SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

Approved by AICTE & Affiliated to Anna University Accredited by NBA & Accredited by NAAC with 'A++' Grade, Recognized by UGC saravanampatti (post), Coimbatore-641035.

Department of Biomedical Engineering

Course Name: 23EET103- ELECTRIC

CIRCUITS & ELECTRON DEVICES

II Year : IV Semester

Unit 1:AC CIRCUITS

Topic :AC Waveform

AC Circuits

- **AC CIRCUITS**

AC Waveform

•The flow of electricity can be done in two ways like AC (alternating current) and DC (direct current).

•Electricity can be defined as the flow of electrons throughout a conductor such as a wire.

•The main disparity among AC & DC mainly lies within the direction where the electrons supplies.

•In direct current, the flow of electrons will be in a single direction & in the alternating current;

the flow of electrons will change their directions like going forward & then going backward.

AC Waveform

•Why we use A.C. in homes

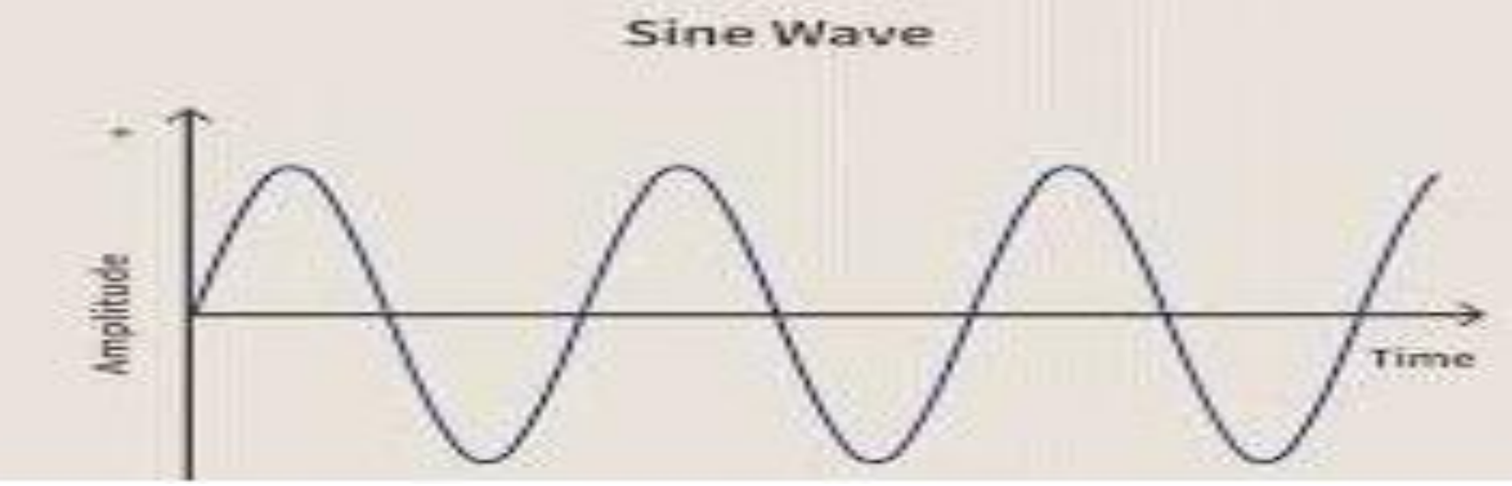
•• AC voltage is capable of converting voltage levels just with use of transformers.

•– To transmit AC over a long distance, voltage is stepped up to 400 KV at generating stations and stepped down at a low level , 400/230 V for household and commercial utilization.

•– AC motors are simple in construction, more efficient and robust as compared to DC motors.

AC Waveform

•Alternating quantity that varies according to sin of angle



•The instantaneous value of a sine-wave voltage for any angle of rotation is expressed in the formula:

•V= Vm sint   is the angle

•Vm = the maximum voltage value

•V = the instantaneous value of voltage at angle

Peak and RMS Values

- The magnitude of alternating quatity can be expressed in three ways:

- 1 Peak Value
- 2 Average Value
- 3 Effective or rms value

- **Peak Value:**
- The maximum value attained by an alternating quantity during oone cycle is called peak value. This is also called maximum value or amplitude. The peak of an alternating voltage or current is represented by Vm and Im

Average Value

• **Average Value:**

• The average value of a periodic waveform whether it is a sine wave, square wave or triangular waveform is defined as: “the quotient of the area under the waveform with respect to time”. In other words, the averaging of all the instantaneous values along time axis with time being one full period, (T).

