A.C.

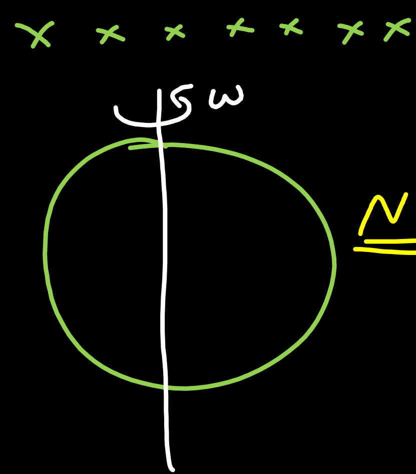
A.C. generator

→ constant ω

$$\boxed{\theta = \omega t}$$

$(\text{dist}) = (\text{Speed})(\text{time})$

Speed → constant



N turns.

$\phi = \vec{B} \cdot \vec{A}$

$\phi = (B A \cos\theta) N$

$\phi = NBA \cos(\omega t)$

$$\boxed{\phi = NBA \cos(\omega t)}$$

$$|(\mathcal{E}_{mf})| = \frac{d\phi}{dt}$$

$$\phi = NBA \cos(\omega t)$$

$$\mathcal{E}mf\ \text{induced} = -\frac{d\phi}{dt}$$

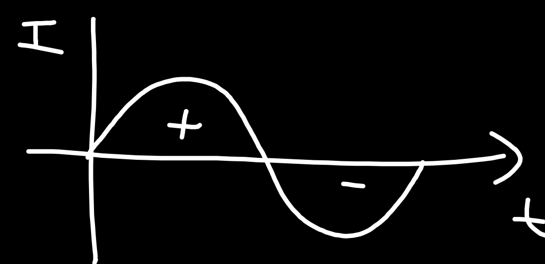
$$= -\left[NBA\left(-\sin(\omega t)\right) \times \omega\right]$$

$$\boxed{\mathcal{E}mf = NBA\omega \sin(\omega t)}$$

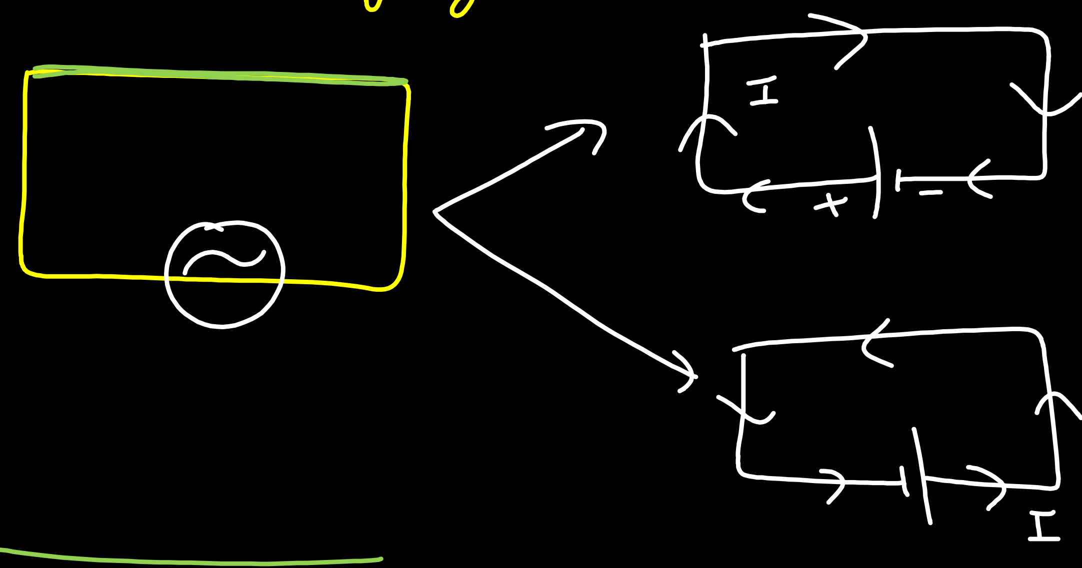
$$I = \frac{\mathcal{E}mf}{\text{Resistance}}$$

$$I = \frac{NBA\omega}{R} \sin(\omega t)$$

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



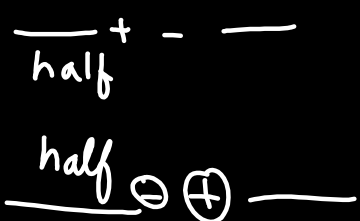
A.C. $\longrightarrow$ half cycle +ve half cycle -ve.

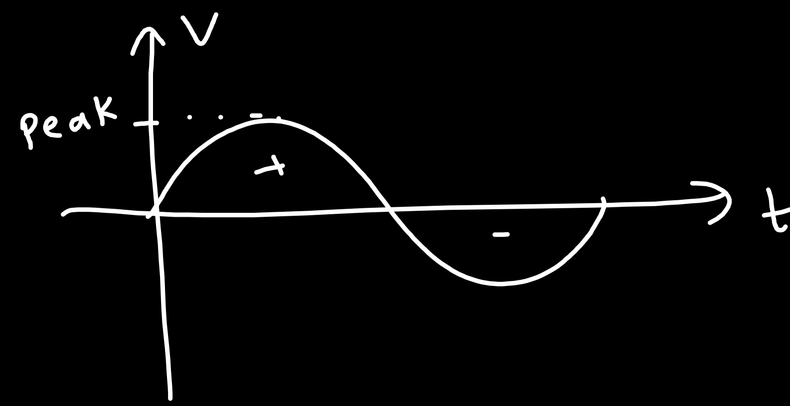


in one cycle total charge flow = 0

$$\boxed{V = V_0 \sin(\omega t + \phi)}$$

A.C. Voltage





Peak value $= V_0$

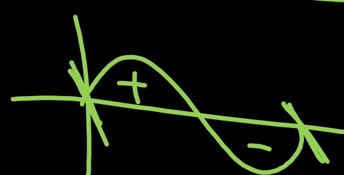
Avg Value

Rms Value.

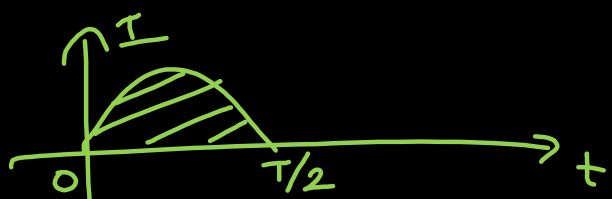
Avg Value

avg value of $y = \langle y \rangle = \dfrac{\int y\,dx}{\int dx} = \dfrac{\int y\,dx}{\Delta x}$

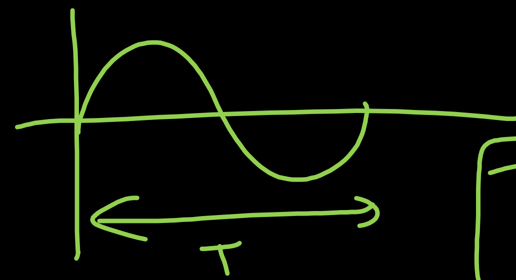
avg value of I = $\boxed{\langle I \rangle = \dfrac{\int I\,dt}{\int dt}}$ ☆☆☆

complete cycle  $I_{avg} = 0$

avg value in positive half



$$\boxed{I = I_0 \sin(\omega t)}$$



$$\boxed{T = \frac{2\pi}{\omega}}$$

$$\text{avg value} = \frac{\int_0^{T/2} I \, dt}{\int_0^{T/2} dt} = \frac{\int I_0 \sin(\omega t) \, dt}{\int dt} = \frac{I_0 \left[\left(-\frac{\cos(\omega t)}{\omega}\right)\right]_0^{T/2}}{\left[t\right]_0^{T/2}}$$

$$= \frac{-I_0}{\omega} \frac{\left[\boxed{\cos(\omega t)}\right]_0^{T/2}}{[t]_0^{T/2}}$$

$$T = \frac{2\pi}{\omega}$$

$$\cancel{\omega} \times \frac{\cancel{2}\pi}{\cancel{2}\,\cancel{\omega}}$$

$$\cos(\pi) = -1$$

$$= \frac{-I_0}{\omega} \frac{\left[\cos\left(\frac{\omega T}{2}\right) - \cos 0\right]}{\left[T/2 - 0\right]}$$

$$= \frac{-I_0}{\omega\, T/2}\left(-1-1\right) = \frac{2I_0}{\omega}\frac{2}{T} = \frac{2I_0}{\cancel{\omega}}\frac{\cancel{2}}{\cancel{2}\pi}\cancel{\omega} = \frac{2I_0}{\pi}$$

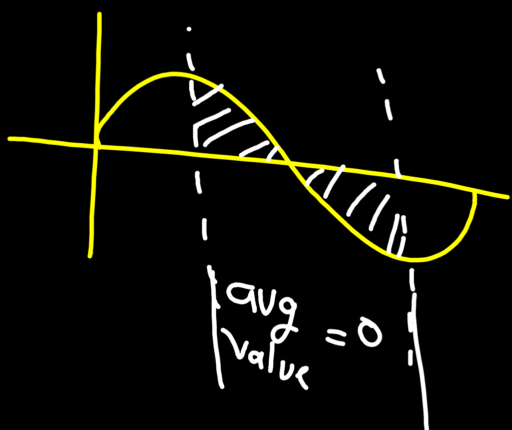
$$= \underline{0.63\, I_0}$$

$$\text{avg Value positive half} = \frac{2I_0}{\pi} = \frac{2(\text{peak})}{\pi} = 0.63 I_0$$

T/F

avg value of AC current in any half time period is $\frac{2I_0}{\pi}$

$\Rightarrow$ False



RMS Value

root

mean

square

I

square

I^2

mean

$$\frac{\int I^2\,dt}{\int dt}$$

root

$$I_{rms} = \sqrt{\frac{\int I^2\,dt}{\int dt}}$$

$$I_{rms} = \sqrt{\frac{\int_0^T I^2\,dt}{\int_0^T dt}}$$

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

$$= \sqrt{\frac{I_0^2 \int \sin^2\theta\,dt}{T}}$$

$\int \sin^2 = \int \frac{1-\cos 2\theta}{2}$

$$= \sqrt{\frac{I_0^2}{T} \int_0^T \frac{(1-\cos 2\omega t)}{2}\,dt}$$

$$= \sqrt{\frac{I_0^2}{2T} \left[t - \frac{\sin(2\omega t)}{2\omega} \right]_0^T}$$

$$= \sqrt{\frac{I_0^2}{2T}[T - 0]}$$

$$= \sqrt{\frac{I_0^2}{2}}$$

$$\varepsilon_{rms} = \frac{I_0}{\sqrt{2}}$$

$$\int_0^{360^\circ} \underset{avg}{\sin\theta} = 0$$

$$\int_0^{360} \underset{avg}{\cos\theta} = 0$$

$\sin^2\theta$ avg 1 cycle $= \frac{1}{2}$

$\cos^2\theta$ avg 1 cycle $= \frac{1}{2}$

peak

I_0

avg

$\frac{2I_0}{\pi}$

$\frac{2(\text{peak})}{\pi}$

$0.63 I_0$

rms

$\frac{I_0}{\sqrt{2}}$

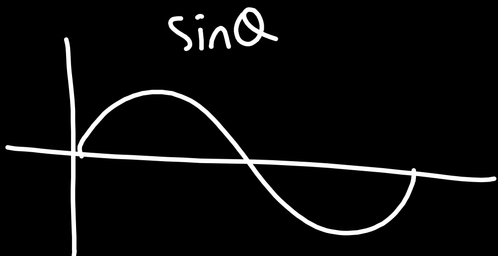
$\frac{\text{peak}}{\sqrt{2}}$

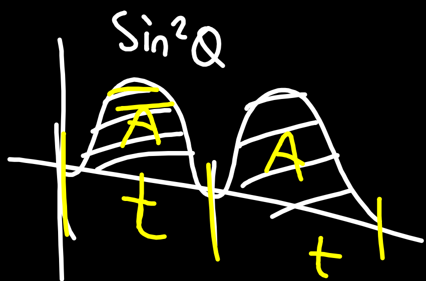
$0.707 I_0$

$\frac{1}{\sqrt{2}} = 0.707$

Peak > rms > avg

rms value for 0 to $T/2$ or for 0 to T is same





$$\text{avg} = \frac{A}{t}$$

$$\text{avg} = \frac{A+A}{t+t} = \frac{\cancel{2}A}{\cancel{2}t}$$

charge flow from 0 to T/2

$$I = \frac{dQ_{flow}}{dt}$$

$$I_{avg} = \frac{\Delta Q_{flow}}{\Delta t}$$

$$\frac{2I_0}{\pi} = \frac{\Delta Q_{flow}}{T/2}$$

$$\Rightarrow \Delta Q_{flow\ 0\ to\ T/2} = (I_{avg})(time)$$

$$= \left(\frac{2I_0}{\pi}\right)\left(\frac{T}{2}\right)$$

$$\boxed{I = 4\sin\left(100\pi t + \frac{\pi}{3}\right)}$$

Find

1. I_{peak}
2. I_{rms}
3. I_{avg} for 1st positive half
4. Time period
5. freQ
6. angular freQ (ω)
7. initial phase
8. I at $t = 1$ sec
9. phase at $t = 1$ sec.

Ans ⇒ peak = 4

$$\text{rms} = \frac{\text{peak}}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$$

$$\text{avg} = \frac{2(\text{peak})}{\pi} = \frac{2(4)}{\pi} = \frac{8}{\pi}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{100\pi} = \frac{1}{50} \text{ sec}$$

$$f = \frac{1}{T} = \frac{1}{(1/50)} = 50 \text{ Hertz}$$

ang freq $\omega = 100\pi$

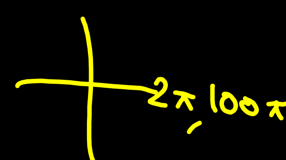
$$I_0 \sin\underbrace{(\omega t + \phi)}_{\text{phase}}$$

$t=0$ initial phase ⇒ ϕ

initial phase $= \pi/3$

$t=1$ phase $= 100\pi + \pi/3$

at $t=1$ $I = 4\sin\left(100\pi + \frac{\pi}{3}\right)$



$$= 4\sin 60^\circ$$

$$I = \frac{4\sqrt{3}}{2} = 2\sqrt{3}$$

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

$$I = I_0 \cos(\omega t)$$

peak I_0 rms $= \frac{I_0}{\sqrt{2}}$

$$I = 4I_0 \sin(\omega t) \Rightarrow \text{peak} = 4I_0$$

rms $= \frac{\text{peak}}{\sqrt{2}} = \frac{4I_0}{\sqrt{2}}$

$$I = I_0 \sin(\omega t + 60^\circ)$$

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

$$= \quad \text{Peak} = \sqrt{I_0^2 + I_0^2} = \sqrt{2}\, I_0$$

$$\text{rms} = \frac{\text{Peak}}{\sqrt{2}} = \frac{I_0 \cancel{\sqrt{2}}}{\cancel{\sqrt{2}}} = I_0 .$$

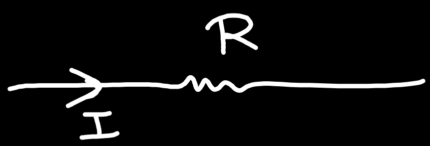
$$a \sin\theta + b \cos\theta$$

$$\downarrow$$

$$\max \Rightarrow \sqrt{a^2 + b^2}$$

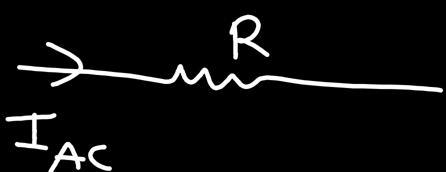
$$\boxed{\sqrt{a^2+b^2}\, \sin(\theta + \alpha)}$$

RMS current   New Point of View



$$\text{Heat} = I^2 R t$$

DC (constant)



$$\text{Heat} = \int I_{AC}^2 R \, dt$$

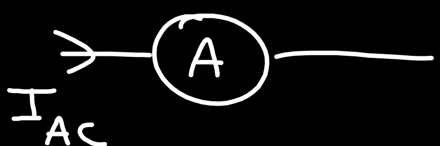
\# Replace I_{AC} by some value of constant current such that heat is same

$$I^2 \cancel{R} t = \int I_{AC}^2 \cancel{R} \, dt$$

$$I_{rms} = \sqrt{\frac{\int I_{AC}^2 \, dt}{t}}$$

Hot wire instruments $\longrightarrow$ rms value report

DC ammeter



reading = 0

India 220 Volt 50 Hz

rms value

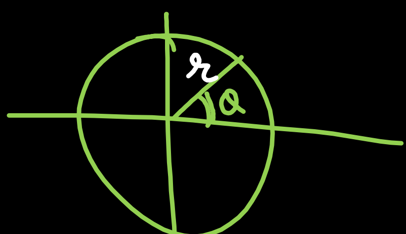
Time Calculation

Phasor Diagram Sikho

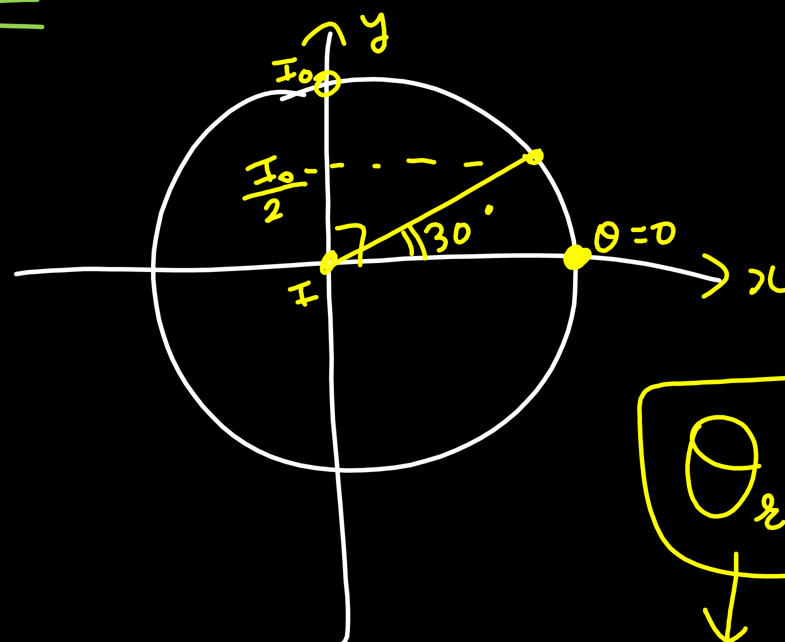
Circle

Parametric

$$x = r\cos\theta$$
$$y = r\sin\theta$$



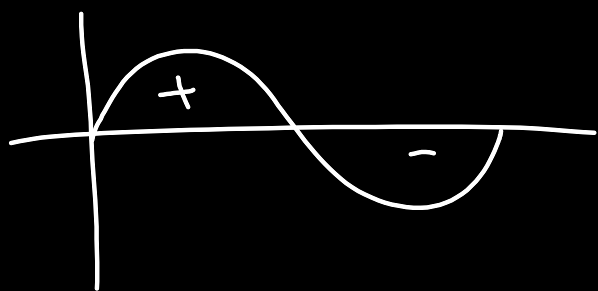
$I = I_0 \sin\theta$ — y coordinate

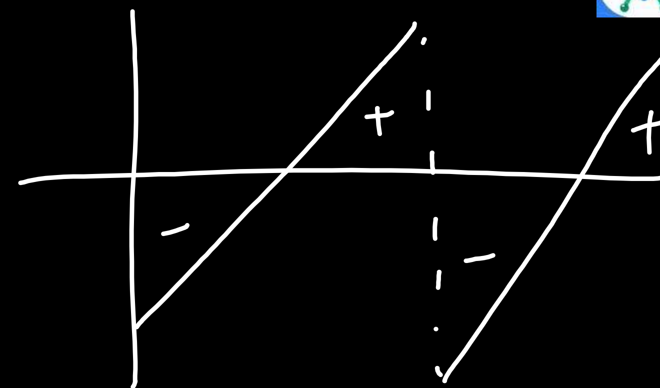


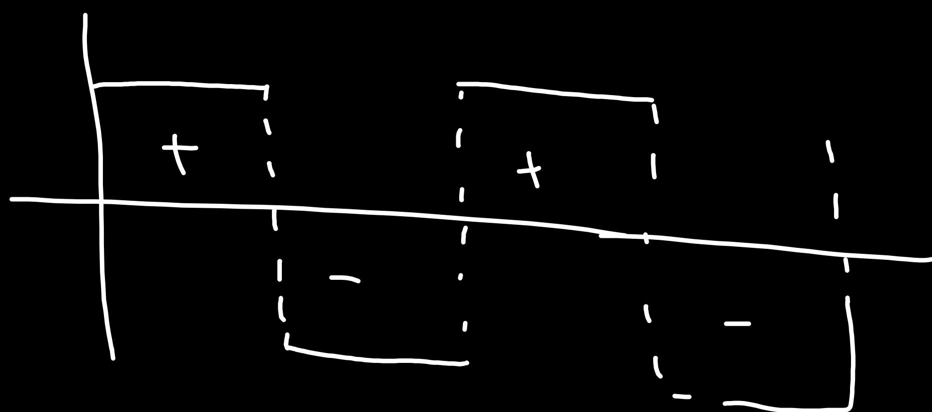
$$\boxed{\theta_{rotated} = \omega t}$$

θ in radian

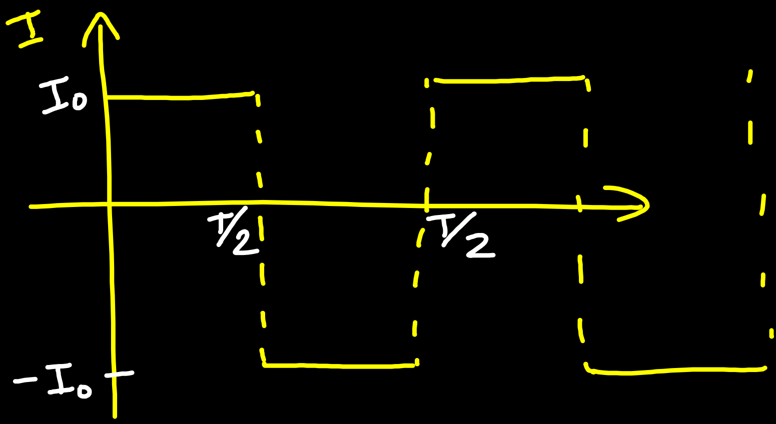
A.C.





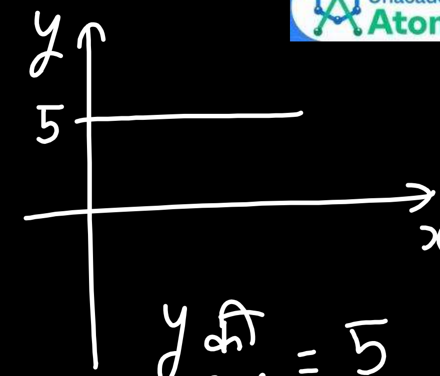


Q



Find avg & rms for 0 to T sec?

Ans: avg = 0   rms = I_0



y की $_{avg} = 5$

y की $_{rms} = 5$

Q $I = 2\sqrt{t}$

Find avg from $t = 2s$ to $t = 4sec$

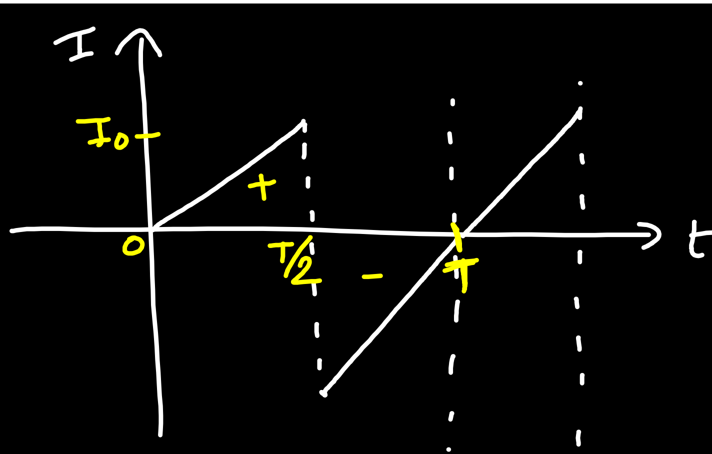
rms from $t = 2s$ to $t = 4sec$

H.W.

$$avg = \frac{\int_2^4 I\,dt}{\int_2^4 dt} = \frac{2}{3}\left(8 - 2\sqrt{2}\right)$$

$$rms = \sqrt{\frac{\int_2^4 I^2\,dt}{\int_2^4 dt}} = 2\sqrt{3}$$

Q//



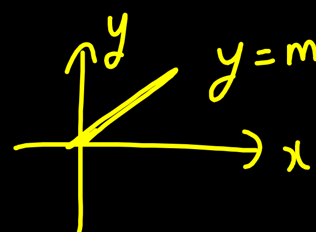
$$\text{rms} = \sqrt{\frac{\int I^2\,dt}{\int dt}}$$

Find rms value??

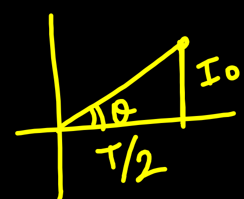
a) $I_0/\sqrt{3}$

b) $I_0/\sqrt{2}$

c) $I_0/2$



$y = mx$



$m = \frac{I_0}{T/2}$

$m = \frac{2I_0}{T}$

$y = mx$

$I = \left(\frac{2I_0}{T}\right)t$

$$\sqrt{\frac{\int I^2\,dt}{\int dt}}$$

$$= \sqrt{\frac{4I_0^2}{T^2}\frac{\int t^2\,dt}{\int dt}}$$

$$= \sqrt{\frac{4I_0^2}{T^2}\,\frac{\left.\frac{t^3}{3}\right]_0^{T/2}}{\left.t\right]_0^{T/2}}}$$

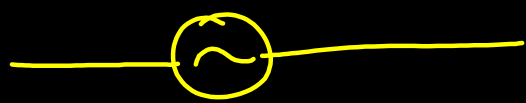
$$= \sqrt{\frac{\cancel{4}I_0^2}{\cancel{T^2}} \times \frac{1}{3} \times \frac{\cancel{T^3}\,\cancel{2}}{8\,\cancel{4}\,\cancel{T}}}$$

$$= \sqrt{\frac{I_0^2}{3}}$$

$$= \frac{I_0}{\sqrt{3}}$$

t.me/ajitlulla

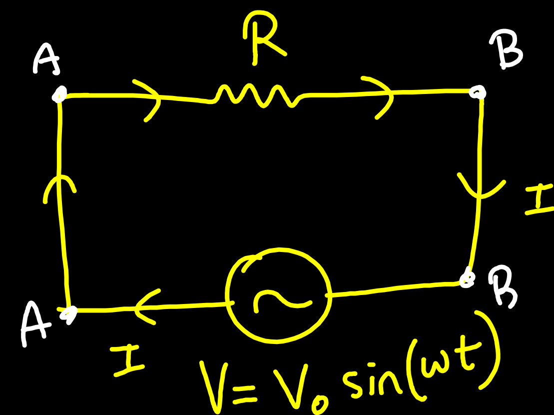
A.C. circuit



half $+$ $-$

half $-$ $+$

R only circuit



$V_A - V_B = IR$

$V_A - V_B = V_0 \sin(\omega t)$

$IR = V_0 \sin(\omega t)$

$$\boxed{I = \frac{V_0}{R} \sin(\omega t)}$$

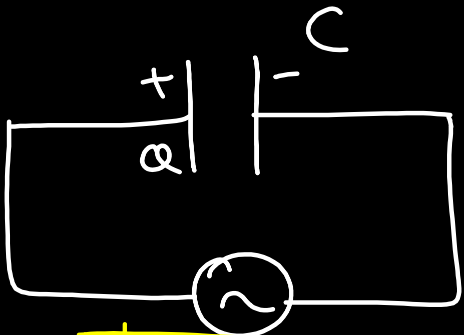
$\rightarrow$ I & V in same phase

$\rightarrow$ I_{peak} in R $= \dfrac{\Delta V_{R(peak)}}{R}$

$I_{peak} = \dfrac{V_{peak}}{R}$

$I_{rms} = \dfrac{V_{rms}}{R}$

C only



$$\boxed{V = V_0 \sin(\omega t)}$$

$$\frac{Q}{C} = V_0 \sin(\omega t)$$

$$Q = C V_0 \sin(\omega t)$$

$$\Rightarrow I = \frac{dQ}{dt} = C V_0 \cos(\omega t) \times \omega$$

$$I = \omega C V_0 \cos(\omega t)$$

$$\boxed{I = \omega C V_0 \sin(\omega t + 90^\circ)}$$

in C $\Rightarrow$ I leads Voltage by $\frac{\pi}{2}$

analogy

$$I = \frac{V}{R}$$

in C

$$I_{peak} = \omega C V_0$$

$$I_{peak} = \frac{V_0}{\left(1/\omega C\right)}$$

$$= \frac{V_0}{X_C}$$

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

Capacitive reactance.

In C

$$V = V_0 \sin(\omega t)$$

$$I = \omega C V_0 \sin(\omega t + \pi/2)$$

I leads V by $\pi/2$

$$I_{peak} = \frac{V_{peak}}{X_c}$$

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

Q// If $V = 5\sin(2t)$ across $C = 5$

find I through capacitor

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

$$= \frac{1}{2(5)}$$

$$X_c = \frac{1}{10}$$

$$I_{peak} = \frac{\Delta V_{across\ C\ peak}}{X_c}$$

$$= \frac{5}{X_c}$$

$$= \frac{5}{1/10}$$

$$I_{peak} = 50$$

$$I = I_{peak} \sin\left(2t + \frac{\pi}{2}\right)$$

$$\boxed{I = 50 \sin\left(2t + \frac{\pi}{2}\right)}$$

In constant Current $\omega = 0$

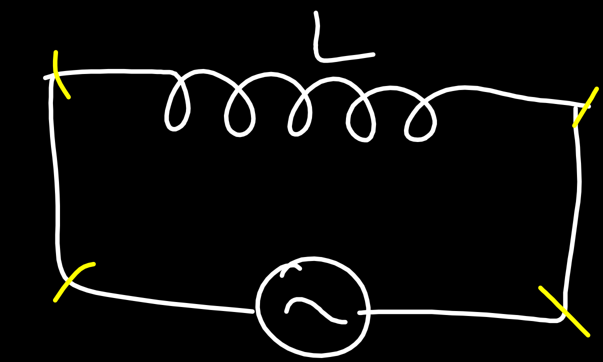
$$X_c = \frac{1}{\omega C} = \frac{1}{0} = \infty$$

$$I_{peak} = \frac{V_{peak}}{X_c} = \frac{V_{peak}}{\infty} = 0$$

$t = \infty$ —| |— behaves as open circuit

constant current —| |— gives ∞ reactance.

Only L



$V = V_0 \sin(\omega t)$

$$L\frac{dI}{dt} = V_0 \sin(\omega t)$$

$$\int dI = \frac{V_0}{L}\int \sin(\omega t)\, dt$$

$$I = \frac{V_0}{L}\,\frac{-\cos(\omega t)}{\omega}$$

$$I = \frac{-V_0}{\omega L}\cos(\omega t)$$

$$\boxed{I = \frac{V_0}{\omega L}\sin(\omega t - 90^\circ)}$$

$\Downarrow$

I lags behind Voltage by $90^\circ / \pi/2$

$$I_{peak} = \frac{V_{peak}}{R}$$

$$\boxed{X_L = \omega L}$$

reactance

inductive

$$I_{peak} = \frac{V_{peak}}{\omega L}$$

$$= \frac{V_{peak}}{X_L}$$

$I = \frac{V}{R}$

$I = \frac{V}{X}$

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

$X_L = \omega L$

CIVIL

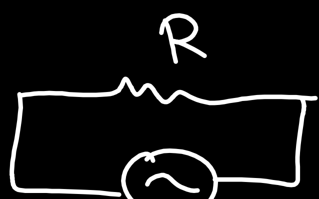
CIV

Capacitor Mein I aage by 90°

VIL

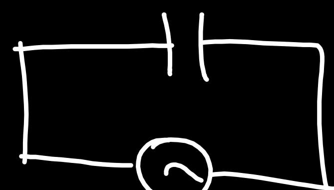
Inductor Mein V aage by 90°

I piche by 90°



$V = V_0 \sin(\omega t)$

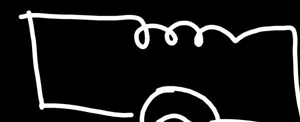
$I = \frac{V_0}{R} \sin(\omega t)$



$V = V_0 \sin(\omega t)$

$I = \frac{V_0}{X_c} \sin(\omega t + 90°)$

$I = \omega C V_0 \sin(\omega t + \frac{\pi}{2})$



$V = V_0 \sin(\omega t)$

$I = \frac{V_0}{X_L} \sin(\omega t - 90)$

$I = \frac{V_0}{\omega L} \sin(\omega t - 90)$

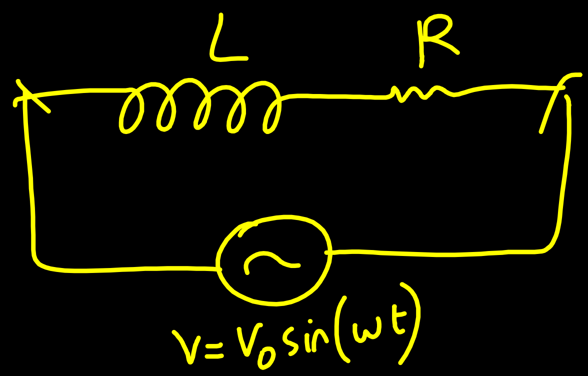
RL

RC

LC

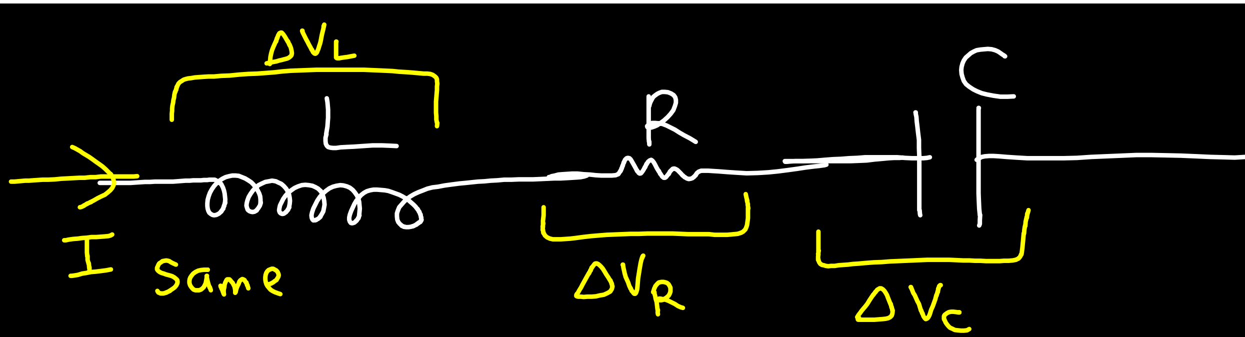
LRC

LR AC circuit



$$L\frac{dI}{dt} + IR = V_0 \sin(\omega t)$$

Phasor Diagram



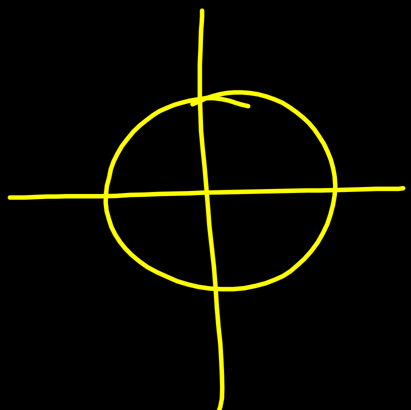
CIVIL

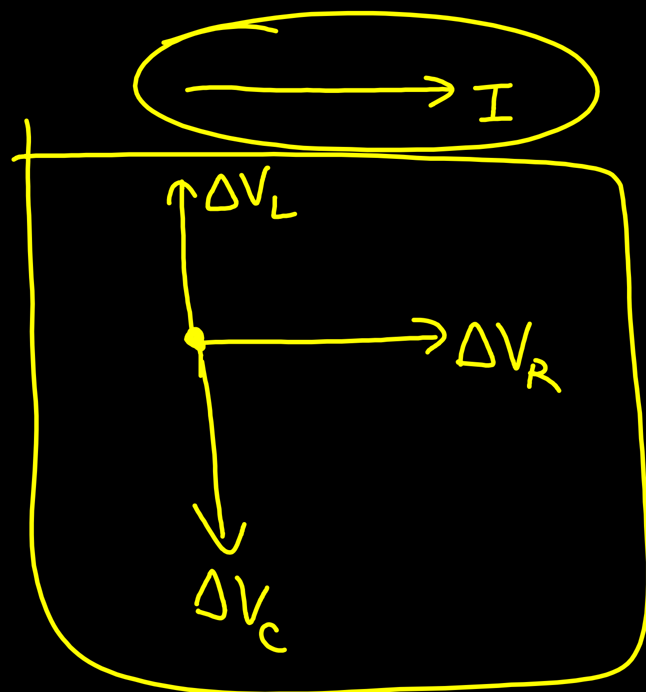
CIV

C Mein I aage
V piche

VIL

L Mein V aage





CIVIL

CIV

Capacitor I pehele

V Baad

I leads V by 90°

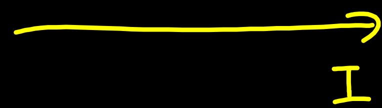
VIL

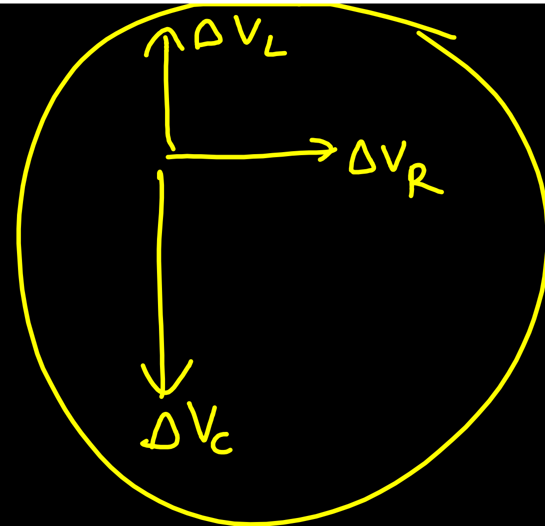
Inductor

V I

V aage by 90°

I piche by 90°





CIVIL

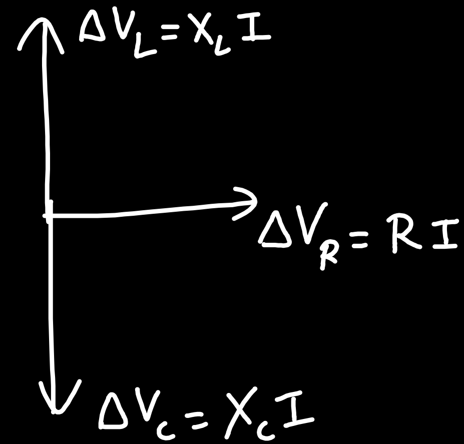
$$I_{peak} = \frac{V_{peak}}{X}$$

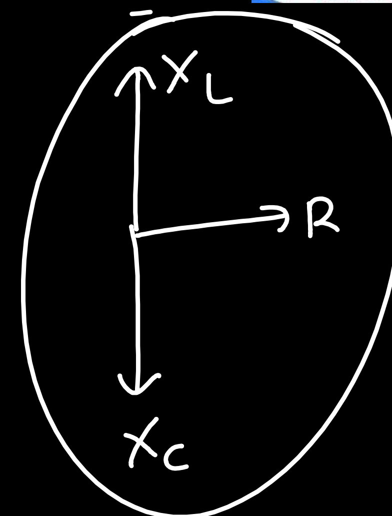
peak

rms

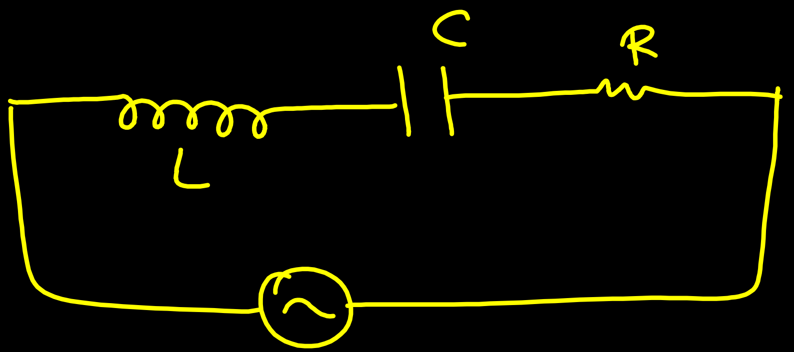
$$X\, I_{peak} = V_{peak}$$

$$X\, I_{rms} = V_{rms}$$



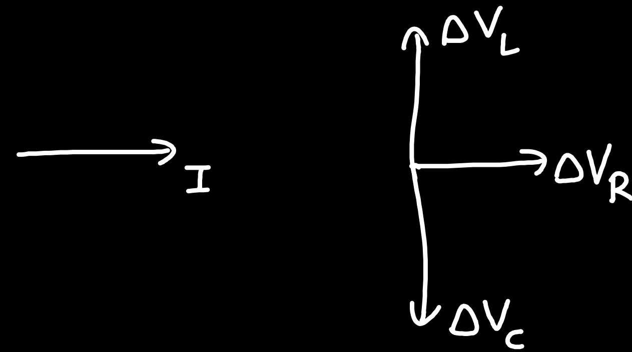


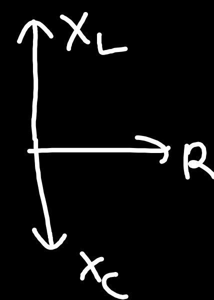
LCR circuit



$V = V_0 \sin(\omega t)$

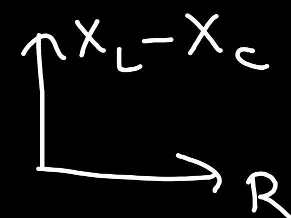
$$\boxed{L\frac{dI}{dt} + \frac{Q}{C} + IR = V_0 \sin(\omega t)}$$

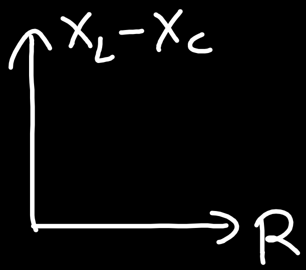




$X_L > X_C$

$\Rightarrow$





$$Z_{net} = \sqrt{R^2 + (X_L - X_c)^2}$$

net impedence

$$\boxed{I_{peak} = \frac{V_{peak}}{Z}}$$

$I = \frac{V}{R}$ only resistor

$I = \frac{V}{X}$ only C or only L

$I = \frac{V}{Z}$ RL, LC, RC or LCR

$$\boxed{I_0 = \frac{V_0}{\sqrt{R^2 + (X_L - X_c)^2}}}$$

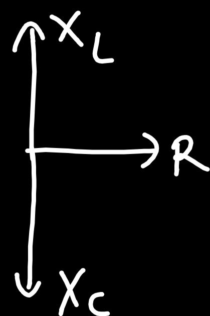
$$V = V_0 \sin(\omega t)$$

$$\boxed{I = \frac{V_0}{Z}\sin(\omega t - \phi)}$$

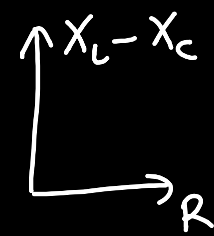
$$I = \frac{V_0}{Z}\sin(\omega t - \phi)$$

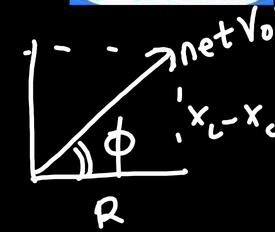
$$\boxed{I = \frac{V_0}{\sqrt{R^2 + (X_L - X_C)^2}}\sin(\omega t - \phi)}$$

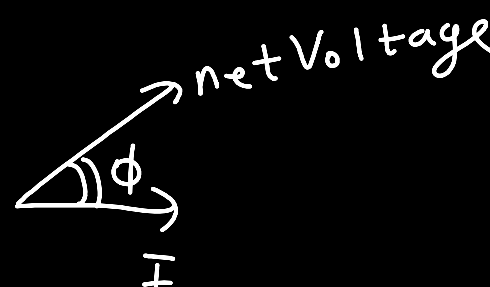
$$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$



$\Rightarrow$





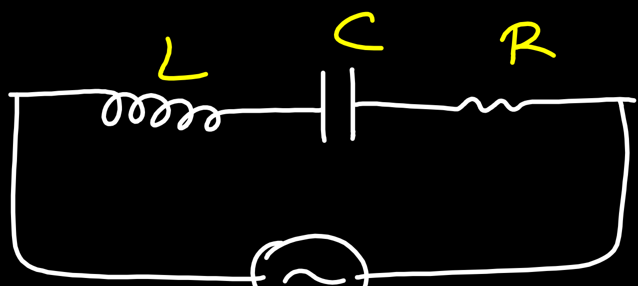


$$\tan\phi = \frac{X_L - X_C}{R}$$

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

Voltage ϕ से aage है

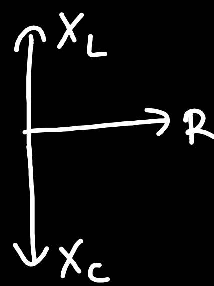
I ϕ से piche है

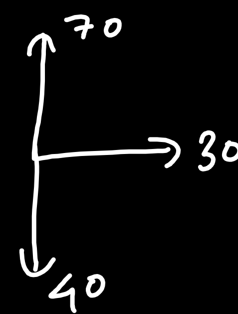


$V = 5 \sin(\omega t)$

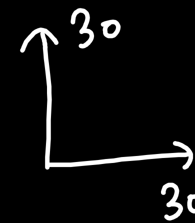
$\rightarrow I$

CIVIL





$Z = \sqrt{30^2 + 30^2} = 30\sqrt{2}$

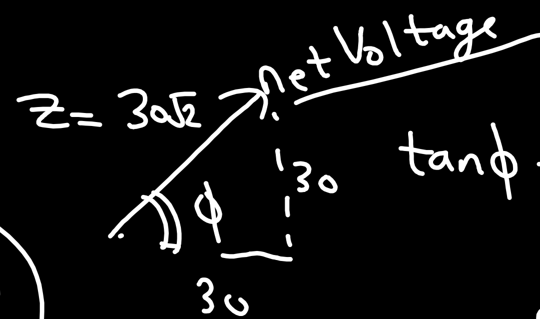


$X_L = 70\,\Omega$

$X_C = 40\,\Omega$

$R = 30\,\Omega$

$$I = \frac{5}{30\sqrt{2}} \sin(\omega t - 45^\circ)$$

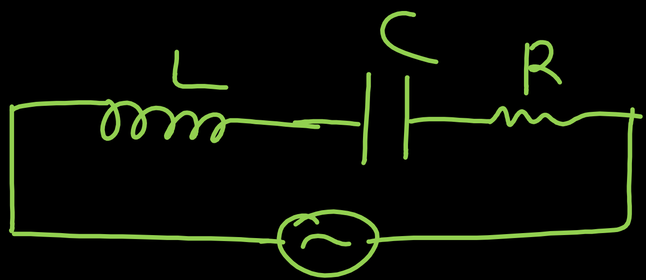


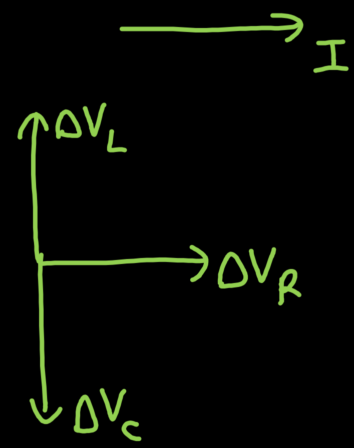
$\tan\phi = \frac{30}{30} = 1$

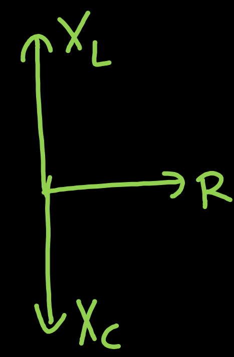
$\phi = 45^\circ$

15 min Break

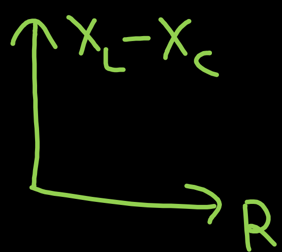
9:30 resume

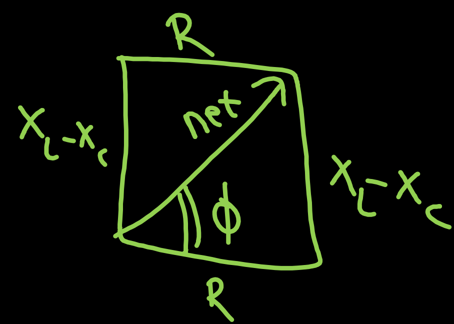






If $X_L > X_c$



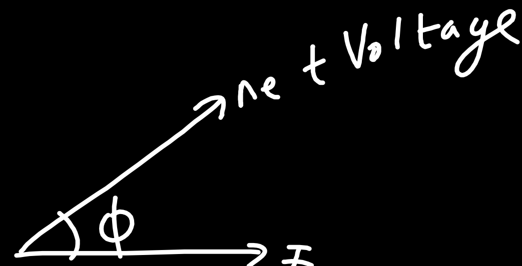


$$Z = \sqrt{R^2 + (X_L - X_c)^2}$$

$$\tan\phi = \frac{X_L - X_c}{R}$$

$$I_{peak} = \frac{V_{peak}}{Z}$$

$$X_L > X_C$$

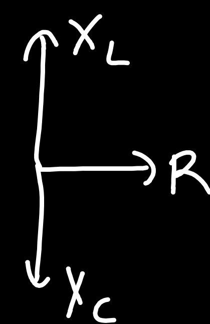


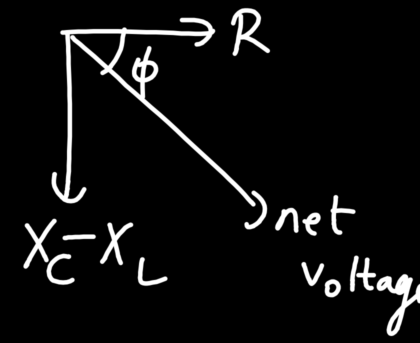
$$I = \frac{V_0}{Z} \sin(\omega t - \phi)$$

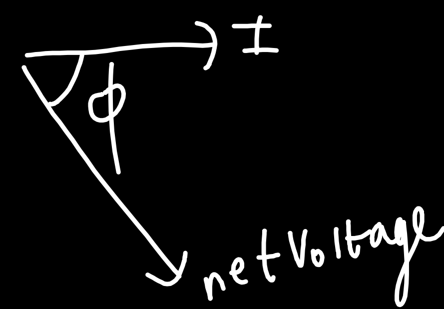
if

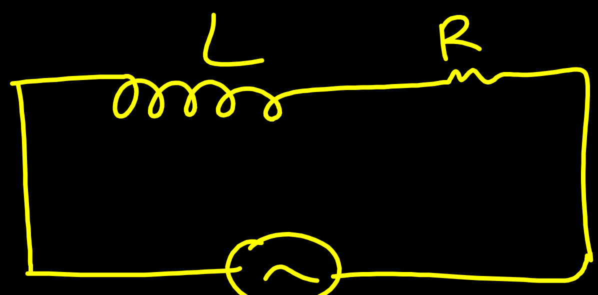
$$V = V_0 \sin(\omega t)$$

If $X_L < X_C$

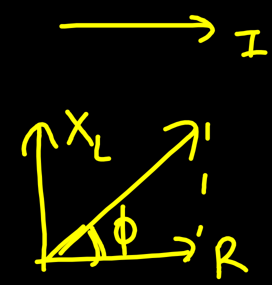


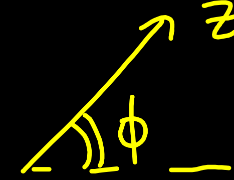






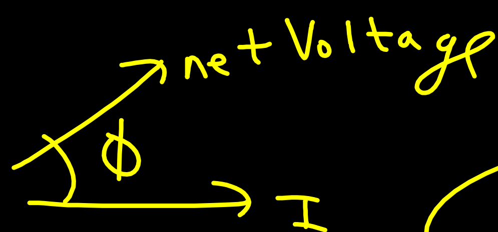
$V = V_0 \sin(\omega t)$



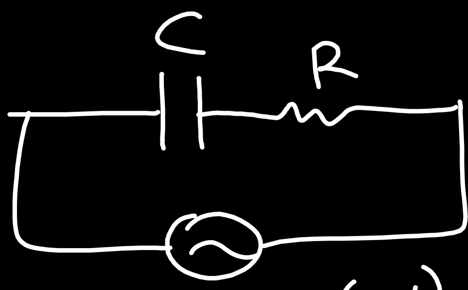


$Z = \sqrt{X_L^2 + R^2}$

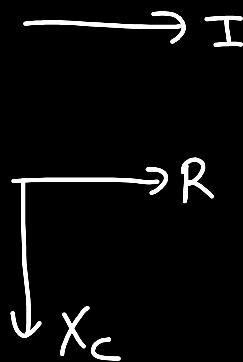
$\tan\phi = \frac{X_L}{R}$

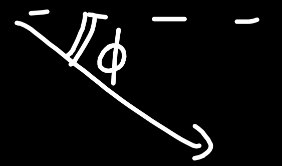


$$I = \frac{V_0}{Z} \sin(\omega t - \phi)$$



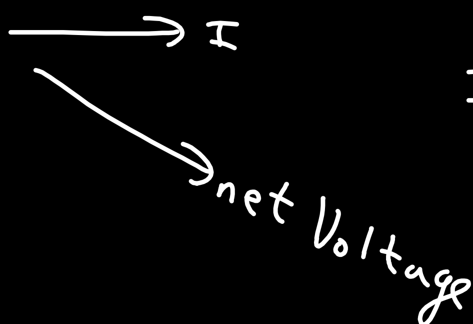
$V = V_0 \sin(\omega t)$





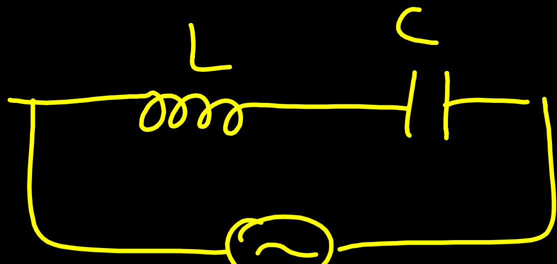
$$\tan\phi = \frac{X_c}{R}$$

$$Z = \sqrt{R^2 + X_c^2}$$



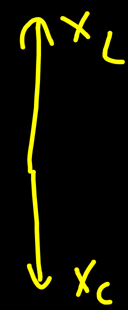
I aage by ϕ

$$I = \frac{V_0}{Z}\sin(\omega t + \phi)$$



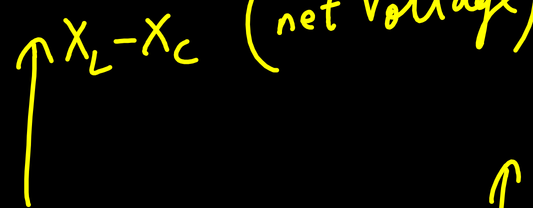
$V = V_0 \sin(\omega t)$

$\longrightarrow I$



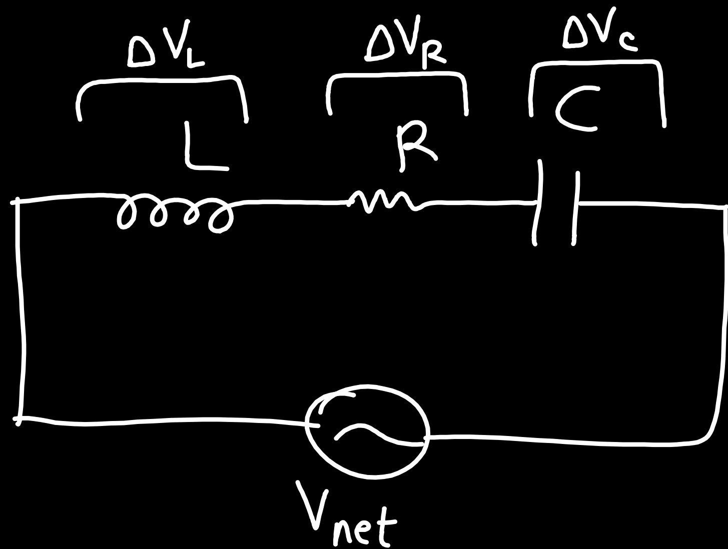
$$\boxed{Z = X_L - X_C}$$

if $X_L > X_C$

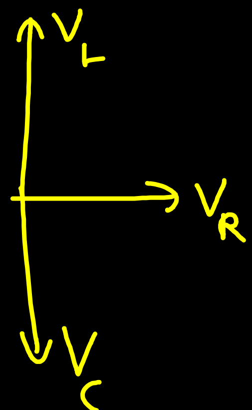


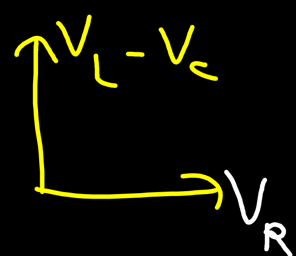
I piche 90°

$$I = \frac{V_0}{Z} \sin(\omega t - 90°)$$



Relation b/w their peak/rms values.

