1

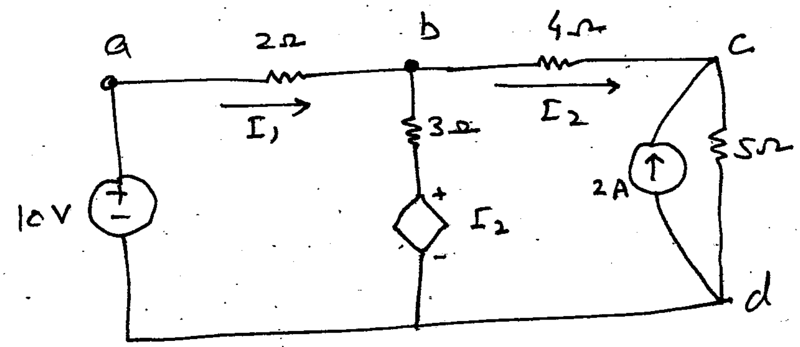
UNIT II Supple

Dependant Sources

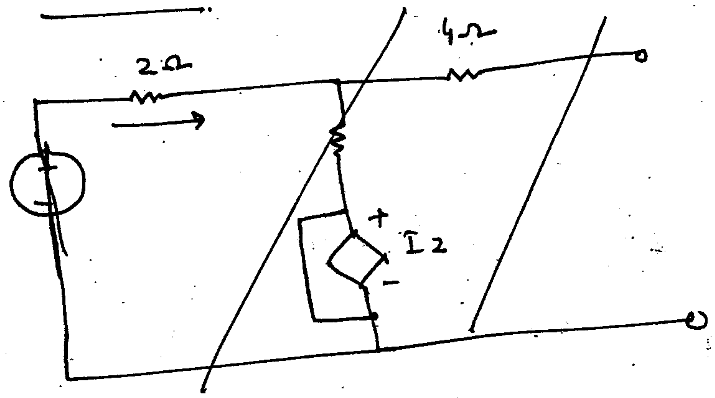
Q1 9/ Assign 2.

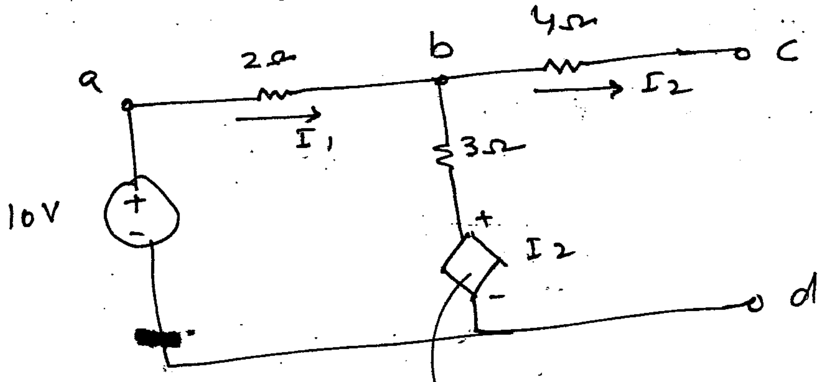
(a) find value of I_1

(b) Thevenin's Equivalent between c and d removing current source of 2 A and 5 Ω resistance.



