Alternating Circuit
Lecture 6

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Definition of Alternating Current:

Alternating current is an electric current which periodically reverses direction and changes its magnitude continuously with time in contrast to direct current which flows only in one direction. The usual waveform of alternating current in most electric power circuit is a sine wave whose positive half period corresponds with positive direction of the current and vice versa. These current typically alternate at higher frequency than those used in power transmission.

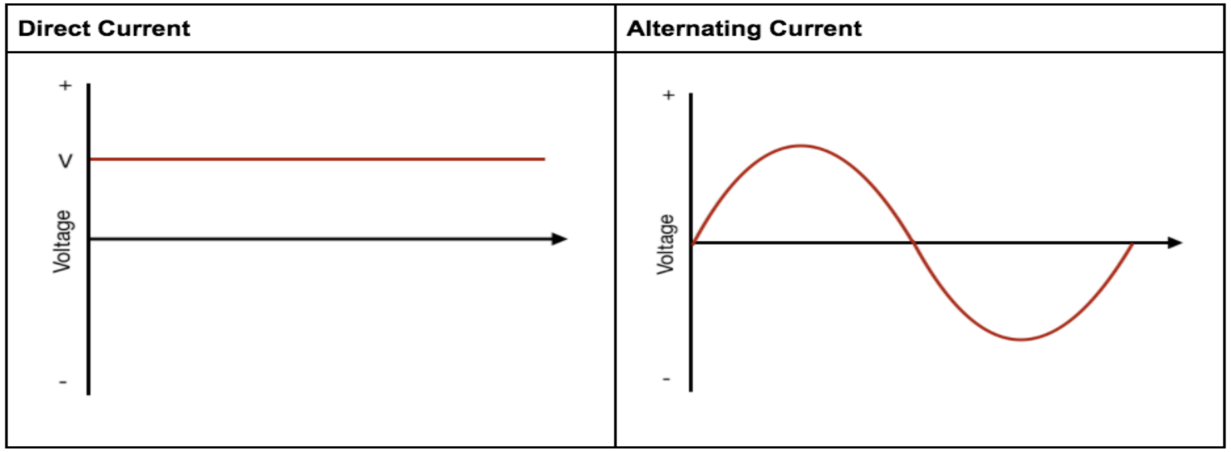

Fig 1

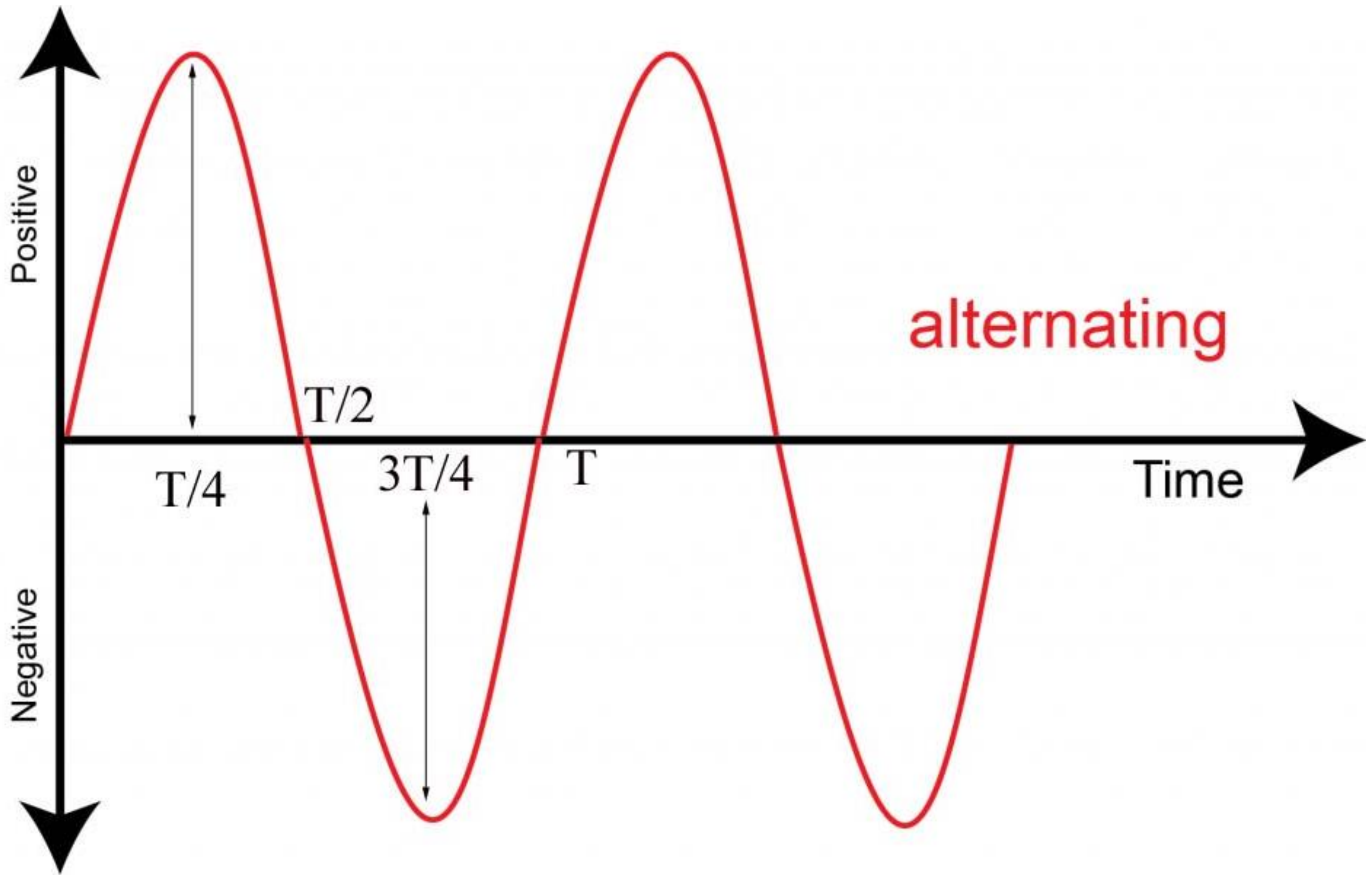

Fig 2

The alternating voltage is generate in two ways

1)By rotating the coil inside the uniform magnetic field at constant speed.

2)By rotating the magnetic field around the stationary coil at the constant speed.

Now considering a stationary coil places inside the uniform magnetic field. The load is connected across the coil with the help of brushes and slip rings. When the coil rotates in the anti clockwise direction at constant angular velocity (ω) the electromotive force induces in the coil. Let number of turns of the coil is N cross sectional area A in the uniform magnetic field B the induced emf at any instant t is given by

$$e = \frac{d\varphi}{dt} = -\frac{d}{dt}(BNAcos\omega t) = BNA\omega sin\omega t \rightarrow (i)$$