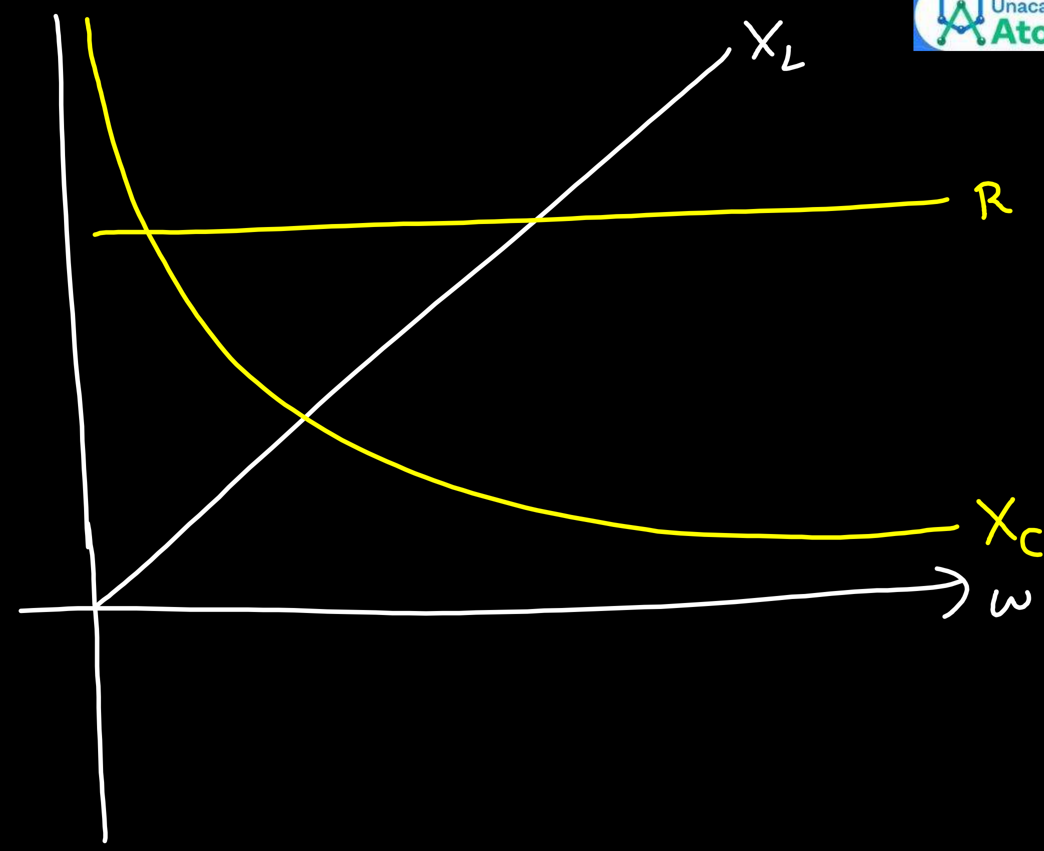




$$\boxed{V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2}}$$

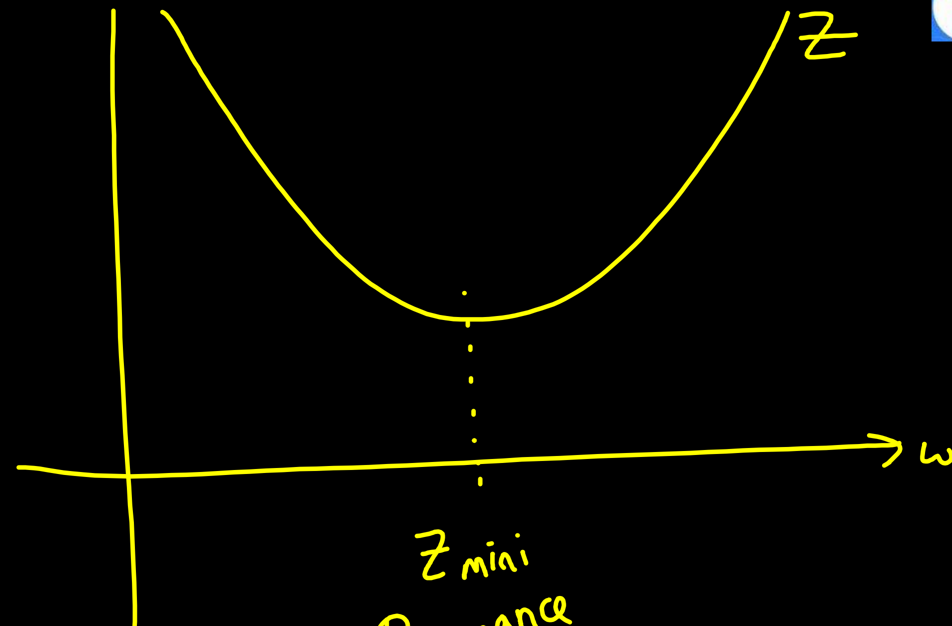
$$X_L = \omega L$$

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



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

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

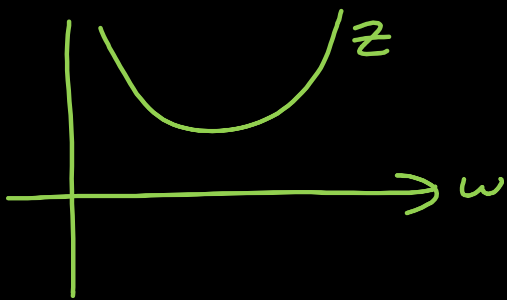


Z_{mini}

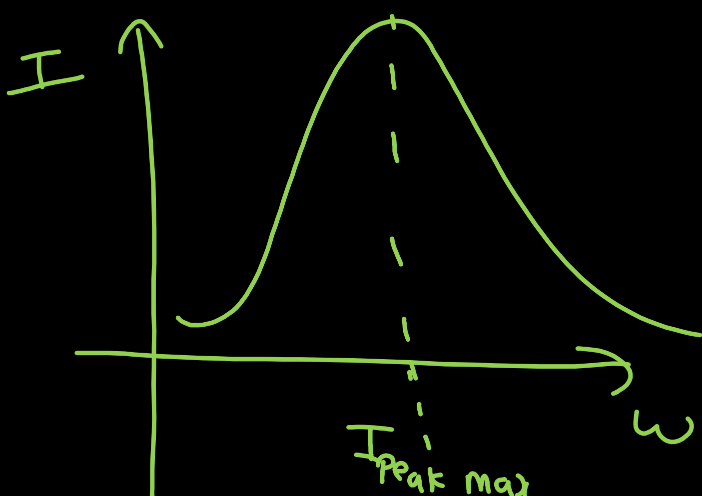
Resonance

$X_L = X_C$

$Z_{net} = R$



$$I_{peak} = \frac{V_{peak\ net}}{Z} \qquad I_{rms} = \frac{V_{net\ rms}}{Z}$$



I_{peak} max

Z_{mini}

Resonance.

Resonance

$X_L = X_C$

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

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

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

$\omega = 2\pi f$

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

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

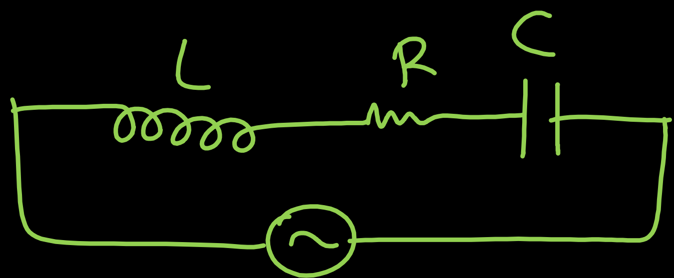
Z mini

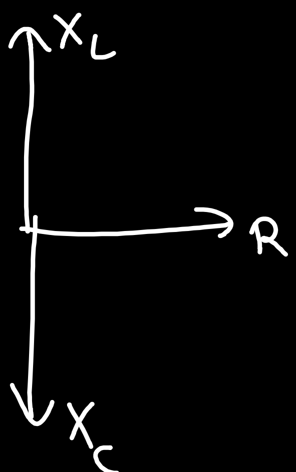
Z_{mini} = Resistance at resonance

I_{peak} maximum.

I_{net} & V_{net} are in same Phase.

Resonance $\longrightarrow$ $X_L = X_C$





if $X_L = X_C$

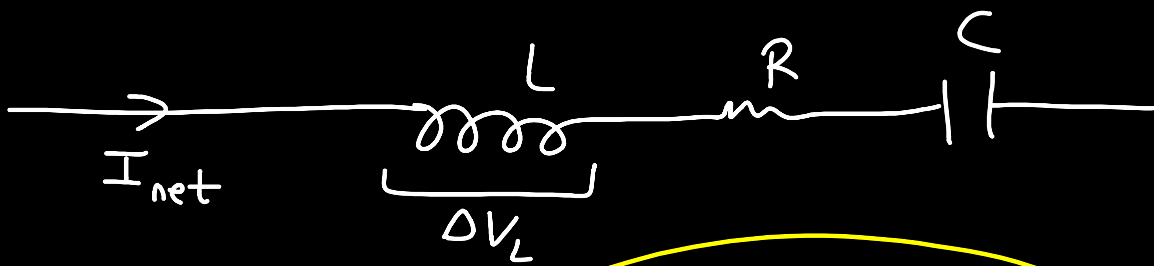
if resonance

$\longrightarrow$ I

$\longrightarrow$ R

$\longrightarrow$ net Voltage

If I_{net} is Known : How to find individual Voltages of each L & C & R



$\Delta V = IR$

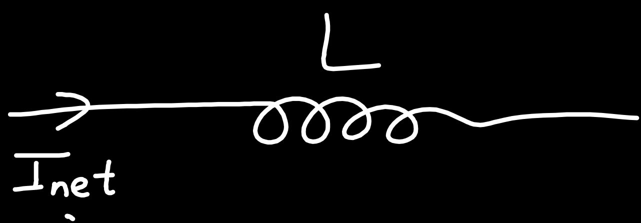
$\Delta V = IX$

for peak & rms.

$$\Delta V_{L_{peak}} = I_{peak} X_L$$

$$\Delta V_{C_{peak}} = I_{peak} X_C$$

$$\Delta V_{R_{peak}} = I_{peak} R$$



Find $\Delta V_{across\ L}$

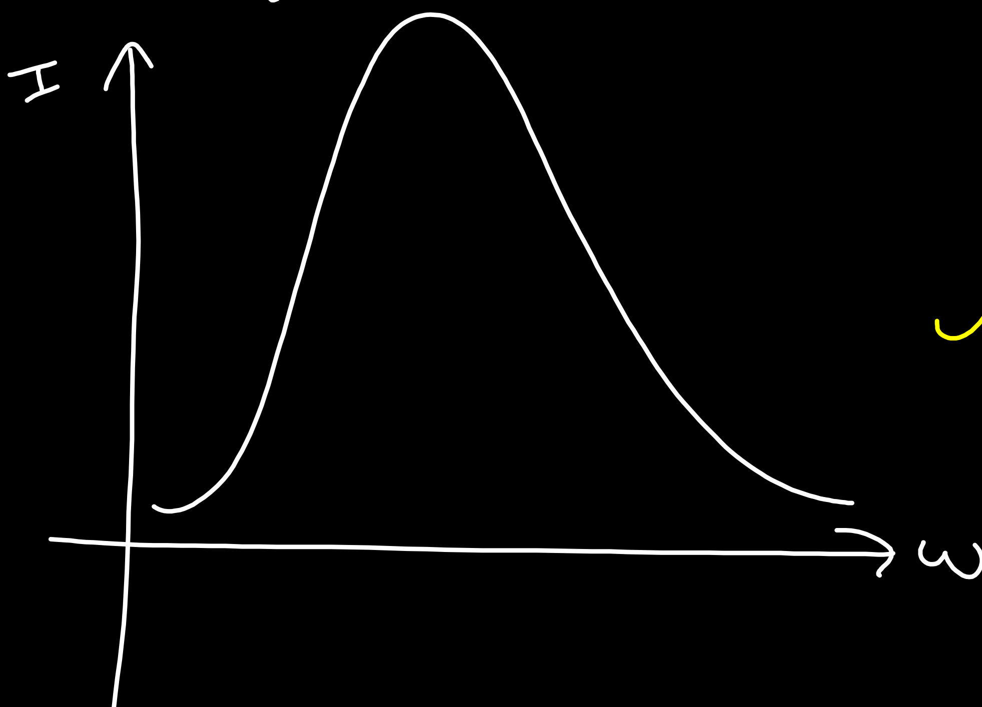
$$\Delta V_{L_{peak}} = I_{peak} X_L$$

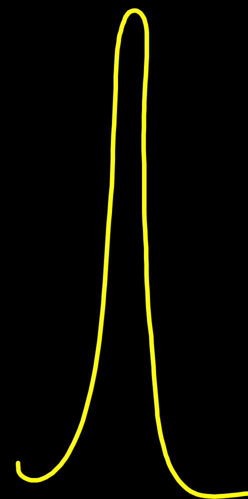
CIVIL

VIL

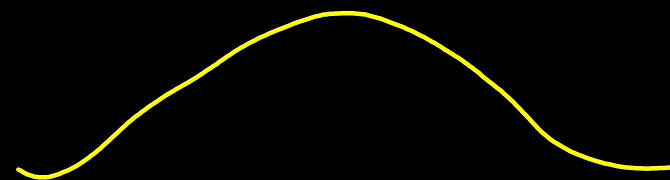
Inductor Voltage aage by 90°

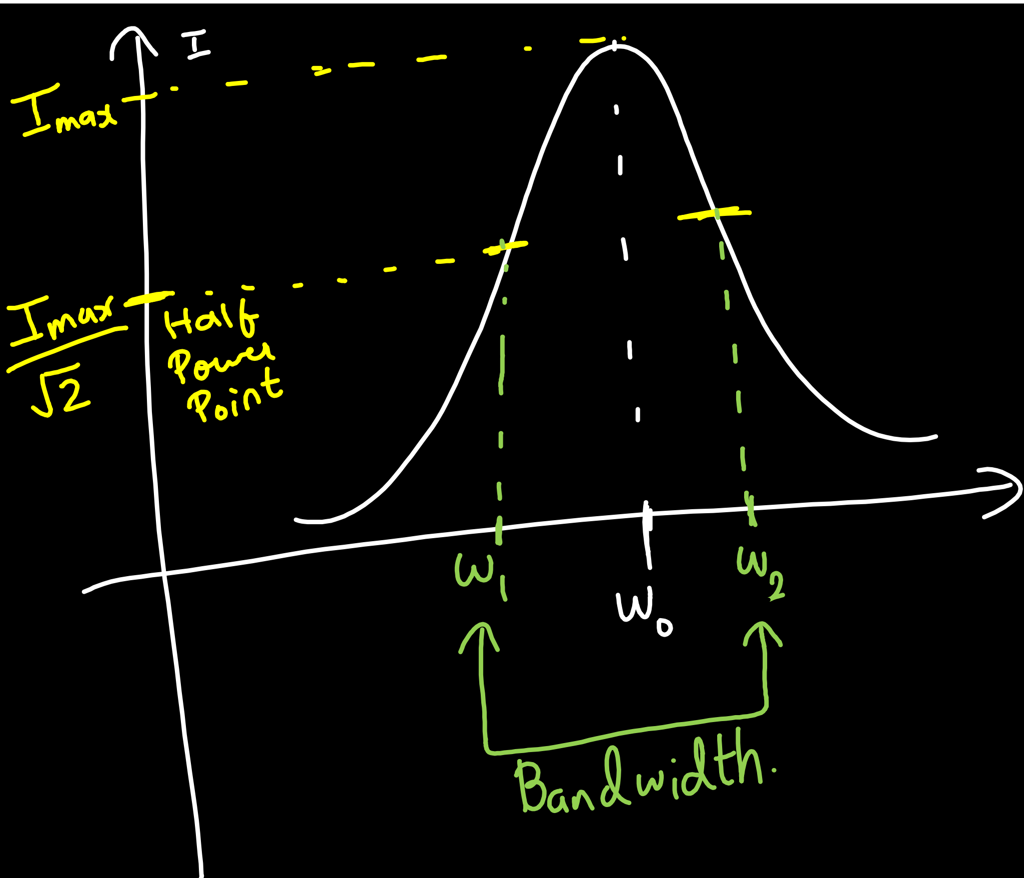
Quality Factor





Quality factor more sharpness more





$P = I^2 R$

$\boxed{\omega_2 - \omega_1 = \text{Bandwidth}}$

$$Q = \frac{\omega_0}{\text{Bandwidth}}$$

$$Q = \frac{\omega_{resonance}}{\text{Bandwidth}}$$

$$Q = \frac{\omega_0}{\omega_1 - \omega_2}$$

$$Q = \frac{\text{Power stored}}{\text{Power lost}}$$

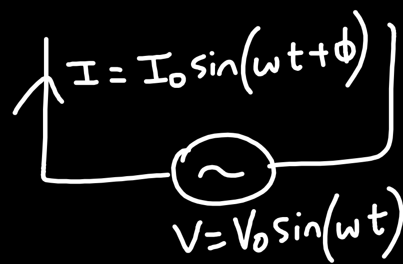
$$Q = \frac{\cancel{I^2} X_L}{\cancel{I^2} R}$$

$$Q = \frac{X_L}{R} \text{ or } \frac{X_C}{R} \text{ at resonance.}$$

$$Q = \frac{\omega L}{R} = \frac{1}{\omega C R} = \frac{1}{\sqrt{LC}} \frac{L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Power in AC circuits

$$P = (\mathcal{E}_{mf})(I)$$



$$P_{\text{instantaneous}} = \underline{V_0 \sin(\omega t) \; I_0 \; \sin(\omega t + \phi)}$$

$$\boxed{P_{avg} = V_{rms} I_{rms} \cos\phi}$$

in one cycle

$$I_{rms} = \frac{V_{rms}}{Z}$$

$\cos\phi$ = Power factor

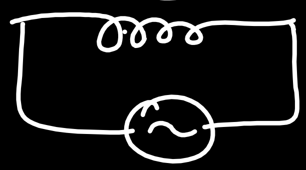
$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

Unacademy Atoms

only L

CIVIL

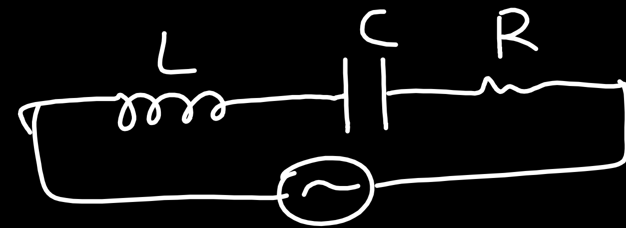


I_{net} & V_{net}

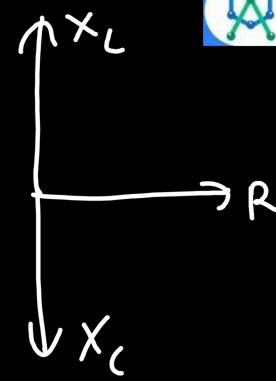
$\phi = 90^\circ$

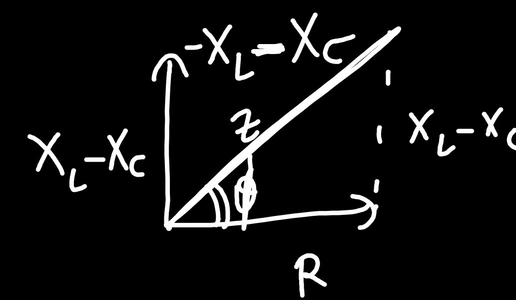
$\cos\phi = 0$

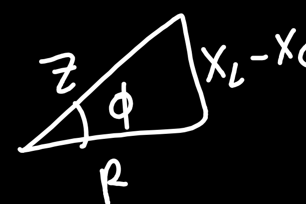
Power lost = 0



$P_{avg} = V_{rms,\,net} I_{rms} \cos\phi$







$$\cos\phi = \frac{R}{Z}$$

at Resonace

$\phi = 0$ $\cos\phi = 1$

power factor = 1

$\longrightarrow I_{net}$

$\longrightarrow V_{net}$

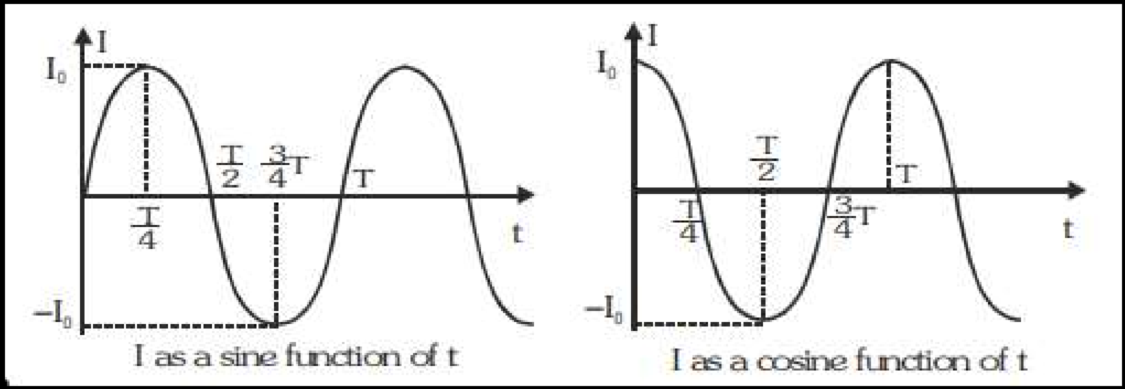
ALTERNATING CURRENT AND VOLTAGE

Voltage or current is said to be alternating if it is change continuously in magnitude and periodically in direction with time. It can be represented by a sine curve or cosine curve

$$I = I_0 \sin \omega t \text{ or } I = I_0 \cos \omega t$$

where I = Instantaneous value of current at time t, I_0 = Amplitude or peak value

$$\omega = \text{ Angular frequency } \omega = \frac{2\pi}{T} = 2\pi f \; T = \text{ time period } \; f = \text{ frequency}$$



AMPLITUDE OF AC

The maximum value of current in either direction is called peak value or the amplitude of current. It is represented by I_0. Peak to peak value $= 2I_0$

PERIODIC TIME

The time taken by alternating current to complete one cycle of variation is called periodic time or time period of the current.

