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L-R Ckt

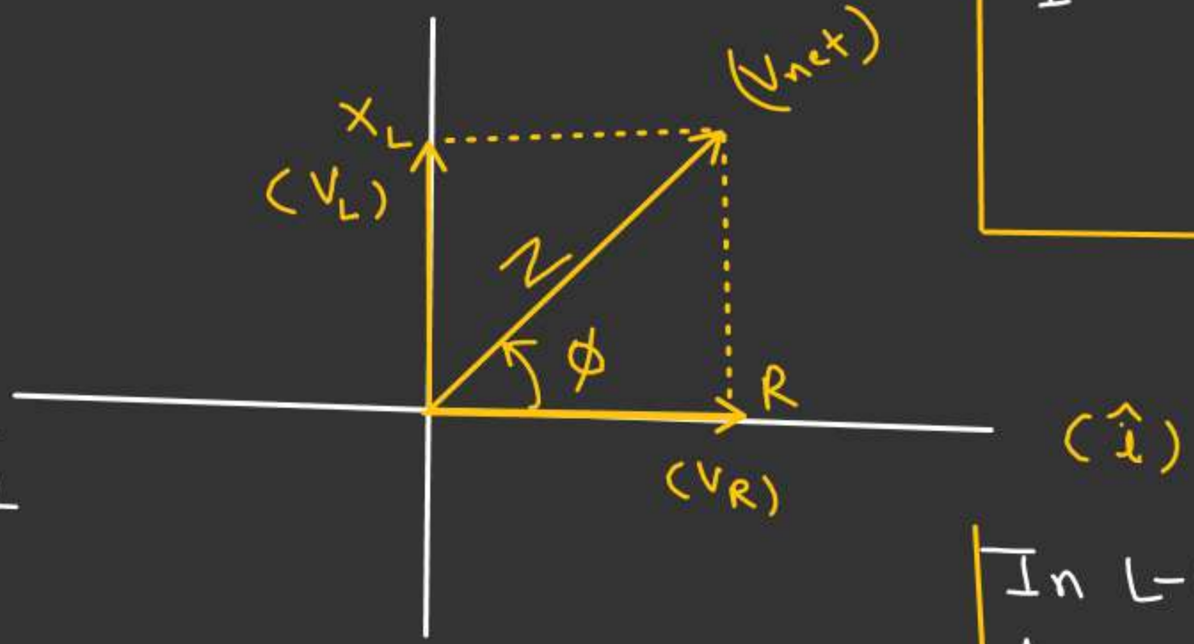
$$\varepsilon = \varepsilon_0 \sin\omega t$$

$$I = I_0 \sin(\omega t - \phi)$$

$$I_0 = \frac{\varepsilon_0}{|Z|}$$

$$|Z| = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + \omega^2 L^2}$$

$$I_0 = \frac{\varepsilon}{\sqrt{R^2 + \omega^2 L^2}}$$

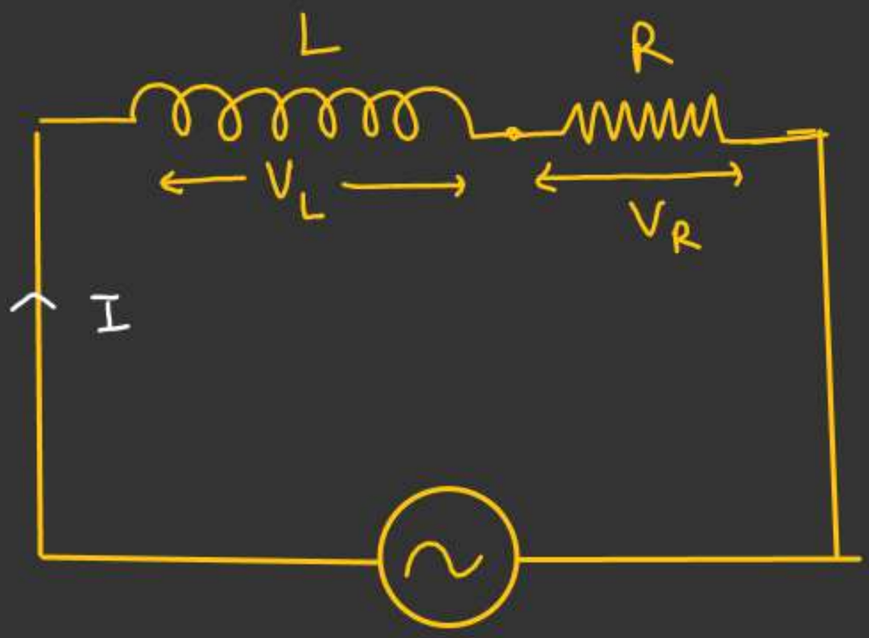


$$\tan\phi = \left(\frac{X_L}{R}\right) = \frac{\omega L}{R}$$

$$\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

$\Downarrow$

Initial phase constant.



$$\varepsilon = \varepsilon_0 \sin\omega t$$

$$\boxed{\begin{aligned} V_L &= I X_L \\ V_R &= I R \\ V &= \sqrt{V_L^2 + V_R^2} \\ V &= I\sqrt{X_L^2 + R^2} \\ V &= IZ. \end{aligned}}$$

In L-R Ckt current is lagging by an angle of ϕ with voltage.

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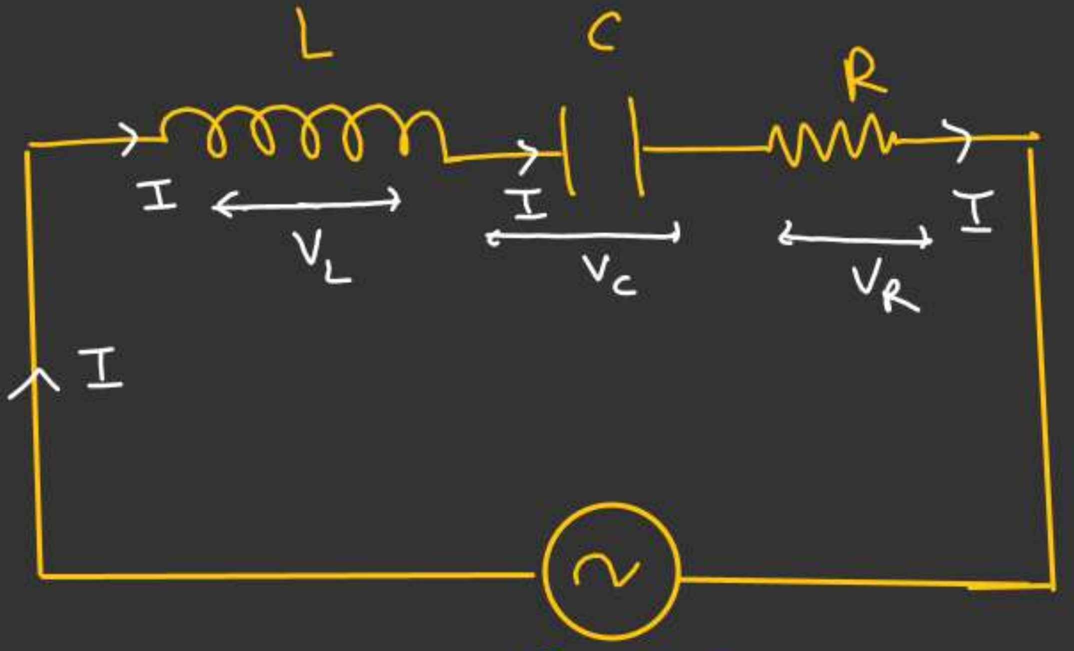
L-C-R Series Ckt

