AC CIRCUITS

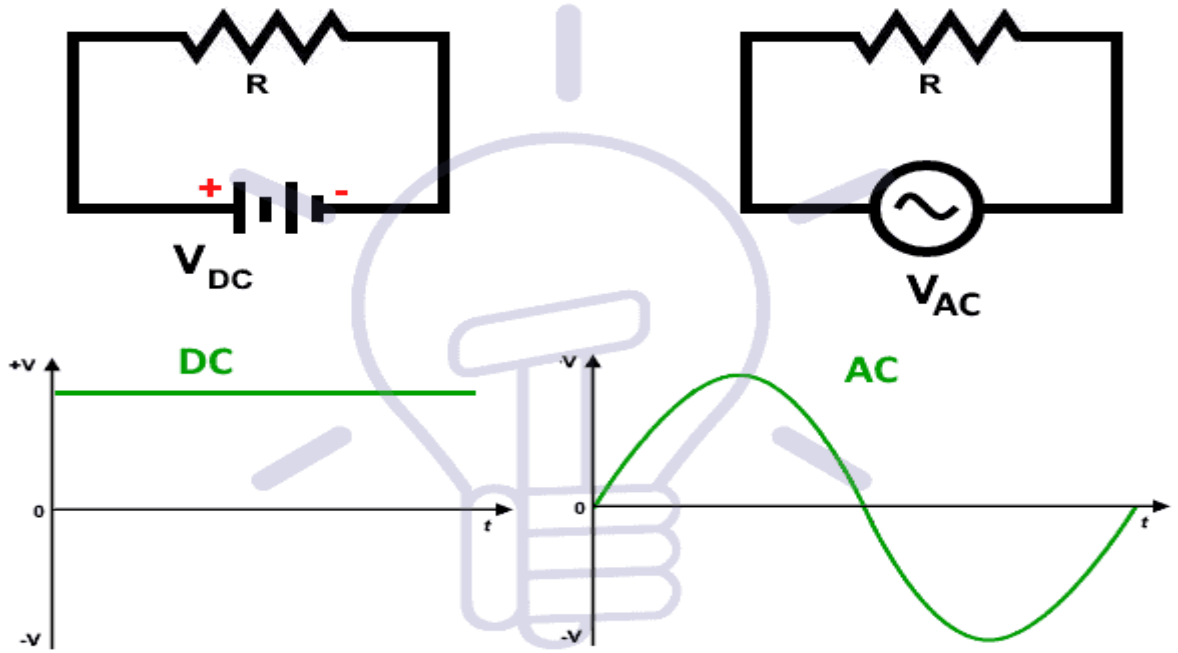
AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor (Simple problems only)

AC and DC Currents

- It is known that the polarity of DC voltage and direction of DC current are always same i.e. it is a unidirectional value which does not change the polarity as well as direction as shown in fig.
- On the other hand, (AC) Alternating Current or Voltage is one which regularly changes its direction as well as its value.
- In other words, alternating current (AC) is a type of current which flows first in one direction and secondly, it flows in the opposite direction.
- In each cycle, it changes the value from zero to the maximum and again hit the zero value.

AC and DC Currents

The value of alternating current or voltage can be express in AC (Sinusoidal) Sine wave as shown in fig below.

