



Al-Mamon University College  
Electrical Power Techniques Engineering Department  
2<sup>nd</sup> Stage



# *Analysis Electrical Circuits*

## *تحليل الدوائر الكهربائية*

### *Alternating Current (AC) Circuit*

BY

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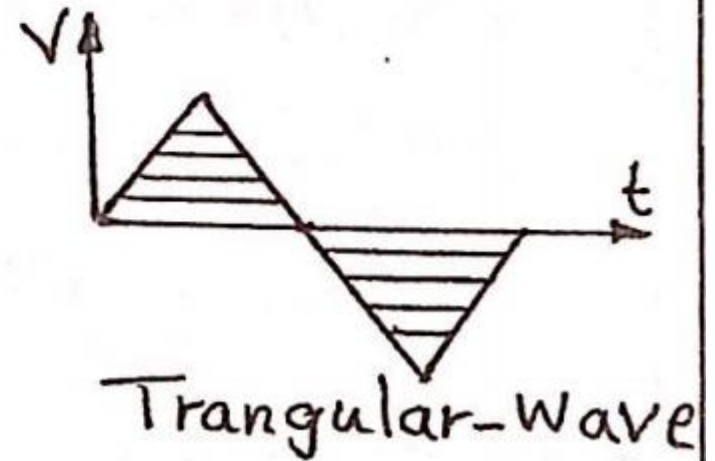
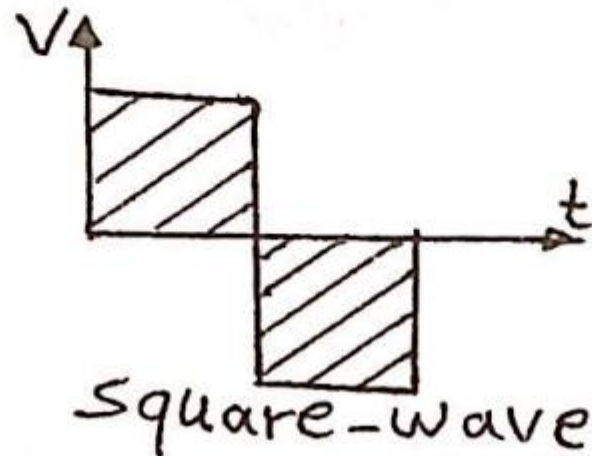
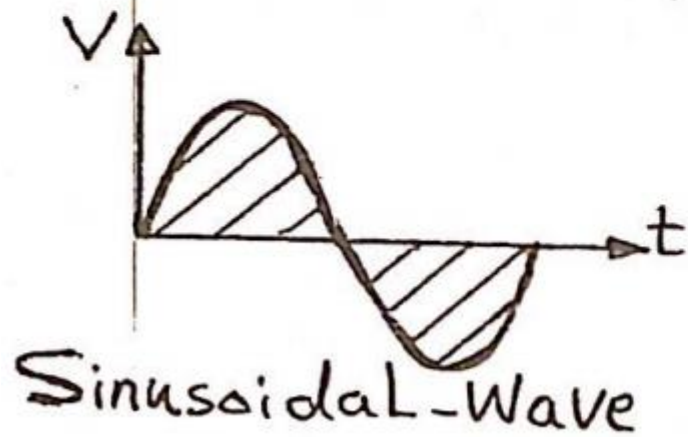
*2020-2021*



