Basic Electrical and Electronics Engineering

LECTURE 2.1

Dr. Sonam Shrivastava/ Assistant Professor (Sr.) /SELECT

BEEE102L

Basic Electrical and Electronics Engineering

1. DC Circuits
2. <u>AC Circuits</u>
3. Magnetic Circuits
4. Electrical Machines
5. Semiconductor Devices and Applications
6. Digital Systems
7. Sensors and Transducers

Books

Text Book

[1] John Bird, ‘Electrical circuit theory and technology’, Newnes publications, 4^{th} Edition, 2010.

Reference Book

[2] Allan R. Hambley, ‘Electrical Engineering - Principles & Applications’ Pearson Education, First Impression, 6/e, 2013.

[3] Simon Haykin, ‘Communication Systems’ , John Wiley & Sons, 5^{th} Edition, 2009.

[4] Charles K Alexander , Mathew N O Sadiku, ‘Fundamentals of Electric Circuits’, Tata Mc Graw Hill , 2012.

[5] Batarseh, ‘Power Electronics Circuits’, Wiley, 2003.

[6] W. H. Hayt, J. E. Kemmerly and S. M. Durbin, ‘Engineering Circuit Analysis’, 6/e, Tata McGraw Hill, New Delhi, 2011.

[7] Fitzger ald, Higgabogan, Grabel, ‘Basic Electrical Engineering’, 5^{th} ed, McGraw Hill, 2009.

[8] S.L.Uppal, ‘Electrical Wiring Estimating and Costing’ , Khannapublishers, NewDelhi, 2008.

Module II. AC Circuits

Alternating voltages and currents, AC values,
Single Phase RL, RC, RLC Series circuits,
Power in AC circuits - Power Factor,
Three Phase Systems,
Star and Delta Connection,
Three Phase Power Measurement,
Electrical Safety, Fuses and Earthing, Residential wiring.

