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A.C [Alternating Current]

$$\phi = BA\cos\theta \qquad \begin{bmatrix} \theta = \omega t \\ \omega = \text{constant} \end{bmatrix}$$

$$\phi = BA\cos\omega t$$

$$\mathcal{E}_{ind} = -\frac{d\phi}{dt} = +\underbrace{B\omega A}\sin\omega t$$

$$\boxed{\mathcal{E}_{ind} = \mathcal{E}_0 \sin\omega t}$$

If R be the resistance of the loop.

$$I_{ind} = \frac{\mathcal{E}_{ind}}{R}$$

$$I_{ind} = \frac{\mathcal{E}_0}{R}\sin\omega t$$

$$\boxed{I_{ind} = I_0 \sin\omega t}$$

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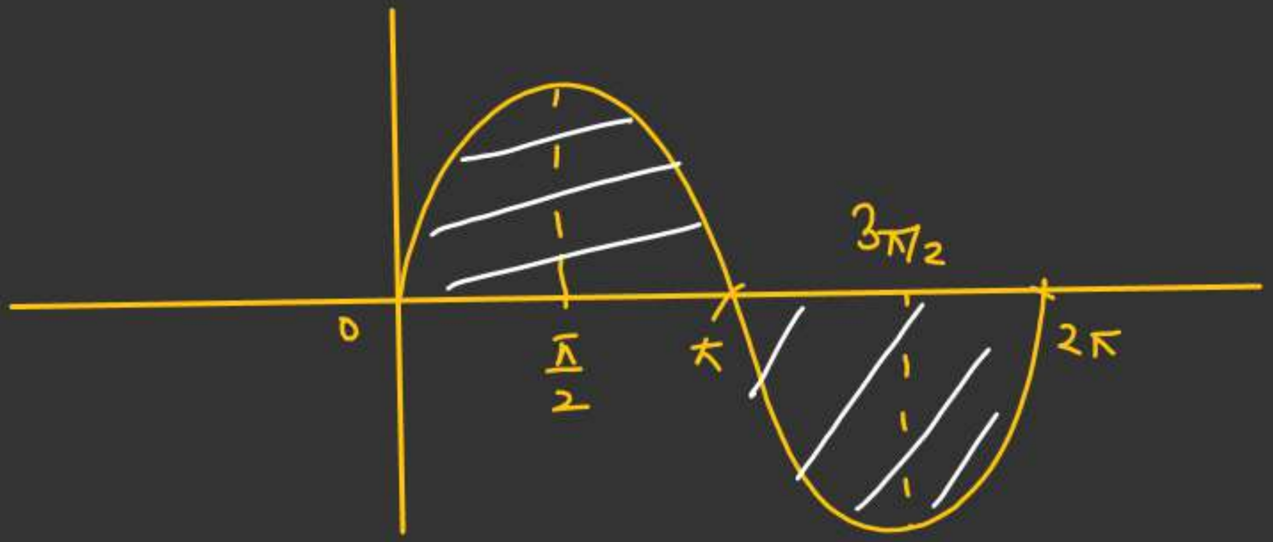
** $\Rightarrow$ i_{avg} for one time period.



$$i_{avg} = \frac{\int_0^{2\pi/\omega} i_0 \sin\omega t \cdot dt}{\int_0^{2\pi/\omega} dt} = \frac{i_0 \int_0^{2\pi/\omega} \sin\omega t \cdot dt}{\int_0^{2\pi/\omega} dt} = 0$$

$\Rightarrow$ $\mathcal{E}_{avg}$ for one time period $= 0$.

i_{avg} for half of the time period:-

$$i_{avg} = \frac{i_0 \int_0^{\pi/\omega} \sin\omega t \cdot dt}{\int_0^{\pi/\omega} dt}$$

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

$$i_{avg} = \frac{i_0}{\omega(\pi/\omega)} \left[\cos\omega t\right]_0^{\pi/\omega}$$

$$i_{avg} = \frac{i_0}{\pi}\left[-\cos\pi + \cos 0\right]$$

$$\boxed{i_{avg} = \frac{2i_0}{\pi}} \qquad \boxed{\mathcal{E}_{avg} = \frac{2\mathcal{E}_0}{\pi}}$$