# Alternating Current (AC) Circuit

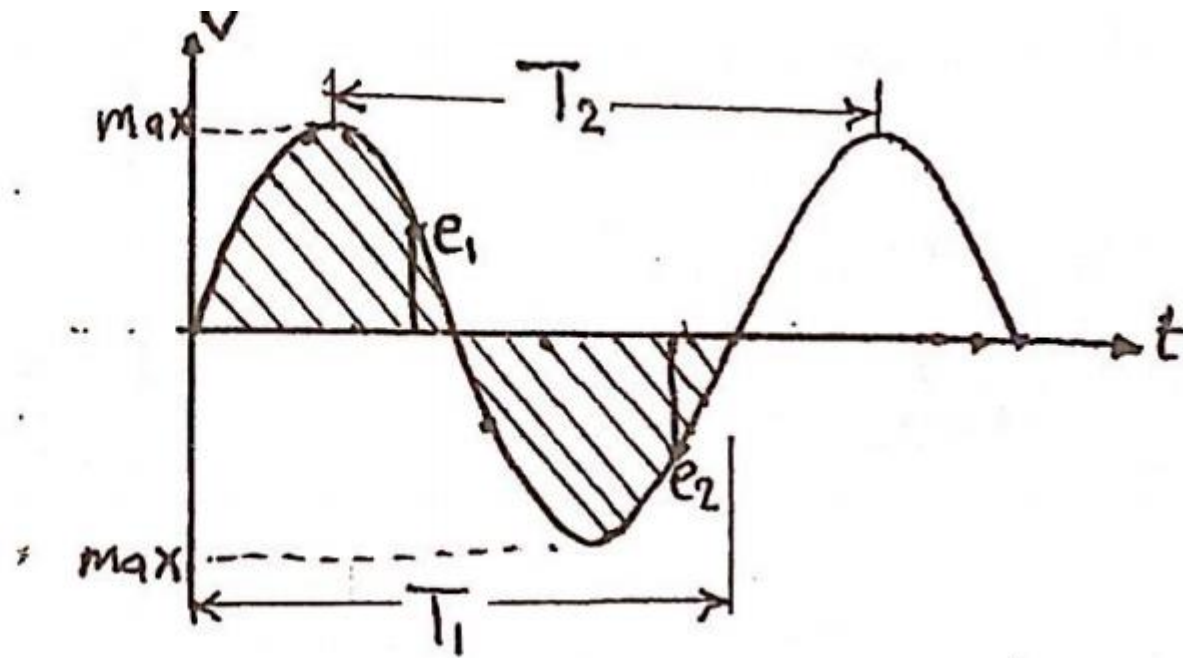
## Alternating Current (A-C) Circuits

The analysis of networks in which the magnitude of the source of e.m.f varies in a set manner



The term *alternating* indicates only that the wave-form alternates between two prescribed Levels, the term *Sinusoidal*, *square*, *triangular* must also be applied. The pattern of particular interest is the *Sinusoidal a-c Voltage*.

## Definitions:





\*\* Wave form : The path traced by a quantity, such as the e.m.f in fig - above. plotted as a function of some variable such as time (above), degree, radian, and so on.

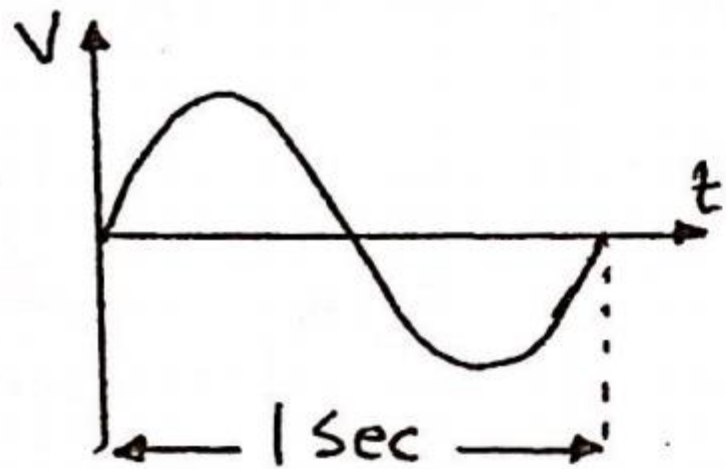
\*\* Instantaneous Value : The magnitude of a wave form at any instant of time, denoted by Lower - case letters ( $e_1$  &  $e_2$ )

\*\* Amplitude or peak Value : The maximum value of a wave form, denoted by Upper - case letters (max).

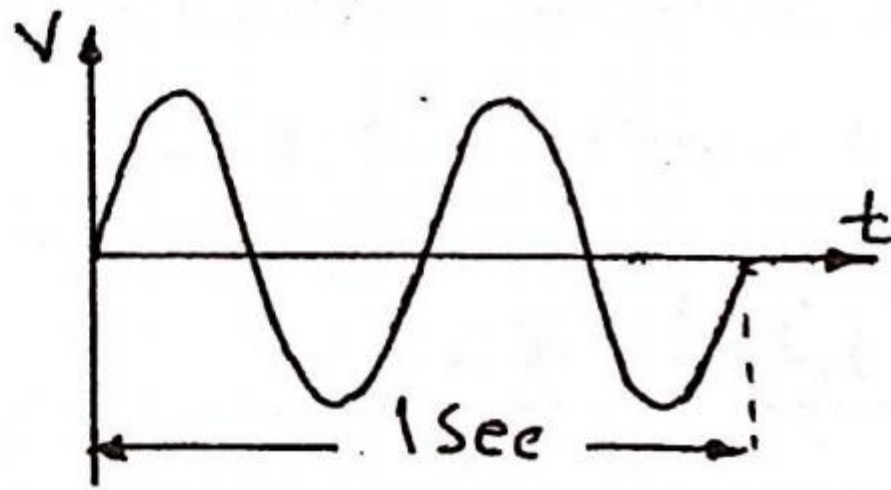
\*\* periodic waveform : A waveform that continually repeats itself after the same time interval.