$$\varepsilon = \varepsilon_0 \sin\omega t$$

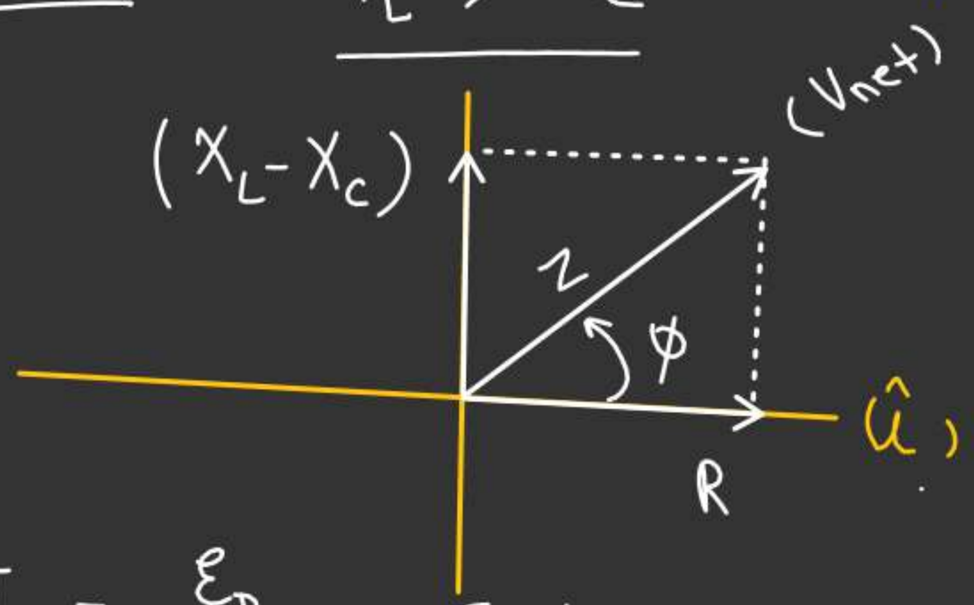
$$I = I_0 \sin(\omega t + \phi)$$

$$I_0 = \frac{\varepsilon_0}{|Z|}$$



$\varepsilon = \varepsilon_0 \sin\omega t$

Case-1 $X_L > X_C$



$$|Z| = \sqrt{R^2 + (X_L - X_C)^2}$$

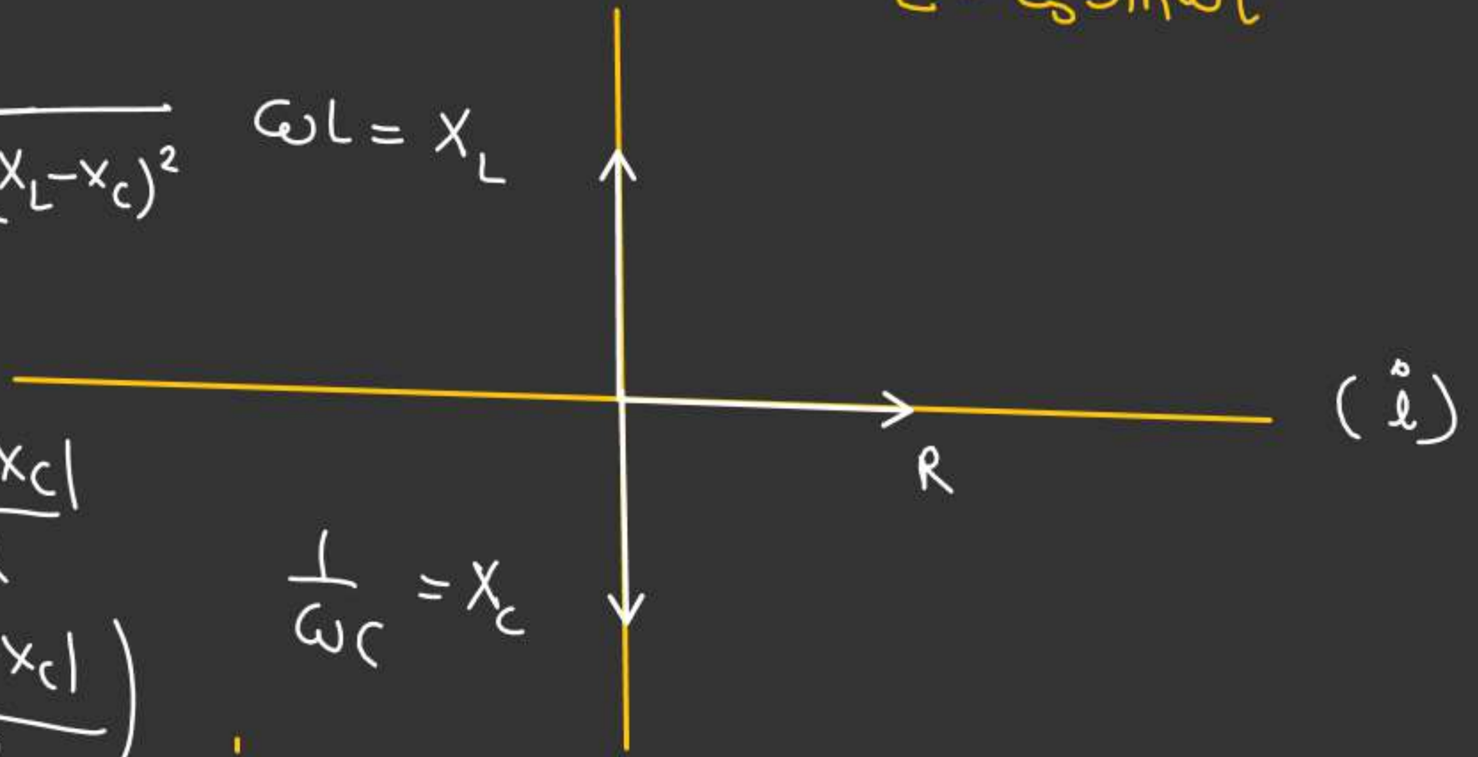
$$\omega L = X_L$$

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

$$\tan\phi = \frac{|X_L - X_C|}{R}$$

$$\phi = \tan^{-1}\left(\frac{|X_L - X_C|}{R}\right)$$

$$I = \frac{\varepsilon_0}{\sqrt{R^2 + (X_L - X_C)^2}} \sin(\omega t - \phi)$$



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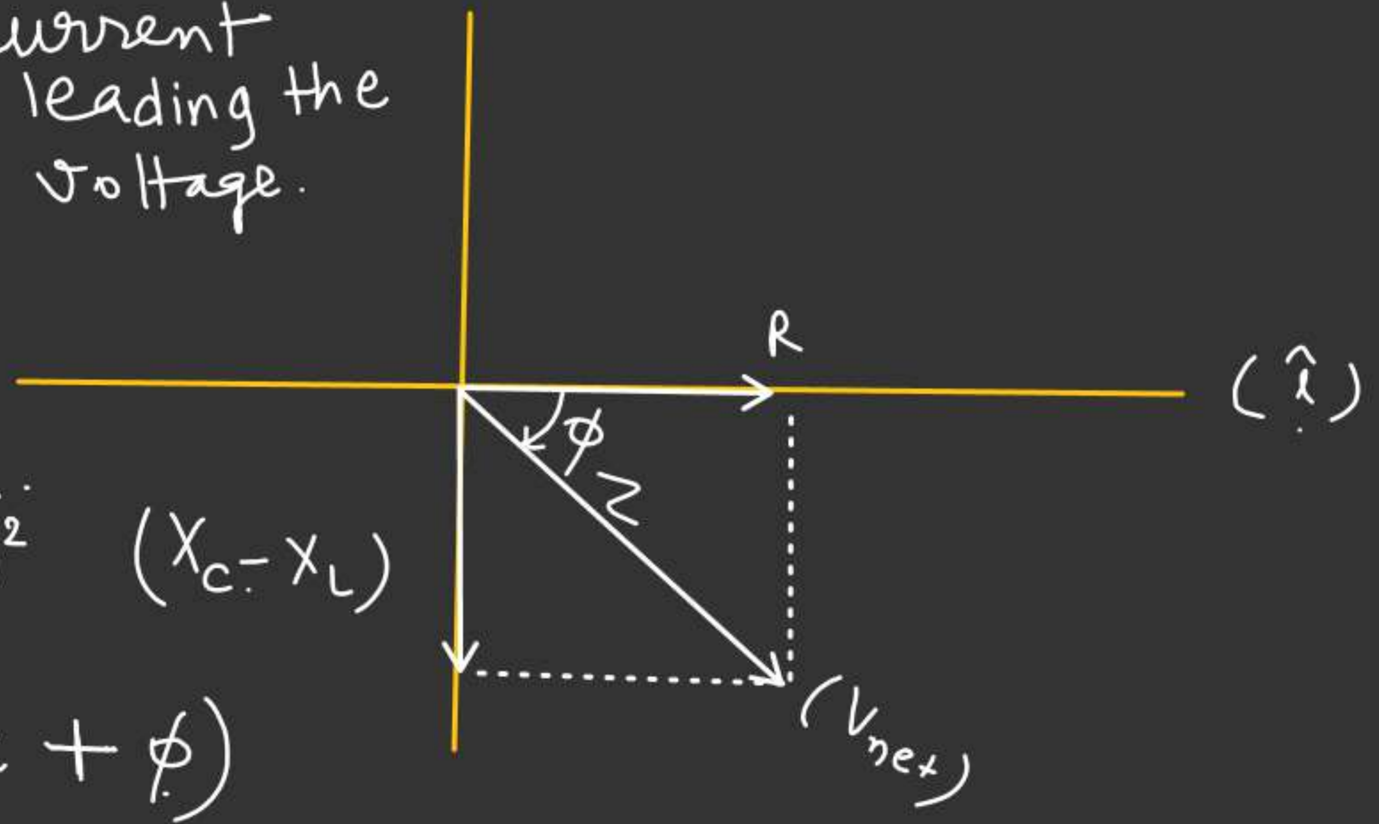
Case - 2

$X_C > X_L \Rightarrow$ Current leading the voltage.

$$|Z| = \sqrt{R^2 + (X_C - X_L)^2}$$

$$I_0 = \frac{\varepsilon_0}{|Z|} = \frac{\varepsilon_0}{\sqrt{R^2 + (X_C - X_L)^2}}$$

$$I = \frac{\varepsilon_0}{\sqrt{R^2 + (X_C - X_L)^2}} \sin(\omega t + \phi)$$



$$\tan\phi = \left(\frac{|X_C - X_L|}{R}\right)$$

$$\phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$$

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Case-3 :- $\boxed{X_L = X_C}$ ⇒ Condition of Resonance in L-C-R Series Ckt.

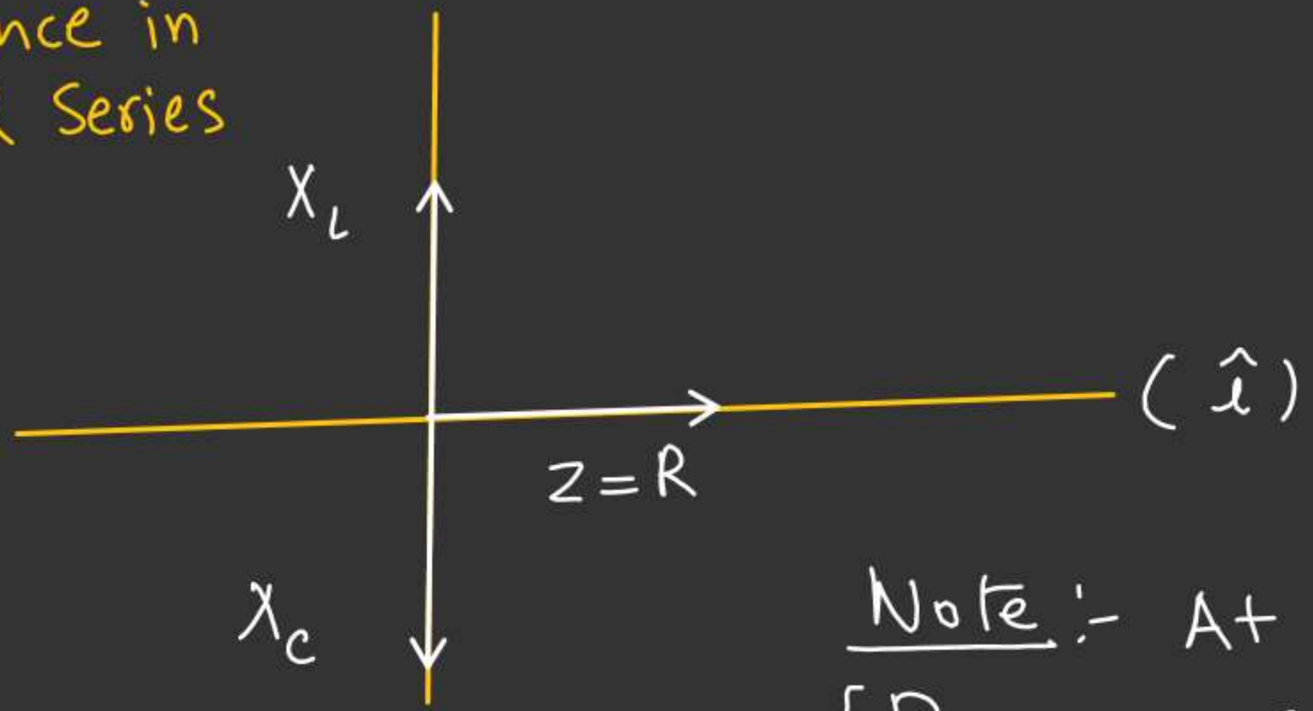
$$|Z| = R.$$

$$I_0 = \frac{\mathcal{E}_0}{|Z|} = \frac{\mathcal{E}_0}{R}$$

$$\boxed{\phi = 0}$$

$$\mathcal{E} = \mathcal{E}_0 \sin\omega t$$

$$I = I_0 \sin\omega t$$



Note :- At Resonance L-C-R series Series behave as purly Resistive Ckt

Condition of Resonance

$$X_L = X_C$$

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

