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Alternating currents, peak and RMS value of alternating current and voltage

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

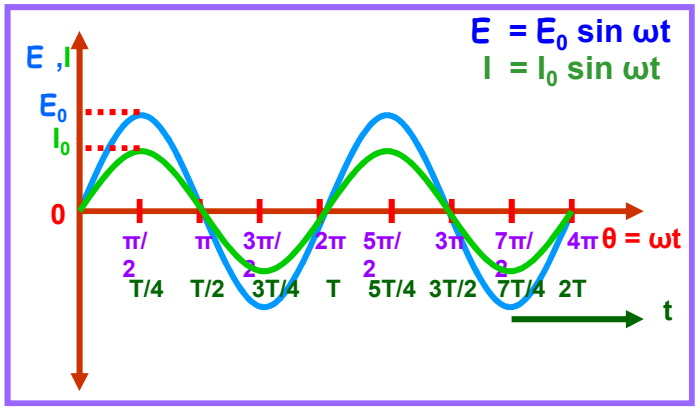
3	@Format for content and slide heading is missing? Just like you have mentioned in DOC., We need to specify, for each slide's heading and text content, what will be the font style +amanrouniyar@odmegroup.org _Assigned to you_ -Swoyan Satyendu , 6/17/2020

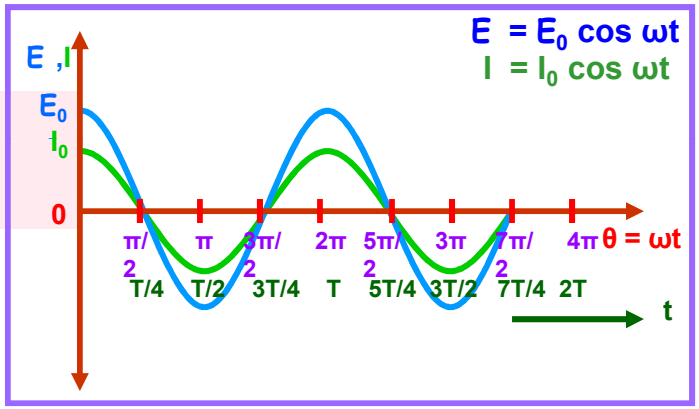
Alternating emf:

Alternating emf is that emf which continuously changes in magnitude and periodically reverses its direction.

Alternating Current:

Alternating current is that current which continuously changes in magnitude and periodically reverses its direction.





E, I – Instantaneous value of emf and current
Peak or maximum value or amplitude of emf and current
ω – Angular frequency t – Instantaneous time
ωt – Phase

E_0, I_0 –

Symbol of AC Source

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Average or Mean Value of Alternating Current:

Average or Mean value of alternating current over half cycle is that steady current which will send the same amount of charge in a circuit in the time of half cycle as is sent by the given alternating current in the same circuit in the same time.

$dq = I\,dt = I_0 \sin \omega t\,dt$

$$q = \int_0^{T/2} I_0 \sin \omega t\,dt$$

$q = 2 I_0 / \omega = 2 I_0 T / 2\pi = I_0 T / \pi$

Mean Value of AC, $I_m = I_{av} = q / (T/2)$

$$I_m = I_{av} = 2 I_0 / \pi = 0.637\, I_0 = 63.7\ \%\ I_0$$

Average or Mean Value of Alternating emf:

$$E_m = E_{av} = 2 E_0 / \pi = 0.637\, E_0 = 63.7\ \%\ E_0$$

Note: Average or Mean value of alternating current or emf is zero over a cycle as the + ve and – ve values get cancelled.

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Root Mean Square or Virtual or Effective Value of Alternating Current:

Root Mean Square (rms) value of alternating current is that steady current which would produce the same heat in a given resistance in a given time as is produced by the given alternating current in the same resistance in the same time.

$dH = I^2R\,dt = I_0^2\,R \sin^2 \omega t\,dt$

$$H = \int_0^T I_0^2\,R \sin^2 \omega t\,dt$$

$H = I_0^2\,RT / 2$ (After integration, ω is replaced with $2\pi / T$)

If I_v be the virtual value of AC, then

$H = I_v^{\,2}\,RT$ $\therefore$ $I_v = I_{rms} = I_{eff} = I_0 / \sqrt{2} = 0.707\,I_0 = 70.7\,\%\,I_0$

Root Mean Square or Virtual or Effective Value of Alternating emf:

$E_v = E_{rms} = E_{eff} = E_0 / \sqrt{2} = 0.707\,E_0 = 70.7\,\%\,E_0$

Note:

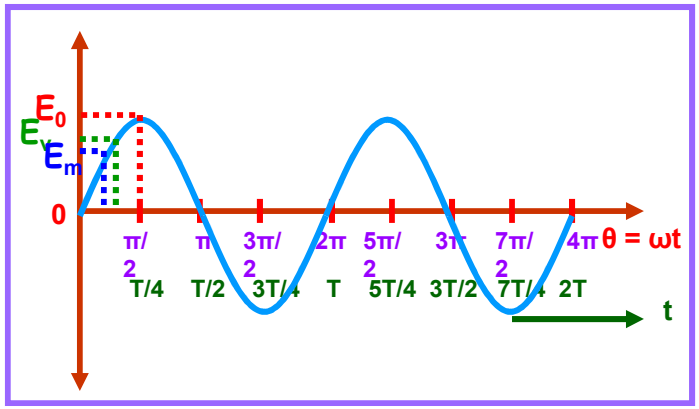
1. **Root Mean Square value of alternating current or emf can be calculated over any period of the cycle since it is based on the heat energy produced.**

2. ***Do not use the above formulae if the time interval under the consideration is less than one period.***

Relative Values Peak, Virtual and Mean Values of Alternating emf:

$E_m = E_{av} = 0.637\ E_0$

$E_v = E_{rms} = E_{eff} = 0.707\ E_0$



Tips:

1. The given values of alternating emf and current are virtual values unless otherwise specified.

   i.e. 230 V AC means $E_v = E_{rms} = E_{eff} = 230$ V

2. AC Ammeter and AC Voltmeter read the rms values of alternating current and voltage respectively.

   They are called as 'hot wire meters'.

3. The scale of DC meters is linearly graduated where as the scale of AC meters is not evenly graduated because $H \alpha I^2$

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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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