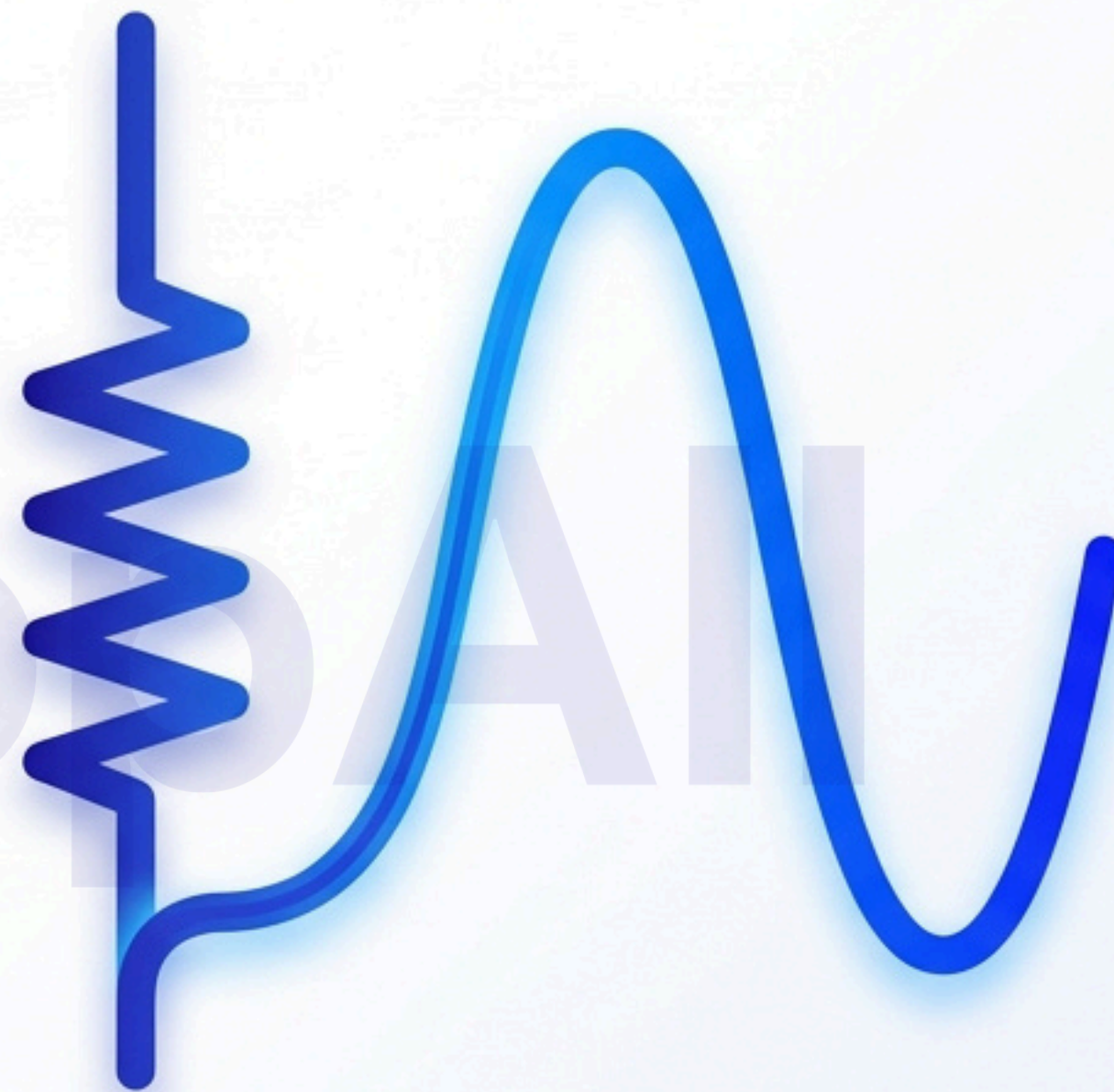


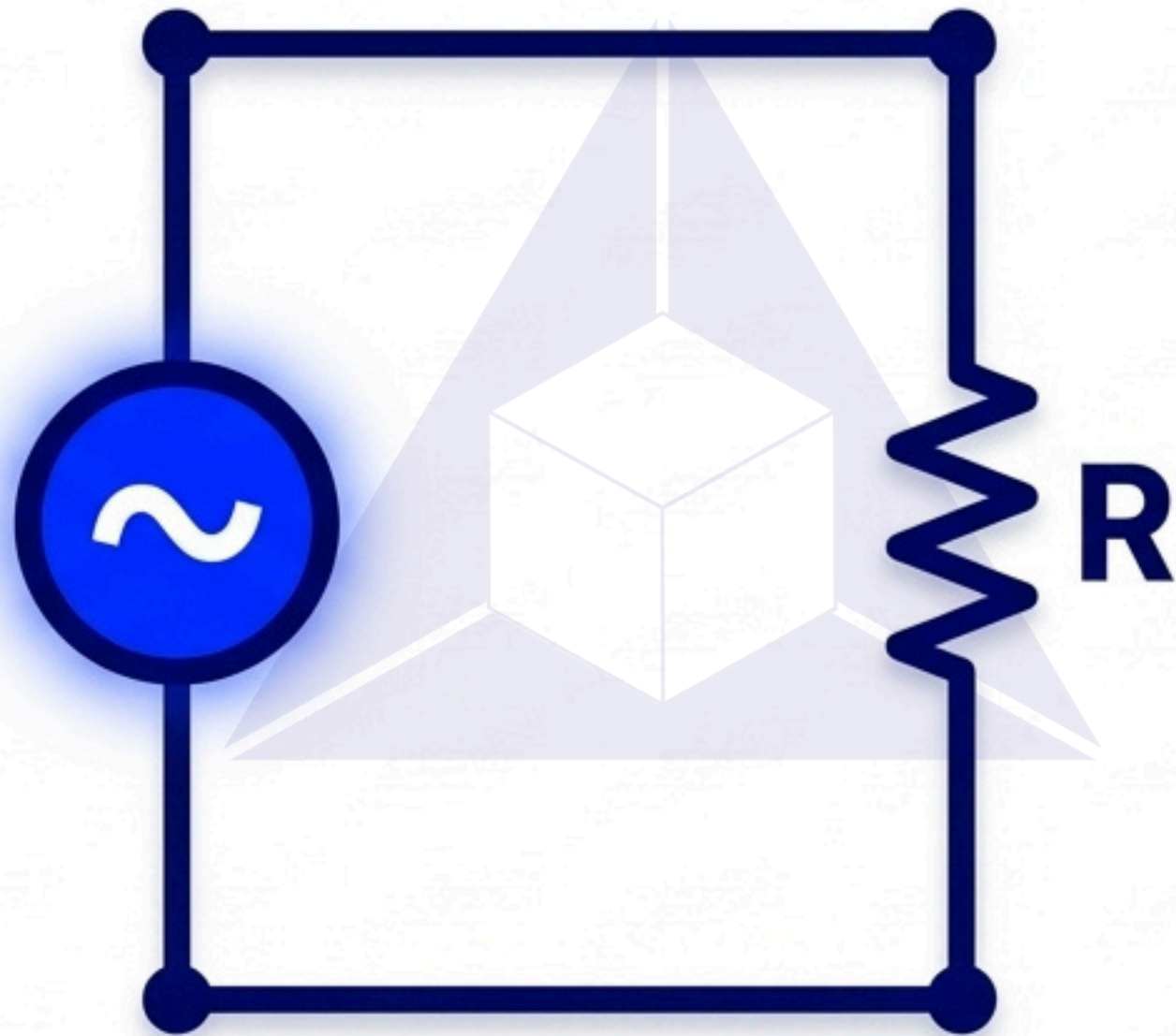
7.2 AC Voltage Applied to a Resistor

Mastering the phase relationship, power dissipation, and RMS values for a purely resistive circuit.

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The Purely Resistive AC Circuit



We begin by connecting a pure resistor (R) to an alternating voltage source. The source produces a sinusoidally varying potential difference.

$$\text{[Eq 7.1]} \quad v = v_m \sin \omega t$$

- v = instantaneous voltage
- v_m = amplitude (peak voltage)
- ω = angular frequency

Calculating the Alternating Current

To find the current, we apply Kirchhoff's loop rule ($\sum \varepsilon(t) = 0$):

$$v_m \sin \omega t = iR$$



Rearranging for instantaneous current gives us our primary wave equation:

$$\text{[Eq 7.2]} \quad i = i_m \sin \omega t$$



Where the current amplitude (i_m) is given by:

$$\text{[Eq 7.3]} \quad i_m = \frac{v_m}{R}$$



KEY INSIGHT: Ohm's Law works equally well for both AC and DC voltages across a resistor!



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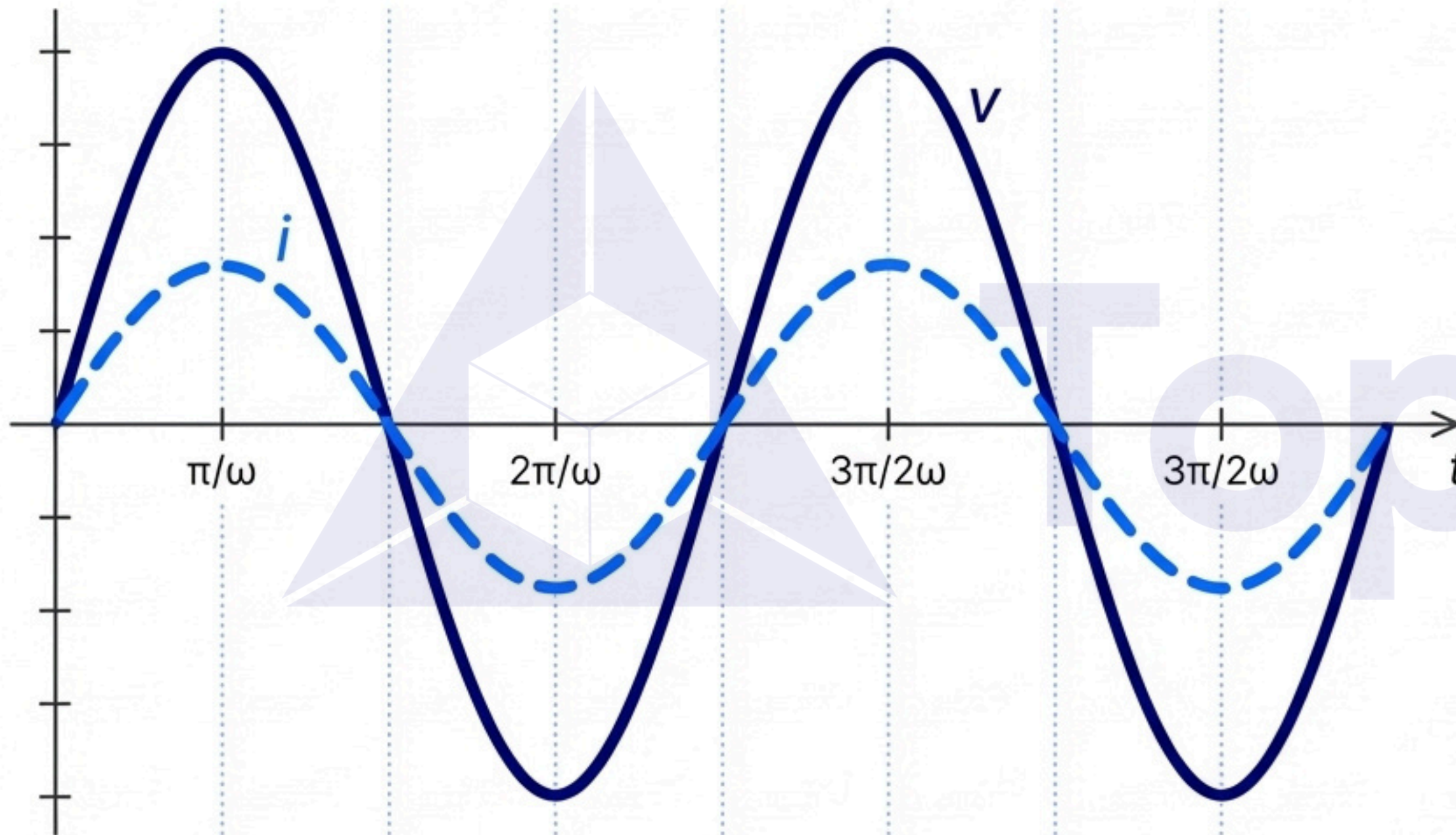
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Visualizing the Phase Relationship

PHASE RELATION: ZERO

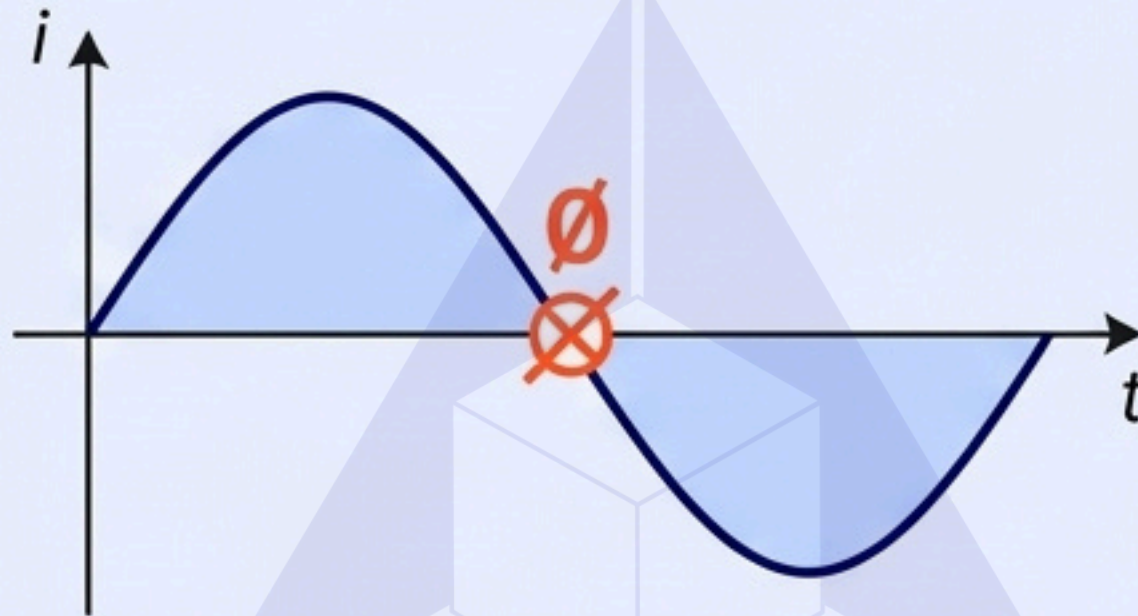


- Both v and i reach zero, minimum, and maximum values at the exact same time.
- Because they perfectly synchronize, the voltage and current are **IN PHASE** with each other.

Figure 7.2: v and i plotted as a function of time.

Why Average Current is Zero, but Power is Not

CURRENT



The sum of instantaneous current over one complete cycle is exactly zero.

$$\langle i \rangle = 0$$

POWER



Joule heating depends on $i^2 R$, not i . Since i^2 is always positive, energy is constantly dissipated as heat!

Instantaneous Power: [Eq 7.4] $p = i^2 R = i_m^2 R \sin^2 \omega t$

Average Power: [Eq 7.5c] $P = \frac{1}{2} i_m^2 R$

Root Mean Square (rms): The DC Equivalent

To express AC power in the same simple form as DC power ($P = I^2 R$), we use the rms (effective) current. It is the equivalent DC current that produces the exact same average heating effect.