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

Angular frequency ← $\omega = \frac{1}{\sqrt{LC}}$

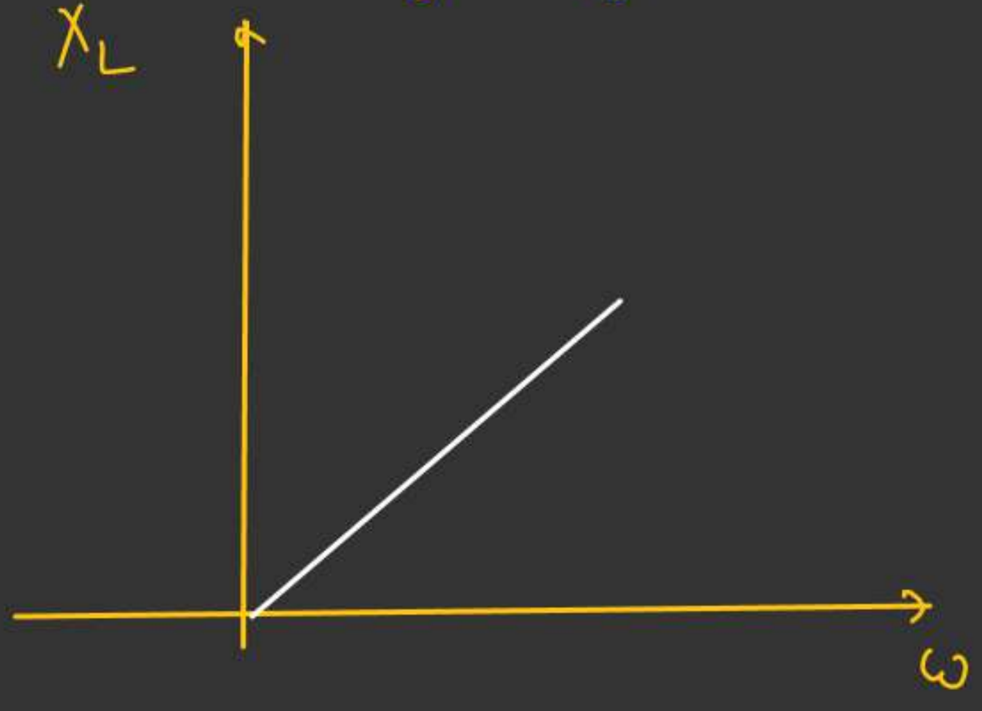
$$\omega = \frac{2\pi}{T} = 2\pi f = \frac{1}{\sqrt{LC}}$$

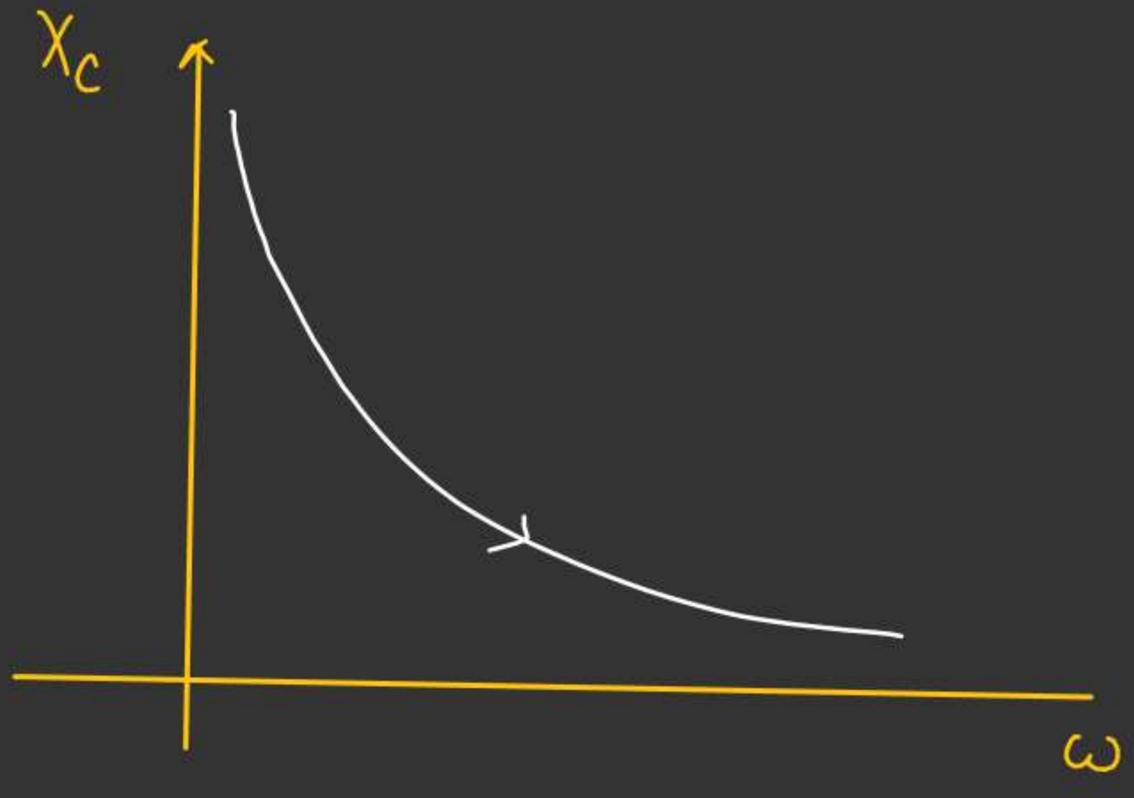
$$\boxed{f = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}}$$

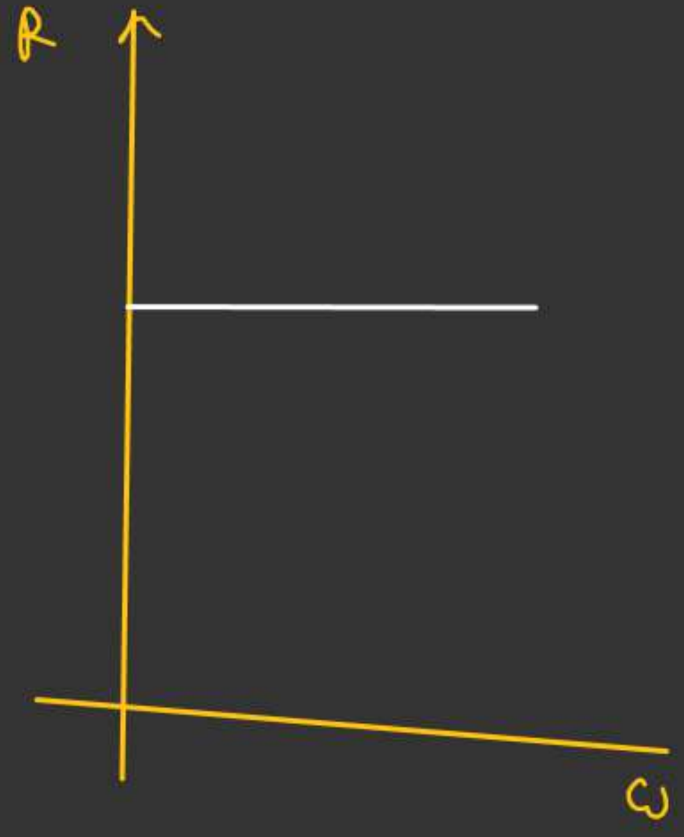
Resonating frequency.

