



Al-Mustaqbal University / College of Engineering & Technology
Department Computer of engineering techniques

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Class (1)
Assist. Lect. Saja Mohsen Abood
AC circuit Theory

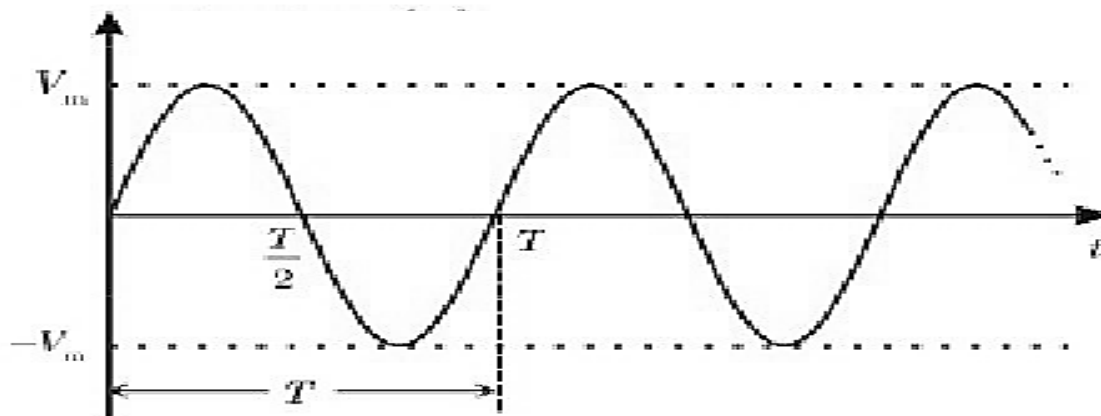
AC circuit Theory

Lecture (1)



1. Introduction to Alternating Current (AC) Circuits

Alternating Current (AC) is a type of electrical current in which the flow of electric charge periodically reverses direction. Unlike Direct Current (DC), which flows in a single, constant direction (like the current from a battery), AC changes its magnitude and polarity over time, usually following a mathematical pattern known as a sine wave ..as fig (1).



In a typical AC system, the voltage starts at zero, grows to a maximum positive peak, falls back to zero, reaches a maximum negative peak, and returns to zero again. This complete sequence is called **a cycle**. The number of these cycles occurring per second is defined as **the frequency**, measured in Hertz (Hz). For instance, in most parts of the world, the standard household frequency is either **50 Hz or 60 Hz**.



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2. Why AC is Dominant?

The primary reason **AC** is used for national power grids is **its ability to be efficiently transformed to different voltage levels**. Using transformers, voltage can be "stepped up" to very high levels for long-distance transmission to reduce energy loss, and then "stepped down" to safer levels (like 110V or 220V) for use in homes and businesses.

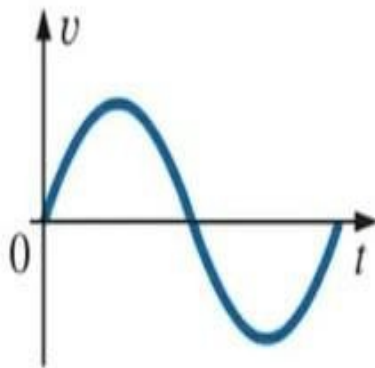
3. AC vs. DC Comparison Table

Feature	Alternating Current (AC)	Direct Current (DC)
Direction of Flow	Electric charge periodically reverses direction.	Flows in one constant direction only.
Frequency	Has a frequency (usually 50 Hz or 60 Hz).	Frequency is zero.
Waveform	Typically a Sine Wave (can be square or triangular).	A Straight Horizontal Line (constant).
Voltage Level	Can be easily stepped up or down using Transformers.	Difficult to change (requires complex electronic converters).
Energy Loss	Low loss over long distances (high-voltage transmission).	High loss over long distances (due to resistance).

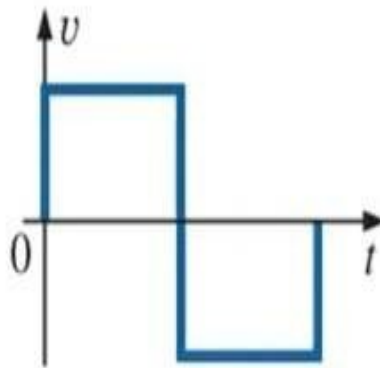


Feature	Alternating Current (AC)	Direct Current (DC)
Common Sources	AC Generators (Alternators), Power Plants, Wall Outlets.	Batteries, Solar Panels, DC Generators, Rectifiers.
Primary Use	Household appliances, industrial motors, power grids.	Electronics (phones, laptops), EVs, flashlights.

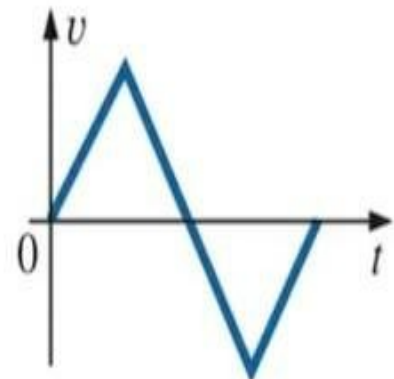
4. shapes of AC waveforms.