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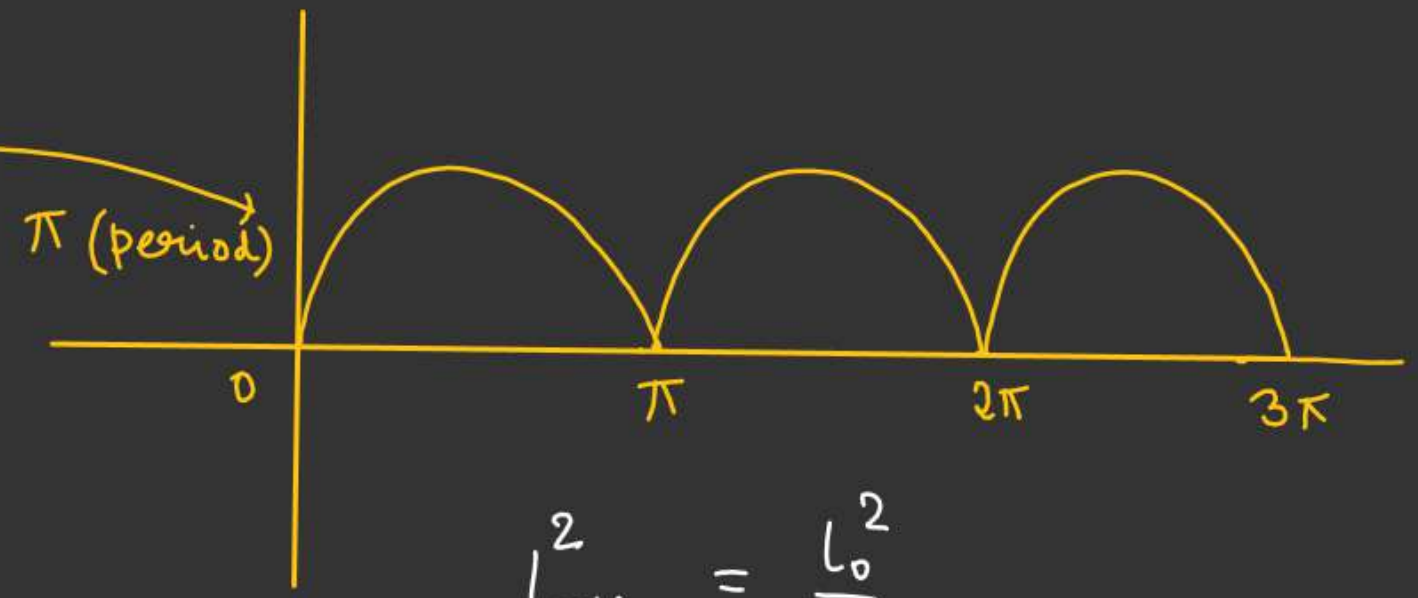
$i = i_0 \sin \omega t$

$i^2_{avg} = ??$



$$i^2_{avg} = \frac{i_0^2 \int_0^{\pi/\omega} \sin^2 \omega t \cdot dt}{\int_0^{\pi/\omega} dt}$$

$$i^2_{avg} = \frac{i_0^2 \int_0^{\pi/\omega} \left(\frac{1 - \cos 2\omega t}{2}\right) dt}{\int_0^{\pi/\omega} dt}$$

$$= \frac{i_0^2 \omega}{2\pi}\left[\int_0^{\pi/\omega} dt - \int_0^{\pi/\omega} \cos 2\omega t \, dt\right]$$

$$= \frac{\omega i_0^2}{2\pi}\left[\frac{\pi}{\omega} - \underbrace{\frac{\left[\sin 2\omega t\right]_0^{\pi/\omega}}{2\omega}}_{0}\right]$$

$$= \frac{i_0^2}{2} \checkmark$$

$$i^2_{avg} = \frac{i_0^2}{2}$$

$$i_{rms} = \sqrt{i^2_{avg}}$$

$$i_{rms} = \sqrt{i^2}$$

$$\boxed{i_{rms} = \frac{i_0}{\sqrt{2}}}$$

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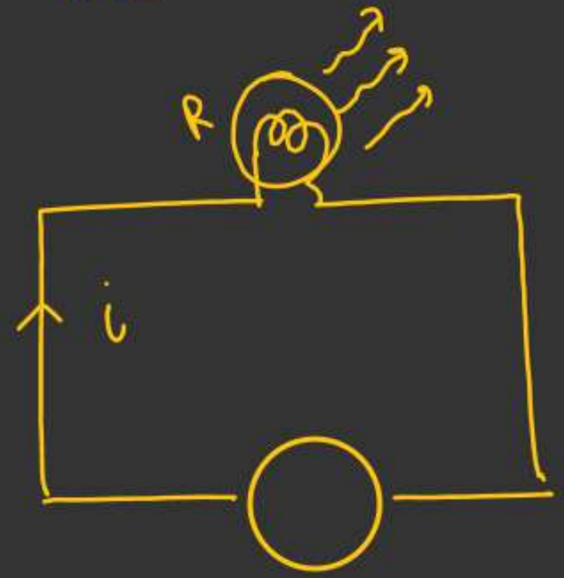
R.M.S Value = $\left(\dfrac{\text{Peak Value / Maximum Value}}{\sqrt{2}}\right)$

(Root mean Square = R.M.S)

$$\boxed{\begin{array}{c} i_{rms} = \dfrac{i_0}{\sqrt{2}} \\ \\ \varepsilon_{rms} = \dfrac{\varepsilon_0}{\sqrt{2}} \end{array}}$$

R.M.S $\rightarrow$ $\sqrt{\overline{i^2}}$

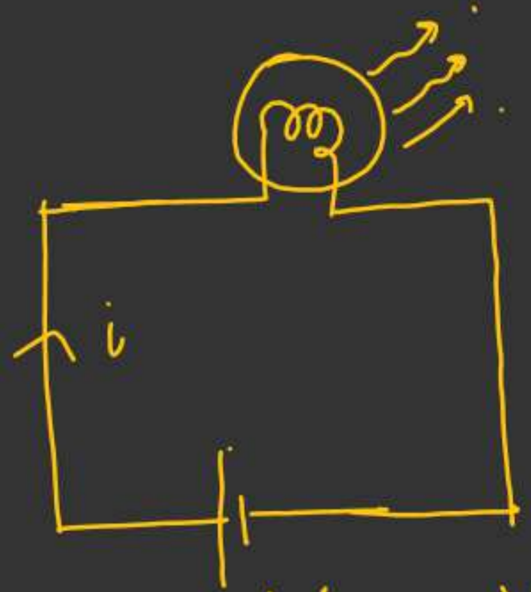


$\Downarrow$

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

$i = \dfrac{\varepsilon_0}{R} \sin\omega t$

$\Longrightarrow$



$V_{rms} = V_b$

$P = \dfrac{V_{rms}^2}{R}$

$$\frac{V_{rms}^2}{R} = P = \frac{\int_0^T i^2 R \cdot dt}{\int_0^T dt}$$

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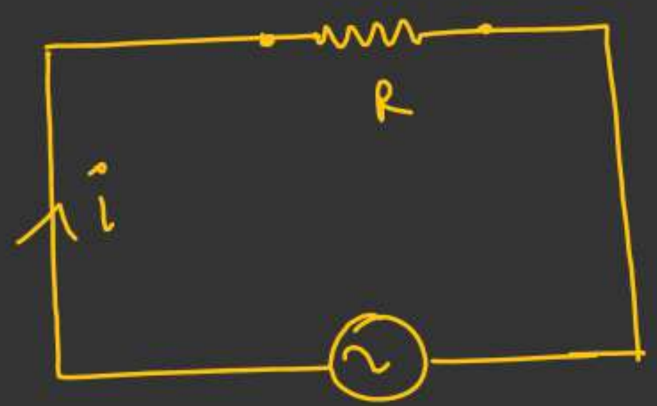
Power in A.C Ckt



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

$i = i_0 \sin(\omega t + \phi)$

ϕ = Initial phase
Constant

$$P_{inst} = \mathcal{E} i$$

$$P_{inst} = (\mathcal{E}_0 \sin\omega t)\left[i_0 \sin(\omega t + \phi)\right]$$

$$P_{inst} = \mathcal{E}_0 i_0 \left[\sin\omega t \cdot \sin(\omega t + \phi)\right]$$

$$P_{avg} = \frac{\int_0^T P_{inst} \cdot dt}{\int_0^T dt} = \frac{\mathcal{E}_0 i_0}{T}\left[\int_0^T \sin\omega t \cdot \sin(\omega t + \phi)\, dt\right]$$