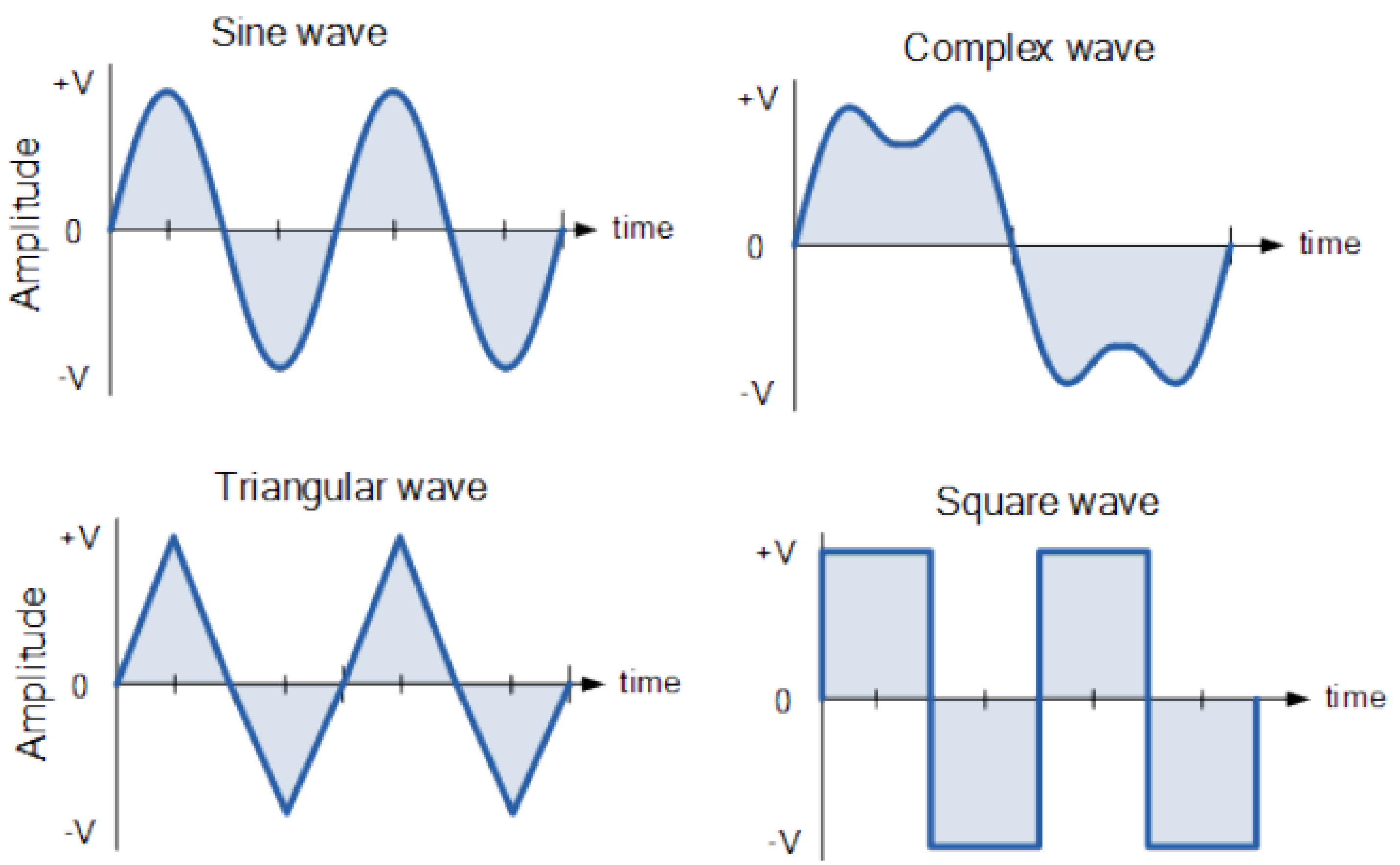
Introduction

- The resistance, inductance and capacitance are three basic elements of any electric network.
- We now begin the analysis of circuits in which the source voltage or current is time-varying.
- In this chapter, we are particularly interested in sinusoidally time-varying excitation, or simply, excitation by a *sinusoid.*
- A sinusoidal current is usually referred to as ***alternating current (ac)***.
- Circuits driven by sinusoidal current or voltage sources are called *ac circuits*.

A sinusoid is a signal that has the form of the sine or cosine function

Alternating Voltages

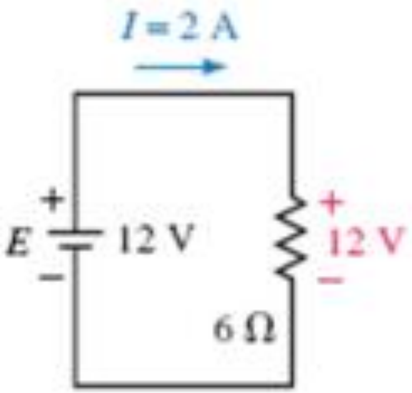
A voltage which periodically changes its polarity at regular intervals of time is called an alternating voltage.



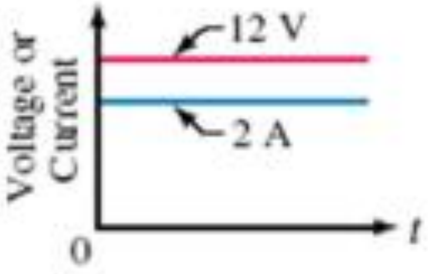
Why Sine Waveform only?

- The sine waveform produces the least disturbance in the electrical circuit and is the smoothest and efficient waveform.
- The use of sinusoidal voltages applied to appropriately designed coils results in a revolving magnetic field which has the capacity to do work.
- The mathematical computations are much simpler with this waveform.
- By means of Fourier series analysis, it is possible to represent any periodic function of whatever waveform in terms of sinusoids.

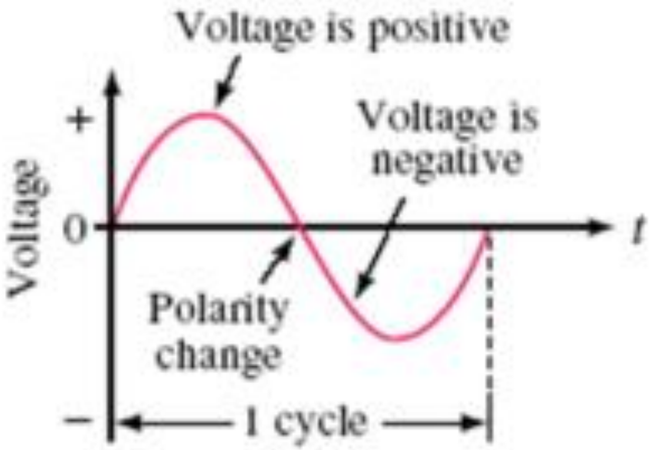
DC and AC



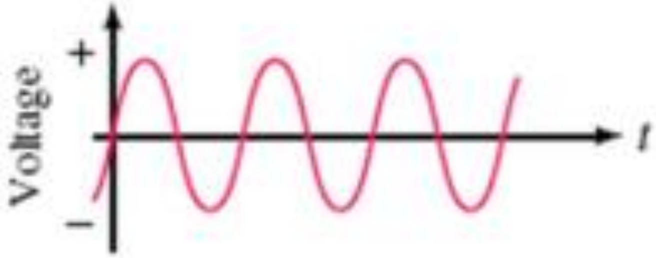
(a)



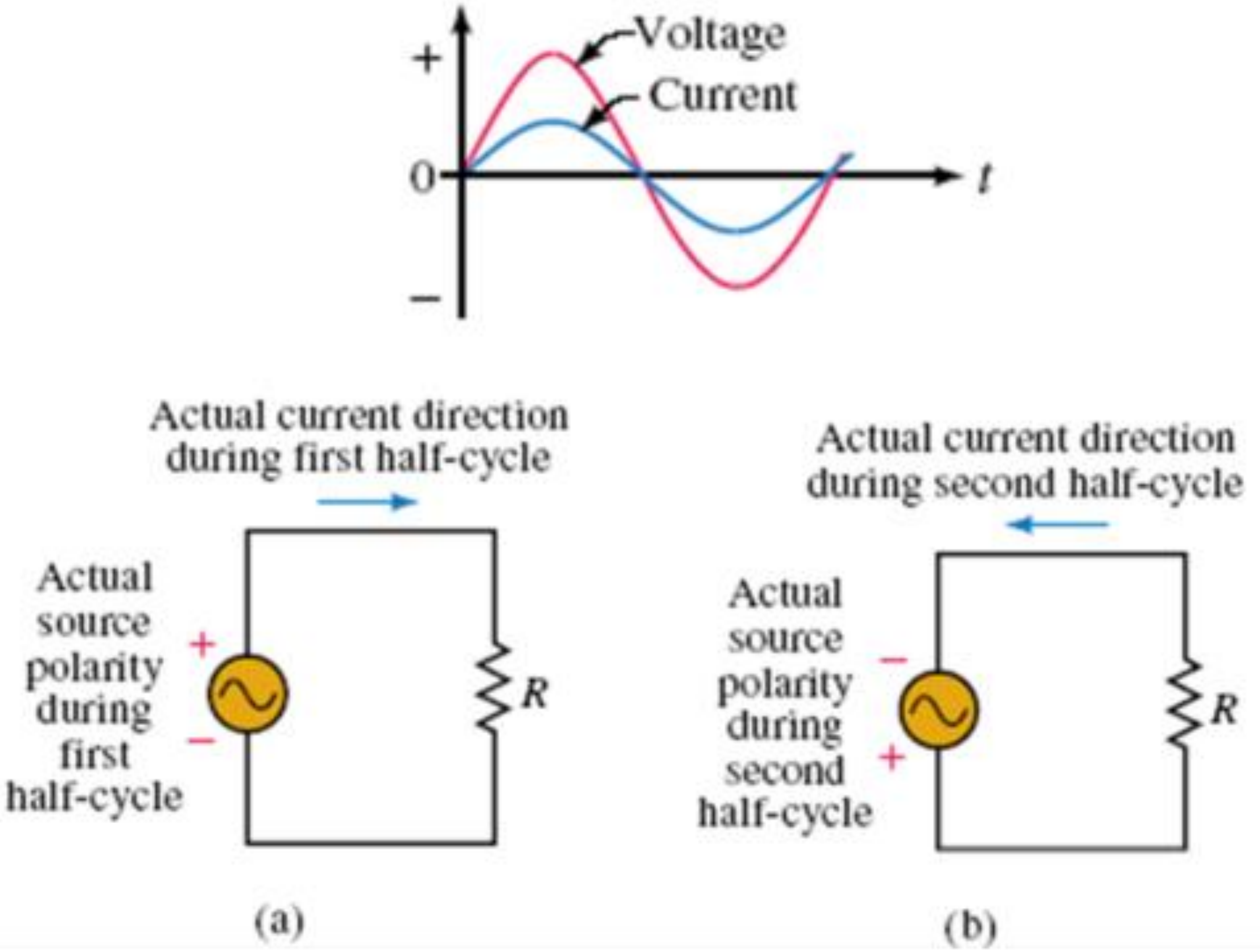
(b) Voltage and current versus time for dc



