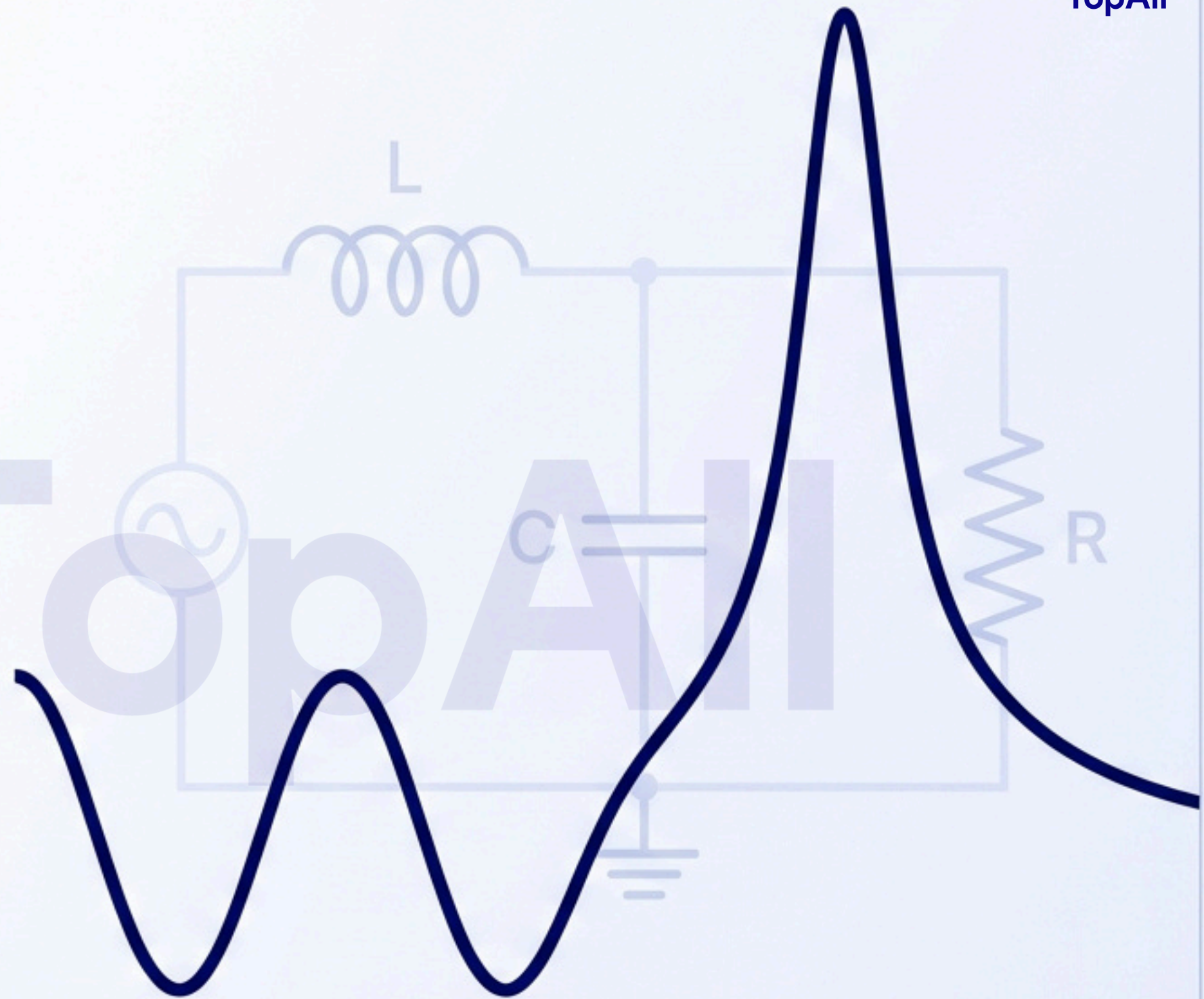


CHAPTER 7 • ALTERNATING CURRENT

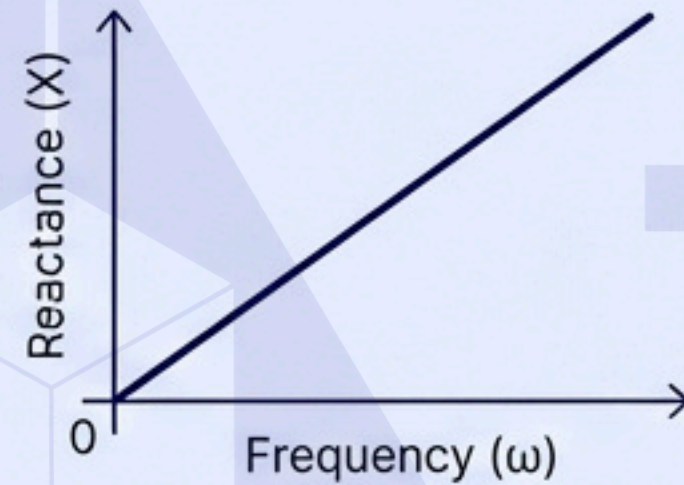
Resonance: The Special Frequency

Mastering the Series LCR Circuit
sweet spot for NEET & JEE.



The Frequency Tug-of-War

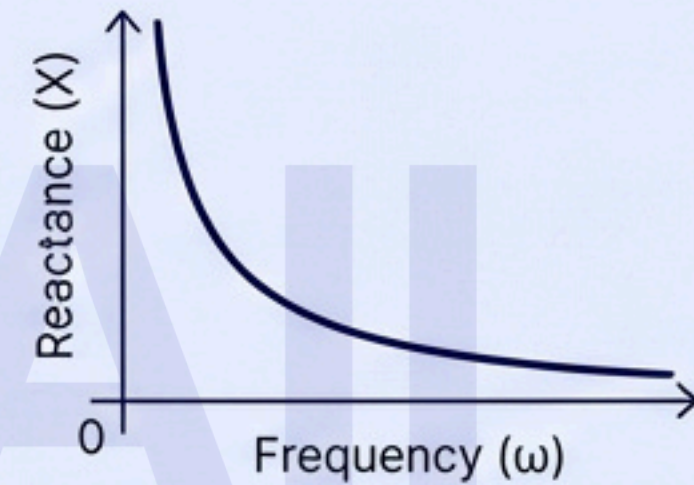
In an AC circuit, the resistance of Inductors (X_L) and Capacitors (X_C) isn't fixed. It changes dynamically with the source frequency (ω).



[INDUCTIVE REACTANCE]

$$X_L = \omega L$$

As frequency increases, X_L increases.
It fights high frequencies.



