

## Department of Artificial Intelligence and Data Science

23EET103-Electric Circuits and Electron Devices.



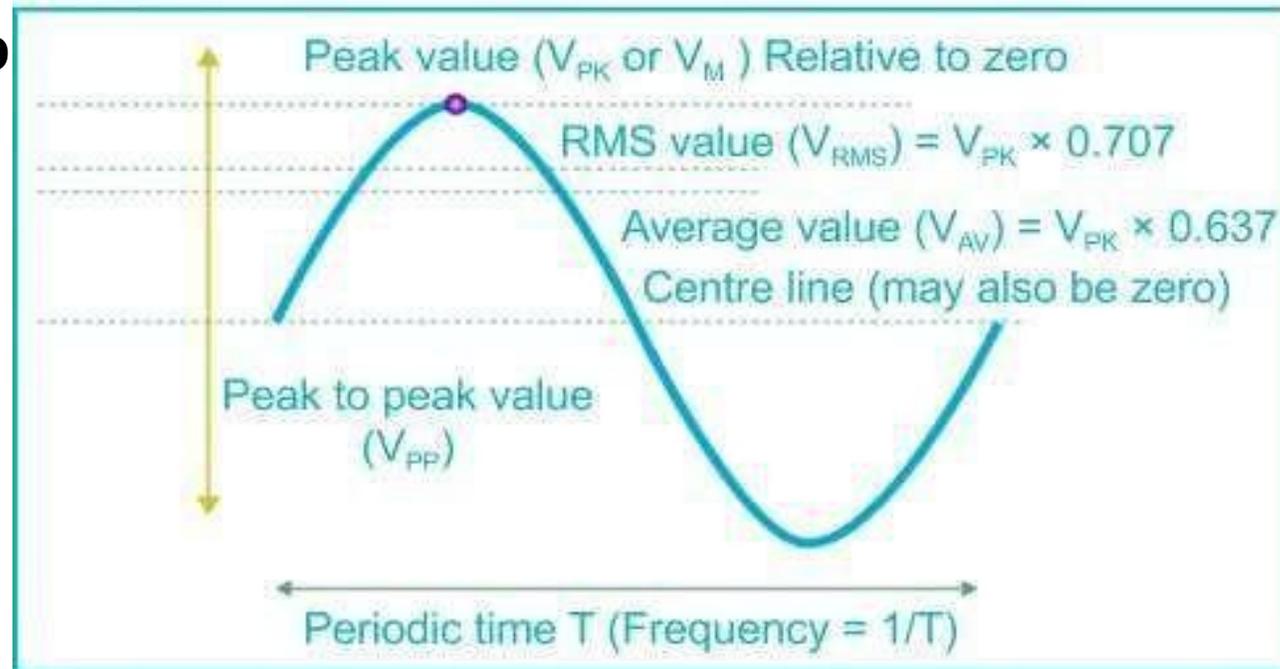
I B.TECH IT / I SEMESTER

## UNIT II : AC CIRCUITS

**Topic :RMS Value and Real Power**

# Let's Recall !!

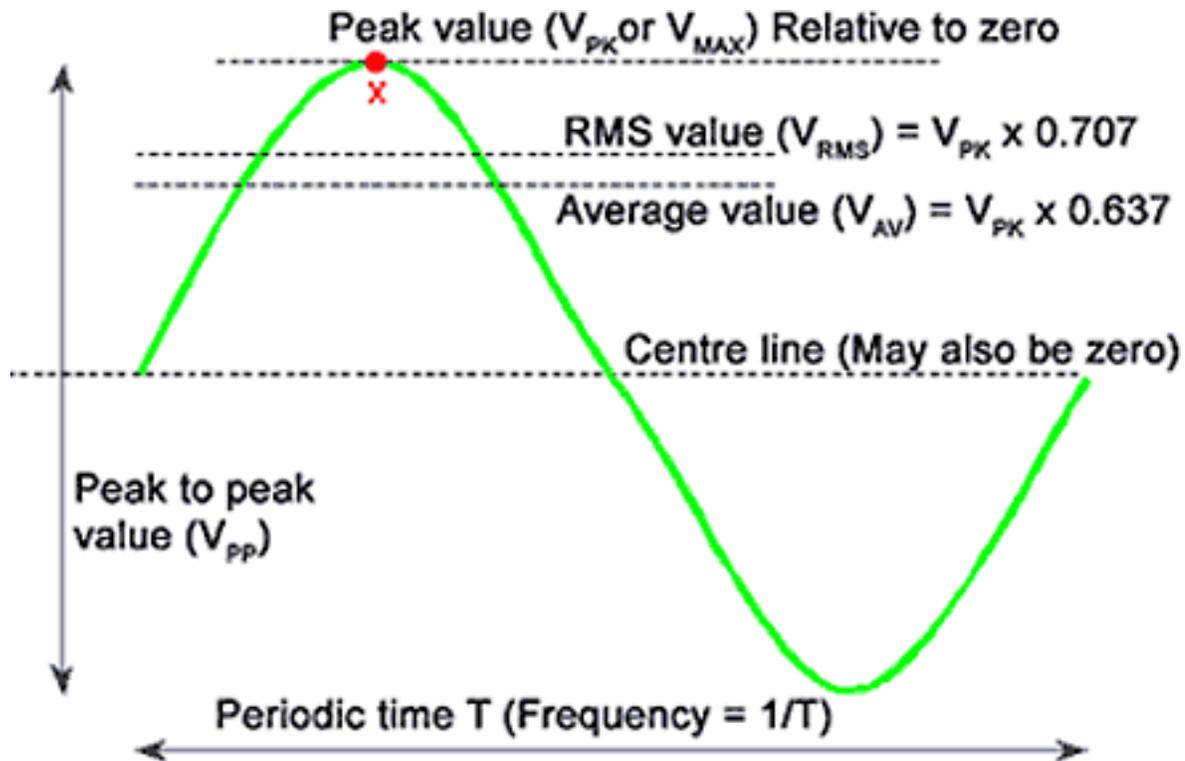
- ◆ What are AC and DC quantities?
- ◆ Difference between instantaneous, peak, average, and RMS values.
- ◆ What is electrical power in resistive, inductive, and capacitive circuits? [w testbook](#)
