Basic Electronics Part 26

by

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Since any circuit has some resistance in it we consider what happens if we have a series circuit with an alternating voltage source, an inductor, and a resistor. (Fig. 1)

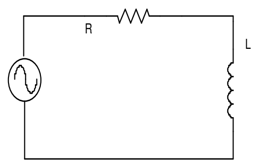

Fig. 1

The applied alternating voltage causes an alternating current to flow through the resistor, R, and the inductor, L. Since this is a series circuit, the same current flows through both components. In part 20 we discussed the fact that the current through and resistor and the voltage across the resistor are in phase; however, the current through the inductor and the voltage across the inductor are not in phase. In part 24 we discovered that the applied voltage leads the current by 90 degrees. We can use a diagram like we used in part 25 to represent the voltage across the inductor as it relates to the voltage across the resistor (Fig 2).

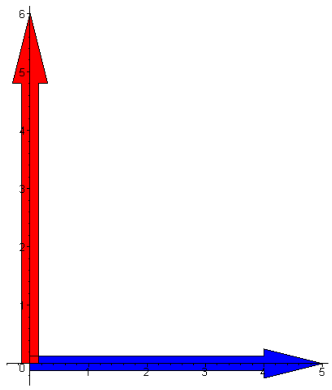

Fig. 2

Here the blue arrow represents the voltage across R and the red arrow represents the voltage across L. Notice that in this representation, the voltage across L leads the voltage across R by 90 degrees. If we calculated the voltage across the resistor to be 5 volts and the voltage across the inductor to be 6 volts, then the total voltage is **NOT** the sum of these two, but rather it would be 7.8 volts. Where does this come from? To see what is happening here consider Fig. 3

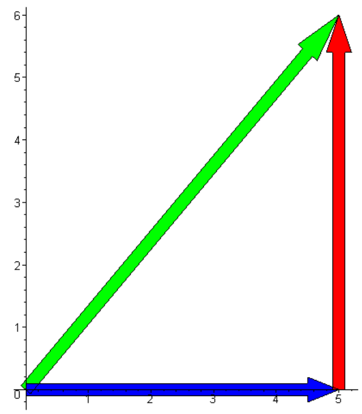

Fig. 3

The blue arrow still represents the voltage on R (5 volts) and the red arrow represents the voltage on L (6 volts). The total voltage is represented by the green arrow and it is the result of combining the two voltages based on their magnitude and direction (vectors). If the blue length is 5 volts and the red length is 6 volts, then we can use the Pythagorean Theorem to see that the length of the green arrow (the hypotenuse) is the square root of the sum of the squares of the two sides. Therefore,

$$\begin{aligned} Total\ \ voltage &= \sqrt{5^2+6^2} \\ &= \sqrt{61} \\ &= 7.8 \end{aligned}$$

The angle between the blue arrow and the green arrow is called the phase angle between the circuit current and the total voltage. We can calculate this phase angle using the tangent function from trigonometry. If we call the phase angle A, then we know that

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

In this case, the opposite side has length 6 and the adjacent side has length 5, so we have

$$\tan(A) = \frac{6}{5} = 1.2$$

Using the inverse tangent function on a calculator we find that $A = 50.2\ \deg rees$.

From this we say that the applied voltage leads the circuit current by 50.2 degrees.

In part 27 we will continue to consider this circuit by measuring current, resistance, and inductive reactance.