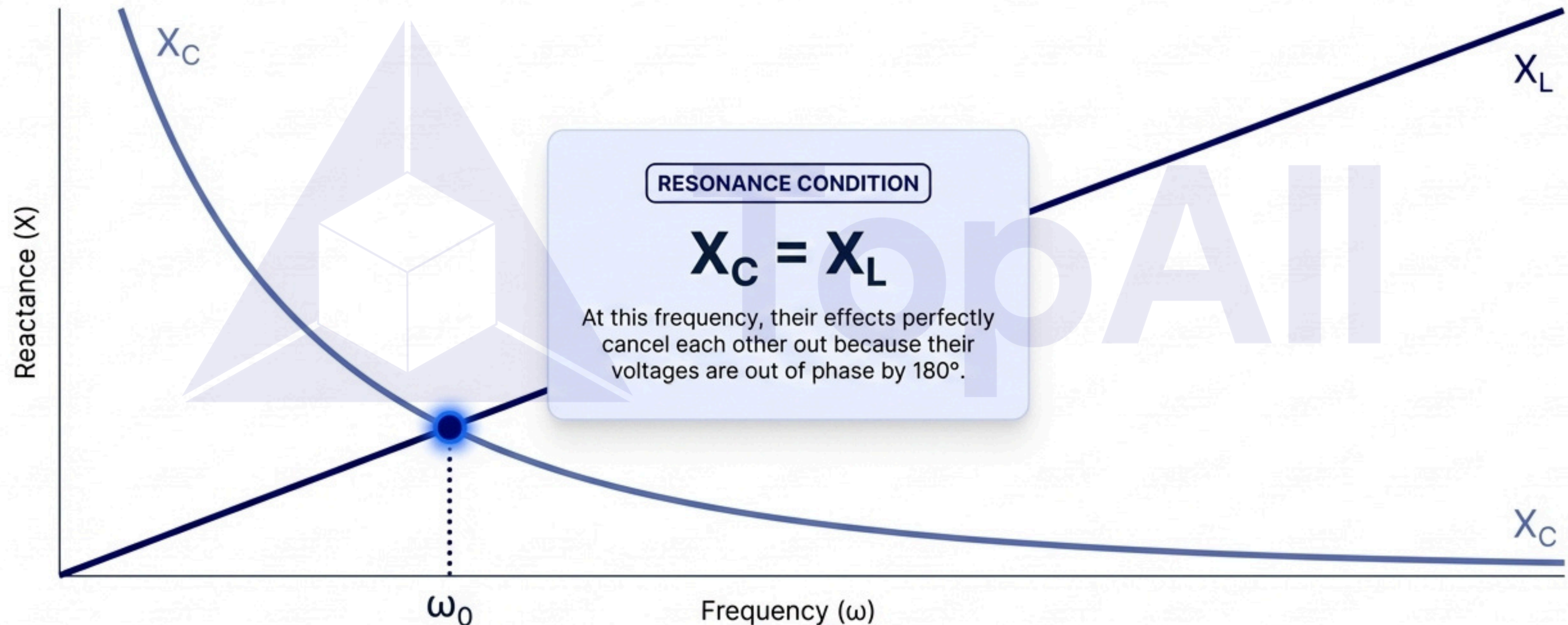
[CAPACITIVE REACTANCE]

$$X_C = \frac{1}{\omega C}$$

As frequency increases, X_C decreases.
It easily passes high frequencies.

The Sweet Spot: $X_C = X_L$

Because they move in opposite directions, there is exactly one specific frequency where the two reactances are perfectly equal.





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$$E=mc^2$$



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H2: Calculating the Resonant Frequency

Step 1: Start with the condition:

$$\omega_0 L = \frac{1}{\omega_0 C}$$



Step 2: Rearrange for ω_0 :