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$$P_{avg} = \frac{\int_0^T P_{inst}\, dt}{\int_0^T dt} = \frac{\varepsilon_0 i_0}{T}\left[\int_0^T \sin\omega t \cdot \sin(\omega t + \phi)\, dt\right]$$

$$P_{avg} = \frac{\varepsilon_0 I_0}{T}\int_0^T \left[\sin\omega t\,[\sin\omega t \cdot \cos\phi + \cos\omega t \cdot \sin\phi]\right] dt$$

$$= \frac{\varepsilon_0 I_0}{T}\left[\left(\int_0^T \sin^2\omega t\right)\cos\phi + \left[\int_0^T (\sin\omega t \cdot \cos\omega t)\, dt\right] \cdot \sin\phi\right]$$

$$= \frac{\varepsilon_0 I_0}{T}\left[\int_0^T \left(\frac{1 - \cos 2\omega t}{2}\right) dt \cdot \cos\phi\right] + \frac{1}{2}\left(\int_0^T \sin 2\omega t \cdot dt\right)\sin\phi$$

$$= \frac{\varepsilon_0 I_0}{T}\left[\frac{1}{2}\int_0^T dt - \underbrace{\int_0^T \frac{\cos 2\omega t}{2}\, dt}_{0}\right]\cos\phi + \frac{1}{2}\underbrace{\left(\int_0^T \sin 2\omega t \cdot dt\right)}_{0}\sin\phi$$

$$P_{avg} = \frac{\varepsilon_0 I_0}{T} \times \frac{T}{2}\cos\phi$$

$$P_{avg} = \frac{\varepsilon_0 I_0}{2}\cos\phi$$

$$P_{avg} = \frac{\varepsilon_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}} \times \cos\phi$$

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

$\cos\phi$ = Power factor

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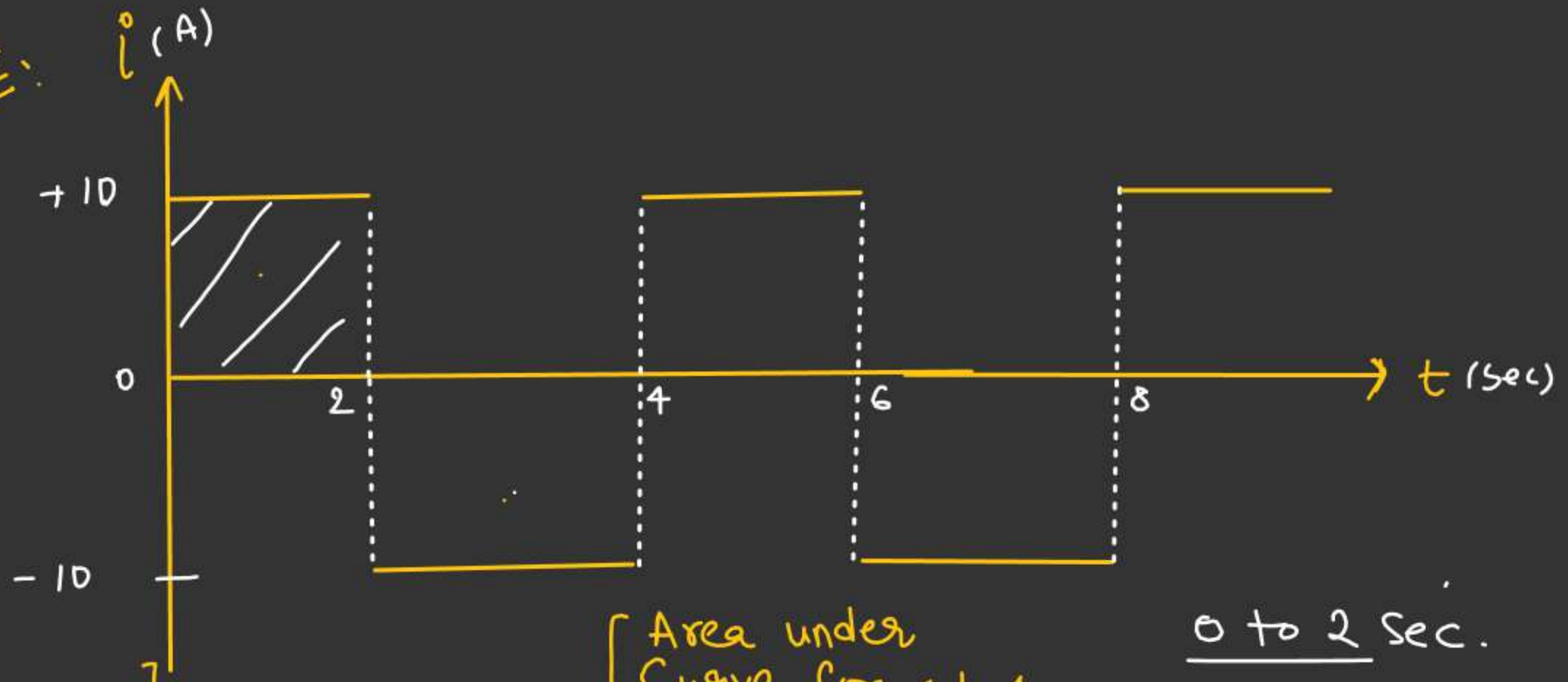

$$i_{avg} = \frac{\text{Area}}{\text{interval}}$$

$$i_{avg} = \frac{20}{2} = 10.$$

[0 to 4]

$i_{rms} = ??$

$i_{avg} = ??$ $\rightarrow 0$

[Area under Curve for 0 to 4 $= 0$.

$i_{avg} = 0$.

$i_{avg} = 0$ for interval 0 to 4 sec.

0 to 2 Sec.

$i = 10$

$$i_{avg} = \frac{\int_0^2 i \cdot dt}{\int_0^2 dt} = 10 \text{ Ans.}$$

$$\overline{i^2} = \frac{100}{2} = 50.$$

$$i_{rms} = \sqrt{\overline{i^2}} = \sqrt{50} = 5\sqrt{2}$$

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H.W $i_{rms} = ??$ By Integration

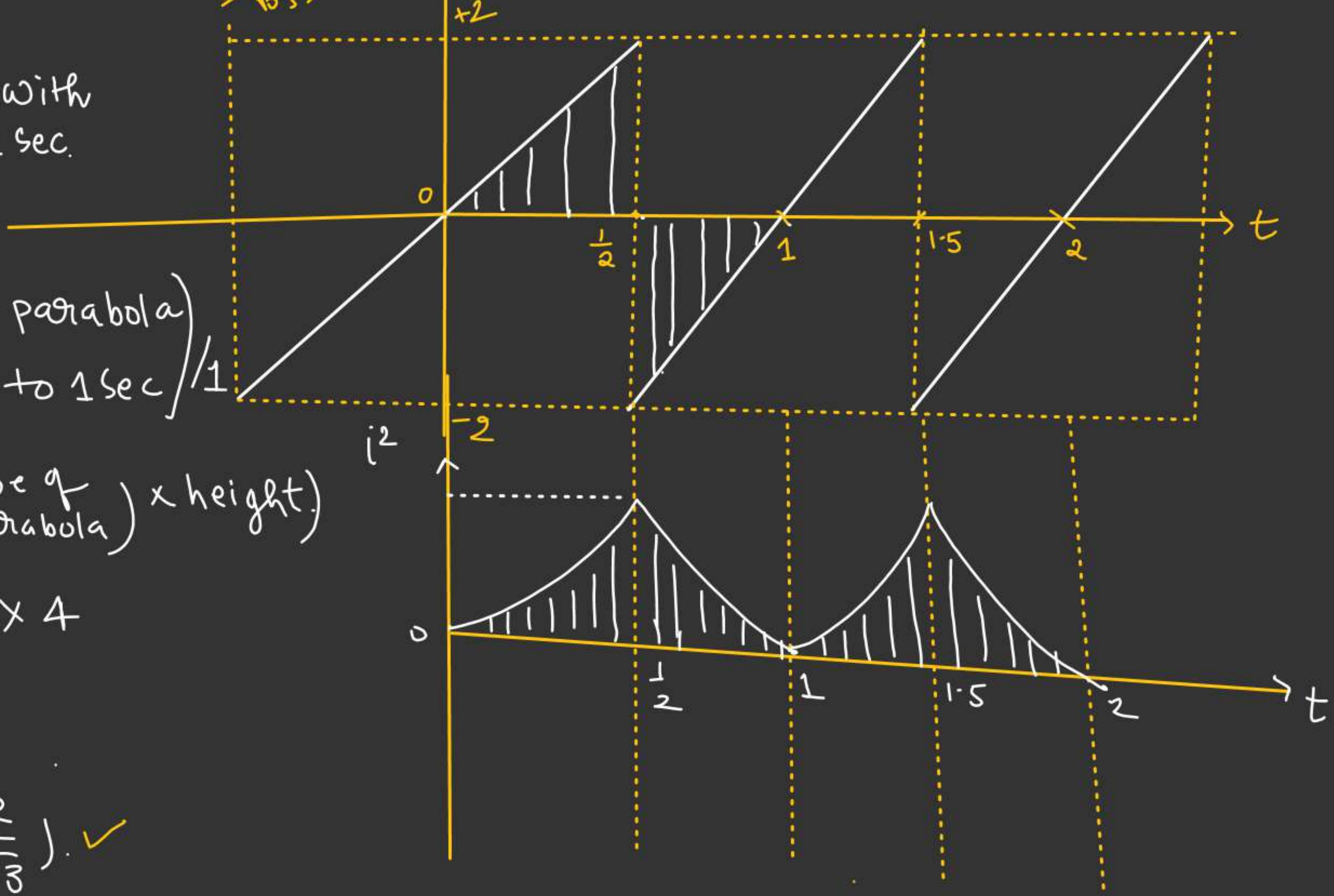
Area of parabola $= \left(\frac{1}{3} \times \text{base} \times \text{height}\right)$

① $i_{avg} = ?$

② $i_{rms} = ??$

$i_{avg} = 0$

Periodic with period 1 sec.



For $\overline{i^2}$

$= \left(\begin{matrix}\text{Area of parabola} \\ \text{b/w 0 to 1 sec}\end{matrix}\right) / 1$