FREQUENCY

The number of cycle completed by an alternating current in one second is called the frequency of the current.
UNIT : cycle/s ; (Hz)
In India : $f = 50$ Hz, supply voltage $= 220$ volt In USA :f $= 60$ Hz, supply voltage $= 110$ volt

CONDITION REQUIRED FOR CURRENT/ VOLTAGE TO BE ALTERNATING

Amplitude is constant - Alternate half cycle is positive and half negative The alternating current continuously varies in magnitude and periodically reverses its direction.

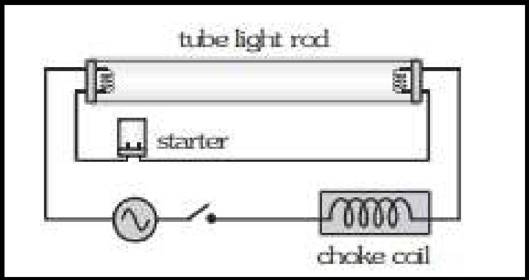
CHOKE COIL

In a direct current circuit, current is reduced with the help of a resistance. Hence there is a loss of electrical energy I^2R per sec in the form of heat in the resistance. But in an AC circuit the current can be reduced by choke coil which involves very small amount of loss of energy. Choke coil is a copper coil wound over a soft iron laminated core. This coil is put in series with the circuit in which current is to be reduced. It also known as ballast.

Circuit with a choke coil is a series L-R circuit. If resistance of choke coil = r (very small)

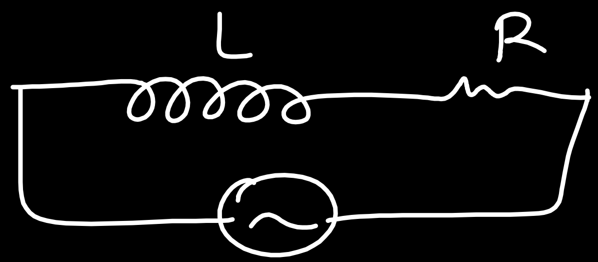
The current in the circuit $I = \frac{E}{Z}$ with $Z = \sqrt{(R+r)^2 + (\omega L)^2}$ So due to large inductance L of the coil, the current in the circuit is decreased appreciably. However, due to small resistance of the coil r,

The power loss in the choke $P_{av} = V_{rma} I_{rma} \cos\phi \rightarrow 0 \because \cos\phi = \frac{r}{Z} = \frac{r}{\sqrt{r^2+\omega^2 L^2}} \approx \frac{r}{\omega L} \rightarrow 0$



KEY POINT

- Choke coil is a high inductance and negligible resistance coil.
- Choke coil is used to control current in A.C. circuit at negligible power loss
- Choke coil used only in A.C. and not in D.C. circuit
- Choke coil is based on the principle of wattless current.
- Iron cored choke coil is used generally at low frequency and air cored at high frequency.
- Resistance of ideal choke coil is zero



Chocke Coil

L very high

R small

Power loss negligible

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

Z high

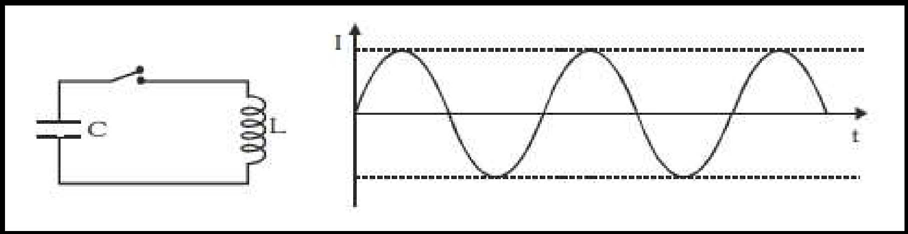
$$I \text{ low} = \frac{V_{net\ rms}}{Z}$$

LC OSCILLATION

The Oscillation of energy between capacitor (electric field energy) and inductor (magnetic field energy) is called LC Oscillation

UNDAMPED OSCILLATION

When the circuit has no resistance , the energy taken once from the source and given to capacitor keeps on oscillating between C and L then the oscillation produced will be of constant amplitude .These are called Undamped Oscillation



After switch is closed

$$\frac{Q}{C}+L\frac{di}{dt}=0 \Rightarrow \frac{Q}{C}+L\frac{d^2Q}{dt^2}=0 \Rightarrow \frac{d^2Q}{dt^2}+\frac{1}{LC}Q=0$$

By comparing with standard equation of free oscillation $\left[\frac{d^2x}{dt^2}+\omega^2x=0\right]$

$$\omega^2=\frac{1}{LC} \quad \text{Frequency of oscillation } f=\frac{1}{2\pi\sqrt{LC}}$$

Charge varies sinusoidally with time $q=q_m\cos\omega t$
current also varies periodically with t $I=\frac{dq}{dt}=q_m\omega\cos\left(\omega t+\frac{\pi}{2}\right)$

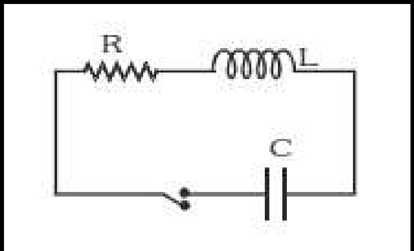
If initial charge on capacitor is q_m then electrical energy stored in capacitor is $U_E=\frac{1}{2}\frac{q^2_{\min}}{2}$
At $t=0$ switch is closed, capacitor is starts to discharge.
As the capacitor is fully discharged, the total electrical energy is stored in the inductor in the form of magnetic energy.

$$U_B=\frac{1}{2}LI_m^2 \quad \text{where } I_m = \text{ max. current}$$

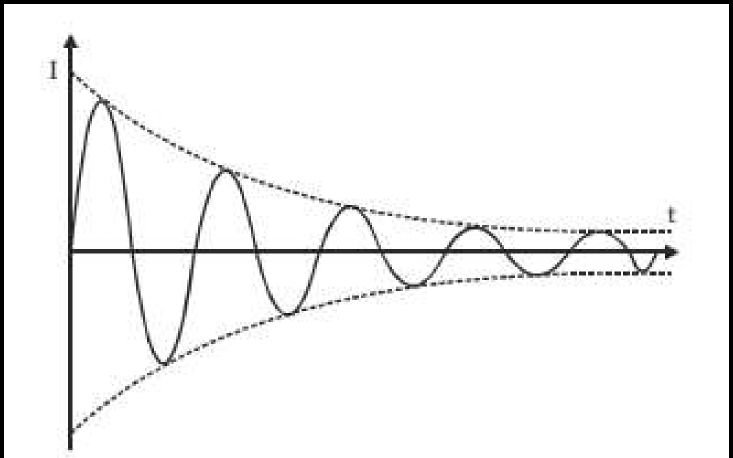
$$(U_{max})_{EPE}=(U_{m\times})_{MPE} \Rightarrow \frac{1}{2}\frac{q_m^2}{C}=\frac{1}{2}LI_m^2$$

DAMPED OSCILLATION

Practically, a circuit can not be entirely resistance less, so some part of energy is lost in resistance and amplitude of oscillation goes on decreasing. These are called damped oscillation.



Angular frequency of oscillation $\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{4\ L^2}}$



frequency of oscillation $f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$

oscillation to be real if $\frac{1}{LC} - \frac{R^2}{4L^2} > 0$

Hence for oscillation to be real $\frac{1}{LC} > \frac{R^2}{4\ L^2}$

KEY POINTS

- In damped oscillation amplitude of oscillation decreases exponentially with time.
- At $t = \frac{T}{4}, \frac{3T}{4}, \frac{5T}{4}$ .... energy stored is completely magnetic.
- At $t = \frac{T}{8}, \frac{3T}{8}, \frac{5T}{8}$ .... energy is shared equally between L and C
- Phase difference between charge and current is

$$\frac{\pi}{2}\begin{bmatrix} \text{uhen darge is maximum, arrent minimum} \\ \text{when dharge is minimumarrent meximum} \end{bmatrix}$$

An alternating current is given by the equation $i = i_1 \sin \omega t + i_2 \cos \omega t$. The rms current will be

a. $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$

b. $\frac{1}{\sqrt{2}}(i_1 + i_2)^2$

c. $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

d. $\frac{1}{\sqrt{2}}(i_1 + i_2)$

Jee 2021

$$I = I_1 \sin(\omega t) + I_2 \cos(\omega t)$$

$$\text{peak} = \sqrt{I_1^2 + I_2^2}$$

$$\text{rms} = \frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{2}}$$

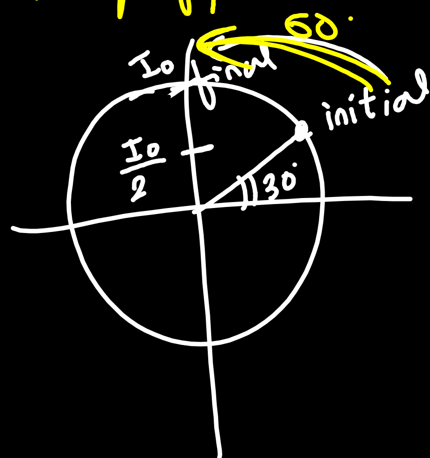
An alternating voltage $v(t) = 220 \sin 100Àt$ volt is applied to a purely resistive load of 50Ω. The time taken for the current to rise from half of the peak value to the peak value is : **[8 April 2019 I]**

(a) 5 ms (b) 2.2 ms (c) 7.2 ms ~~(d)~~ 3.3 ms

$V = 220 \sin(\underline{100\pi t})$

$R = 50\,\Omega$

half of peak $\longrightarrow$ Peak



$\theta_{rotated} = \omega t$

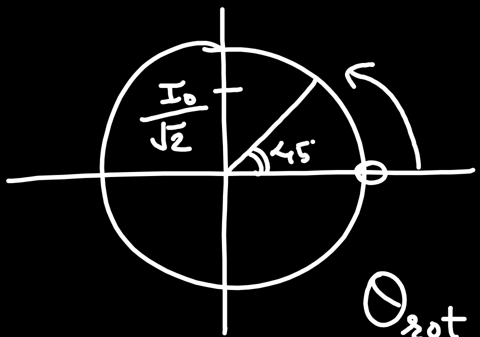
60

$\frac{\pi}{3} = 100\pi t$

$\frac{1}{300} = t$

$\frac{6.33}{100} = \frac{3.3}{1000}$

0 to rms time

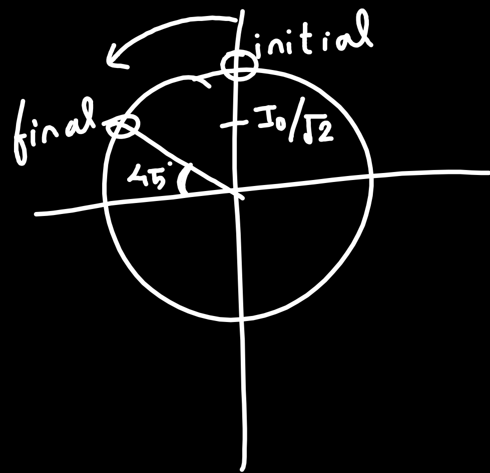


$$\theta_{rot} = \omega t$$

45°

$$\frac{\pi}{4} = \omega t$$

Peak to rms

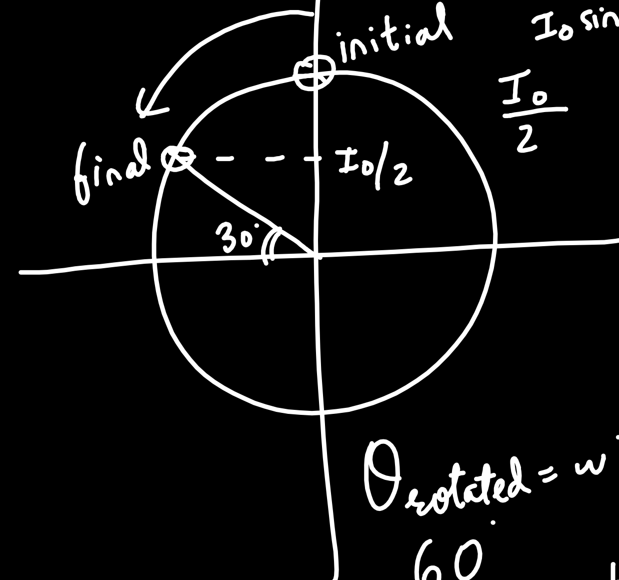


$$\theta_{rot} = \omega t$$

45°

$$\frac{\pi}{4} = \omega t$$

(Peak) to $\left(\frac{\text{Peak}}{2}\right)$



$I_0 \sin\theta$

$\frac{I_0}{2}$

$$\theta_{rotated} = \omega t$$

60°

$$\frac{\pi}{3} = \omega t.$$

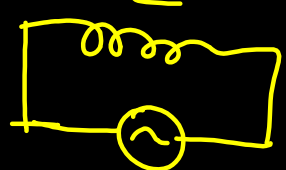
A sinusoidal voltage $V(t) = 100 \sin(500t)$ is applied across a pure inductance of $L = 0.02$ H. The current through the coil is: **[Online April 12, 2014]**

