
7 Alternating Current Circuits

Nikola Tesla proposed the alternating current (ac) system as a better alternative to the direct current (dc) system. His idea was initially met with fierce resistance from Thomas Edison as explained in chapter 1. Eventually the ac was selected for power systems worldwide essentially because of three main reasons:

1. The voltage of the ac system can be adjusted by transformers, which are relatively simple devices.
2. The voltage of the long transmission lines can increase to high levels; thus reducing the current of the line, reducing the transmission line losses, and reducing the cross section of the conductors of the transmission lines.
3. The ac systems reduce rotating magnetic fields that spin electric motors. Keep in mind that electric motors represent the majority of electrical loads.

Nomenclature

In this chapter, the following nomenclatures are used:

Instantaneous current	i	Instantaneous voltage	v
Average current	i_{ave}	Average voltage	v_{ave}
Maximum (peak) current	i_{max}	Maximum (peak) voltage	v_{max}
Current magnitude in root mean square		voltage magnitude in root mean square	
Phasor current in complex form	I	Phasor voltage in complex form	V
Impedance in complex form	Z	Apparent power in complex form	S
Magnitude of impedance		Magnitude of apparent power	
Instantaneous power	p	Real power	
Reactive power			

7.1 ALTERNATING CURRENT WAVEFORM

The ideal ac circuit has its voltage and current in sinusoidal forms. A voltage waveform is shown in figure 7.1 and can be expressed mathematically by

$$v = V_{\text{max}} \sin \omega t \quad (7.1)$$

where

- v is the instantaneous voltage
- V_{max} is the peak (maximum) value of the voltage
- ω is the angular frequency
- t is the time

The unit of ω is radian/second (rad/s) and is expressed by

$$\omega = 2\pi f \quad (7.2)$$

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