$$X_L = \omega L$$

$$\underbrace{X_C}_{y} = \frac{1}{\underbrace{\omega C}_{x}}$$







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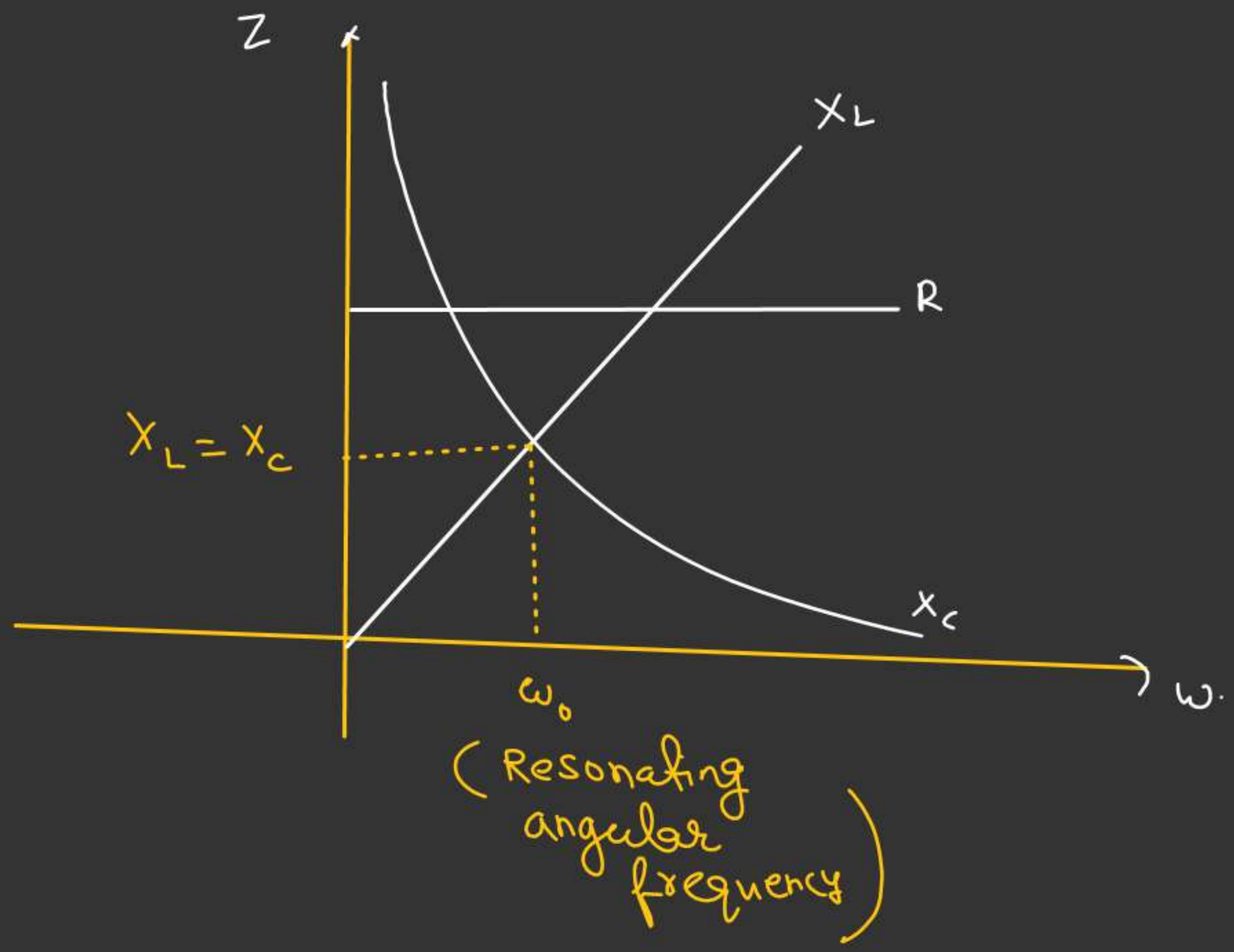

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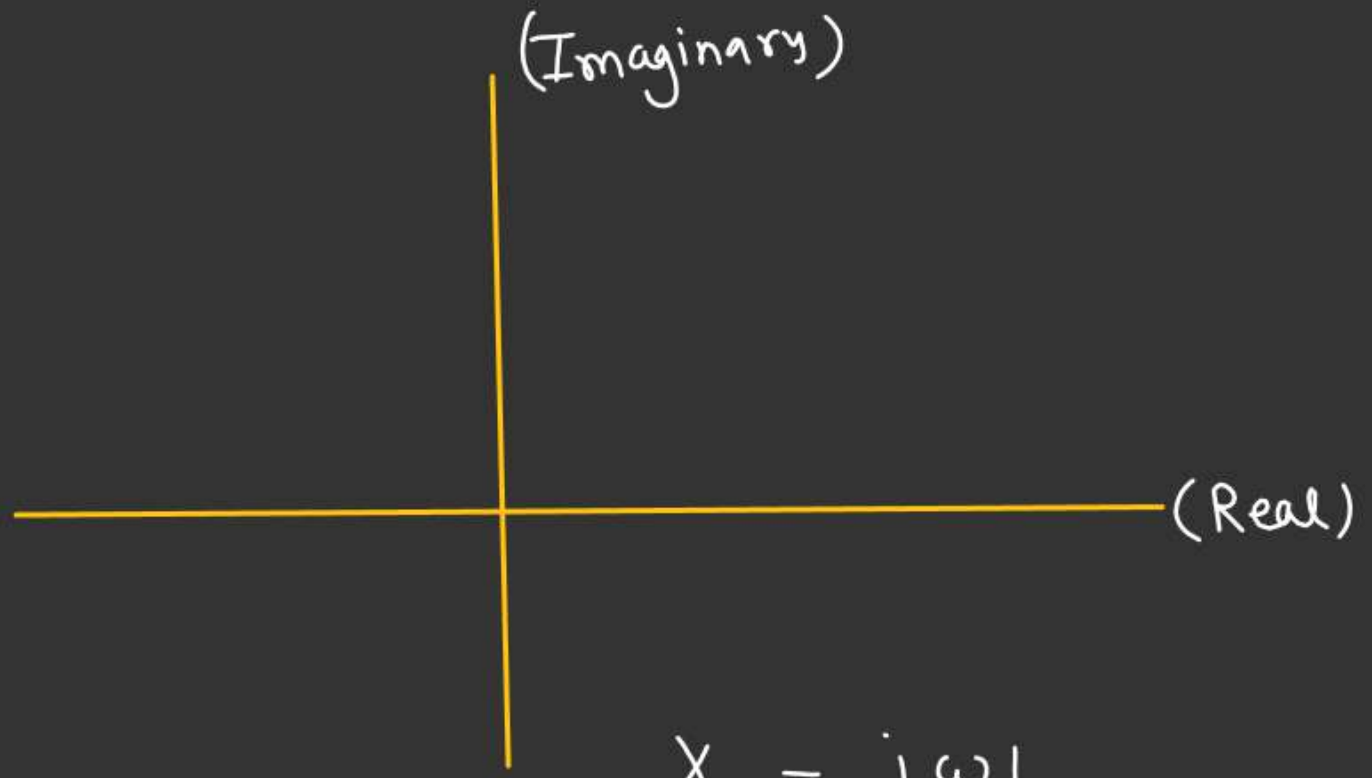
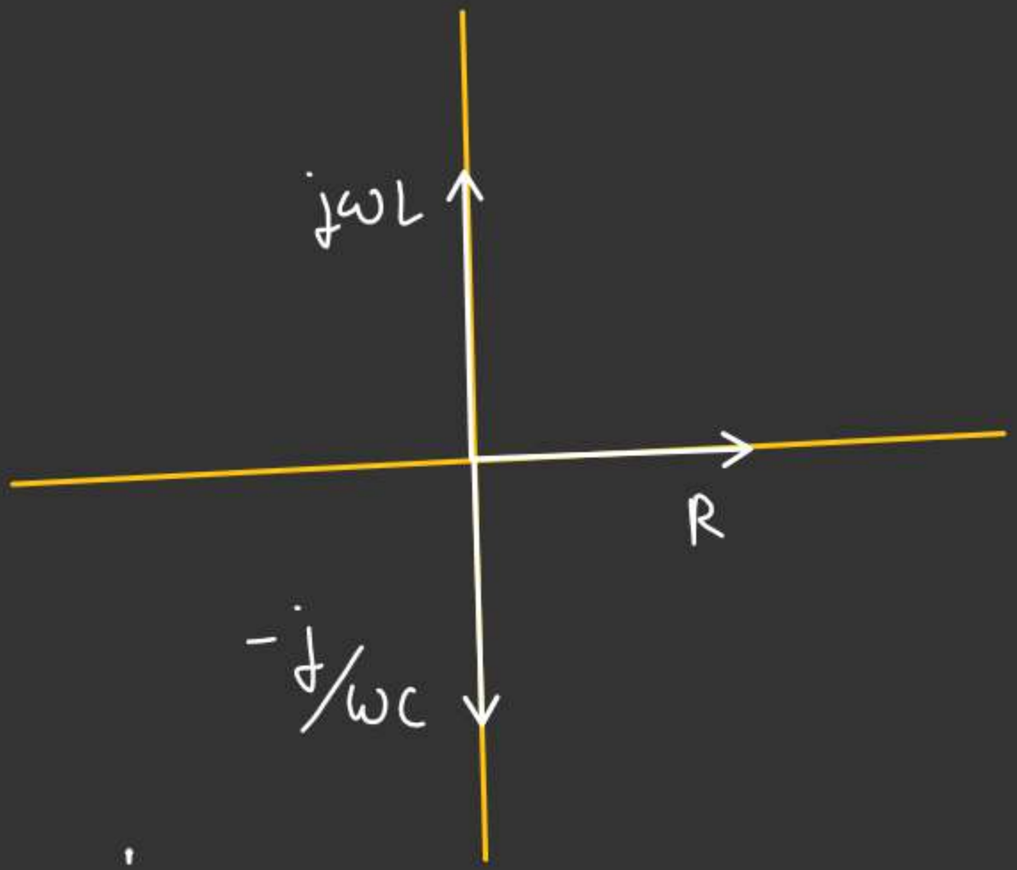
General A.C Ckt

