Alternating current fundamentals:

Principle of generation of alternating voltages and currents

The generation of alternating voltage and current is based on the principle of electromagnetic induction, discovered by Michael Faraday. When a conductor moves through a magnetic field, or when the magnetic field surrounding a stationary conductor varies, an electromotive force (EMF) is induced in the conductor. In practical systems, this is achieved using rotating machines like alternators. In an alternator, a coil of wire rotates in a magnetic field, creating a time-varying flux linkage. The induced EMF is sinusoidal because the flux linkage changes sinusoidally with time as the coil rotates through the magnetic field. This sinusoidal nature of EMF is foundational to alternating current systems, as it allows for efficient transmission and transformation of electrical energy.

Equations and waveforms of alternating Voltage and current

Alternating voltage and current vary periodically with time, described mathematically by sinusoidal functions. For instance, an alternating voltage can be expressed as $v(t)=Vm\ \sin(\omega t+\phi)$ where Vm is the maximum or peak voltage, ω is the angular frequency,t is time, and ϕ is the phase angle. The waveform of alternating voltage or current is typically represented as a sine wave, which alternates between positive and negative values, completing a full cycle in one period. These waveforms are fundamental to understanding AC systems, as they define how voltage and current behave over time.

Average, Peak and RMS values

In AC systems, the average value, peak value, and root mean square (RMS) value are essential metrics for analyzing and describing alternating voltages and currents. The peak value is the maximum magnitude of the waveform, representing the highest voltage or current attained during a cycle. The average value of a sine wave over one complete cycle is zero, but over a half-cycle, it represents the mean of the absolute values of the waveform. The RMS value is particularly important in AC systems as it provides a measure of the effective or equivalent DC value of an alternating quantity. It is calculated as the square root of the average of the squares of instantaneous values over one cycle and is widely used in practical applications to quantify power.

Three phase system

A three-phase system is a method of generating, transmitting, and distributing electrical power using three alternating voltages or currents that are phase-shifted by 120 degrees from each other. This system is highly efficient and widely used in industrial and power applications. In a balanced three-phase system, the sum of instantaneous voltages or currents is always zero, eliminating the need for a neutral conductor in transmission. Three-phase systems can be connected in either a star (Y) or delta (Δ) configuration, each with distinct characteristics and applications. The star connection allows for the provision of a neutral point, making it suitable for systems requiring multiple voltage levels. The delta connection, on the other hand, is often used in transmission and distribution due to its higher efficiency in power transfer.