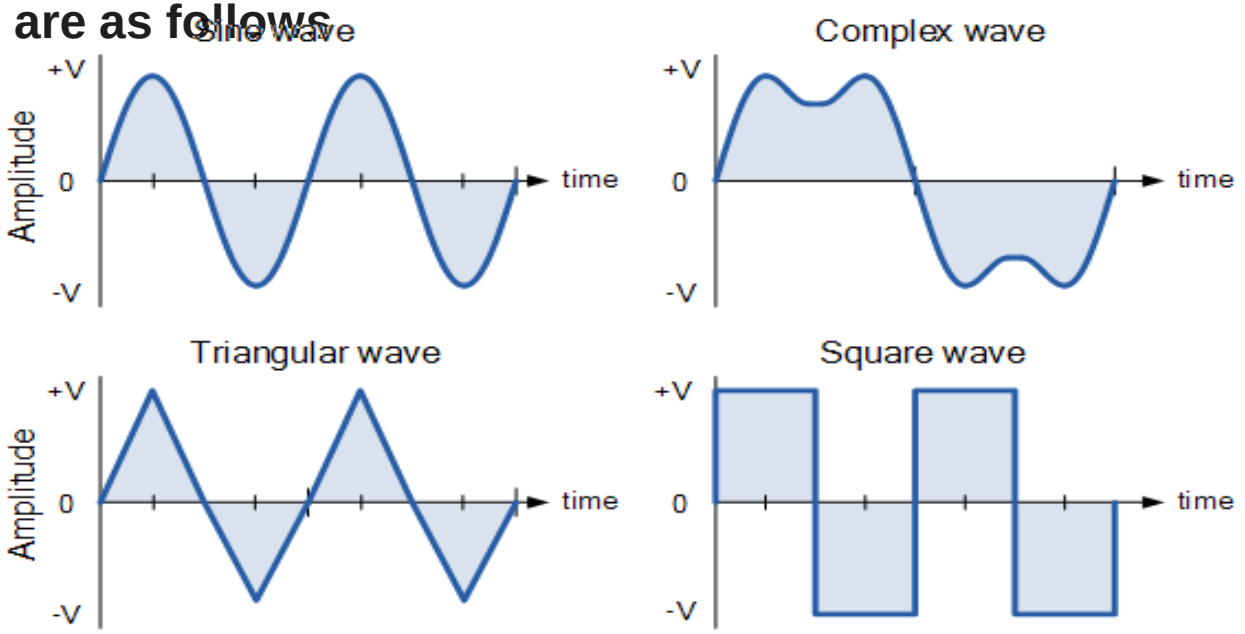


Demonstration of DC and AC

Wave Form

The term AC or to give it its full description of Alternating Current, generally refers to a time-varying waveform with the most common of all being called a Sinusoid better known as a Sinusoidal Waveform. Sinusoidal waveforms are more generally called by their short description as Sine Waves.