$\hat{j} \rightarrow \hat{i}$





$$X_L = j\omega L$$

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

$$X_C = \frac{1}{j\omega C} \times \frac{j}{j} = \frac{-j}{\omega C}$$

Condition of Resonance

↳ For Resonance imaginary part of impedance will be zero.

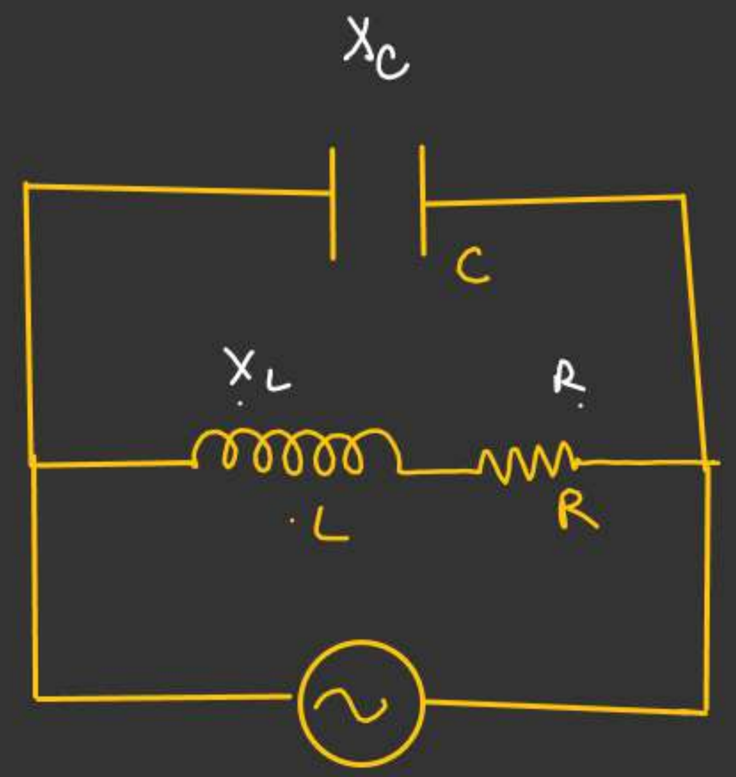
$$X_C = \frac{-j}{\omega C} = \frac{1}{j\omega C}$$

$$X_L = j\omega L$$

$$\frac{1}{Z} = \frac{1}{X_L + R} + \frac{1}{X_C}$$

$$\frac{1}{Z} = \frac{1}{R + j\omega L} + j\omega C$$

$$\frac{1}{Z} = \frac{1}{R^2 + \omega^2 L^2}(R - j\omega L) + j\omega C$$



$\mathcal{E} = \mathcal{E}_0 \sin\omega t$

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$$\frac{1}{Z} = \frac{1}{R^2+\omega^2L^2}(R-j\omega L) + j\omega C.$$

$$\frac{1}{Z} = \frac{R}{R^2+\omega^2L^2} + j\underbrace{\left(\omega C - \frac{\omega L}{R^2+\omega^2L^2}\right)}_{\Downarrow}$$

Imaginary part.

For Resonance.

$$Im(Z) = 0.$$

$$\omega C - \frac{\omega L}{R^2+\omega^2L^2} = 0.$$

$$C = \frac{L}{R^2+\omega^2L^2}$$

$$R^2+\omega^2L^2 = \frac{L}{C}$$

$$\omega^2L^2 = \frac{L}{C} - R^2$$

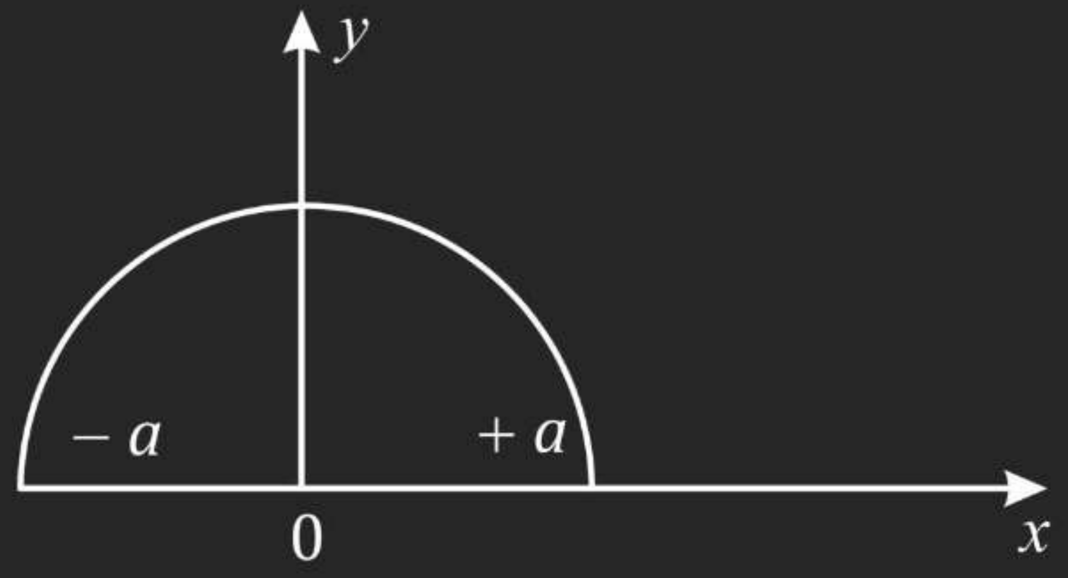
$$\boxed{\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}}$$

Resonating frequency.