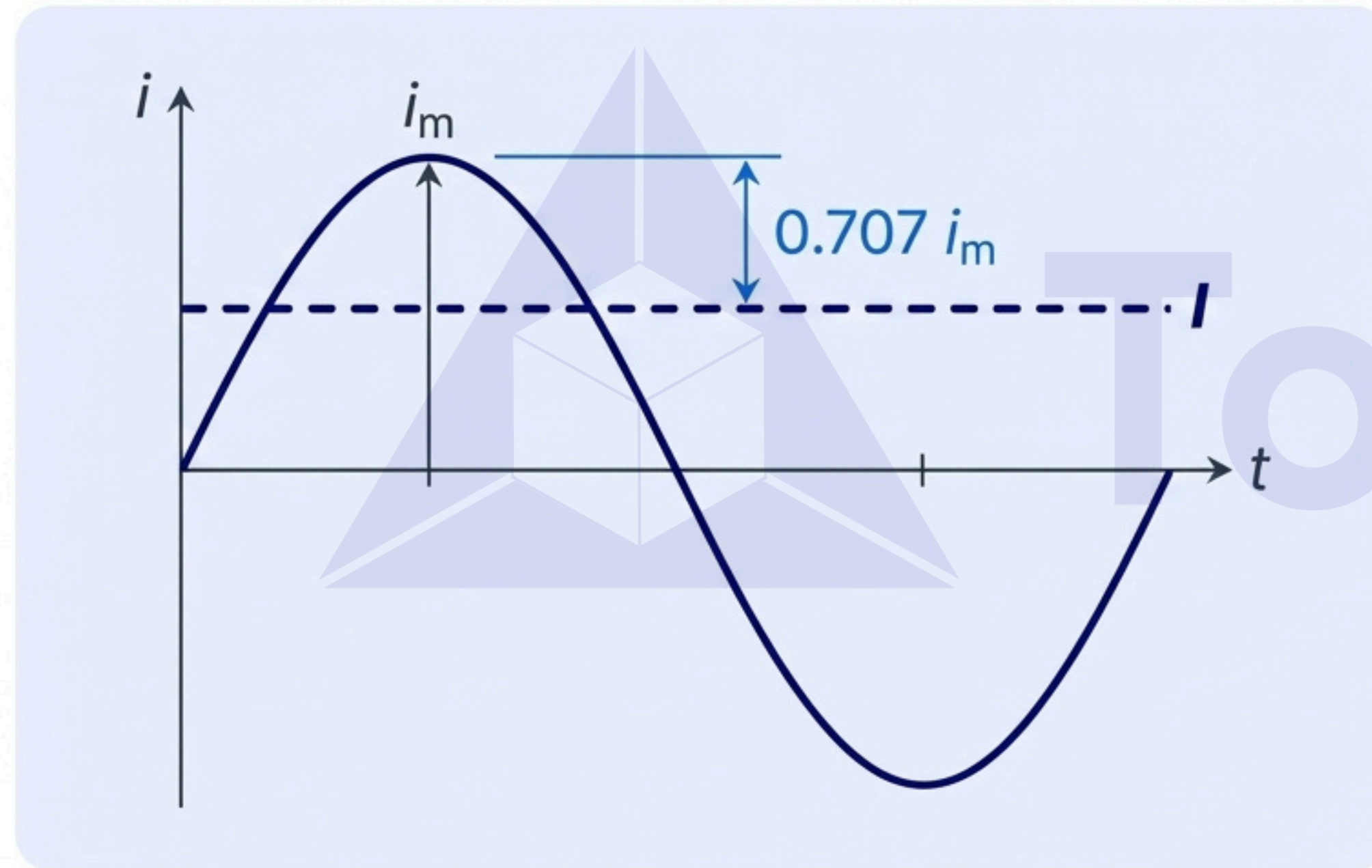


Figure 7.3: The rms current I is related to peak current i_m .

$$[\text{Eq 7.6}] \quad I = \frac{i_m}{\sqrt{2}} = 0.707 i_m$$

$$[\text{Eq 7.8}] \quad V = \frac{v_m}{\sqrt{2}} = 0.707 v_m$$

$$[\text{Eq 7.9}] \quad V = IR$$

Chapter 7.2 Mastery

Plus Jakarta Sans Title Case

KEY TAKEAWAYS

- In a pure resistor, V and I are in phase.
- The wave equations strictly follow $i = i_m \sin \omega t$ and $v = v_m \sin \omega t$.
- Average power dissipated is calculated via $P = I^2 R = V^2 / R$.

⚠ EXAM TIP

Don't confuse Peak (v_m, i_m) with RMS (V, I)! Standard household voltages (e.g., 220V) are ALWAYS RMS. The peak voltage is actually much higher: $220 \times \sqrt{2} = 311V$.

Try Chapter 7.2 MCQs Next →



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