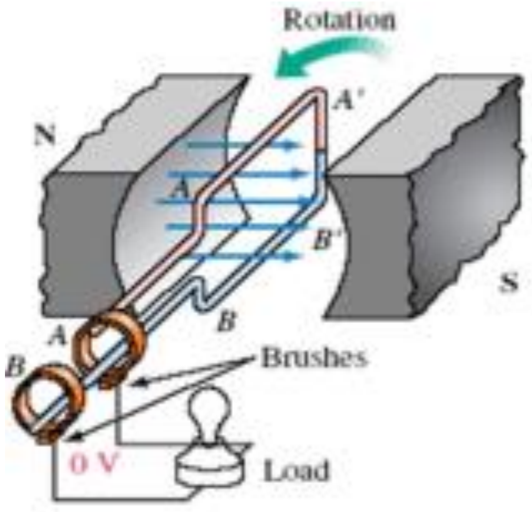
(a) Variation of voltage versus time



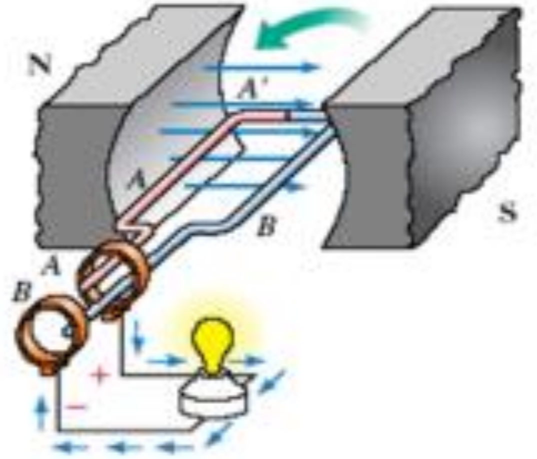
(b) A continuous stream of cycles



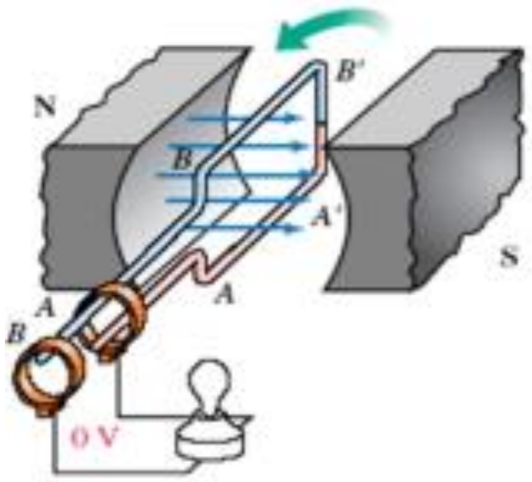
Voltage
Current
+
0
−
t
Actual current direction during first half-cycle
Actual source polarity during first half-cycle
+
−
R
(a)
Actual current direction during second half-cycle
Actual source polarity during second half-cycle
−
+
R
(b)