\*\* period (T) : The time interval between two successive repetitions of a periodic waveform ( $T_1 = T_2$ ).

\*\* Frequency : The number of cycles that occur in 1 sec.  
The unit of frequency is cycle/sec (CPS) or Hertz (Hz)



$$\left. \begin{array}{l} f = 1 \text{ cps} \\ = 1 \text{ Hz} \end{array} \right\} T = 1 \text{ sec}$$



$$\left. \begin{array}{l} f = 2 \text{ cps} \\ = 2 \text{ Hz} \end{array} \right\} T = \frac{1}{2} \text{ sec.}$$

Since the frequency is inversely proportional to the period, the two can be related by the following equation

$$f = \frac{1}{T}$$



# The Sine Wave

The basic mathematical format for sinusoidal wave form is  $(A \sin \alpha)$ .

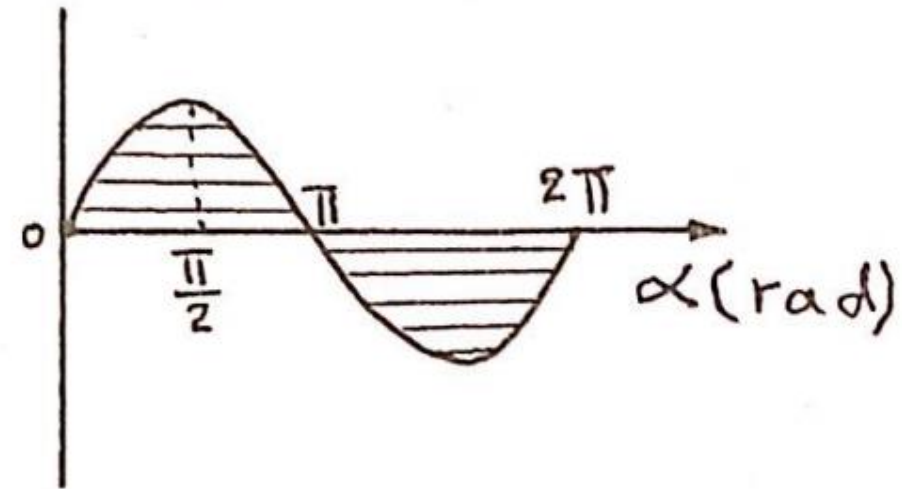
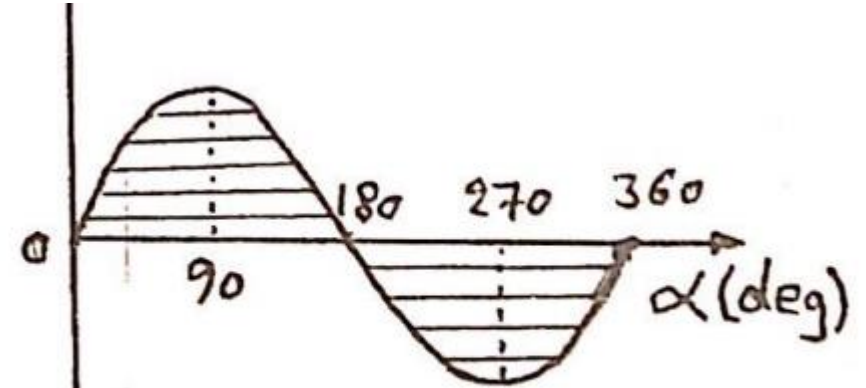
Where:  $A$  is the max. or peak value.

$\alpha$  is the unit of measurement of horizontal axis, it may be in degree or radian.

$$2\pi \text{ (rad)} = 360 \text{ (Deg)}.$$

OR

$$\text{Rad} = \frac{\pi}{180} \text{ Deg}.$$

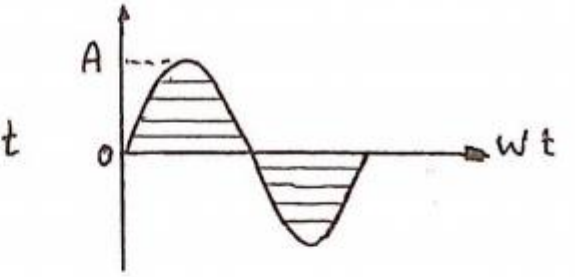


# Phase relations

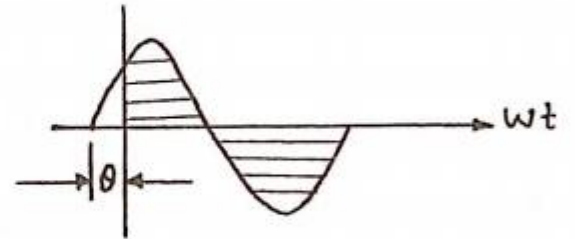
If the wave form is shifted to the right or left of zero, the expression becomes:

$$A \sin(\omega t \pm \theta).$$

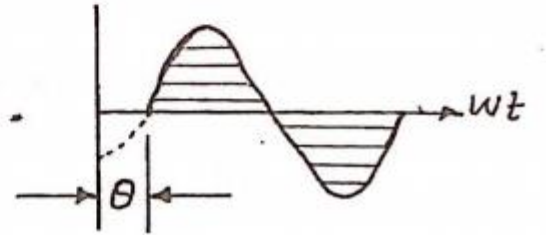
$$A \sin \omega t$$



$$A \sin(\omega t + \theta)$$

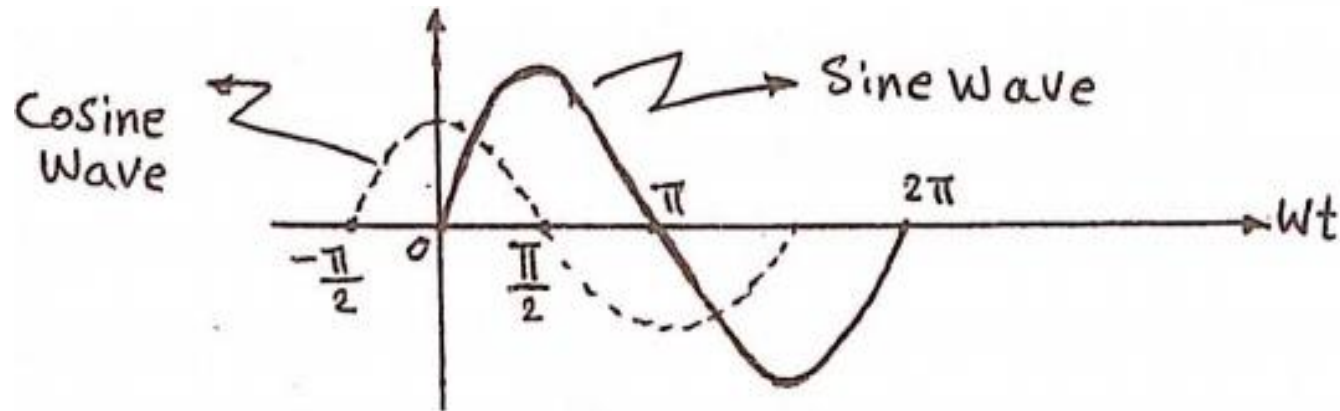


$$A \sin(\omega t - \theta)$$



The cosine wave is said to **lead** the sine wave by  $90^\circ$ , and the sine wave is said to **lag** the cosine wave by  $90^\circ$ .

Note:- Lead and Lag indicate the relationship between two sine wave of same frequency.



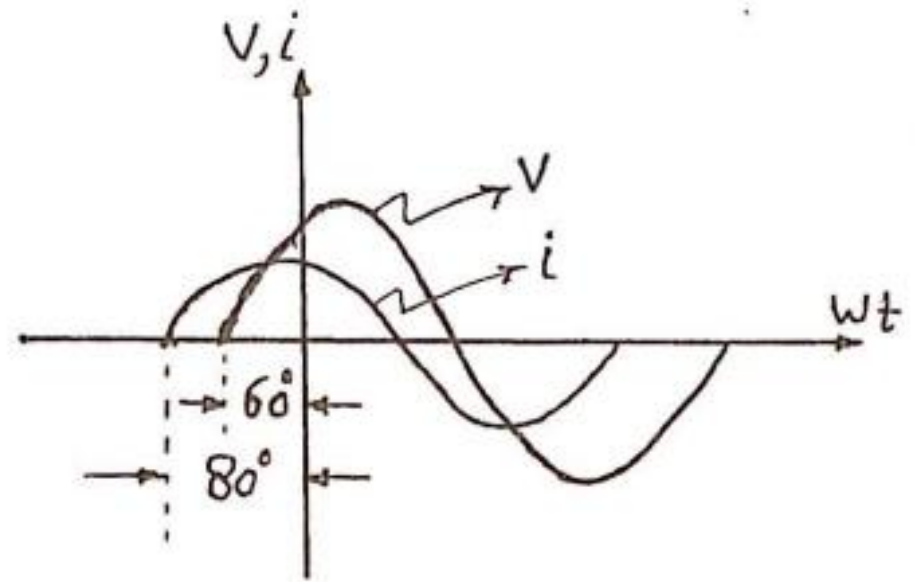


Ex: What is the phase relationship between  $V$  &  $i$ .

$$V = 10 \sin(\omega t + 60^\circ).$$

$$i = 5 \sin(\omega t + 80^\circ).$$

$\therefore i$  Lead  $V$  by  $20^\circ$ .  
or  $V$  Lags  $i$  by  $20^\circ$ .



