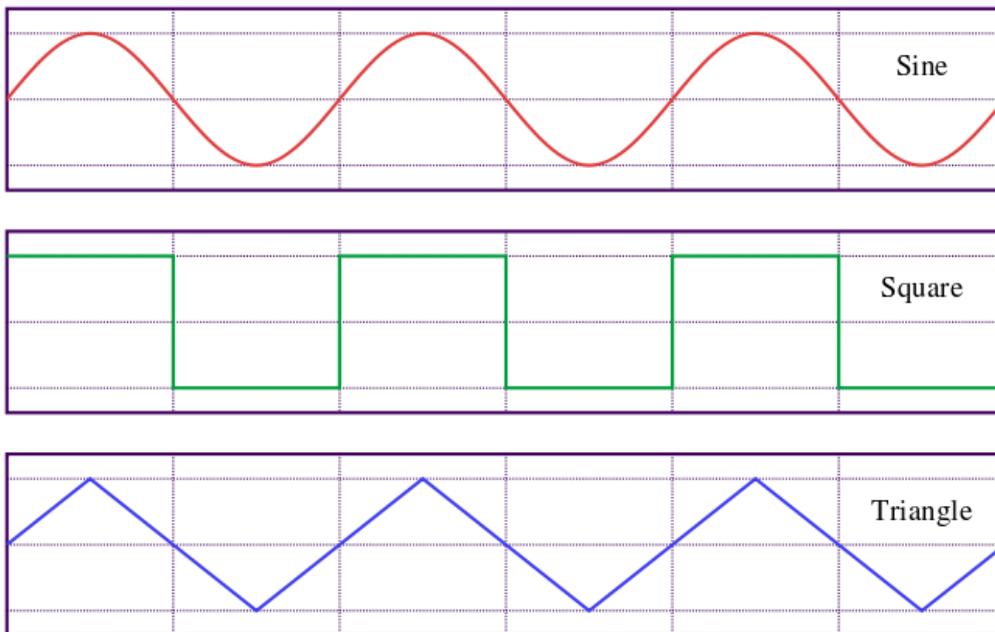


# ALTERNATING VOLTAGE

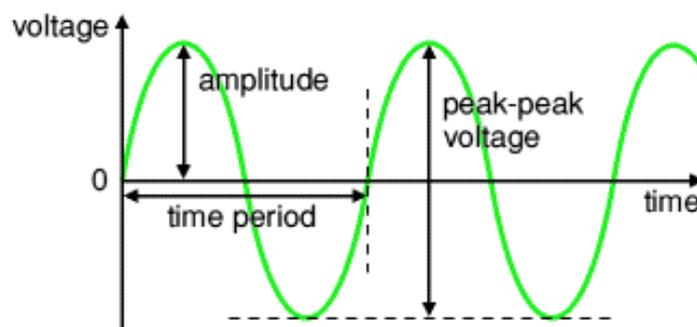
AC (Alternating Current) waveforms refer to continually changing time-varying voltages and currents. The magnitude and direction of these voltages and currents vary in a set manner from a minimum to a maximum value, in a specific time interval. This is in contrast to DC (Direct Current), where currents or voltages do not change in magnitude or direction.

AC waveforms can be sinusoidal (sine wave), square or triangular.



The only waveform available in nature is the sinusoidal. The square and the triangular waveforms are made from sinusoidal waveforms with the help of electronic circuitry.

The voltage-time graph shows various properties of an electrical signal. The diagram shows a sine wave but these properties apply to any signal with a constant shape.



**Periodic Waveform** is a waveform that continuously repeats itself.

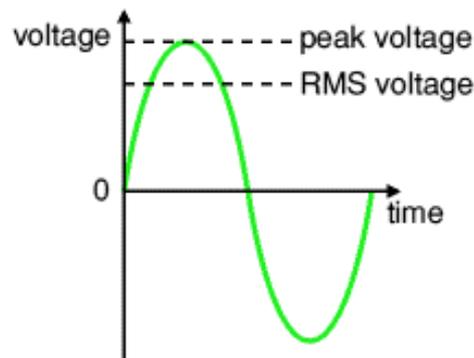
**Period (T)** is the time interval in seconds that the waveform takes to repeat itself from start.