$$\omega_0^2 = \frac{1}{LC}$$

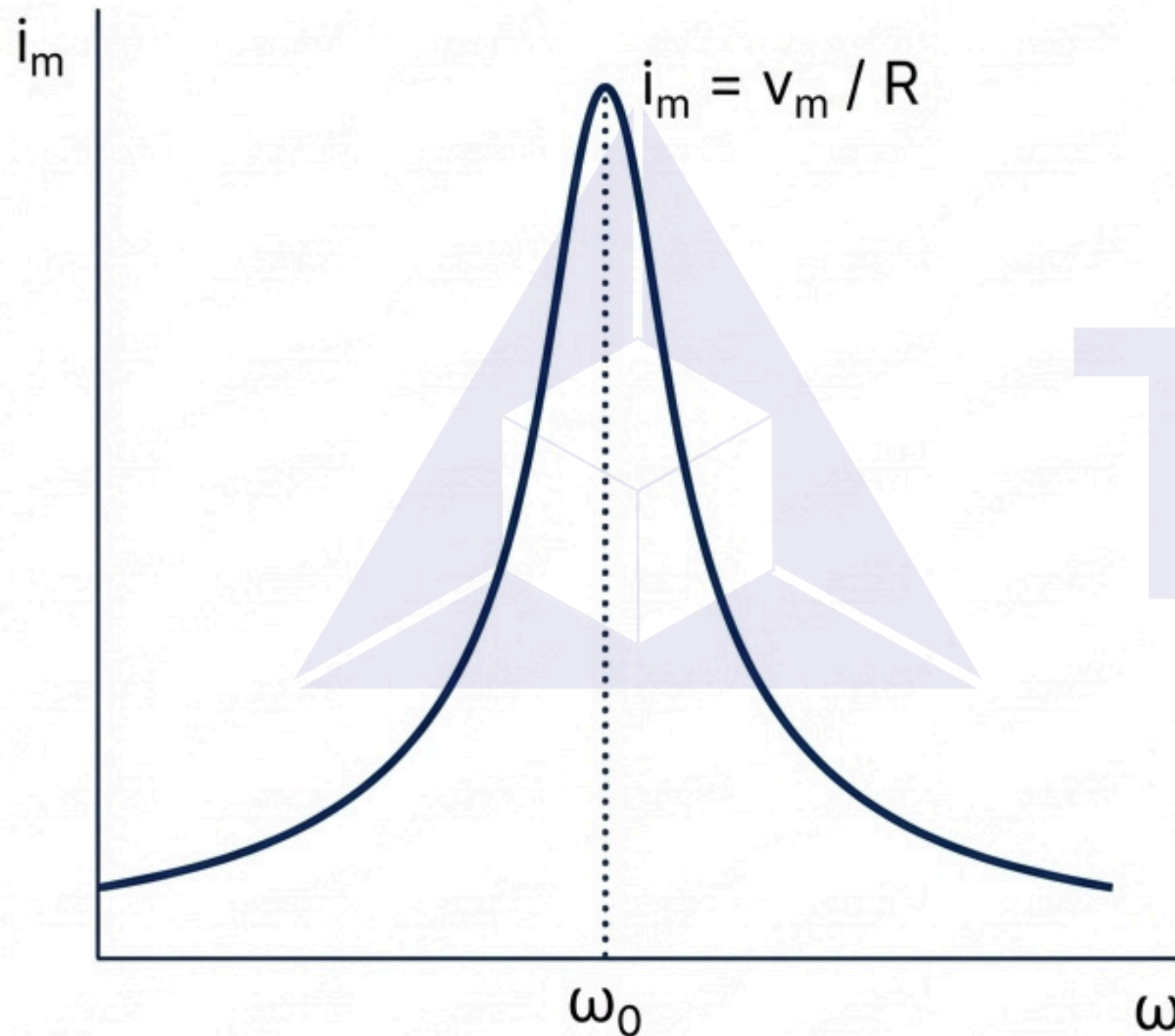


[CRITICAL FORMULA]

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

This is the natural frequency of the system. If the AC source matches this, resonance occurs.

The Surge: When Barriers Drop

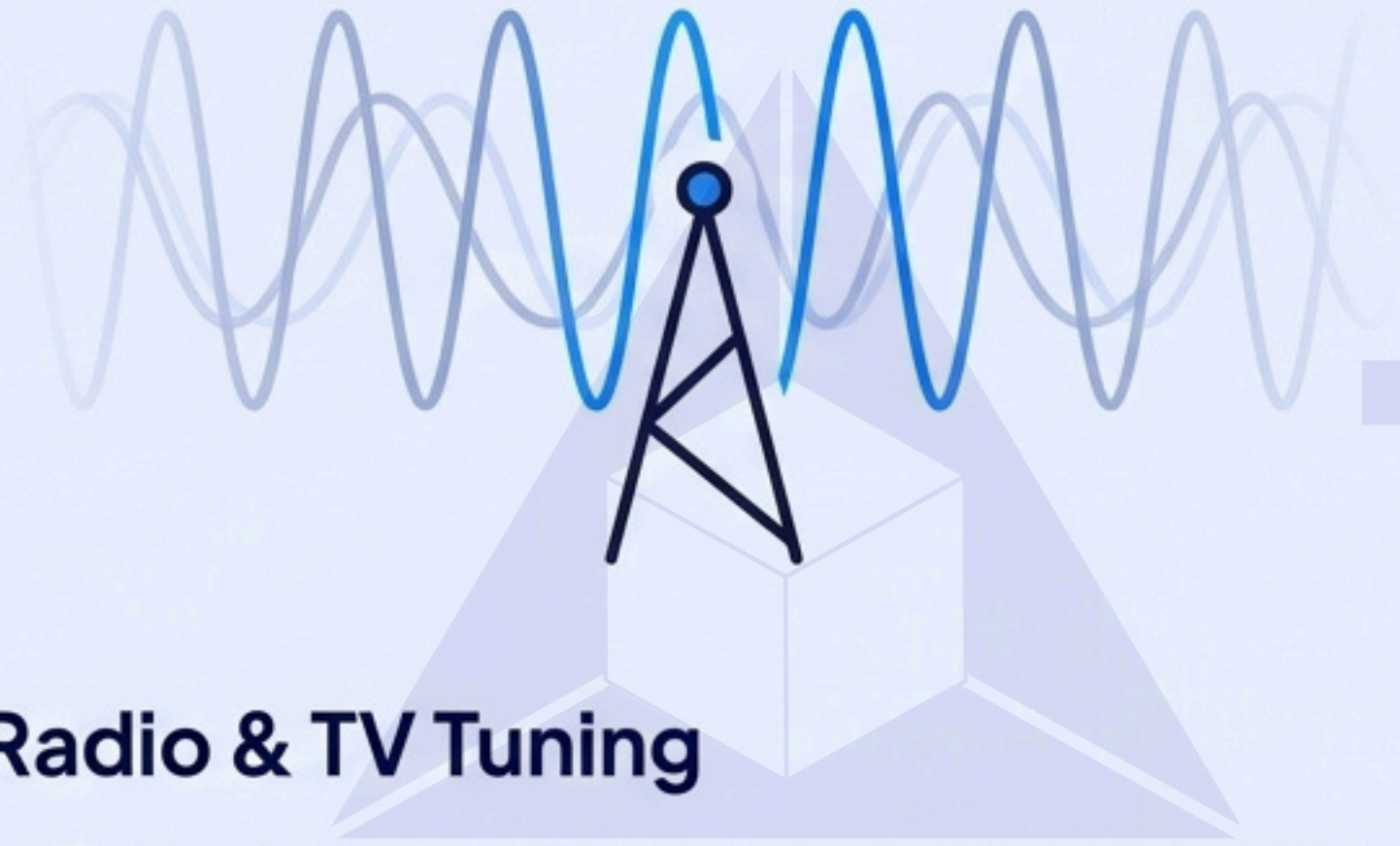


1. **Impedance Plummet:** With $X_C - X_L = 0$, the total impedance drops to its absolute minimum. $Z_{\min} = R$. [CRITICAL FORMULA]

2. **Current Peaks:** Because Z is minimal, the current amplitude surges to its maximum. $I_{\max} = v_m / R$. [RESONANCE CONDITION]

3. **Power Maximizes:** With $\cos\phi = 1$, power dissipation through the resistor hits its absolute peak. $P_{\max} = I^2 R$. [CRITICAL FORMULA]

H2 How We Use The Peak



Radio & TV Tuning

- Turning the dial changes the capacitor (C) in your radio's circuit.
- When the circuit's ω_0 perfectly matches the broadcast station's frequency, current maximizes.
- You hear that specific channel loud and clear.



Metal Detectors

- You walk through a coil (Inductor L) in a tuned resonant circuit.
- Metal in your pocket changes the magnetic field, instantly altering L.
- This breaks the resonance, the current drops instantly, and the alarm sounds!

H2 Key Takeaways

The Trigger: Occurs only in series LCR circuits when $X_C = X_L$.

The Formula: Resonant angular frequency is $\omega_0 = 1 / \sqrt{LC}$.

The Effect: Impedance is entirely resistive ($Z = R$) and reaches its absolute minimum.

The Result: Current and Power dissipation surge to their absolute maximums.

[TRY CHAPTER MCQs NEXT →]



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