ODM EDUCATIONAL GROUP
Changing your Tomorrow

Reactance and Impedance, LC oscillation (qualitative treatment only),

CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 07
CHAPTER NAME : ALTERNATING CURRENT

CHANGING YOUR TOMORROW

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LEARNING OUTCOME

After this lesson, students will be able:

- Explain from where electricity comes and how we use it.
- Define electrical energy in terms of charge, voltage, current and resistance.
- Identify the types of engineering careers that work primarily with electrical energy.

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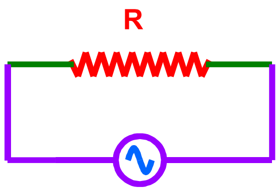
Slide 2

3 @Format for content and slide heading is missing? Just like you have mentioned in DOC., We need to specify, for each slide's heading and text content, what will be the font style +amanrouniyar@odmegroup.org
Assigned to you
-Swoyan Satyendu
, 6/17/2020

AC Circuit with a Pure Resistor:

$E = E_0 \sin \omega t$



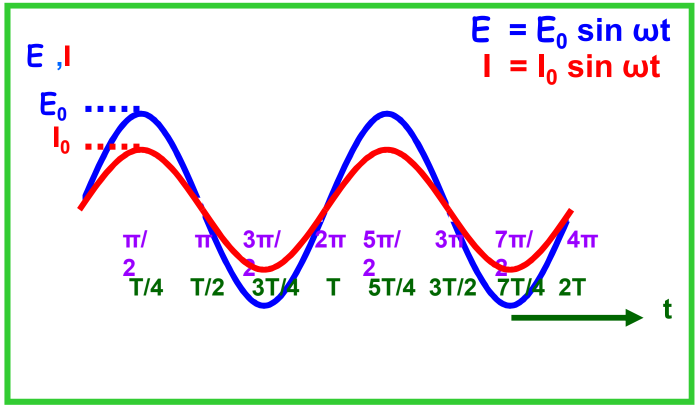
$I = E / R$

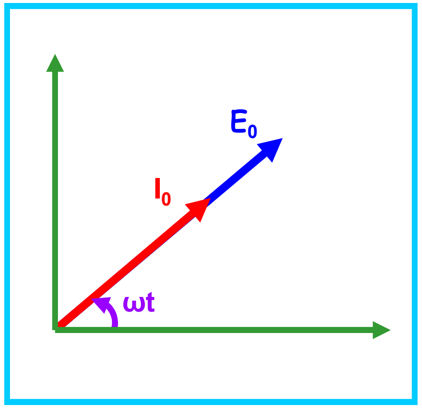
$= (E_0 / R) \sin \omega t$

$I = I_0 \sin \omega t$

(where $I_0 = E_0 / R$ and $R = E_0 / I_0$)

Emf and current are in same phase.



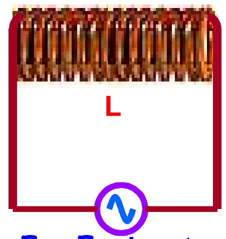


AC Circuit with a Pure Inductor:

$E = E_0 \sin \omega t$

Induced emf in the inductor is $- L\,(dI / dt)$

In order to maintain the flow of current, the applied emf must be equal and opposite to the induced emf.