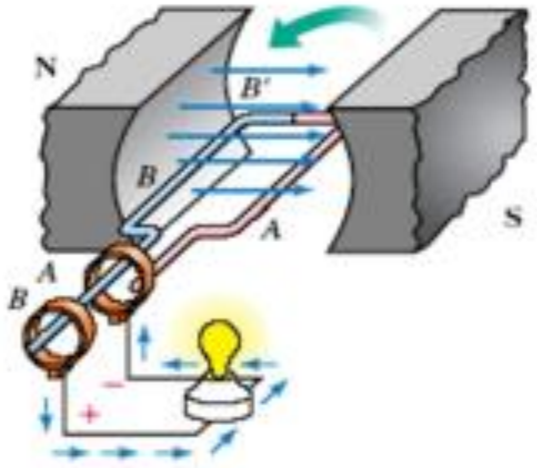
(a) 0° Position: Coil sides move parallel to flux lines. Since no flux is being cut, induced voltage is zero.



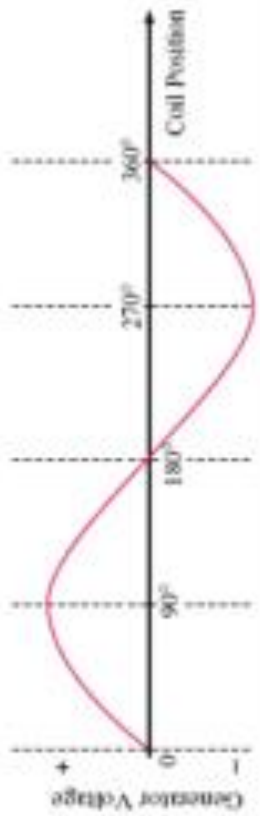
(b) 90° Position: Coil end *A* is positive with respect to *B*. Current direction is out of slip ring *A*.