Sinusoidal



Square wave



Triangular wave

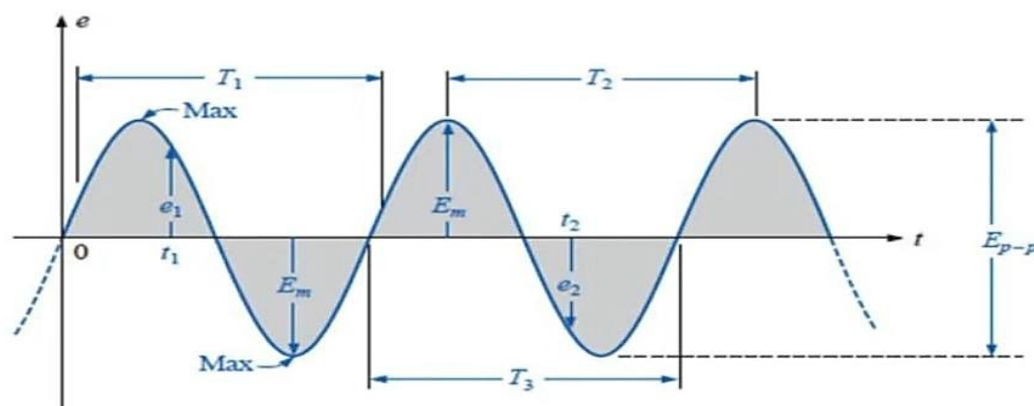


5. The relationship between time and frequency in Alternating Current (AC)

1. **Waveform**: The path traced by a quantity, such as the voltage plotted as a function of some variable such as time or position, degrees, radians, temperature, and so on.

2. **Instantaneous value**: The magnitude of a waveform at any instant of time;

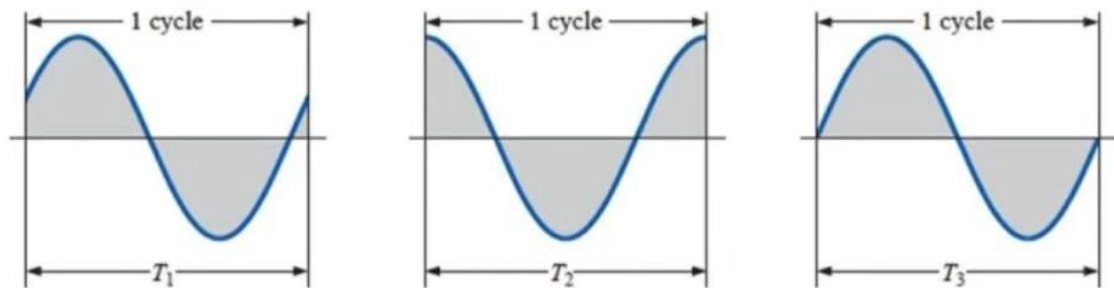
3- **Peak value**: The maximum value of a waveform as measured from its average, or mean, value, denoted by uppercase letters (such as E_m for sources of voltage and V_m for the voltage drop across a load). For the waveform as shown in figure, the average value is zero volts..





4. **Peak-to-peak value:** Denoted by E_{p-p} or V_{p-p} , it is the full voltage between positive and negative peaks of the waveform, that is, the sum of the magnitude of the positive and negative peaks.
5. **Periodic waveform:** A waveform that continually repeats itself after the same time interval.
6. **Period (T):** The time interval between repetitions of a periodic waveform
7. **Cycle:** The portion of a waveform contained in one period of time.
8. **Frequency (f):** The number of cycles that occur in 1 s. its unit is 1 cycle per second, or hertz (Hz).

1 hertz (Hz) = 1 cycle per second (c/s)





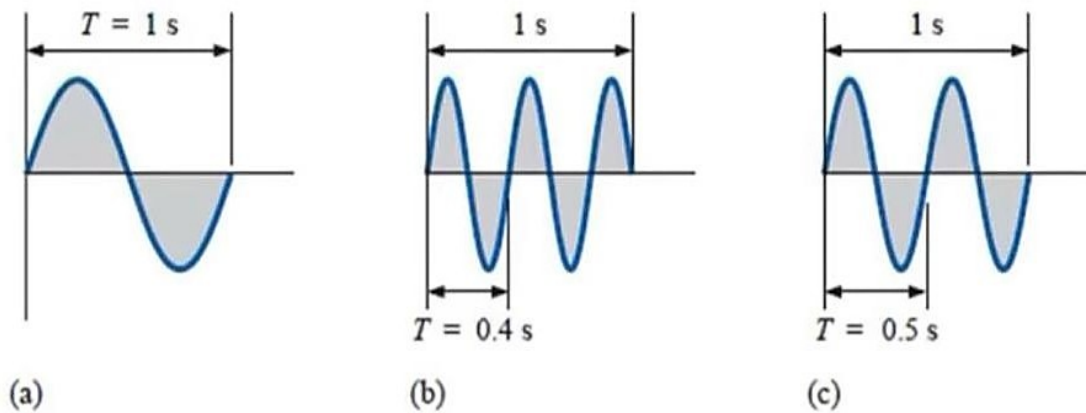
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T = time for one cycle

f = number of cycles per second

Relationship **$f = 1/T$**

Ex.1: for the following figures determine the frequency for each periodic waveform.





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Source (Reference)

1. Theraja, B. L., & Theraja, A. K. (2005). A Textbook of Electrical Technology: Volume II. S. Chand Publishing.
 2. Boylestad, R. L. (2015). Introductory Circuit Analysis. Pearson Education.
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