$\therefore\ E = L\,(dI / dt)$

$E_0 \sin \omega t = L\,(dI / dt)$

$dI = (E_0 / L) \sin \omega t \, dt$

⇒

$I = \int (E_0 / L) \sin \omega t \, dt$

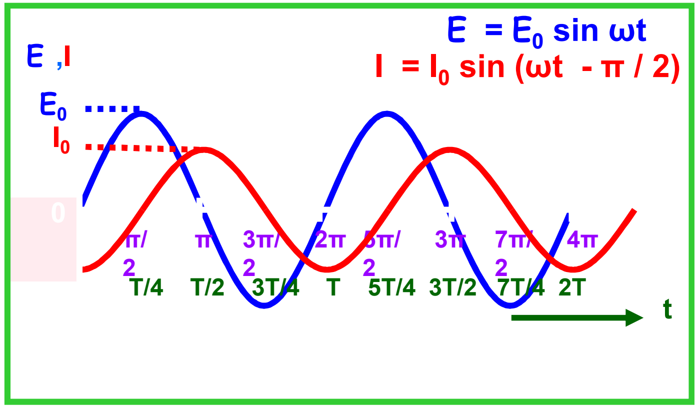
$I = (E_0 / \omega L)\,(- \cos \omega t)$

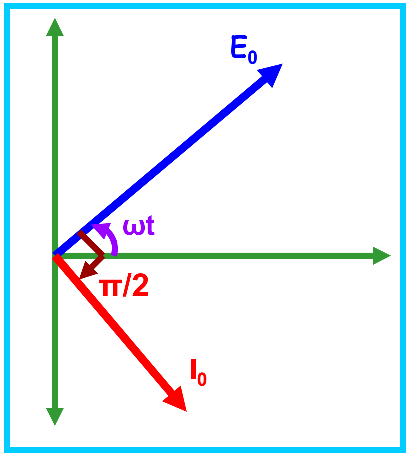
$I = I_0 \sin (\omega t - \pi / 2)$

(and $X_L = \omega L = E_0 / I_0$)

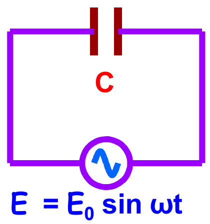
X_L is Inductive Reactance. Its SI unit is ohm.

Current lags behind emf by $\pi/2$ rad.





AC Circuit with a Capacitor:



$E = E_0 \sin \omega t$

$q = CE = CE_0 \sin \omega t$

$I = dq / dt$

$= (d / dt) [CE_0 \sin \omega t]$

$I = [E_0 / (1 / \omega C)] (\cos \omega t)$

$I = I_0 \sin (\omega t + \pi / 2)$

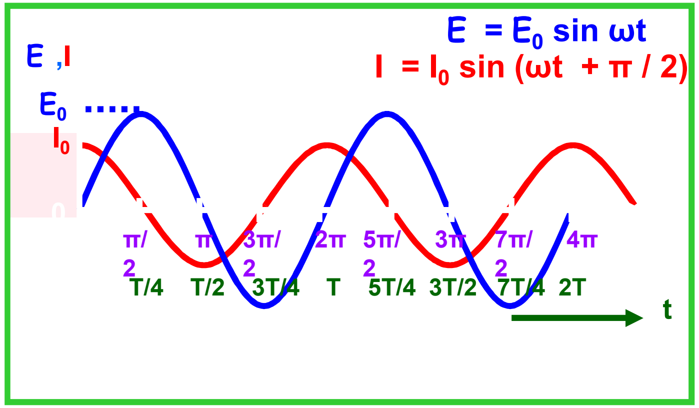
(and

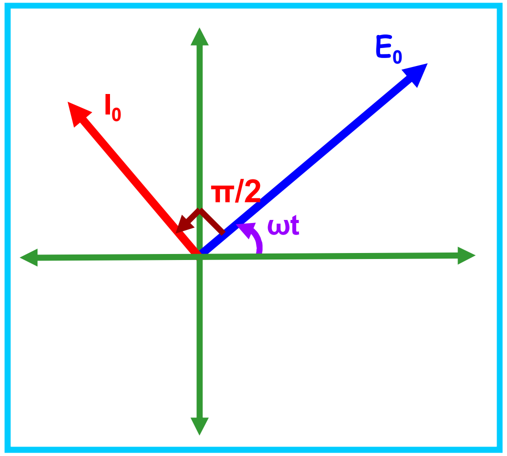
$X_C = 1 / \omega C = E_0 / I_0$)

X_C is Capacitive Reactance.