- ◆ Why AC power?



# Topics for discussion

- Concept of Alternating Quantities
- RMS Value – Definition and Derivation
- Average Value
- Relation between RMS, Average, and Peak Values
- Real Power – Definition and Formula
- Power Triangle
- Power Factor and Its Significance
- Applications and Example Problems
- Summary and References

# Lets explore !!



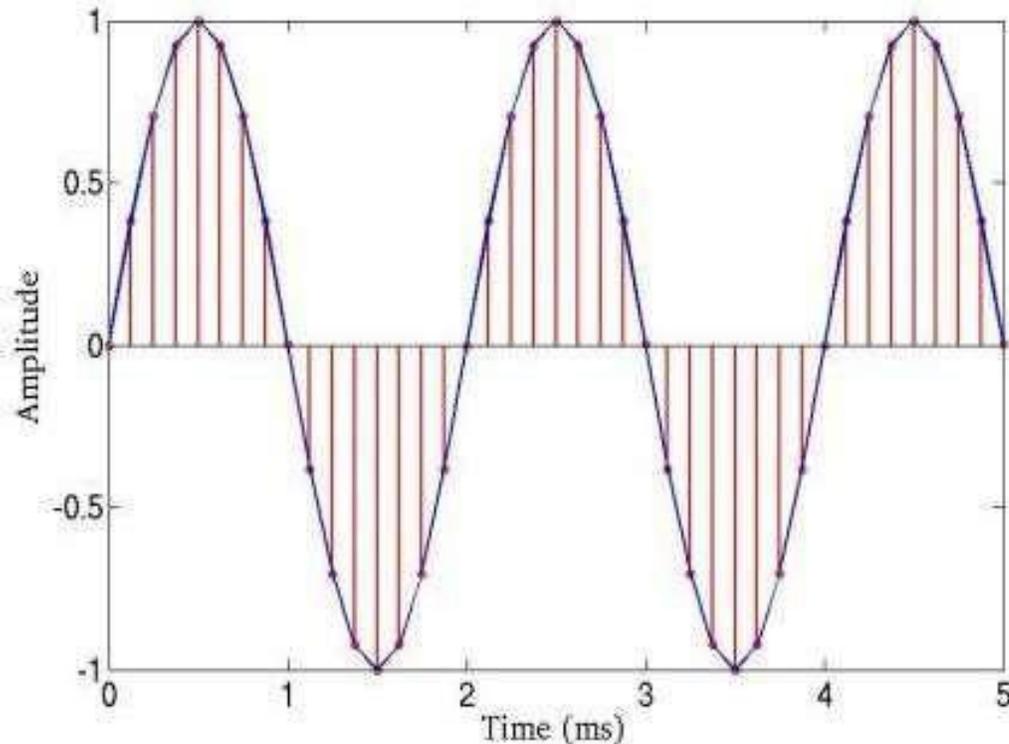
**Alternating Current (AC):** Current that changes direction and magnitude periodically.

