An alternating current varying sinusoidally with a frequency of 50 Hz has an rms value of 20 A.

1) Write down the equation for the instantaneous current.
2) Find the instantaneous value of current at 0.0025 s.
3) Find the instantaneous value of current 0.125 s after passing through a positive max. value.
4) At what time, measured from a the max. value, will the instantaneous current be 14.14 A.

$f = 50\,Hz, \quad I_{rms} = 20\,A.$

$I_m = \sqrt{2}\, I_{rms} = \sqrt{2} \times 20 = 28.28\,A$

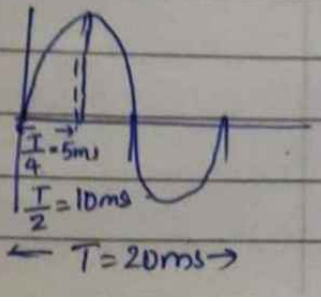
1) $i = I_m \sin(\omega t) = I_m \sin(2\pi f t)$
$= 28.28 \sin(2\pi \times 50 \times t)$
$= \underline{28.28 \sin(100\pi t)}$

2) $t = 0.0025$
$\Rightarrow i = 28.28 \sin(100\pi \times 0.0025)$
$= \underline{20\,A}$

3) $t = .125 + \frac{T}{4} =$

$= 5\,ms + .125\,sec$

$= \underline{.13\,sec}$



$i = 20\sin 28.28 \sin(100\pi \times 0.13)$

$= 0$ ↳ in radians

4) $14.14 = 28.28 \sin(100\pi t)$

$\Rightarrow \sin(100\pi t) = \frac{1}{2}$

$100\pi t = \frac{\pi}{6}$ or $5\frac{\pi}{6}$ ($\frac{\pi}{6}$ is not possible since first +ve is at $\frac{\pi}{2}$)

so $100\pi t = 5\frac{\pi}{6}$

$\Rightarrow t = 8.33$ ms

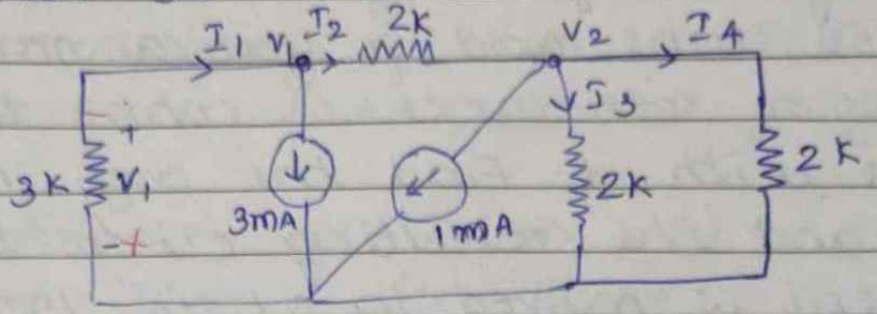
time measured from +ve max. value

$= 8.33$ ms $- 5$ ms $= 3.33$ ms

(t of +ve peak)

Page No.
Date

Using nodal analysis find V_1 in the given ckt.



(1)

$$I_1 - I_2 - 3 \times 10^{-3} = 0$$

(2)

$$V_1 + \frac{-V_1}{3000} - \left(\frac{V_1 - V_2}{2000}\right) - 3 \times 10^{-3} = 0$$

$$-\frac{V_1}{3} - \frac{V_1}{2} + \frac{V_2}{2} = 3$$

$$-0.33V_1 - 0.5V_1 + 0.5V_2 = 3$$

$$-0.83V_1 + 0.5V_2 = 3 \quad \text{—— (1)}$$

(2)

$$I_2 - I_3 - I_4 - 1 \times 10^{-3} = 0$$

$$\frac{V_1 - V_2}{2000} - \frac{V_2}{2000} - \frac{V_2}{2000} - 1 \times 10^{-3} = 0$$

$$\frac{V_1 - V_2}{2} - \frac{V_2}{2} - \frac{V_2}{2} = 1$$

$$0.5V_1 - 0.5V_2 - V_2 = 1$$

$$0.5V_1 - 1.5V_2 = 1 \quad \text{—— (2)}$$

$V_1 = \underline{5.02V}$ $\quad V_2 = \underline{2.34V}$

$$I_1 = -\frac{5.02}{3000} = -1.6\,mA$$

$V = 1.6 \times 10^{-3} \times 3000 = 4.8$ $\quad V = \underline{-5.02V}$

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EP

Page No.
Date

1. A coil of 50Ω resistance placed in a magnetic field of 1mwb. The coil has 50 turns and a galvanometer of 400Ω resistance is connected in series with it. Find the avg. induced emf and the resulting current if the coil is moved in 0.1 sec from the given field to another field of 0.2 mwb.

e = 0.4V i = 0.88mA

$R = 50\Omega$, $\phi = 1$mwb, $N = 50$, $R_g = 400\Omega$

$dt = 0.1$ sec, $\phi_1 = 1$mwb, $\phi_2 = 0.2$mwb

$$e = N\frac{d\phi}{dt} = \frac{50(1-0.2)\times 10^{-3}}{0.1} = 0.4\,V$$

$$i = \frac{V}{R} = \frac{0.4}{450} = 0.88\,mA$$

2. Two coupled coils of self inductance 0.8H and 0.35H have a coefficient of coupling 0.9. Find the mutual inductance between the coils.