**Frequency (f)** is the number of times the waveform repeats itself within a one second time period. Frequency is the reciprocal of the time period, ( $f = 1/T$ ) with the unit Hz.

**Instantaneous Value (v)** is the voltage of the waveform at any instant of time.

**Amplitude or Maximum or Peak Value ( $V_p$ )** is the maximum voltage of the waveform using the zero level as reference.

**Peak-to-Peak Value ( $V_{p-p}$ )** is the voltage between the positive peak (maximum) and the negative peak (minimum) and is twice the peak voltage (amplitude).



**Root-Mean-Square (RMS) or Effective Value ( $V_{rms}$ )** is the amount of DC voltage that is required for producing the same amount of power as the AC waveform.

For the Sine Waveform: Effective Value = Peak Value/ $\sqrt{2}$

For the Square Waveform: Effective Value = Peak Value

For the Triangular Waveform: Effective Value = Peak Value/ $\sqrt{3}$

**Average value ( $V_{av}$ )** of a pure sinusoidal waveform over one period is zero. This is because the area above the horizontal axis is equal and opposite of the area below the horizontal axis.

The equation that describes the sinusoidal waveform is:  $v = V_p \cdot \sin(\omega t + \phi)$

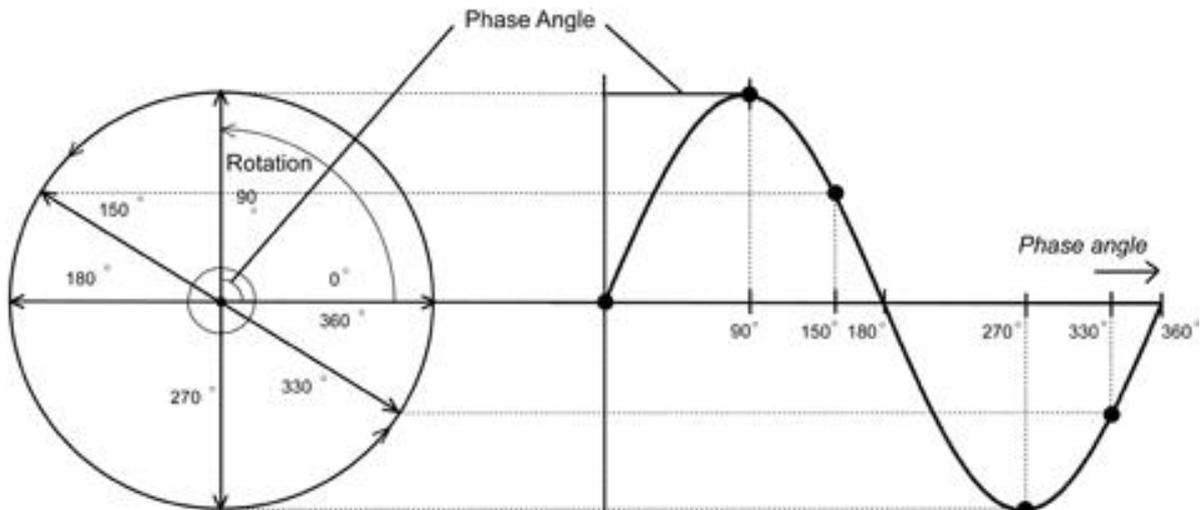
where:

$V_p$  - is the peak value,

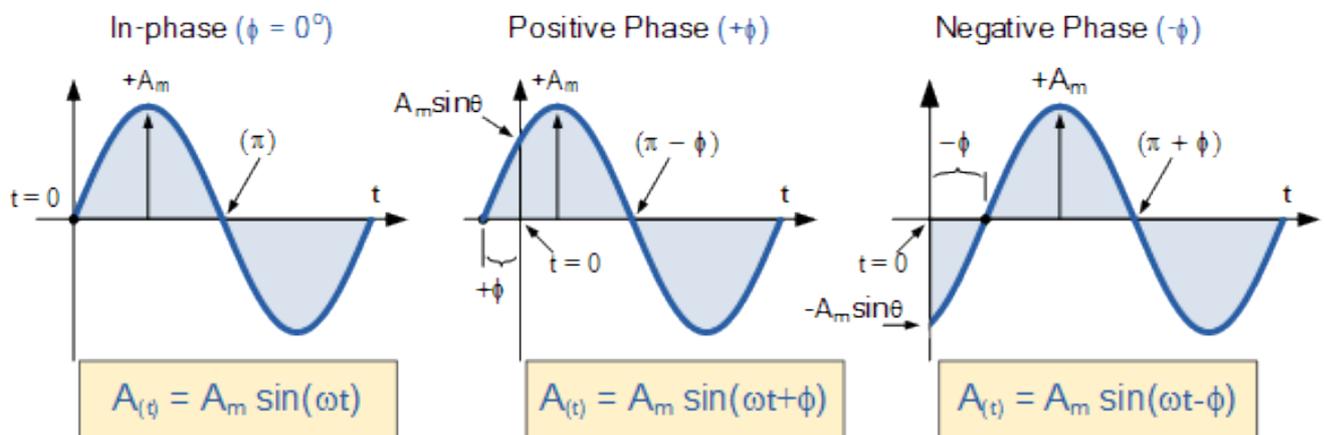
sin - indicates a sine wave, and

$\omega$  - is the **angular velocity** of a radius vector that rotates about a center. This vector has magnitude  $V_p$  and the sinusoidal waveform can be constructed taking the length of the vertical projection, at every instant of rotation of this vector, over one complete rotation. The angular velocity is calculated as the ratio of distance over time, where the distance is measured in radians or degrees and the time in seconds.

$$\omega = 2 \cdot \pi / T = 2 \cdot \pi \cdot f$$



$\phi$  - is the phase angle in degrees or radians that the waveform has shifted either left or right from the reference point.



## 1. COMPREHENSION CHECK

ANSWER THE FOLLOWING QUESTIONS IN THE SHORTEST POSSIBLE WAY.

1. What is difference in waveforms between AC and DC voltage?
2. What shape can AC waveforms have?
3. Which is the only natural AC waveform?
4. How are the other two forms produced?
5. Describe the graph.
6. What is a Periodic Waveform?
7. What is a Period (T)?
8. What is Frequency (f) and what is its unit?
9. Describe the term Instantaneous Value (v).
10. How can you explain the term Amplitude, Maximum or Peak Value ( $V_p$ )?
11. What is Peak-to-Peak Value ( $V_{p-p}$ )?
12. What does the term Effective Value ( $V_{rms}$ ) represent?
13. What are the equations for:
  - a) Sine Waveform
  - b) Square Waveform
  - c) Triangular Waveform?
14. Which equation describes sinusoidal waveform?
15. Define angular velocity.
16. How do we calculate angular velocity?
17. Define phase velocity.

## 2. TRANSLATE

1. AC (Alternating Current)
2. DC (Direct Current)
3. magnitude
4. sinusoidal waveform
5. circuitry
6. continuously
7. constantly
8. reciprocal
9. instantaneous
10. Peak Value
11. Peak-to-Peak Value
12. RMS (Root-Mean-Square) Value

13. angular velocity
14. ration
15. phase angle
16. radius vector

**3. WHAT ARE SYNONYMOUS WORDS FOR:**

1. to change
2. to be available
3. circuitry
4. properties
5. continuously
6. to apply
7. an instant
8. average
9. to rotate
10. to shift
11. speed
12. period