Types of Waveforms are as follows

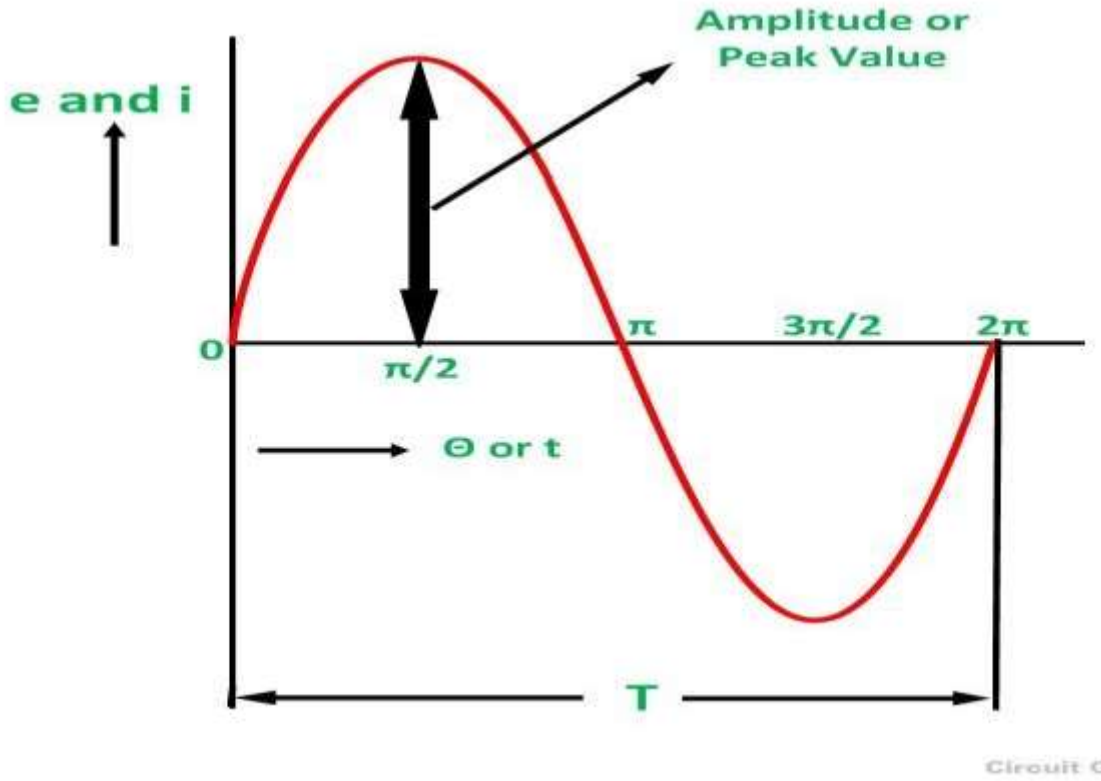


Peak Value

Definition: The maximum value attained by an alternating quantity during one cycle is called its P**eak value**.

- It is also known as the **maximum value** or **amplitude** or **crest value**.
- The sinusoidal alternating quantity obtains its peak value at 90 degrees as shown in the figure below.
- The peak values of alternating voltage and current is represented by E_m and I_m respectively.

PEAK VALUE


Amplitude or
Peak Value
e and i
0
π/2
π
3π/2
2π
Θ or t
T
Circuit Globe

Average Value

Definition: The average of all the instantaneous values of an alternating voltage and currents over one complete cycle is called **Average Value.**

- If we consider symmetrical waves like sinusoidal current or voltage waveform, the positive half cycle will be exactly equal to the negative half cycle. Therefore, the average value over a complete cycle will be **zero**.
- The work is done by both, positive and negative cycle and hence the average value is determined without considering the signs.
- So, the only positive half cycle is considered to determine the average value of alternating quantities of sinusoidal waves.
- Let us take an example to understand it.

Average Value

Divide the positive half cycle into (*n*) number of equal parts as shown in the above figure