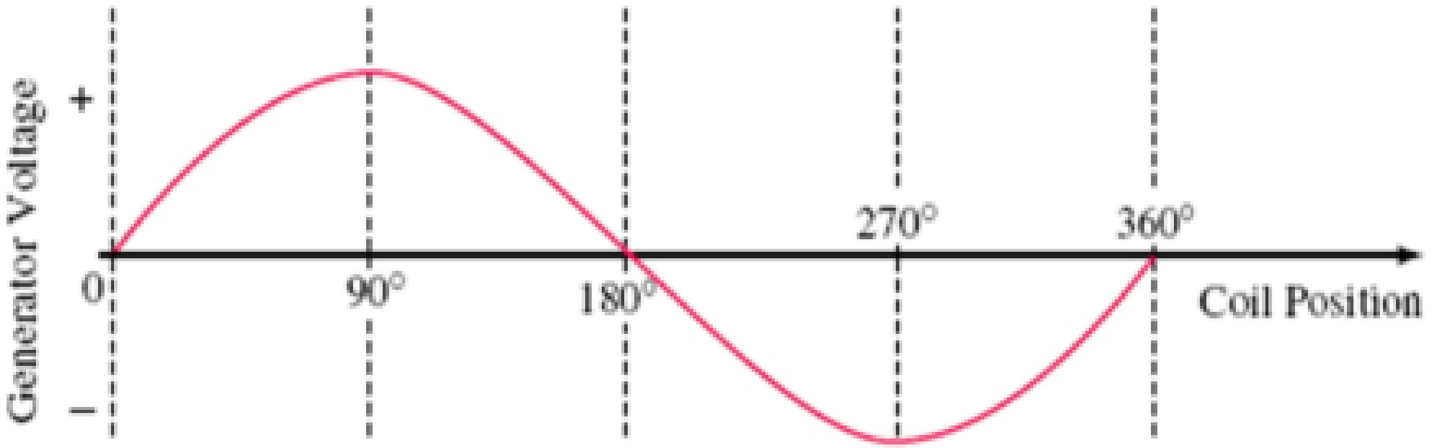


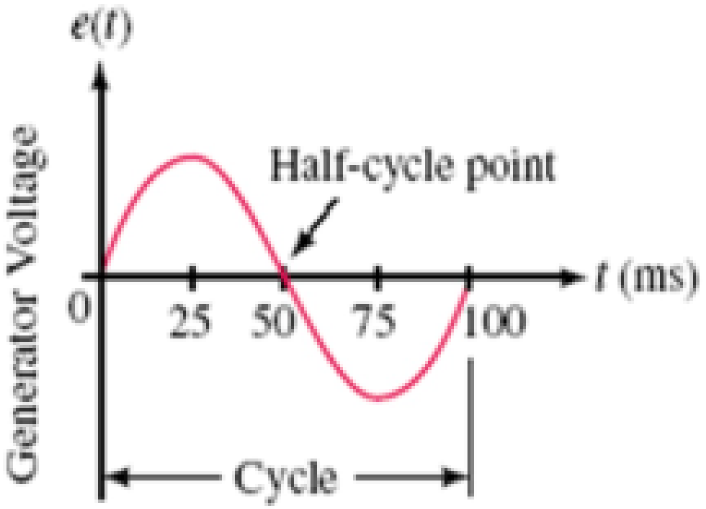
(c) 180° Position: Coil again cutting no flux. Induced voltage is zero.



(d) 270° Position: Voltage polarity has reversed, therefore, current direction reverses.

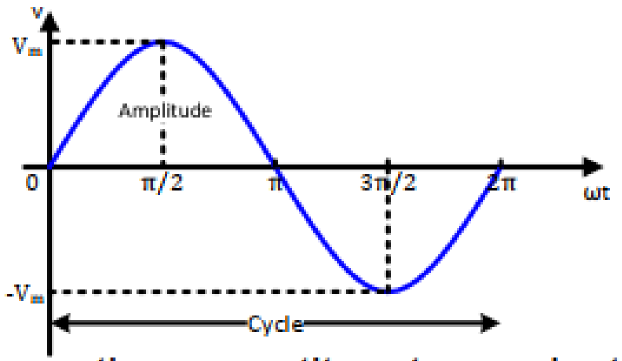






The length of time required to generate one cycle depends on the velocity of rotation. If the coil rotates at 600 rpm (revolutions per minute). Six hundred revolutions in one minute equals 600 rev/60 s 10 revolutions in one second. At ten revolutions per second, the time for one revolution is one tenth of a second, i.e., 100 ms. Since one cycle is 100 ms, a half-cycle is 50 ms, a quarter-cycle is 25 ms, and so on.

A.C. Terminology



Instantaneous value

The value of an alternating quantity at any instant is called instantaneous value. The instantaneous values of alternating voltage and current are represented by *v* and *i* respectively.

Cycle

One complete set of positive and negative values of an alternating quantity is known as a cycle.