When $\omega t = 0, sin\omega t = 0 \; and \; e = 0$

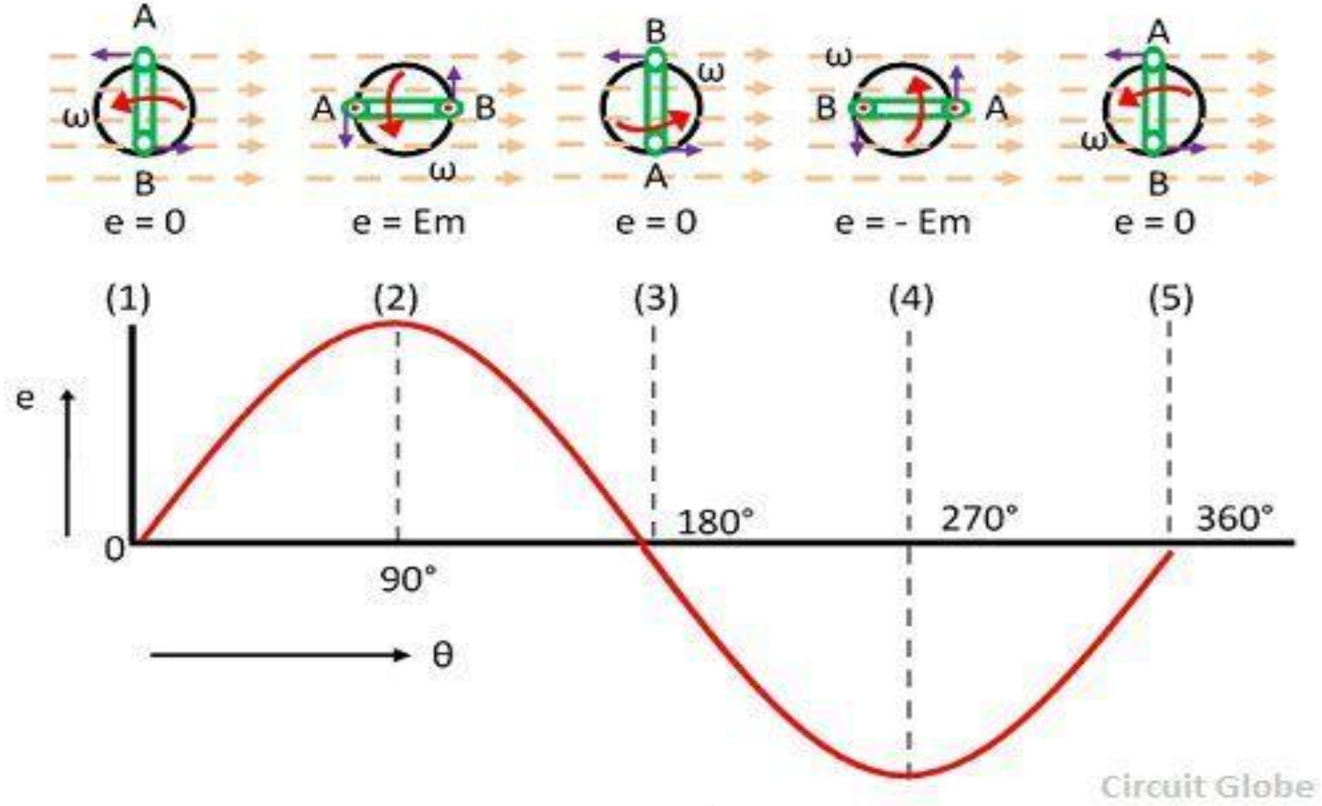

Fig 3

$$\omega t = \frac{\pi}{2}, sin\omega t = 1\ and\ e = BNA\omega$$

$$\omega t = \pi, sin\omega t = 0\ and\ e = 0$$

$$\omega t = \frac{3\pi}{2}, sin\omega t = -1\ and\ e = -BNA\omega$$

$$\omega t = 2\pi, sin\omega t = 0\ and\ e = 0$$

The magnitude of the induced emf becomes maximum when the conductor becomes perpendicular to the magnetic lines of force. The conductor cuts the maximum flux at this point. The direction of the emf induces in the conductor is determined by Fleming's Right Hand Rule.

Then equation (i) can be written as

$$e = e_m sin\omega t \rightarrow (ii)$$

Here $e_m = BNA\omega$ and $i_m = \frac{e_m}{R}$

Similarly

$$i = i_m sin\omega t \rightarrow (iii)$$

It represents a sinusoidal alternating emf at an instant t. This will develop an instantaneous voltage v is given by

$$v = v_m sin\omega t \rightarrow (iv)$$

The time of one cycle is known as time period T. The number of cycle per second is the frequency f where $f = \frac{1}{T}$