Ex: Find the phase relation between  $V$  &  $i$ .

$$i = -2 \sin(\omega t + 20^\circ).$$

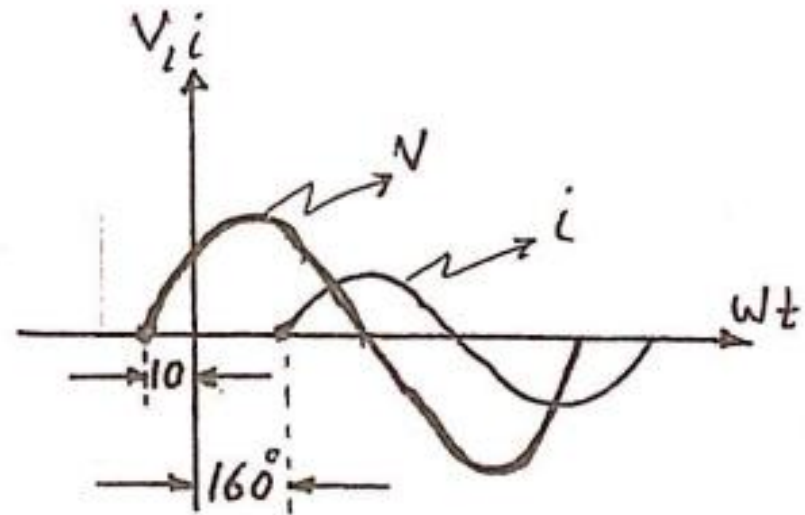
$$V = 5 \sin(\omega t + 10^\circ).$$

$$i = -2 \sin(\omega t + 20^\circ).$$

$$= 2 \sin(\omega t + 20^\circ - 180^\circ)$$

$$= 2 \sin(\omega t - 160^\circ).$$

$\therefore V$  leads  $i$  by  $170^\circ$   
or  $i$  lags  $V$  by  $170^\circ$ .



# Phasors

phasors:- A rotating radius vector having a constant magnitude (Length) with one end fixed at origin, during its rotation it produces the Sine wave, for example we can express the instantaneous value of current ( $i$ ).

$$W = \text{Angular Velocity} = \frac{\text{Distance (Deg or Rad)}}{\text{Time}}$$

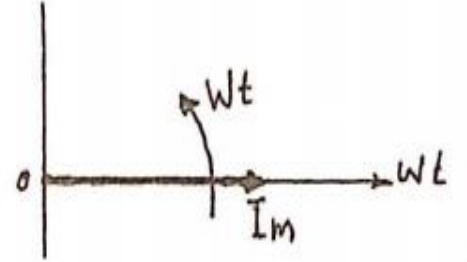
$$= \frac{\alpha}{t} = \frac{2\pi}{T}$$

$\therefore$

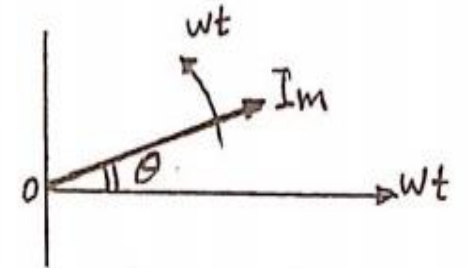
$$W = 2\pi f$$

(rad/sec).

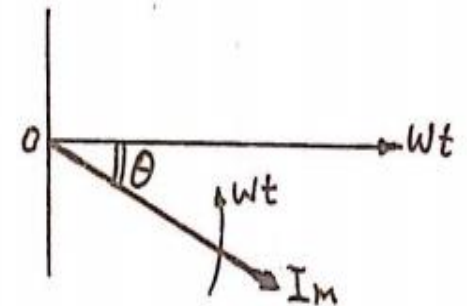
$$i = I_m \sin \omega t$$



$$i = I_m \sin(\omega t + \theta)$$



$$i = I_m \sin(\omega t - \theta)$$





*Thank You*

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