

Basic Electronics Part 21  
by  
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In order to talk about how alternating voltage and alternating current behave in circuits with inductance and capacitance, we need to talk about phase. Basically, two waveforms are in phase if their peaks and zero points match or occur at the same points in time. This means that they are not in phase if their peaks and zero points occur at different points in time.

To illustrate this suppose we have two waveforms that have the same amplitude and frequency. (Fig. 1)

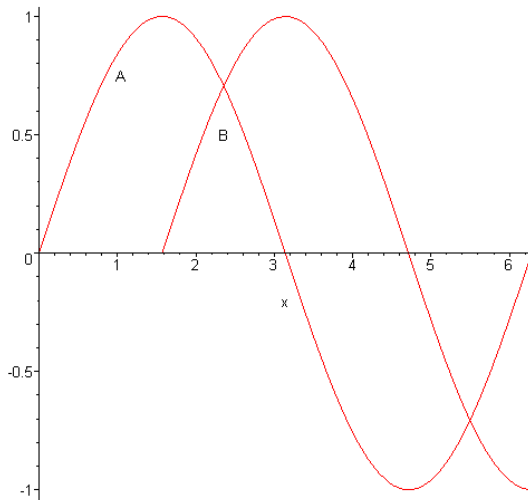


Fig. 1

Notice that the waveform labeled A starts at a zero, but the waveform labeled B starts later in time. In this case we say the waveforms are not in phase. Waveform A seems to be ahead of waveform B so we say that A leads B. Waveform A goes through one complete cycle as the horizontal axis goes from 0 to 360 degrees. Waveform B starts when waveform A is at its peak. The peak for waveform A occurs at 90 degrees. Since these two waveforms are at the same frequency, they will be out of step by the same angular amount at every point in time. Because of this, we can express phase shift for two waveforms of the same frequency as a constant quantity for the entire wave. We may describe this relationship by saying that waveform A leads waveform B by 90 degrees. If these waveforms represent voltages (or currents), then we say that voltage (current) A leads voltage (current) B by 90 degrees. This is just one example. For different situations the number of degrees that A leads B could be different. In particular, if A leads B by 180 degrees, then the two waveforms would be mirror images as in Fig. 2.

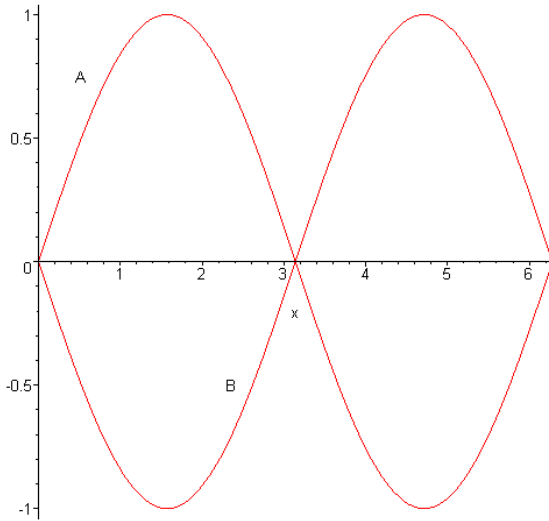


Fig. 2

Phase shift, like voltage, is a relative measurement between two things. There is no universal reference for phase. In the analysis of alternating current circuits, the voltage waveform of the power supply is used as a reference for phase. That voltage is usually stated as XXX volts at 0 degrees. Any other AC voltage or current in that circuit will have its phase shift expressed in terms relative to that source voltage.

If A and B are currents (or voltages) and if A leads B by 90 degrees, we may also say that B lags A by 90 degrees. This is just a different way of expressing the same relationship.

We may compare two waveforms that have the same frequency but not necessarily the same amplitude. For example we could have one waveform representing an alternating voltage and another waveform representing an alternating current (Fig. 3).

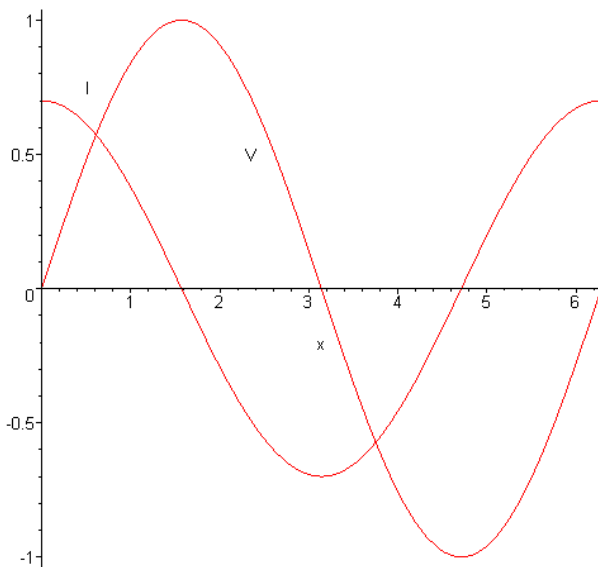


Fig. 3

Here the current, I, is leading the voltage, V, by 90 degrees. We will see in the next issue that this kind of relationship occurs when we have capacitance in an AC circuit.