(a) $10 \cos(500t)$ (b) $-10 \cos(500t)$

(c) $10 \sin(500t)$ (d) $-10 \sin(500t)$

$$V = 100 \sin(500t)$$

L



$\omega = 500$

$V_0 = 100$

$L = 0.02$

CIVIL

VIL

Voltage aage I piche

$$I = \frac{V_0}{X_L} \sin(500t - 90^\circ)$$

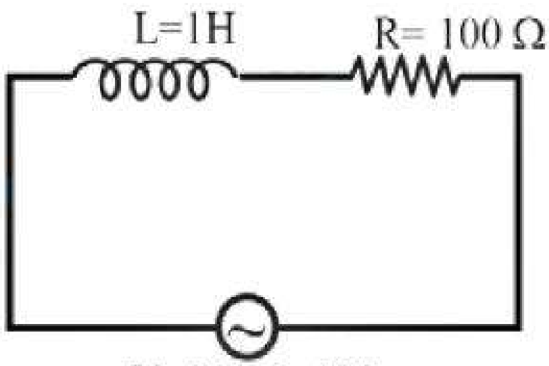
$$= 10\left[-\cos(500t)\right]$$

$X_L = \omega L$

$= 500 \times 0.02$

$= 5\cancel{00} \times \frac{2}{1\cancel{00}}$

In the adjacent circuit, the instantaneous current equation is



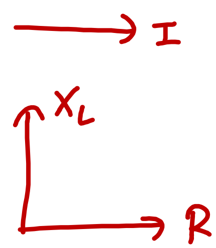
$L = 1$

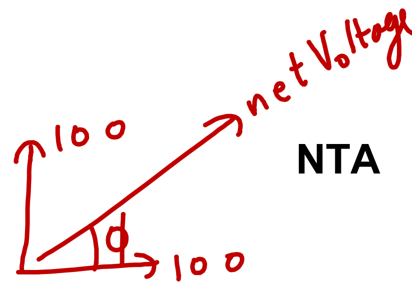
$R = 100$

$V_0 = 200$

$\omega = 100$

$X_L = \omega L = 100$





NTA

$Z = 100\sqrt{2}$

$\phi = 45^\circ$

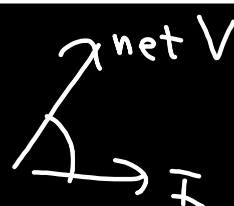
(A) $2\sin\left(100t - \frac{\pi}{4}\right)$

(B) $\sqrt{2}\sin\left(100t - \frac{\pi}{4}\right)$

(C) $\sqrt{2}\sin\left(200t - \frac{\pi}{4}\right)$

(D) $\sqrt{2}\left(100t + \frac{\pi}{4}\right)$

$V = 200\sin(100t)$



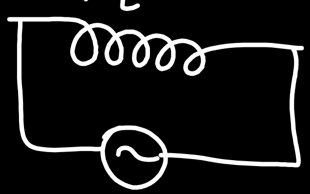
I piche by 45°

$I = \frac{V_0}{Z}\sin(100t - 45)$

An inductance coil has a reactance of 100 Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the applied voltage leads the current by 45°. The self-inductance of the coil is : **[Sep. 02, 2020 (II)]**

(a) 1.1×10^{-2} H
(b) 1.1×10^{-1} H
(c) 5.5×10^{-5} H
(d) 6.7×10^{-7} H

$X_L = 100\,\Omega$



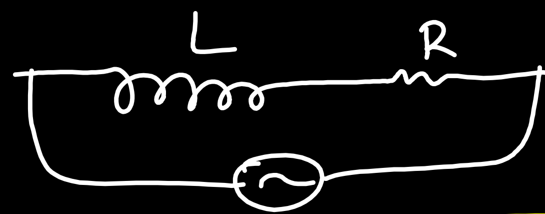
$f = 1000$ Hz

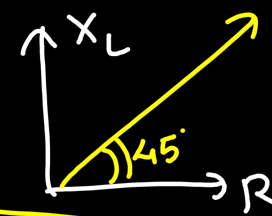
Voltage aage by 45°

$L = ?$

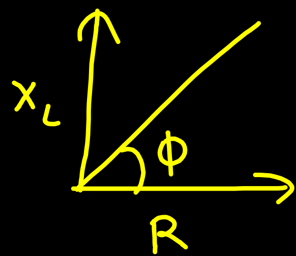
only L

$\phi = 90^\circ$





$\boxed{\omega = \frac{2\pi}{T} = 2\pi f}$



$f = 1000$

$X_L = \omega L$

$Z = 100\,\Omega$

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

$= \sqrt{X^2 + X^2}$

$Z = X\sqrt{2}$

$100 = X\sqrt{2}$

$\frac{100}{\sqrt{2}} = X = \omega L$

$\tan\phi = \frac{X_L}{R}$

$\tan 45 = \frac{X}{R} = 1$

$R = X$

$$X = \omega L = \frac{100}{\sqrt{2}}$$

$$2\pi f L = \frac{100}{\sqrt{2}}$$

$$2\pi(10\cancel{0}\cancel{0})L = \frac{1\cancel{0}\cancel{0}}{\sqrt{2}}$$

$$L = \frac{1}{20\sqrt{2}\,\pi}$$

A circuit connected to an *ac* source of *emf* $e = e_0 \sin(100t)$ with t in seconds, gives a phase difference of $\frac{\pi}{4}$ between the *emf* e and current i. Which of the following circuits will exhibit this? **[8 April 2019 II]**

$\phi = 45°$

$\omega = 100$

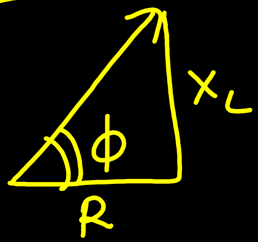
(a) RL circuit with R = 1 kΩ and L = 10 mH $R = X_L$

(b) RL circuit with R = 1 kΩ and L = 1 mH $R = X_L$

(c) RC circuit with R = 1 kΩ and C = 1 μF $R = X_C$

(d) RC circuit with R = 1 kΩ and C = 10 μF. $R = X_C$

LR

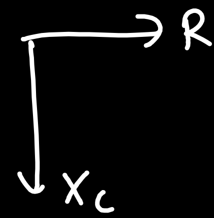


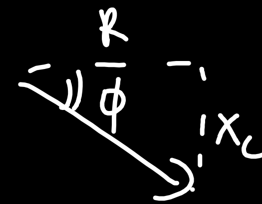
$$\tan\phi = \frac{X_L}{R} = 1$$

$$X_L = R$$

$$\omega L = R$$

RC





$$\tan\phi = \frac{X_c}{R} = 1$$

$$X_c = R$$

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

In LC circuit the inductance L = 40 mH and capacitance C = 100 μF. If a voltage $V(t) = 10 \sin(314\, t)$ is applied to the circuit, the current in the circuit is given as:

[9 Jan. 2019 II]

(a) $0.52 \cos 314\, t$

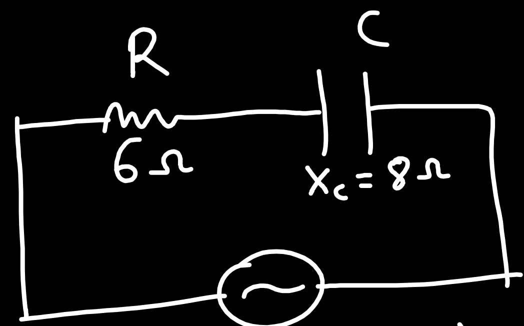
(b) $10 \cos 314\, t$

(c) $5.2 \cos 314\, t$

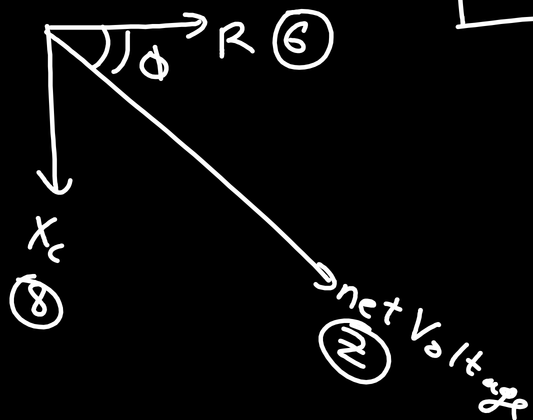
(d) $0.52 \sin 314\, t$

Find function of I with time??

$\longrightarrow I$

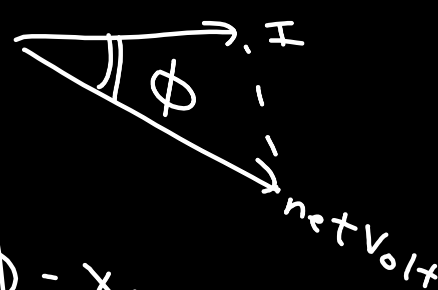


$V = 20\sin(\omega t)$



$Z = \sqrt{R^2 + X_c^2}$

$Z = 10$



$\tan\phi = \frac{X_c}{R} = \frac{8}{6} = \frac{4}{3}$

$\phi = \tan^{-1}\left(\frac{4}{3}\right) = 53^\circ$

I aage by ϕ

$I = \frac{V_0}{Z}\sin(\omega t + \phi)$

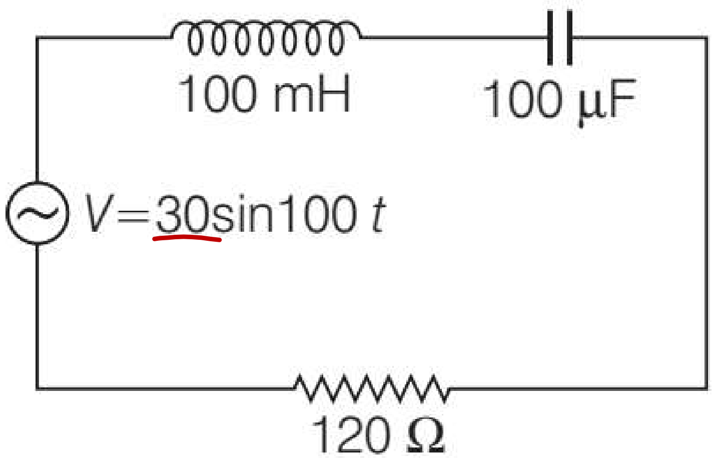
$I = \frac{20}{10}\sin(\omega t + 53^\circ)$

$\boxed{I = 2\sin(\omega t + 53^\circ)}$

Find the peak current and resonant frequency of the following circuit (as shown in figure).

2021

$\pi = \sqrt{10}$



a. 0.2 A and 50 Hz
b. 0.2 A and 100 Hz
c. 2 A and 100 Hz
d. 2 A and 50 Hz

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

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

$$f = \frac{1}{2\pi\sqrt{100\times10^{-3}\times100\times10^{-6}}}$$

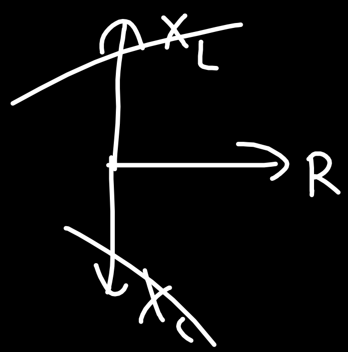
$$= \frac{1}{2\pi\sqrt{10^{-5}}}$$

$$= \frac{1\sqrt{100000}}{2\pi}$$

$$= \frac{100\cancel{\sqrt{10}}}{2\cancel{\pi}} = 50$$

$$I_{peak} = \frac{V_{peak}}{Z_{mini}} = \frac{30}{120} = \frac{1}{4} = \underline{\underline{0.25}}$$

at Resonance $X_L = X_C$



A sinusoidal voltage of peak value 283 V and angular frequency 320/s is applied to a series LCR circuit. Given that R = 5 Ω, L = 25 mH and C = 1000 μF. The total impedance, and phase difference between the voltage across the source and the current will respectively be :

H.W.

[Online April 9, 2017]

(a) 10 Ω and $\tan^{-1}\left(\frac{5}{3}\right)$ ~~(b)~~ 7 Ω and 45°

(c) 10 Ω and $\tan^{-1}\left(\frac{8}{3}\right)$ (d) 7 Ω and $\tan^{-1}\left(\frac{5}{3}\right)$

$V_0 = 283$

$\omega = 320$

$R = 5\Omega$

$L = 25\,mH$

$C = 1000\,\mu F$

$Z = ?$

$\phi = ?$

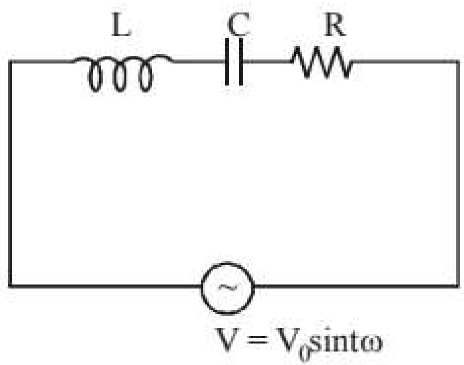
$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

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

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

For the LCR circuit, shown here, the current is observed to lead the applied voltage. An additional capacitor C', when joined with the capacitor C present in the circuit, makes the power factor of the circuit unity. The capacitor C', must have been connected in :

[Online April 11, 2015]



(a) series with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$

(b) series with C and has a magnitude $\frac{1 - \omega^2 LC}{\omega^2 L}$

(c) parallel with C and has a magnitude $\frac{1 - \omega^2 LC}{\omega^2 L}$

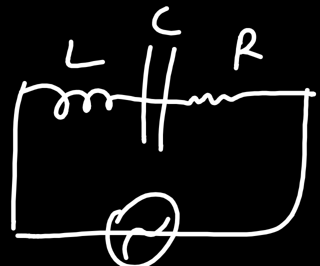
(d) parallel with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$

When the rms voltages V_L, V_C and V_R are measured respectively across the inductor L, the capacitor C and the resistor R in a series LCR circuit connected to an AC source, it is found that the ratio $V_L : V_C : V_R = 1 : 2 : 3$. If the rms voltage of the AC sources is 100 V, the V_R is close to:

[Online April 9, 2014]

(a) 50 V (b) 70 V (c) 90 V (d) 100 V

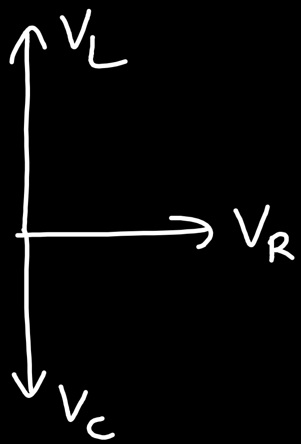
$V_{\substack{net \\ rms}} = 100\,V$

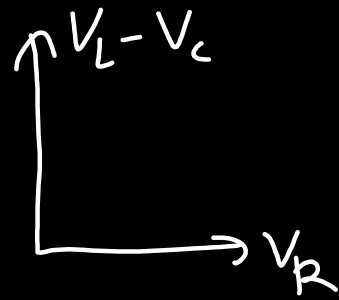


V_L 1 x

V_C 2 $2x$

V_R 3 $3x$





$$V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$100 = \sqrt{(3x)^2 + (x - 2x)^2}$$

$$100 = \sqrt{9x^2 + x^2}$$

$$100 = \sqrt{10x^2}$$

$$1000\cancel{0} = \cancel{10}x^2$$

$$\underline{10\sqrt{10} = x}$$

$$V_R = 3x$$

$$= 3(10\sqrt{10}) = 30\sqrt{10}$$

$$= \underline{30 \times 3.14}$$

When resonance is produced in a series LCR circuit, then which of the following is not correct ?