$L_1 = 0.8$ H, $L_2 = 0.35$ H, $K = 0.9$

$$M = K\sqrt{L_1 L_2} = 0.9\sqrt{0.8 \times 0.35}$$

$$= 0.476\ H.$$

3. An iron ring of cross sectional area $1cm^2$ is wound with a coil of 2000 turns. Calculate the magnetising current required to produce a flux

of 0.1 mwb in the iron path if mean length of the path is 30 cm and relative permeability of iron is 2500. Neglect magnetic leakages and fringing.

$a = 1\,cm^2$, $N = 2000$, $\phi = 0.1$ mwb
$l = 30$ cm, $\mu_r = 2500$.

$$S = \frac{l}{\mu_0 \mu_r a} = \frac{30 \times 10^{-2}}{4\pi \times 10^{-7} \times 2500 \times 1 \times 10^{-4}}$$

$$= 954929.65^{-}$$

$$mmf = \phi S = 0.1 \times 10^{-3} \times 954929.65^{-}$$
$$= 95.492 \text{ AT}$$

$$I = \frac{mmf}{N} = \frac{95.492}{2000} = 0.047 \text{ A}$$

4. An alternating current is represented by $i(t) = 14.14 \sin(377t)$. Find i) rms value ii) frequency iii) time period and iv) instantaneous value of the current at $t = 3$ ms.

$I_m = 14.14$
$\omega = 377$

i) $I_{rms} = \frac{I_m}{\sqrt{2}} = 10$ A

ii) $\omega = 2\pi f \Rightarrow f = \frac{377}{2\pi} = 60$ Hz

iii) $T = \frac{1}{f} = \frac{1}{60} = 0.016$ sec.

iv) $e = 14.14 \sin\left(377 \times 3 \times \frac{180}{\pi}\right)^{\circ} = 0.376$

4) $i = I_m \sin \omega t$

$14.14 = 28.28 \sin \omega t$

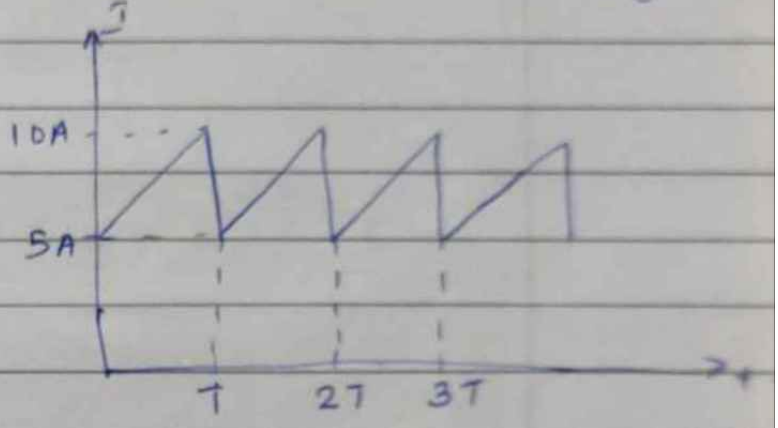
$\sin \omega t = 0.5$

$1 rad \times \frac{180}{\pi} = deg$

$\omega t = 30^\circ = 30 \times \frac{\pi}{180} = 52.35$

$t = \frac{52.35^\circ}{\omega} = \frac{52.35^\circ}{2\pi} = 8.33 ms$

6. calculate the rms and average values of the current waveform shown in the fig.



$y = mx + c$

$= \left(\frac{10-5}{T-0}\right)t + 5$

$= \frac{5t+5}{T}$

eqn. of wave is

$i(t) = \frac{5}{T}t + 5$

$I_{avg.} = \frac{1}{T}\int_0^T \left(\frac{5}{T}t + 5\right) dt$

$= \frac{1}{T}\left[\frac{5t^2}{T \cdot 2} + 5t\right]_0^T = \frac{1}{T}\left[\frac{5T^2}{2T} + 5T\right]$

$= \frac{5}{2} + 5 = \frac{15}{2} = 7.5 A$

$I_{rms}^2 = \frac{1}{T}\int_0^T \left(\frac{5}{T}t + 5\right)^2 dt$

$= \frac{1}{T}\int_0^T \left(\frac{5^2}{T^2}t^2 + 25 + \frac{2 \times 5t \times 5}{T}\right) dt$

$= \frac{1}{T}\left[\frac{25}{T^2}\frac{t^3}{3} + 25t + \frac{50}{T}\frac{t^2}{2}\right]_0^T$

Page No. _____
Date

$$= \frac{1}{T}\left[\frac{25}{T^2} + \frac{T^3}{3} + 25T + \frac{50}{T}\cdot\frac{T^2}{2}\right]$$

$$= \frac{1}{T}\left[\frac{25T^3}{3} + 25T + \frac{50T}{2}\right]$$

$$= \frac{1}{T}\left[\frac{25T}{3} + 50T\right] = \frac{25}{3} + 50 = 58.33$$

$$I_{rms} = \sqrt{58.33} = 7.64\,A$$