**Instantaneous Value:** Value of current or voltage at any instant.

**Peak Value ( $V_m$  or  $V_{PK}$ ):** Maximum value reached by AC in one cycle.

**Average Value:** Mean of all instantaneous values over half cycle

# RMS Value - Definition



- RMS = *Root Mean Square* value.
- It represents the **effective value** of an alternating current or voltage which produces the same heating effect as an equivalent DC current.
- Mathematically,

$$I_{RMS} = \sqrt{\frac{1}{T} \int_0^T i^2(t) dt}$$

For sinusoidal current  $i(t) = I_m \sin \omega t$ ,

$$I_{RMS} = \frac{I_m}{\sqrt{2}} = 0.707 I_m$$

# Average Value

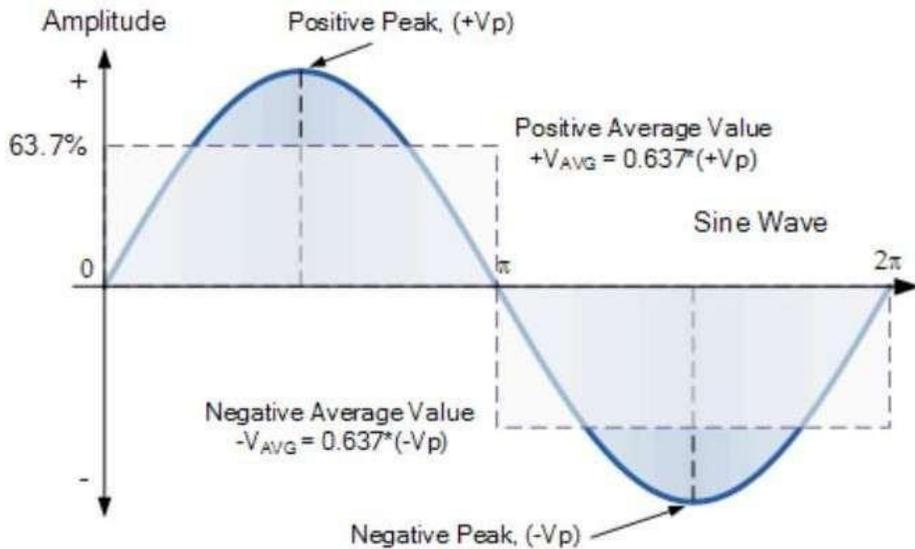
- Average value is useful in rectifier and DC measurement calculations.

