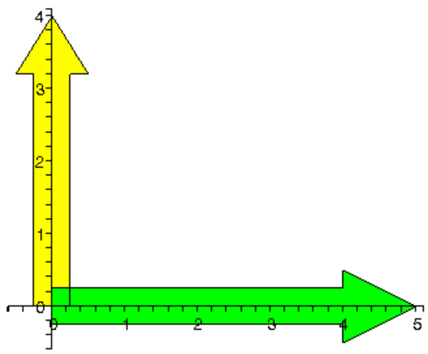


Fig. 3

Here the yellow arrow is the total reactance and the green arrow is still the resistance.
In order to calculate the impedance in this circuit we will redraw the diagram placing the yellow arrow at the head of the green arrow as in Fig. 4

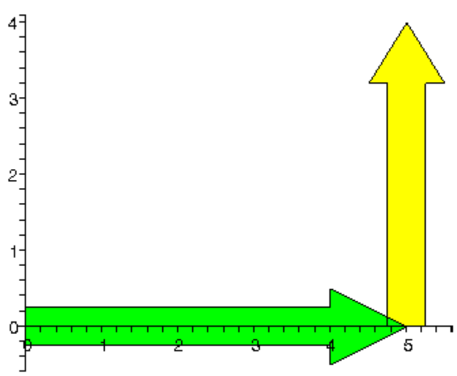


Fig. 4

The resistance (green) and the reactance (yellow) are the sides of a right triangle whose hypotenuse (violet) represents the impedance of the circuit in Fig 5.

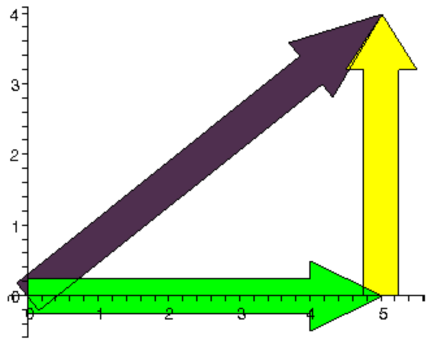


Fig. 5

We can calculate the value of the impedance, $Z$, using the Pythagorean relationship as before.

$$Z = \sqrt{(5000)^2 + (4000)^2}$$
$$= 6403\ \Omega.$$

We can use the tangent function to calculate the phase angle. The phase angle, A, is the angle from the green arrow to the violet arrow.

$$\tan(A) = \frac{opposite\ side}{adjacent\ side}$$
$$= \frac{4000}{5000}$$
$$= 0.8$$

This means that $A = 39\ \deg rees$.

If we measure the current in this series circuit to be 400 mA, then we can calculate the total applied voltage from the generator.

$$E_{Total} = I\ Z$$
$$= 400 \times 10^{-3} \times 6403$$
$$= 2561\ volts.$$

We normally state the total voltage as $E_{Total} = 2561\ volts\ at\ 39^o$.

You can also calculate the total voltage by calculating the voltage across each component and then combining those values using the techniques we used in previous sessions. You should get the same total voltage as we did above.

This is the last part of the Basic Electronics series. I hope you have enjoyed reading these articles as much as I have enjoyed writing them. I plan to begin a series of articles on antennas with the next NARC Newsletter.