

Basic Electronics Part 23  
by  
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Now consider an ac circuit with a single inductor as shown in Fig. 1 below.

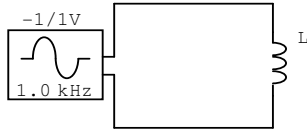
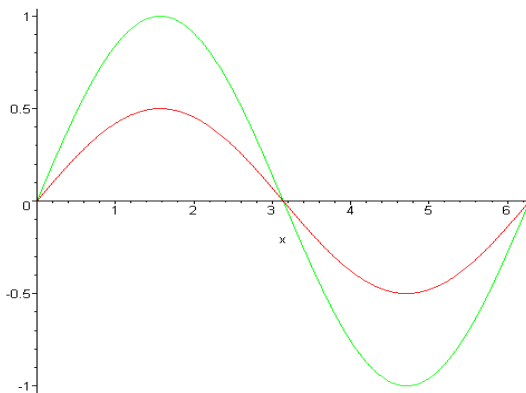


Fig. 1

Inductors oppose alternating current. This opposition is called inductive reactance. Inductive reactance is low for low frequencies and high for high frequencies. As an alternating current flows through an inductor, the inductor stores some electrical energy as a magnetic field around the inductor. If we start with zero current and begin to increase toward a positive peak, the increasing current causes a magnetic field to build up around the inductor, storing energy. The current increases rapidly at the beginning, so the magnetic field strength increases rapidly. When the current reaches a positive peak and begins to decrease, the energy stored in the inductor reaches a maximum. As the current decreases, the magnetic field collapses, returning its energy to the circuit. When the current crosses zero the magnetic field returns all its energy, and the field strength becomes zero.

The current reverses direction with the current increasing toward a peak negative value. The magnetic field direction reverses, storing energy again. This magnetic field increases until the current reaches its peak negative value. Then the current decreases and the inductor returns the energy stored in it as the magnetic field collapses. The relationship between the alternating current and the magnetic field strength is illustrated below.

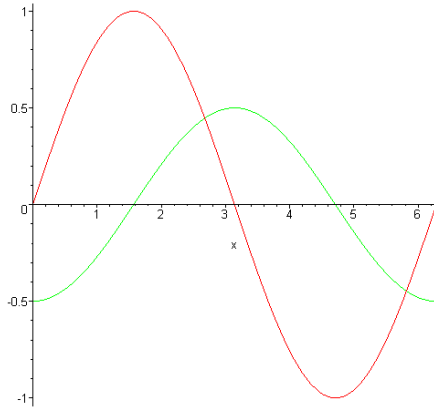


The current is represented by the green curve and the magnetic field strength is represented by the red curve. Note that the magnetic field is in phase with the alternating current.

Now we recall that a changing magnetic field induces a voltage across the inductor. The voltage is largest when the magnetic field changes fastest. Therefore, a slowly changing magnetic field induces a small voltage. Looking at the curves above we see that the magnetic field is changing the fastest as we begin at zero. That means that the induced voltage is a maximum there. When the magnetic field reaches its maximum in either direction, there is a moment when it is not changing, therefore, the induced voltage is

zero there. Since the magnetic field and the alternating current are in phase, then we have a similar relationship between current and induced voltage.

The induced voltage has a polarity that opposes the changing current because it tries to maintain a steady current. This means that when the current is in the positive direction, the induced voltage has a negative polarity. This is illustrated by the graph below.



Here the red curve is current and the green curve is induced voltage. As you can see, the induced voltage lags the current by 90 degrees or the current leads the induced voltage by 90 degrees.

As you know, you must have an applied alternating voltage to create the alternating current through the inductor. This applied voltage is different from the induced voltage caused by the magnetic field. Next time we will discuss how this applied voltage relates to the induced voltage.