ALTERNATING CURRENT

HW

Q.1 Determine the rms value of a semi-circular current wave which has a maximum value of a.



(A) $(1/\sqrt{2})a$

(B) $\sqrt{(3/2)}a$

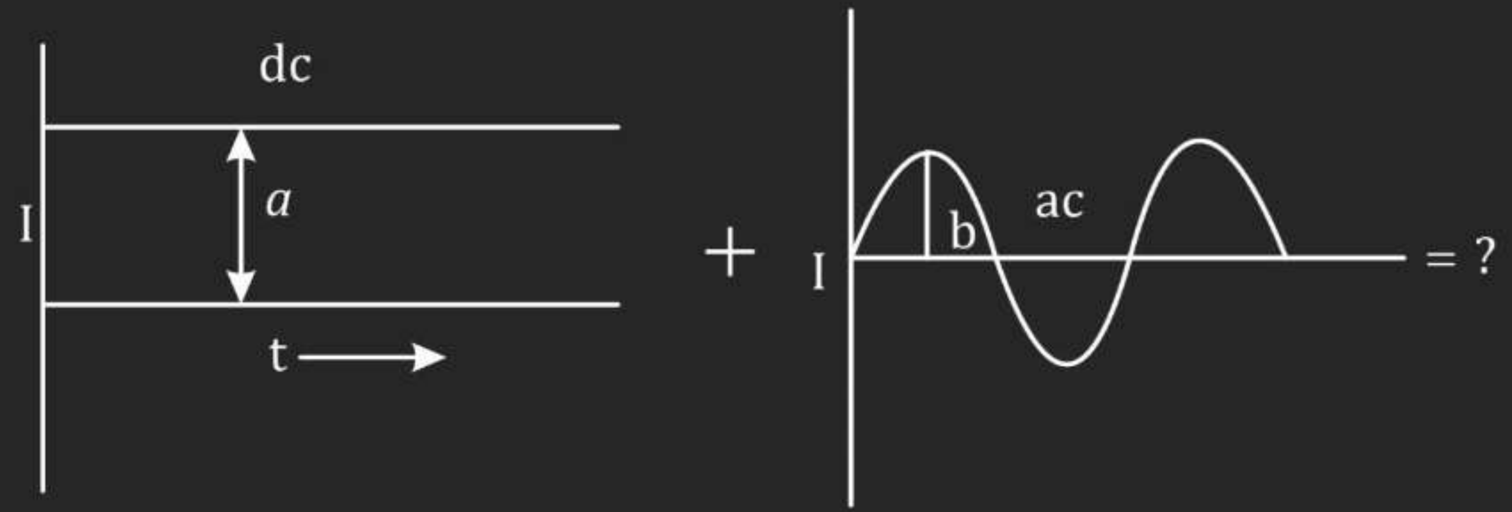
(C) $\sqrt{(2/3)}a$

(D) $(1/\sqrt{3})a$

H.W

ALTERNATING CURRENT

Q.2 If a direct current of value a ampere is superimposed on an alternative current $I = b\sin\omega t$ flowing through a wire, what is the effective value of the resulting current in the circuit?



(A) $\left[a^2 - \frac{1}{2}b^2\right]^{1/2}$

(B) $\left[a^2 + b^2\right]^{1/2}$

(C) $\left[\frac{a^2}{2} + b^2\right]^{1/2}$

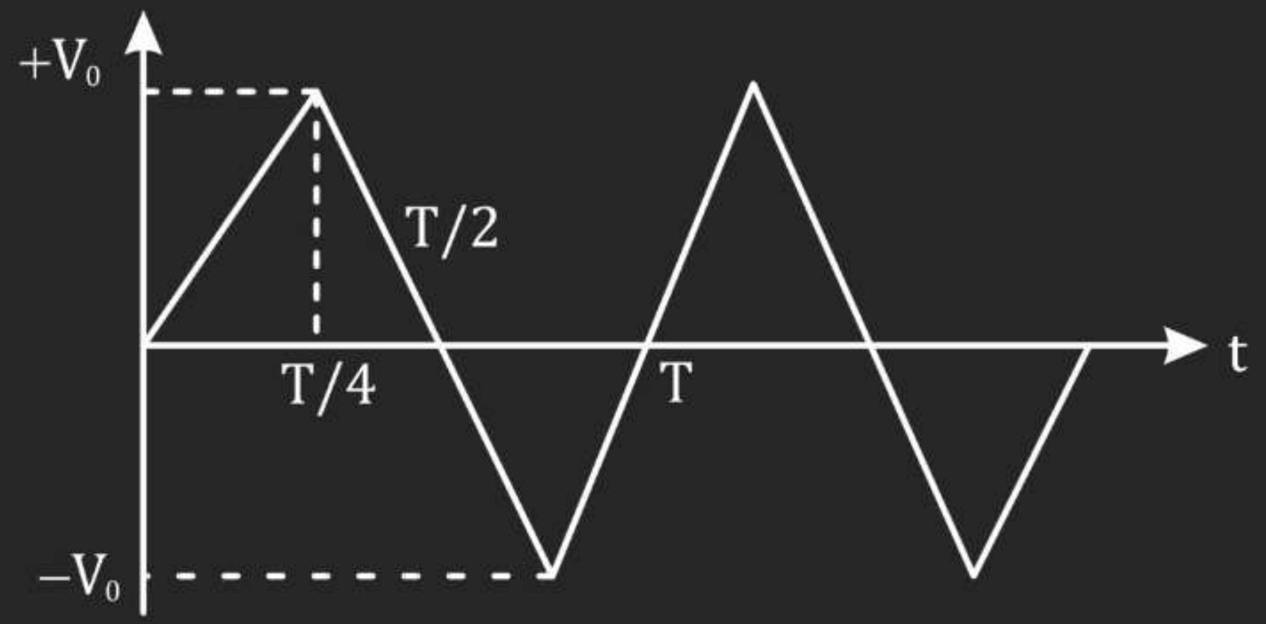
(D) $\left[a^2 + \frac{1}{2}b^2\right]^{1/2}$

Nishant Jindal

ALTERNATING CURRENT

H-W

Q.3 The voltage time $(V - t)$ graph for triangular wave having peak value V_0 is as shown in



H-W. Fig in Q-3.

ALTERNATING CURRENT

Q.4 The rms value of V in time interval from $t = 0$ to $T/4$ is

(A) $\frac{V_0}{\sqrt{3}}$

(B) $\frac{V_0}{2}$

(C) $\frac{V_0}{\sqrt{2}}$

(D) None of these

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H.W Fig in Q.No-3.

ALTERNATING CURRENT

Q.5 In the above question, the average value of voltage (V) in one time period will be

(A) $\frac{V_0}{\sqrt{3}}$

(B) $\frac{V_0}{2}$

(C) $\frac{V_0}{\sqrt{2}}$

(D) 0

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ALTERNATING CURRENT

H-W

For problems 6 – 8

A series LCR circuit containing a resistance of 120Ω has angular resonance frequency $4 \times 10^5 \text{rads}^{-1}$. At resonance the voltages across resistance and inductance are 60 V and 40 V. respectively.