$= \left(\frac{1}{3} \times \left(\text{base of parabola}\right) \times \text{height}\right)$

$= \frac{1}{3} \times 1 \times 4$

$= \left(\frac{4}{3}\right)$

$i_{rms} = \sqrt{\overline{i^2}} = \left(\frac{2}{\sqrt{3}}\right)$ ✓

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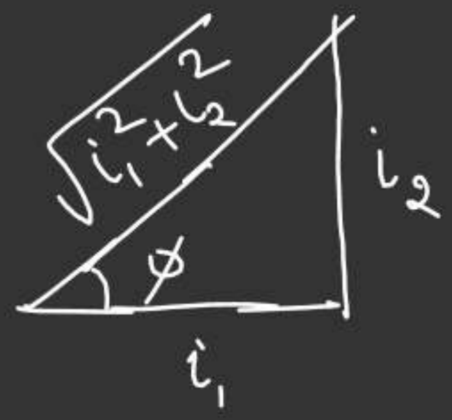
$$i = i_1 \sin\omega t + i_2 \cos\omega t$$

$$i_{rms} = ??$$

$$i_{rms} = \frac{\text{Peak value}}{\sqrt{2}}$$

$$i = \sqrt{i_1^2 + i_2^2}\left[\frac{i_1}{\sqrt{i_1^2+i_2^2}}\sin\omega t + \frac{i_2}{\sqrt{i_1^2+i_2^2}}\cos\omega t\right]$$



$$i = \sqrt{i_1^2+i_2^2}\left[\cos\phi \sin\omega t + \sin\phi \cos\omega t\right]$$

$$i = \underline{\sqrt{i_1^2+i_2^2}}\left[\sin(\omega t + \phi)\right]$$

$$i_{rms} = \sqrt{\frac{i_1^2 + i_2^2}{2}}$$

$$i_{max} \text{ or } i_0 = \left(\sqrt{i_1^2+i_2^2}\right)$$