• For symmetrical waves like sinusoidal current or voltage waveform, the positive half cycle will be exactly equal to 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

Effective or RMS Value:

- **Effective or RMS Value**:

- "RMS" stands for "Root-Mean-Squared", also called the effective or heating value of alternating current, which would provide the same amount of heat generation in a resistor as the AC voltage would if applied to that same resistor.

- That steady current which, when flows through a resistor of known resistance for a given period of time than as a result the same quantity of heat is produced by the alternating current when flows through the same resistor for the same period of time is called R.M.S or effective value of the alternating current.

- In other words, the R.M.S value is defined as the square root of means of squares of instantaneous values.
- Let I be the alternating current flowing through a resistor R for time t seconds, which produces the same amount of heat as produced by the direct current (Ieft).

Differentiate between rms value and average value.

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Form Factor and Peak Factor

Form Factor and Peak Factor

- Form Factor is defined as the ratio of the root mean square value to the average value of an alternating quantity (current or voltage).

- Form Factor = $Irms$ /$Iavg$ = 1.11

- Peak Factor is defined as the ratio of maximum value to the R.M.S value of an alternating quantity. The alternating quantities can be voltage or current.

- Peak Factor =$Imax$/ $Irms$ = 1.4142

Phasor Representation of alternating quantity

An alternating quantity can be represented in the form of wave and equation.

The waveform gives the graphical representation whereas equation represents the mathematical expression of the instantaneous value of an alternating quantity.

The same alternating quantity can be represented by a line of definite length (representing the maximum value) rotating in counterclockwise direction at a constant velocity (w rad/sec)

Alternating Current (AC) is a type of electric current that reverses its direction periodically in contrast to the Direct Current (DC) which flows in a single direction.

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II Year : IV Semester

Unit 1:AC CIRCUITS

Topic :Introduction to Single Phase Circuits

Introduction to Single Phase Circuits

Composed of one alternating voltage source and load.

Common in residential and small commercial applications.

Waveforms in AC Circuits

1. AC signals vary with time, often represented as sine waves.
2. A complete oscillation of the waveform is called a cycle.
3. The horizontal axis represents time, and the vertical axis represents voltage or current. Sinusoidal wave is the most common AC waveform.
4. Other waveforms include square, triangular, and saw tooth waves.
5. Positive and negative half-cycles alternate in each period.

6. Amplitude indicates the maximum value of voltage or current.
7. Zero crossings occur when the waveform passes through the horizontal axis.
8. Phase shift describes the displacement of one waveform relative to another.
9. AC waveforms are repetitive, with identical patterns in each cycle.

Period and Frequency

1. **Period (T):** Time taken for one complete cycle.
2. Measured in seconds (s) or milliseconds (ms).
3. **Frequency (f):** Number of cycles per second.
4. Measured in Hertz (Hz).
5. Relationship: f=1Tf = \frac{1}{T}f=T1
6. Higher frequency means faster oscillations.
7. Common frequencies: 50 Hz (Europe) and 60 Hz (North America).
8. Period and frequency are inversely proportional.
9. Determines how fast the AC voltage changes polarity.
10. Used to calculate inductive and capacitive reactance.

Peak Value

1. Maximum amplitude of the waveform.
2. Denoted as Vmax V_{max}Vmax or Imax I_{max}Imax.
3. Occurs once in each positive and negative half-cycle.
4. Determines the highest voltage or current reached.
5. Important for insulation ratings and safety. Directly related to RMS and average values.
6. Peak-to-peak value is double the peak value.
7. Used in calculating instantaneous power.
8. Affects voltage stress in components.
9. Helps size components like capacitors and inductors.