6. The value of inductance L is

(A) 0.1mH (B) 0.2mH (C) 0.35mH (D) 0.4mH

7. The value of capacitance C is

(A) $\frac{1}{32}\mu\text{F}$ (B) $\frac{1}{16}\mu\text{F}$ (C) $32\mu\text{F}$ (D) $16\mu\text{F}$

8. At what frequency, the current in the circuit lags the voltage by 45° ?

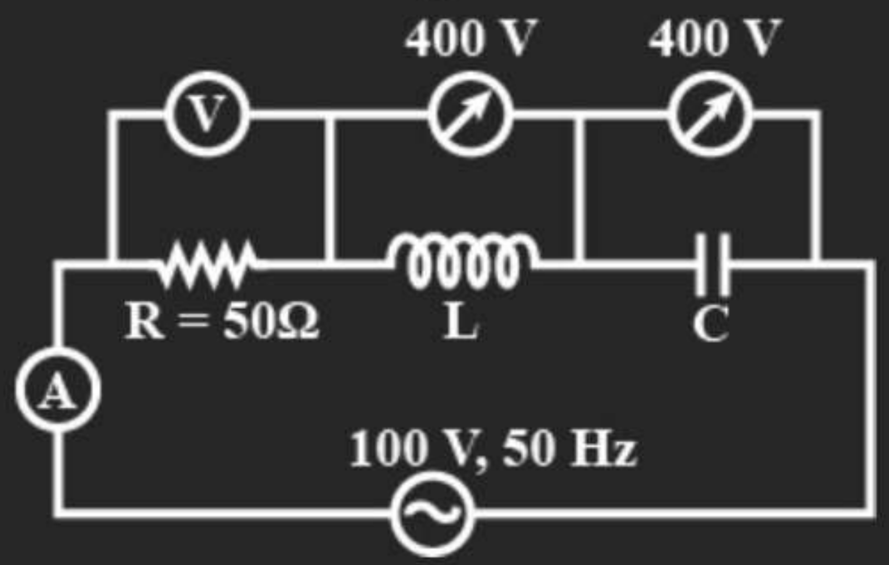
(A) $4 \times 10^5 \text{rad}s^{-1}$ (B) $3 \times 10^5 \text{rad}$

(C) $8 \times 10^5 \text{rad}s^{-1}$ (D) $2 \times 10^5 \text{rad}s^{-1}$

H-W

ALTERNATING CURRENT

Q.9 In the series LCR circuit (Fig), the voltmeter and ammeter readings are:



(A) $V = 100\ V, I = 2\ A$

(B) $V = 100\ V, I = 5\ A$

(C) $V = 1000\ V, I = 2\ A$

(D) $V = 300\ V, I = 1\ A$

HW

ALTERNATING CURRENT

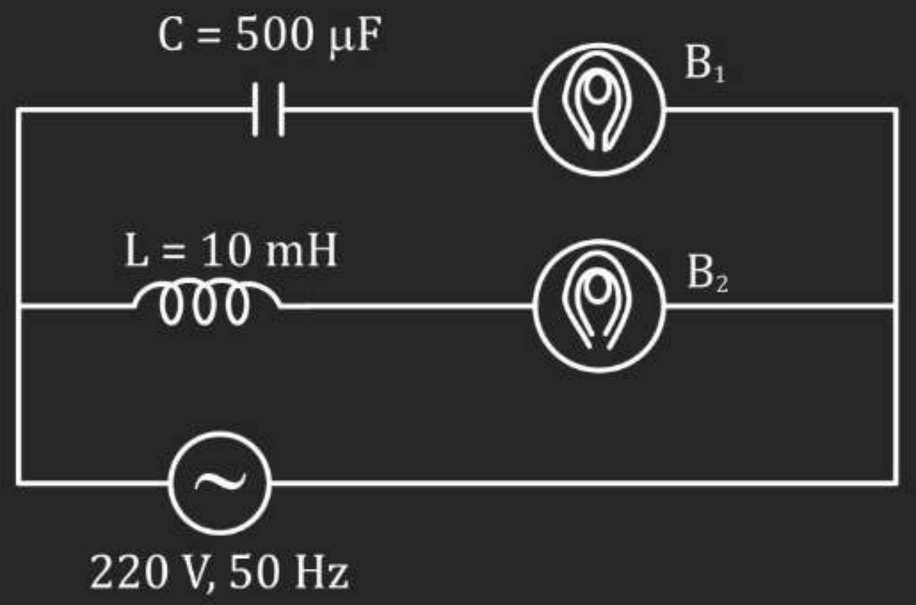
Q.10 In the circuit shown in Fig, if both the bulbs B_1 and B_2 are identical,

(A) their brightness will be the same

(B) B_2 will be brighter than B_1

(C) B_1 will be brighter than B_2

(D) only B_2 will glow because the capacitor has infinite impedance



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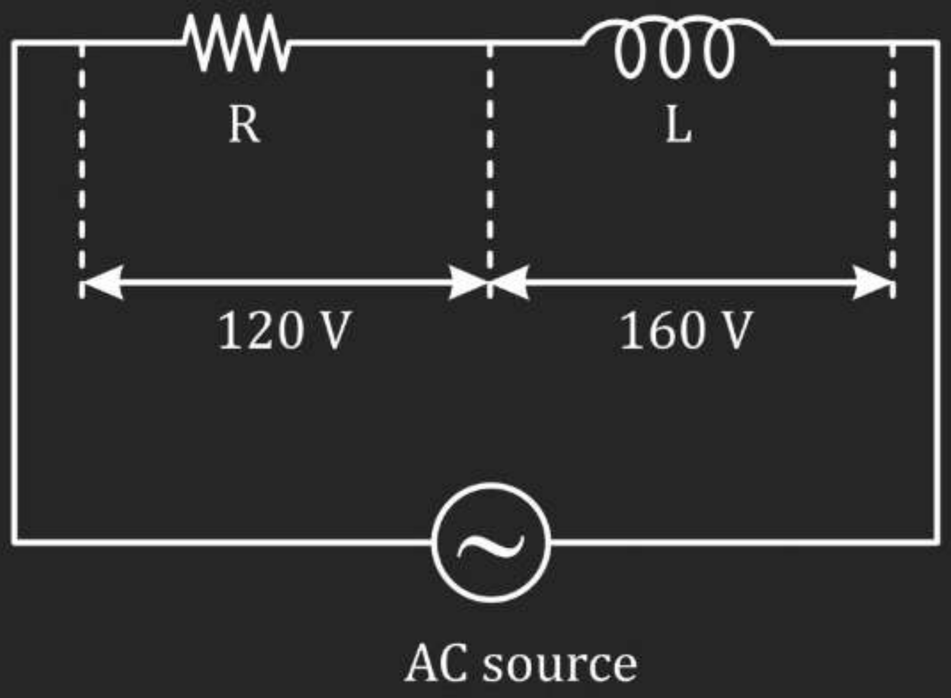
ALTERNATING CURRENT

H-W

Q.10 The circuit given in Fig. has a resistance less choke coil L and a resistance R. The voltages across R and L are also given in the figure. The virtual value of the applied voltage is



(A) 100 V

(B) 200 V

(C) 300 V

(D) 400 V