Let i_1, i_2, i_3..... i_n be the mid ordinates

The Average value of current I_{av} = mean of the mid ordinates

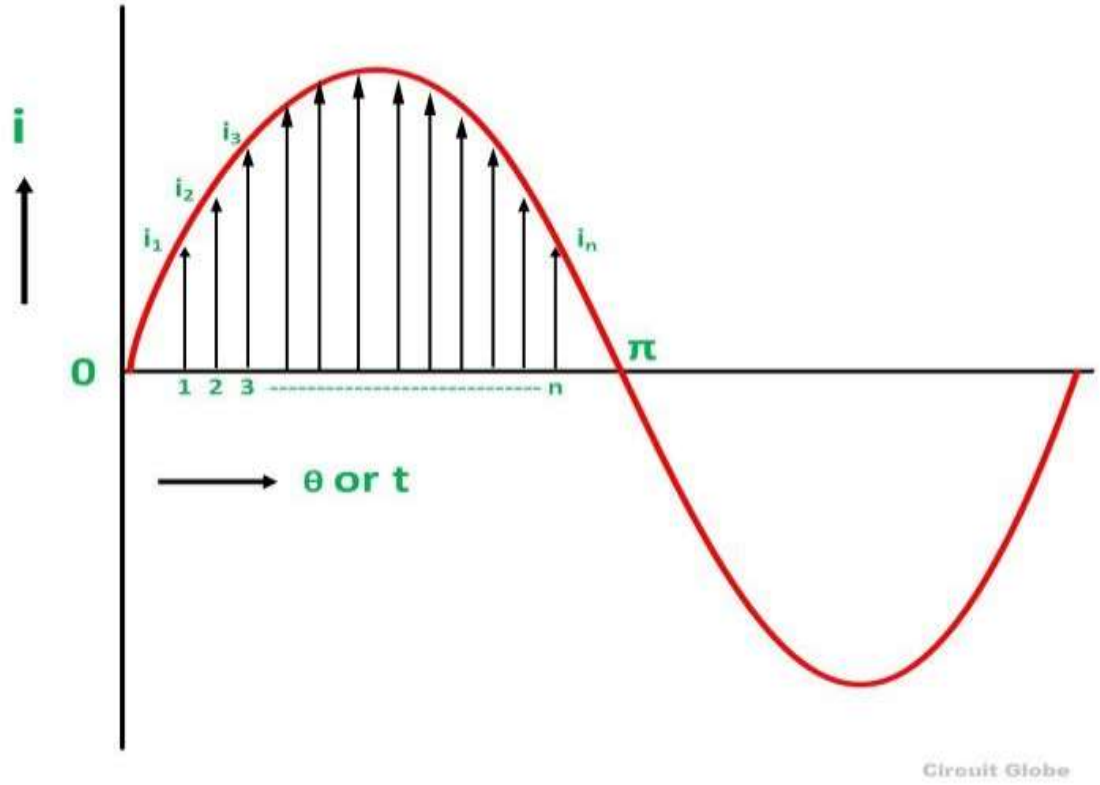
The arithmetical average of all the instantaneous values of an alternating quantity over one cycle is known as the "Average Value of Alternating Quantity".

$$Average\ value = \frac{Sum\ of\ all\ instantaneous\ values\ over\ one\ cycle}{Number\ of\ instants}$$

$$I_{avg} = \frac{Total\ are\ under\ the\ curve\ for\ time\ period\ T}{TimePeriod(T)}$$

$$= \frac{i_1+i_2+i_3+...+i_n}{n}$$

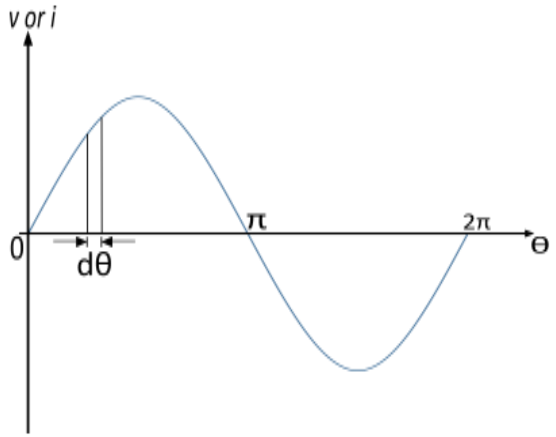
Average Value



Average Value

Derivation – The average value of AC can be obtained by integrating the instantaneous values of current or voltage over the half cycle i.e. area of the curve over half cycle and dividing the result by base length of half cycle.

$$\text{Average value} = \frac{\text{Area over half cycle}}{\text{base length of half cycle}}$$



Average Value

The equation of a sinusoidal varying voltage is given by

u=Vm sinθ

Let us take a strip of thickness dθ in the positive half cycle of the wave. Consider v be the average height of the strip. Hence,

Area of Strip =u dθ

Area of half cycle $= {}_0^{\pi}\int u \sin\theta d\theta$

$= Vm\,[-\cos\theta]_0^{\pi} = 2Vm$

Averagevalue(Vavg) $= \frac{\text{Area of halfcycle}}{\text{Baselengthofhalfcycle}}$

$= 2Vm / \pi = 0.637Vm$

Similarly, for Sinusoidal alternating current,

Averagevalue(Iavg)=Area of half cycle / Base length of half cycle =2Im / π =0.637Im

Therefore, the average value of sinusoidal alternating current or voltage is equal to 0.637 times of the maximum or peak value.