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RMS Value

1. RMS stands for **Root Mean Square**.
2. Represents the equivalent DC value that produces the same power.
3. Formula for sinusoidal wave: Vrms=Vmax2V_{rms} = \frac{V_{max}}{\sqrt{2}}Vrms=2Vmax.
4. Indicates effective heating effect in resistive loads.
5. More useful in power calculations than peak value.
6. Power formula: P=Vrms× Irms×cosθ P = V_{rms} \times I_{rms} P=Vrms×Irms×cosθ.
7. Used in ratings for appliances and electrical systems.
8. Helps in designing fuses and circuit breakers.
9. RMS value for current follows the same formula as voltage.
10. Ensures accurate measurement of AC signals.

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Inductive Elements in AC Circuits

Inductors oppose changes in current flow. Inductance is measured in **Henrys (H)**.
Voltage across an inductor
Inductive reactance: XL=2πfLX_L = 2\pi f LXL=2πfL.
Current lags voltage by 90° in a purely inductive circuit.
Stores energy in a magnetic field.
Increases impedance with higher frequency.
Causes phase shift between voltage and current.
Used in transformers and motors. Filters high-frequency signals in circuits..

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Unit 1:AC CIRCUITS

Topic :Types of Powers

Types of power

1. Real power:
2. Reactive power:
3. Apparent power:

Types of power

Real power:

The power which is actually consumed or utilized in ac circuit is called true power or active power or real power. It is consumed by the resistive load in the circuit. The unit of real power is watts.

Real power = $VI \cos \phi$ Watts

Types of power

Reactive power:

The power which flows back and forth that means it moves in both the directions in the circuit or reacts upon itself, is called Reactive Power. A pure inductor and a pure capacitor do not consume any power since in a half cycle whatever power is received from the source by these components, the same power is returned to the source. This power which returns and flows in both the direction in the circuit, is called Reactive power.

This reactive power does not perform any useful work in the circuit. It is measured in a unit called Volt-AmpsReactive (VAR), rather than watts.

Types of power

- **Apparent power:**

The product of root mean square (RMS) value of voltage and current is known as Apparent Power. This power is measured in kVA or MVA.

In a purely resistive circuit, the current is in phase with the applied voltage, whereas in a purely inductive and capacitive circuit the current is 90 degrees out of phase, i.e., if the inductive load is connected in the circuit the current lags voltage by 90 degrees and if the capacitive load is connected the current leads the voltage by 90 degrees.

Hence, from all the above discussion, it is concluded that the current in phase with the voltage produces true or active power, whereas, the current 90 degrees out of phase with the voltage contributes to reactive power in the circuit. Therefore, True power = voltage x current in phase with the voltage Reactive power = voltage x current out of phase with the voltage

Three phase circuits

- **Three-phase balanced circuits, voltage and current relations in star and delta connections.**

- Poly-phase system: An ac system having a group of (two or more than two) equal voltages of same frequency arranged to have equal phase difference between them is called a poly-phase system.

Generation of three phase circuits

•Generation of 3 Phase E.M.Fs in a 3 Phase Circuit In a 3 phase system, there are three equal voltages or EMFs of the same frequency having a phase difference of 120 degrees.

•These voltages can be produced by a three-phase AC generator having three identical windings displaced apart from each other by 120 degrees electrical.

•When these windings are kept stationary, and the magnetic field is rotated as shown in the figure A below or when the windings are kept stationary, and the magnetic field is rotated as shown below in figure B, an emf is induced in each winding.

•The magnitude and frequency of these EMFs are same but are displaced apart from one another by an angle of 120 degrees.

Three phase system

- **Advantage of three –phase system over single phase system.**

- 1. Power delivered is constant. In single phase circuit the power delivered is pulsating and objectionable for many applications.
- 2. For a given frame size a poly-phase machine gives a higher output than a single phase machine.
- 3. Poly-phase induction motors are self starting and are more efficient. Single phase motor has no starting torque and requires an auxiliary means for starting.
- 4. Comparing with single phase motor, three phase induction motor has higher power factor and efficiency.
- 5. Three phase motors are very robust, relatively cheap, and generally smaller, have selfstarting properties, provide a steadier output and require little maintenance compared with single phase motors.
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