[Online April 25, 2013]

(a) Current in the circuit is in phase with the applied voltage. correct

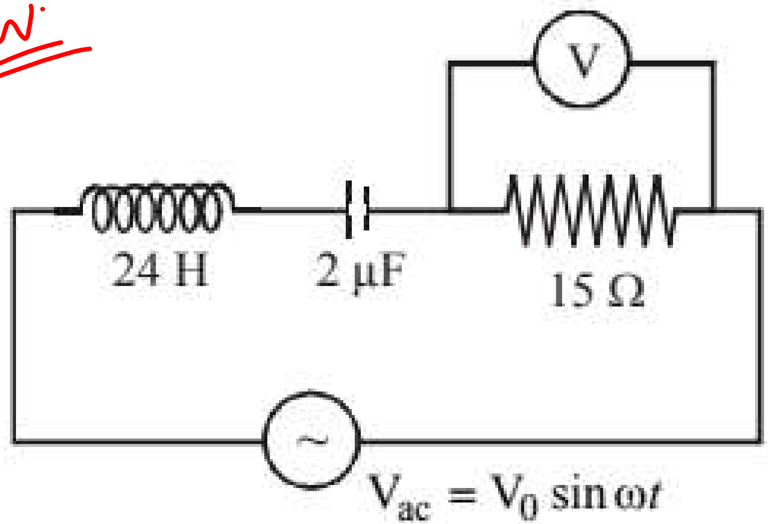
(b) Inductive and capacitive reactances are equal. $X_L = X_C$ correct

(c) If R is reduced, the voltage across capacitor will increase.

(d) Impedance of the circuit is maximum. Z minimum not correct

An LCR circuit as shown in the figure is connected to a voltage source V_{ac} whose frequency can be varied.

H.W.



The frequency, at which the voltage across the resistor is maximum, is : **[Online April 22, 2013]**

(a) 902 Hz (b) 143 Hz (c) 23 Hz (d) 345 Hz

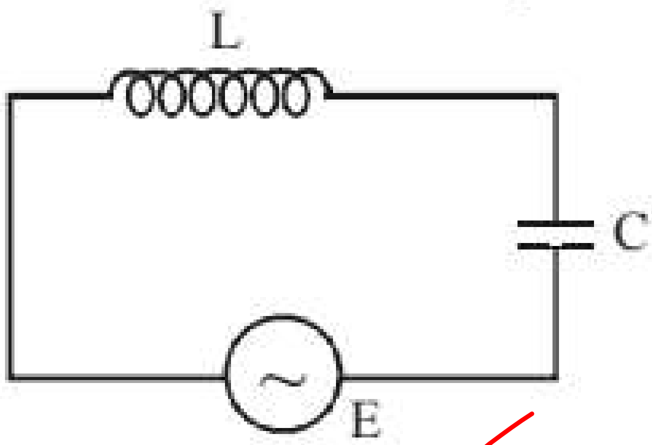
$\Delta V_R = IR$

max ⇒ I_{max}

Resonance

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

In the circuit shown here, the voltage across E and C are respectively 300 V and 400 V. The voltage E of the ac source is : **[Online April 9, 2013]**



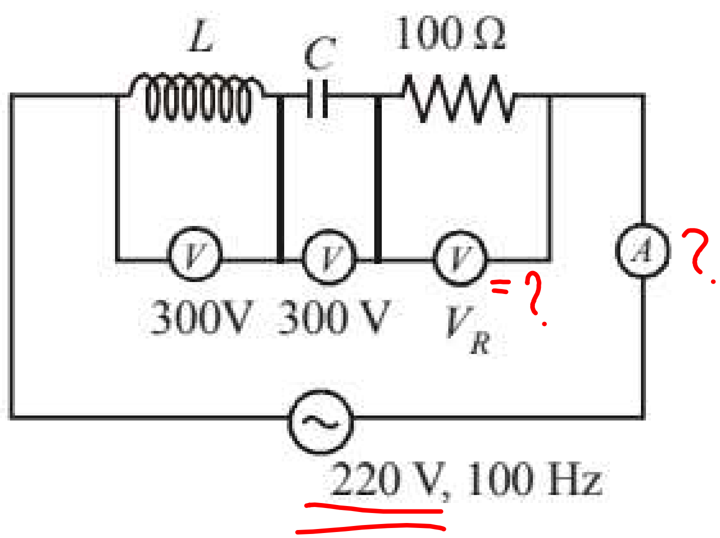
(a) 400 Volt (b) 500 Volt (c) 100 Volt (d) 700 Volt

X_L 300

X_C 400

100

In an *LCR* circuit shown in the following figure, what will be the readings of the voltmeter across the resistor and ammeter if an *a.c.* source of 220V and 100 Hz is connected to it as shown? **[Online May 7, 2012]**



(a) 800 V, 8 A (b) 110 V, 1.1 A

(c) 300 V, 3 A (d) 220V, 2.2 A

$\cancel{\Delta V_L = 300}$

ΔV_R

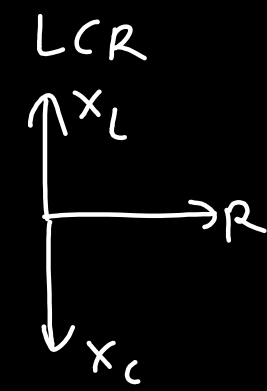
$\cancel{\Delta V_C\ 300}$

Resonance $Z = R$

$$I = \frac{V}{Z} = \frac{220}{100} = \underline{2.2\,A}$$

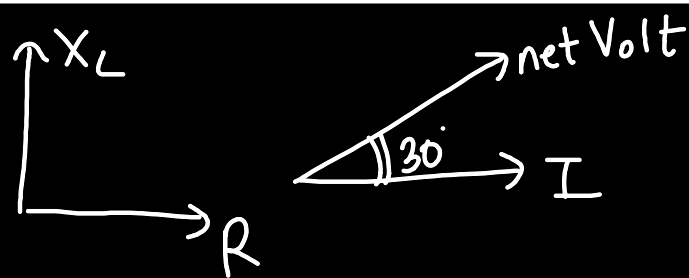
In a series LCR circuit $R = 200\Omega$ and the voltage and the frequency of the main supply is 220V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30°. On taking out the inductor from the circuit the current leads the voltage by 30°. The power dissipated in the LCR circuit is **[2010]**

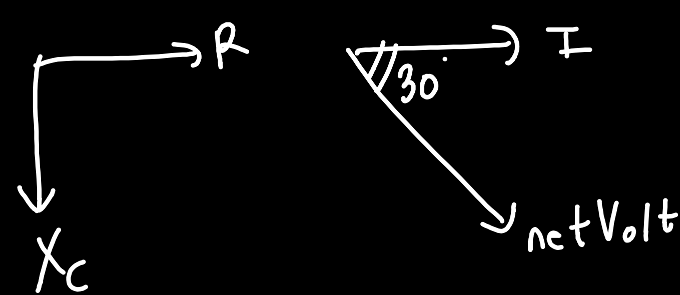
(a) 305 W (b) 210 W (c) Zero W (d) 242 W

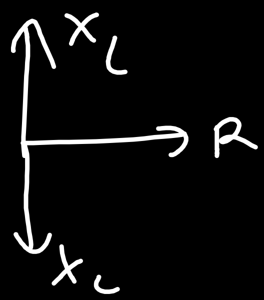


$\phi = ?$

$\cos\phi = ?$







Resonace $\phi = 0$

$\longrightarrow R$

$$I = \frac{V_{rms}}{Z}$$

$=$

$$P = V_{rms} I_{rms} \cos\phi$$

$$= V_{rms}\left(\frac{V_{rms}}{Z}\right) 1$$

$$= \frac{(V_{rms})^2}{R}$$

$$= \frac{(220)^2}{200} = \frac{\overset{11}{\cancel{22}}\cancel{0} \times 22\cancel{0}}{\cancel{2}\cancel{0}\cancel{0}}$$

$$= \underline{242}$$

The phase difference between the alternating current and emf is $\frac{\pi}{2}$. Which of the following cannot be the constituent of the circuit? [2005]

(a) R, L (b) C alone (c) L alone (d) L, C

In an LCR series a.c. circuit, the voltage across each of the components, L, C and R is 50V. The voltage across the LC combination will be **[2004]**

(a) 100 V

(b) $50\sqrt{2}$ V

(c) 50 V

(d) 0 V (zero)

In an a.c. circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by **[2007]**

(a) $P = \sqrt{2} E_0 I_0$

(b) $P = \frac{E_0 I_0}{\sqrt{2}}$

(c) $P = \text{zero}$

(d) $P = \frac{E_0 I_0}{2}$

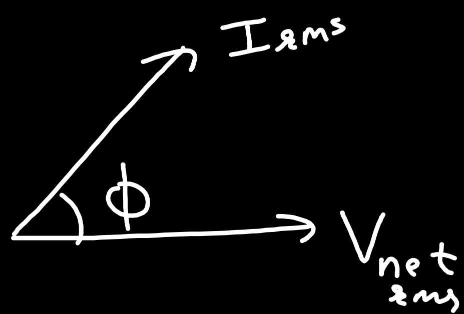
$V = V_0 \sin(\omega t)$

$I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$

$P_{avg} = \frac{V_0}{\sqrt{2}} \frac{I_0}{\sqrt{2}} \cos(90)$

$= 0$

Wattless Current



$$P_{avg} = V_{rms} I_{rms} \cos\phi$$

$I_{rms} \cos\phi$

Powerful Current

→ Component of I along net Voltage

$I_{rms} \sin\phi$

→ Wattless current

→ Component of I ⊥'ar to net Voltage

In an a.c. circuit, the instantaneous e.m.f. and current are given by

$e = 100 \sin 30t$

$$i = 20 \sin\left(30t - \frac{\pi}{4}\right)$$

In one cycle of a.c., the average power consumed by the circuit and the wattless current are, respectively: **[2018]**

(a) 50W, 10A

(b) $\frac{1000}{\sqrt{2}}$ W, 10A

(c) $\frac{50}{\sqrt{2}}$ W, 0

(d) 50W, 0

$V_{rms} = \frac{100}{\sqrt{2}}$

$I_{rms} = \frac{20}{\sqrt{2}}$

$\phi = 45°$

$P_{avg} = \frac{100}{\sqrt{2}} \frac{20}{\sqrt{2}} \cos 45$

$= \frac{1000}{\sqrt{2}}$

$$I_{rms} \cos\phi$$

$$\frac{20}{\sqrt{2}} \cos 45$$

$$\frac{20}{\sqrt{2}} \frac{1}{\sqrt{2}}$$

$$\frac{20}{2}$$

$$10$$

A 750 Hz, 20 V (rms) source is connected to a resistance of 100 Ω, an inductance of 0.1803 H and a capacitance of 10 μF all in series. The time in which the resistance (heat capacity 2 J/°C) will get heated by 10°C. (assume no loss of heat to the surroundings) is close to :

H.W.

[Sep. 03, 2020 (I)]

(a) 418 s (b) 245 s

(c) 365 s (d) 348 s

$$\frac{Heat}{time} = Power$$

$$Heat = (Power)(time)$$

$$Heat = (V_{rms} I_{rms} \cos\phi)\, t$$

$V_{rms} = 20$

$R = 100$

$L = 0.1803$

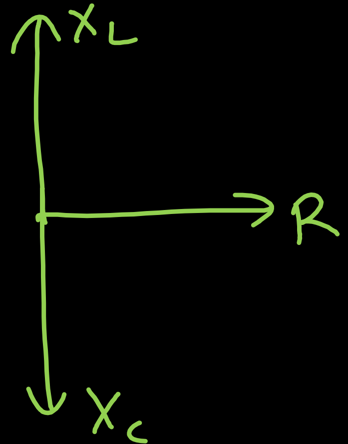
$C = 10 \mu F$

heat capacity $(ms) = 2$

$\Delta T = 10°c$

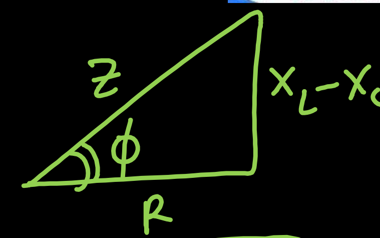
$$Heat = ms\Delta T$$

$$= ms\Delta T$$



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

$$I_{rms} = \frac{V_{rms}}{Z}$$



$$\cos\phi = \frac{R}{Z}$$

on solving $Z \approx 835$

$\text{Ans} = \underline{\underline{348 \text{ sec}}}$

. A series AC circuit containing an inductor (20 mH), a capacitor (120 μF) and a resistor (60 Ω) is driven by an AC source of 24 V/50 Hz. The energy dissipated in the circuit in 60 s is: **[9 Jan. 2019 I]**

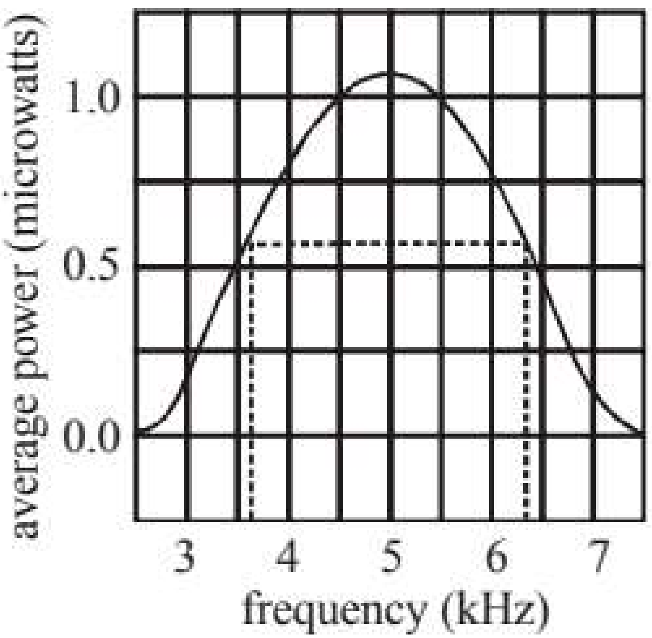
(a) 5.65×10^2 J (b) 2.26×10^3 J

(c) 5.17×10^2 J (d) 3.39×10^3 J

Transformer $\Rightarrow$ EMI

Done in Bounceback

The plot given below is of the average power delivered to an LRC circuit versus frequency. The quality factor of the circuit is : **[Online April 23, 2013]**



(a) 5.0 (b) 2.0 (c) 2.5 (d) 0.4

An AC circuit has $R = 100\ \Omega$, $C = 2\ \mu F$ and $L = 80\ mH$, connected in series. The quality factor of the circuit is :

[Sep. 06, 2020 (I)]

(a) 2 (b) 0.5

(c) 20 (d) 400

$$Q = \frac{\omega L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{80\times10^{-3}}{2\times10^{-6}}} = \frac{1}{100}\sqrt{4\times10^{4}}$$

$$= 2$$

For an RLC circuit driven with voltage of amplitude v_m and frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ the current exhibits resonance. The quality factor, Q is given by: **[2018]**

(a) $\frac{\omega_0 L}{R}$ (b) $\frac{\omega_0 R}{L}$ (c) $\frac{R}{(\omega_0 C)}$ (d) $\frac{CR}{\omega_0}$

$\frac{X_L}{R}$ $\frac{X_c}{R}$

$\frac{\omega L}{R}$ $\frac{1}{\omega CR}$

$\frac{1}{R}\sqrt{\frac{L}{C}}$

In an LCR circuit, the resonant frequency is 600 Hz and half-power points are at 650 Hz and 550 Hz. The quality factor is

$\omega_0 \quad f_0 = 600$

$$Q = \frac{f_0}{\text{Bandwidth}} = \frac{f_0}{f_2 - f_1}$$

$f_1 = 550$

$f_2 = 650$

Band = 100

$$= \frac{600}{650 - 550} = \frac{600}{100}$$

$$= 6$$

A resonance circuit having inductance and resistance 2×10^{-4} H and 6.28 Ω respectively oscillates at 10 MHz frequency. The value of quality factor of this resonator is ....

[Take, π = 3.14]

Ans = 2000

Jee 2021

H.W.

L

R

f

$$Q = \frac{\omega L}{R} = 2\pi f \frac{L}{R}$$