

Basic Electronics Part 22
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Now consider an ac circuit with a single capacitor such as in Fig. 1:



Fig 1

As we have discussed before, this capacitor will have an opposition to an alternating current flowing in the circuit. This opposition is called capacitive reactance. At low frequencies this reactance is large, and it decreases as the frequency increases.

When we apply an alternating voltage across this capacitor, the increasing voltage stores energy as an electric field. The capacitor returns that energy to the circuit when the voltage decreases. More specifically, if we start the voltage at zero there is no charge on the capacitor so there is a large current that begins to flow. As electrons build up on the negative plate of the capacitor, this charge tries to prevent more electrons from moving onto the plate. This causes the current to decrease. When the voltage reaches its maximum value the capacitor is fully charged so the current stops.

Next the applied voltage begins to decrease. Since the capacitor voltage is then larger than the applied voltage, electrons move off the negative plate of the capacitor. This changes the direction of flow of current in the circuit. As the applied voltage decreases to zero, the capacitor current increases, draining all the charge off the capacitor plates. This relationship between alternating voltage and alternating current is shown graphically in Fig. 2

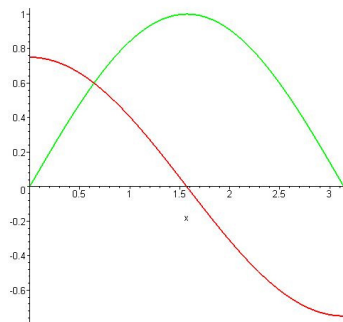


Fig. 2

The green curve is voltage and the red curve is current. In general, the two waveforms have different amplitudes.

Now notice the phase relationship between the voltage across the capacitor and the current through it. These two waveforms are 90 degrees out of phase with the current waveform reaching its maximum at 0 degrees and the voltage reaching its maximum value at 90 degrees. The current waveform reaches its negative peak at 180 degrees where the voltage waveform is back to zero. In this situation we say that the current

leads the voltage by 90 degrees. Of course we could also say that the voltage lags the current by 90 degrees. Both of these statements mean the same thing.

As an exercise, see if you can complete the waveforms as the voltage reaches its negative maximum and returns to zero.

Recall that power is the product of voltage and current, so we can plot the power curve on this same graph as in Fig. 3

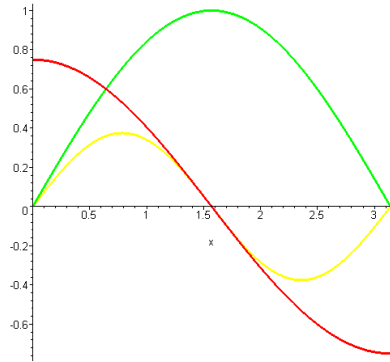


Fig. 3.

Here the power waveform is the yellow curve.

In the next installment we will consider what happens to voltage and current if we replace the capacitor with an inductor.