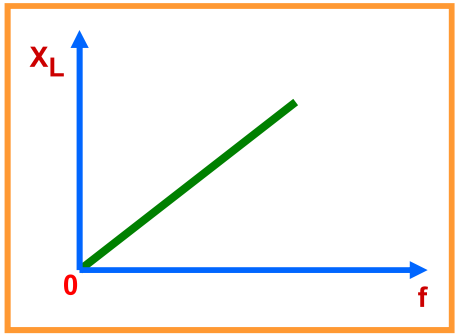
Its SI unit is ohm.

Current leads the emf by π/2 radians.





Variation of X_L with Frequency:

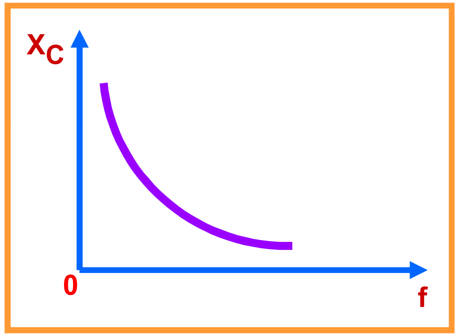


and $X_L = \omega L$

X_L is Inductive Reactance and $\omega = 2\pi f$

$X_L = 2\pi f L$ i.e. $X_L \propto f$

Variation of X_C with Frequency:



and $X_C = 1 / \omega C$

X_C is Inductive Reactance and $\omega = 2\pi f$

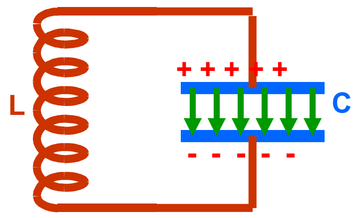
$X_C = 1 / 2\pi f C$ i.e. $X_C \propto 1 / f$

TIPS:

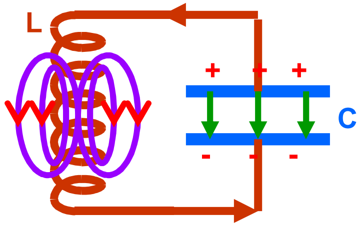
1) Inductance (L) can not decrease Direct Current. It can only decrease Alternating Current.

2) Capacitance (C) allows AC to flow through it but blocks DC.

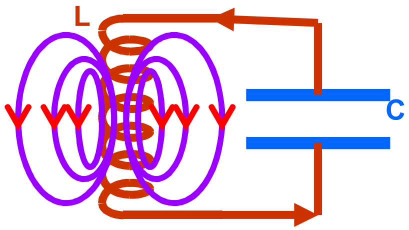
L C Oscillations:



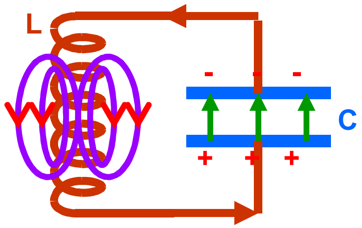
At t = 0, U_E=Max. & U_B=0



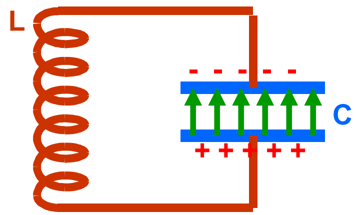
At t = T/8, U_E = U_B



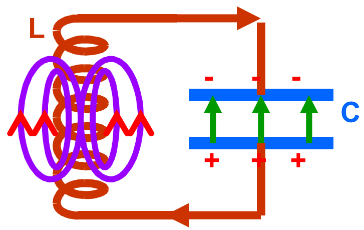
At t = 2T/8, U_E=0 & U_B=Max.



