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AC waveform is represented by:

A(t) = Amax \* sin(2\*pi\*f\*t)

Average value of an AC Waveform:

Average Voltage = (V1+V2+V3+V4+...+Vn) / n

For pure sinusoidal waveform this average or mean value will always be equal to 0.637 \* Maximum Voltage. This is also true and same for Average Current.

RMS Value of an AC Waveform:

RMS Voltage = Sqrt [(V1^ 2+V2^ 2+ V3^ 2+ V4^ 2+...+ Vn^ 2) / n]

For pure sinusoidal waveform this effective or RMS value will always be equal to [1/ Sqrt (2)] \* Maximum Voltage, i.e., equal to 0.707 \* Maximum Voltage. This is also true and same for RMS Current.

Form Factor = RMS value / Average value

in pure voltage, form factor is (0.707 \* Vmax) / (0.637 \* Vmax) = 0.707/0.637 = 1.11.

Crest Factor = Peak value / RMS value

in pure voltage, crest factor is Vmax / 0.707 \* Vmax = 1 / 0.707 = 1.414.

AC power is generated by rotation of coil inside the magnetic field. This is the reason why AC waveform is sinusoidal in nature, and it is time dependent.

The amount of EMF induced into a coil cutting the magnetic lines of force is determined by the following three factors.

> Speed: The speed at which the coil rotates inside the magnetic field.

> Strength: The strength of the magnetic field.

> Length: The length of the coil or conductor passing through the magnetic field.

Increasing the speed of rotation of the coil, the frequency will also be increased. Therefore, frequency is proportional to the speed of rotation. (i.e., f ∝ N) N is R.P.M.

Increasing the pair of poles, the frequency will also be increased. Therefore, frequency is proportional to the pair of poles. (i.e., f ∝ P) P is number of pair of poles.

Concluding from above two statements. Frequency is equal to Rotation speed times Number of pair of poles. (i.e., f = N \* P)

Frequency is measured in Hertz. Therefore, Frequency (f) = (NP / 60) Hz. Where N is the speed of rotation in R.P.M and P is the number of pairs of poles and 60 converts it into seconds.

Instantaneous Value of waveform:

Vi = Vmax \* sin (θ), Where θ = ω\*t, is the rotational angle of the coil with respect to time.

Radian and Degree:

2π rads = 360 degrees. Therefore, 1 rads = 57.3 degree.

1 rads = (360 / 2π) degrees.

Relationship between Degrees and Radians:

Radians = (π / 180) \* Degrees

Degrees = (180 / π) \* Radians

Angular Velocity of sinusoidal waveforms:

ω = 2πf (rad / sec).

In countries where standard frequency is 50 Hz, the angular velocity is 314.2 rad / s and in countries where the standard frequency is 60 Hz, the angular velocity is 377 rad / s.

Since, frequency (f) = 1 / T. Therefore, Angular velocity can also be written as ω = 2π / T (rad / sec).

Phase Difference and Phase Shift:

Phase difference is used to describe the difference in degree or radian when two or more alternating quantities reach their maximum or zero values.

Phasors are an effective way of analysing the behaviour of elements within an AC circuit when the circuit frequencies are the same. The result of adding together two phasors depends on their relative phase, whether they are “in-phase” or “out-of-phase” due to some phase difference.

The difference or phase shift is represented in angle Φ (phi), in degrees or radian that the waveform has shifted from a certain reference point along the horizontal zero axis.

The difference between phases, of an alternating waveform during one complete cycle and this can be anywhere along the horizontal axis between, Φ = 0 to 2π (radian) or Φ = 0 to 360⁰, depending upon the angular units used.

Phase difference equation:

Where:

* – is the amplitude of the waveform.
* – is the angular frequency of the waveform in rad/sec.
* Φ – is the phase angle in degree or radian that the waveform has shifted either left or right from the reference point.

Phase Relationship of a Sinusoidal Waveform:

When the phase angle (Φ) is greater than 0 (i.e., Φ > 0⁰), then that phase is in Lead. In graph, the waveform appears earlier in time than 0 producing an anticlockwise rotation of the vector.

Positive phase will produce an equation:

When the phase angle (Φ) is lesser than 0 (i.e., Φ < 0⁰), then that phase is in Lag. In graph, the waveform appears later in time than 0⁰ producing a clockwise rotation of the vector.

Negative phase will produce an equation:

When the phase angle (Φ) is equal to 0 (i.e., Φ = 0⁰), then that phase is in called In-Phase. In graph, the waveform appears at time in 0⁰ producing no rotation of the vector.

In-Phase will produce an equation: