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Power in AC circuits, Power factor Wattles current,

CLASS-XII

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

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

Power in AC Circuit with L, C, R:

$E = E_0 \sin \omega t$

$I = I_0 \sin (\omega t + \Phi)$ (where Φ is the phase angle between emf and current)

Instantaneous Power $= E\ I$

$= E_0 I_0 \sin \omega t \sin (\omega t + \Phi)$

$= E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi]$

If the instantaneous power is assumed to be constant for an infinitesimally small time dt, then the work done is

$dW = E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi]$

Work done over a complete cycle is

$$W = \int_0^T E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi]\, dt$$

$W = E_0 I_0 \cos \Phi \times T / 2$

Average Power over a cycle is $P_{av} = W / T$

$P_{av} = (E_0 I_0 / 2) \cos \Phi$

$P_{av} = (E_0/\sqrt{2})(I_0/\sqrt{2}) \cos \Phi$

$P_{av} = E_v I_v \cos \Phi$

(where $\cos \Phi = R / Z$

$= R / \sqrt{[R^2 + (\omega L - 1/\omega C)^2]}$ is called Power Factor)

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$P_{av} = E_v I_v \cos \Phi$

Power in AC Circuit with R:

In R, current and emf are in phase.

$\Phi = 0°$

$P_{av} = E_v I_v \cos \Phi = E_v I_v \cos 0° = E_v I_v$

Power in AC Circuit with L:

In L, current lags behind emf by π/2.

$\Phi = - \pi/2$

$P_{av} = E_v I_v \cos (-\pi/2) = E_v I_v (0) = 0$

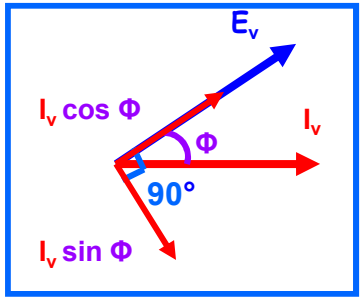
Power in AC Circuit with C:

In C, current leads emf by π/2.

$\Phi = + \pi/2$

$P_{av} = E_v I_v \cos (\pi/2) = E_v I_v (0) = 0$

Wattless Current or Idle Current:



The component $I_v \cos \Phi$ generates power with E_v.

However, the component $I_v \sin \Phi$ does not contribute to power along E_v and hence power generated is zero. This component of current is called wattless or idle current.

Note:

Power (Energy) is not dissipated in Inductor and Capacitor and hence they find a lot of practical applications and in devices using alternating current.

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?

THANKING YOU

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