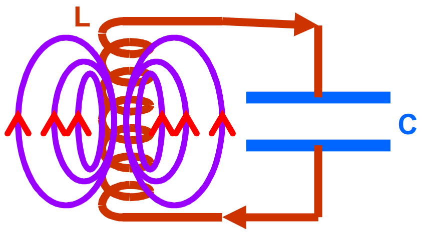
At t =3T/8, U_E = U_B



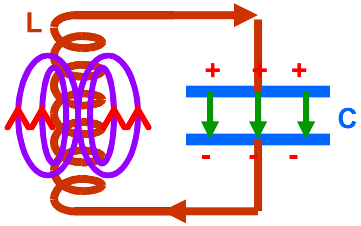
At t = 4T/8, U_E=Max. & U_B=0



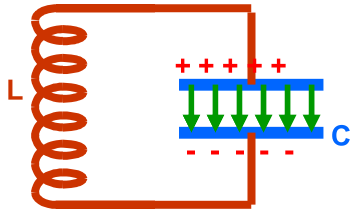
At t =5T/8, U_E = U_B



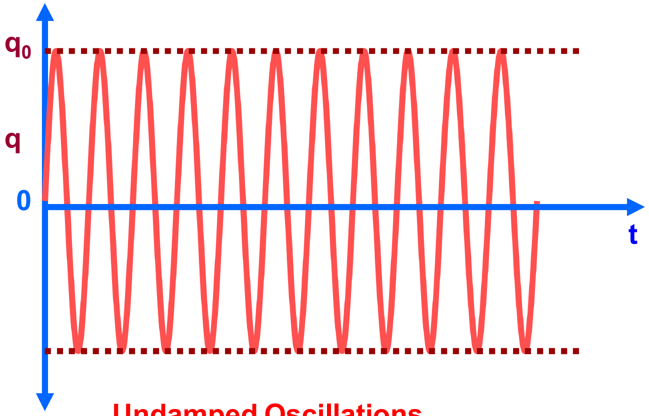
At t = 6T/8, U_E=0 & U_B=Max.



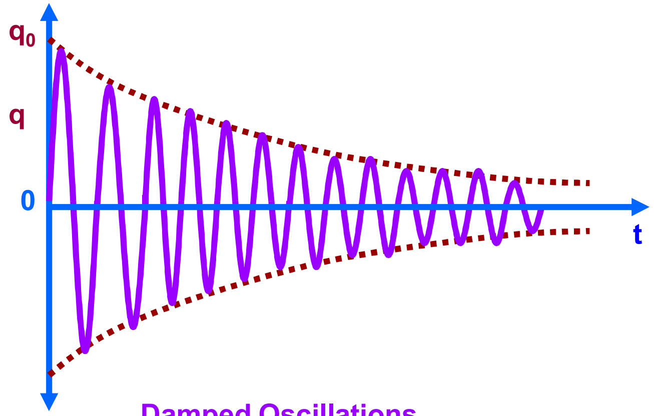
At t =7T/8, U_E = U_B



At t =T, U_E=Max. & U_B=0



Undamped Oscillations



Damped Oscillations

If q be the charge on the capacitor at any time t and dI / dt the rate of change of current, then

$L\, dI / dt + q / C = 0$

or $L (d^2q / dt^2) + q / C = 0$

or $d^2q / dt^2 + q / (LC) = 0$

Putting $1 / LC = \omega^2$

$d^2q / dt^2 + \omega^2 q = 0$

The final equation represents **Simple Harmonic Electrical Oscillation** with ω as angular frequency.

So, $\omega = 1 / \sqrt{LC}$

or

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

HOME ASSIGNMENT

1. Two bulbs are rated (P_1, V) $and(P_2, V)$. If they are connected (i) in series and (ii) in parallel across a supply V, find the power dissipated in the two combinations in terms of P_1 and P_2 .
2. Two electric bulbs P and Q have their resistances in the ratio of 1:2. They are connected in series across a battery. Find the ratio of the power dissipation in these bulbs.

3. A 25 W and a 100W bulb are joined in (i) series (ii) parallel and connected to the main. Which bulb glows brighter?

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THANKING YOU

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