Time period

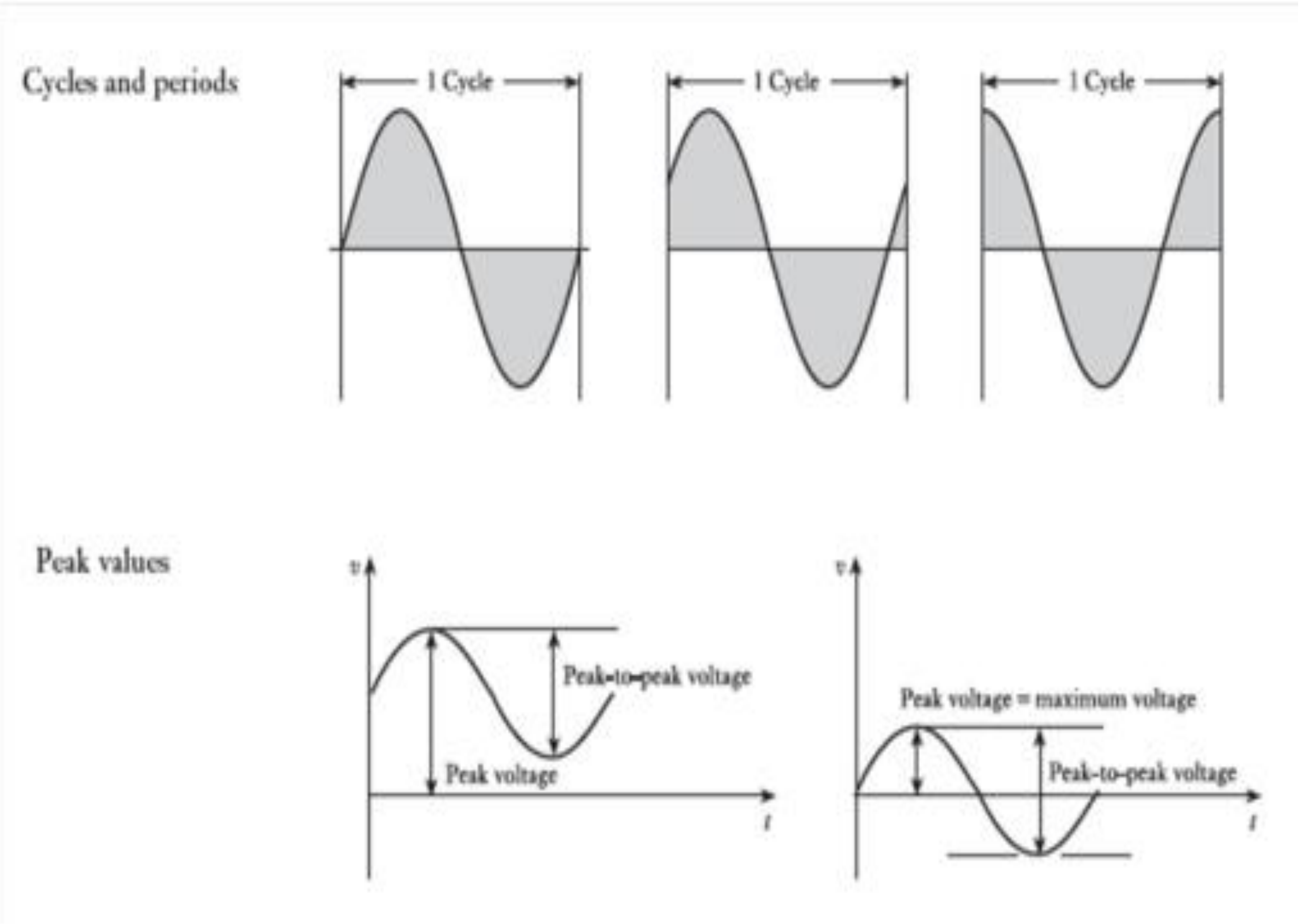
The time taken in seconds to complete one cycle of an alternating quantity is called its time period. It is generally represented by T.

Frequency

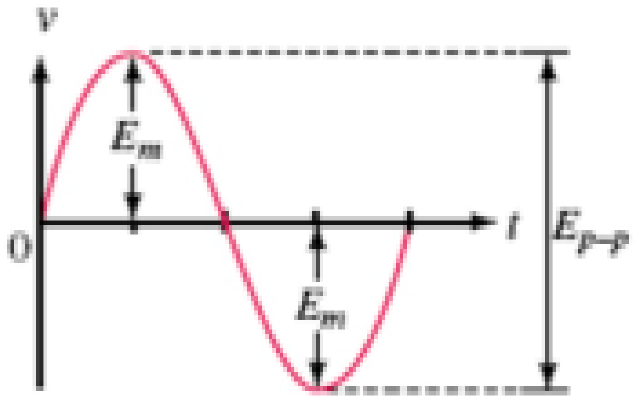
The number of cycles that occur in one second is called the frequency (f) of the alternating quantity. It is measured in cycles/sec (C/s) or Hertz (Hz). One Hertz is equal to 1C/s.

Amplitude

The maximum value (positive or negative) attained by an alternating quantity is called its amplitude or peak value.

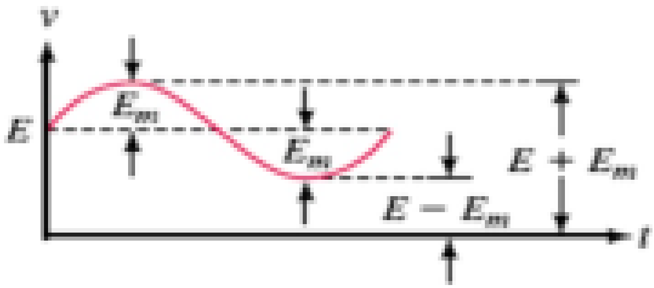

Cycles and periods
1 Cycle
1 Cycle
1 Cycle
Peak values
v
Peak-to-peak voltage
Peak voltage
t
v
Peak voltage = maximum voltage
Peak-to-peak voltage
t