$$I_{avg} = \frac{2I_m}{\pi} = 0.637I_m$$

- Relation between RMS and Average:

$$\frac{I_{RMS}}{I_{avg}} = \frac{0.707}{0.637} = 1.11$$

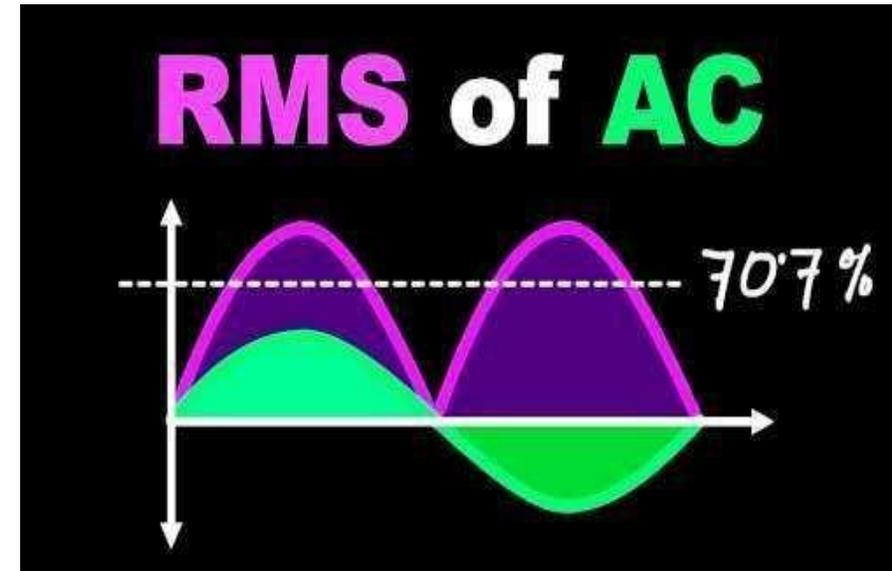
RMS value is 1.11 times greater than average value.



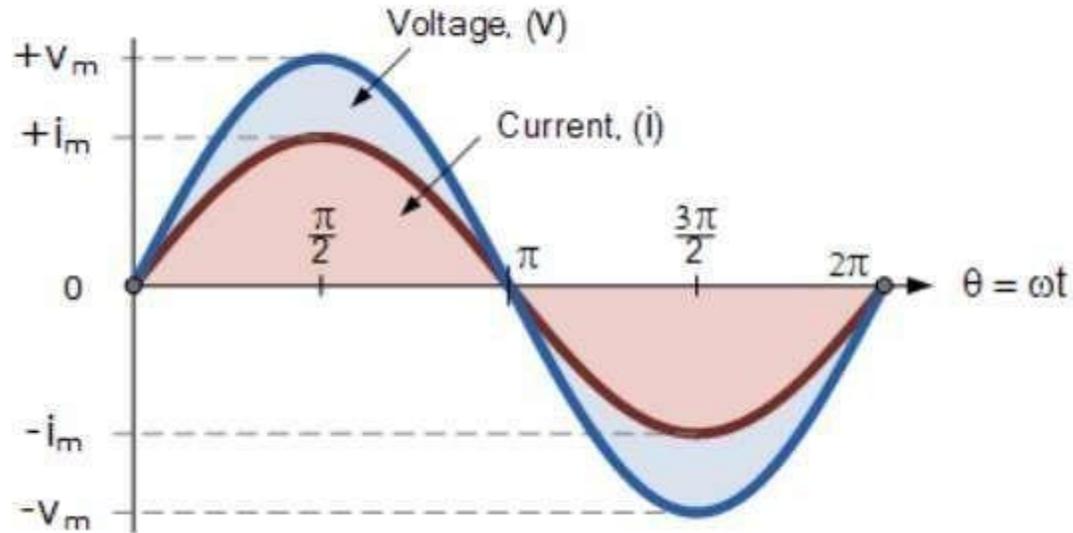
# Significance of RMS Value

- RMS value is used to:
- Determine power consumption in AC circuits.
- Compare AC with equivalent DC current.
- Set the ratings of electrical devices (bulbs, motors, heaters, etc.).
- Example: A 230 V AC supply means 230 V RMS, not peak

Peak voltage  $V_m = 230 \times \sqrt{2} = 325V$ .



# Real Value - Definition



- **Real Power (P):**

Actual power consumed by resistive elements of an AC circuit to perform useful work (heat, light, mechanical energy).

$$P = VI \cos \phi$$

where

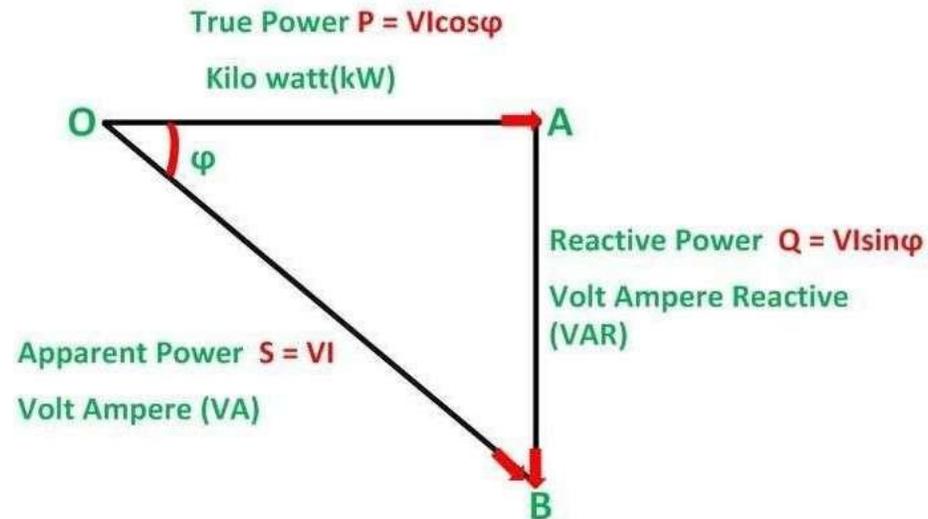
$V$  = RMS voltage,

$I$  = RMS current,

$\phi$  = phase angle between  $V$  and  $I$ .

Unit: **Watt (W)**

# Power Triangle



Circuit Globe

- Shows relationship between:
- **Real Power (P)** – in watts
- **Reactive Power (Q)** – in VAR
- **Apparent Power (S)** – in VA

$$S^2 = P^2 + Q^2$$

$$\text{Power factor } \cos \phi = \frac{P}{S}$$

# Power Factor



- Indicates how effectively electrical power is converted into useful work.

$$\text{Power Factor} = \cos \phi = \frac{\text{Real Power}}{\text{Apparent Power}}$$

- **Power Factor = 1:** Purely resistive load.
- **Power Factor < 1:** Inductive or capacitive load.

High power factor improves efficiency and reduces losses

# Example Problem

Given:

$$V = 230V, I = 10A, \phi = 30^\circ$$

$$P = VI \cos \phi = 230 \times 10 \times 0.866 = 1991W$$

Therefore, Real Power = 1.991 kW

 *Extra:*

$$\text{Apparent Power } S = 230 \times 10 = 2300VA$$

$$\text{Power Factor} = \frac{1991}{2300} = 0.866$$

# Application

- Used in **energy metering and billing** systems.
- Determines **device heating and efficiency**.
- Helps in **motor and transformer design**.
- Important in **power factor correction and load analysis**.
- *Example:* Power companies charge based on **real power**, not apparent power.

# Summary

- ◆ RMS value gives the *effective* AC value producing same heating as DC.
- ◆ Real power is *true power* used to perform work.
- ◆  $I_{RMS} = I_m / \sqrt{2}$ ,  $P = VI \cos \phi$ .
- ◆ Power triangle relates P, Q, and S.
- ◆ High power factor = better efficiency.

# Reference



- <https://www.electronics-tutorials.ws/>
- <https://www.khanacademy.org/>
- <https://learnabout-electronics.org/>
- **“Basic Electrical Engineering” – Nagrath & Kothari**
- **“Electrical Technology” – B.L. Theraja**