Amplitude and Peak-to-Peak Value
The **amplitude** of a sine wave is the distance from its average to its peak. Thus, the amplitude of the voltage is E_m. **Peak-to-peak voltage** is also indicated. It is measured between minimum and maximum peaks. Peak-to-peak voltages are denoted $E_{p\text{-}p}$ or $V_{p\text{-}p}$



Peak Value
The **peak value** of a voltage or current is its maximum value with respect to zero.

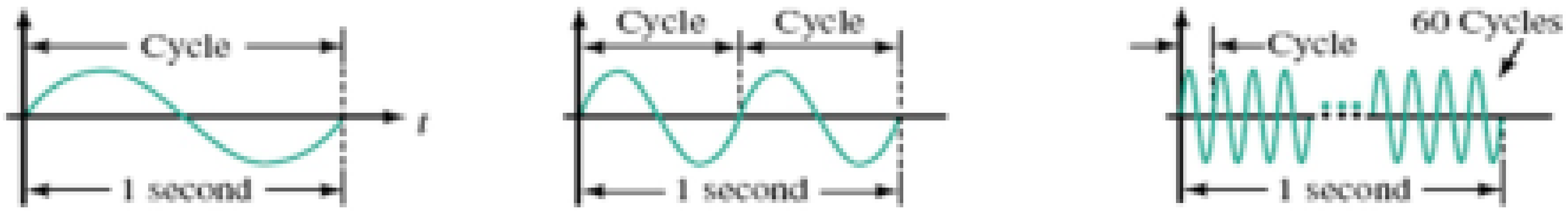
Here, a sine wave rides on top of a dc value, yielding a peak that is the sum of the dc voltage and the ac waveform amplitude. For the case indicated, the peak voltage is $E + E_m$



Frequency

The number of cycles per second of a waveform is defined as its **frequency.**

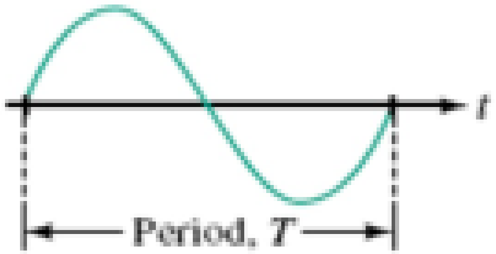
$$1\ \text{Hz} = 1\ \text{cycle per second}$$



(a) 1 cycle per second = 1 Hz (b) 2 cycles per second = 2 Hz (c) 60 cycles per second = 60 Hz

Period

The **period,** *T*, of a waveform, is the duration of one cycle. It is the inverse of frequency.



$$T = \frac{1}{f} \quad \text{(s)}$$

$$f = \frac{1}{T} \quad \text{(Hz)}$$

Sinusoids

- Consider the sinusoidal voltage

$$v(t) = V_m \sin \omega t$$

where

$$V_m = \text{the } \textit{amplitude} \text{ of the sinusoid}$$
$$\omega = \text{the } \textit{angular frequency} \text{ in radians/s}$$
$$\omega t = \text{the } \textit{argument} \text{ of the sinusoid}$$

Angular velocity and frequency

In one revolution of the coil, the angle turned is 2π radians and the voltage wave completes 1 cycle. The time taken to complete one cycle is the time period T of the alternating voltage

Angular velocity $\omega = \dfrac{Angle\ turned}{Time\ taken} = \dfrac{2\pi}{T} = 2\pi f$

$$e = E_m \sin \alpha \quad (\mathrm{V})$$

α is the instantaneous angular position of the coil.

Angular Velocity ω

The rate at which the generator coil rotates is called its **angular velocity**

$$\alpha = \omega t$$

$$t = \frac{\alpha}{\omega} \quad (\mathrm{s})$$

$$\omega = \frac{\alpha}{t}$$

Radian Measure

In practice, ω is usually expressed in radians per second, where radians and degrees are related by the identity

$$2\pi \text{ radians} = 360°$$