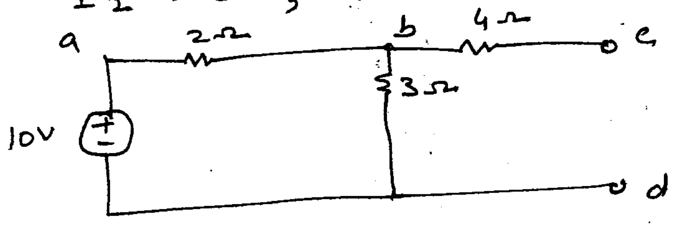
Soln: For Voc





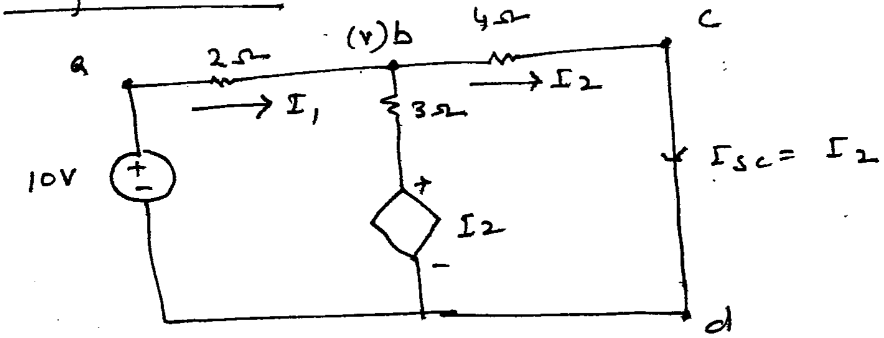
This is 0 i.e. SC

$I_2 = 0$; so



$V_{cd} = V_{bd} = \frac{3 \times 10}{5} = 6V$

To find I_{sc}



$$\frac{10 - V}{2} - \frac{V}{4} - \frac{V - I_2}{3} = 0$$

(I_1) $\quad (I_2)$

$$\frac{10 - V}{2} - \frac{V}{4} - \frac{V - \left(\frac{V}{4}\right)}{3} = 0$$

$$5 - \frac{V}{2} - \frac{V}{4} - \frac{3V}{12} = 0$$

$$5 - \frac{V}{2} - \frac{V}{4} - \frac{V}{4} = 0$$

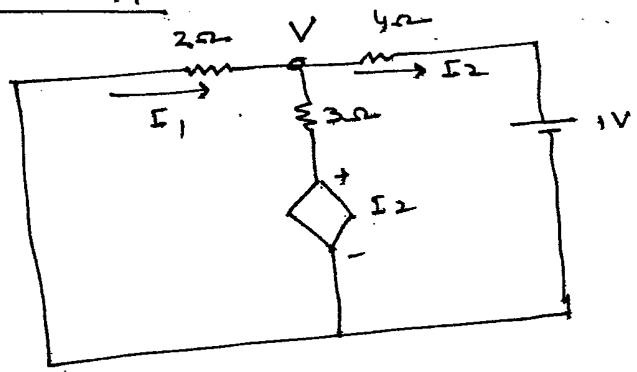
$$5 - V = 0$$

$$V = 5$$

$$I_2 = I_{sc} = \frac{5}{4}\ A.$$

$$R_{Th} = \frac{V_{oc}}{I_s} = \frac{6}{5/4} = \frac{24}{5}\ \Omega \quad \text{Ans.}$$

To find R_{Th}



$$-\frac{V}{2} - \frac{V - I_2}{3} - \frac{V-1}{4} = 0$$

$$-\frac{V}{2} - \frac{V - \left(\frac{V-1}{4}\right)}{3} - \frac{V-1}{4} = 0$$

$$-\frac{V}{2} - \frac{4V - V + 1}{3.4} - \frac{V-1}{4} = 0$$

$$\frac{V}{2} - \frac{3V+1}{12} - \frac{V-1}{4} = 0$$

$$-\frac{V}{2} - \frac{V}{4} - \frac{1}{12} - \frac{V}{4} + \frac{1}{4} = 0$$

$$-V - \frac{1}{12} + \frac{1}{4} = 0$$

$$-V + \frac{2}{12} = 0$$

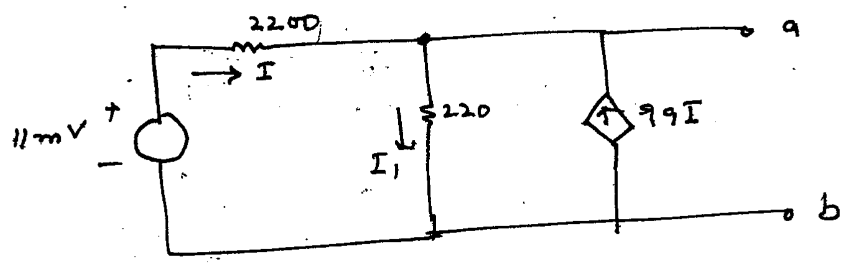
$$-V + \frac{1}{6} = 0$$

$$V = +\frac{1}{6} \qquad \cancel{V = 6V}$$

$$I_2 = \cancel{\frac{6-1}{4}} \; \cancel{\frac{5}{4}A} = \frac{1/6-1}{4} \; \frac{-5/6}{4} = -\frac{5}{24}$$

$$R_{Th} = \cancel{\frac{1}{5/4}} = \cancel{\frac{4}{5}\Omega} \; \frac{1}{+5/24} = \left(+\frac{24}{5}\right)\Omega$$

Q2 <u>Determine R_{Th} at ab</u>



<u>KCL at a</u>

$$-I + I_1 - 99I = 0 \qquad I_1 = 100I$$

<u>KVL for Left loop</u>

$$-11\times10^{-3} + 2200I + 220I_1 = 0$$

$\cancel{-11\times10^{-3} + 2200I + 22000I}$

$-11\times10^{-3} + 22I_1 + 220I_1 = 0$

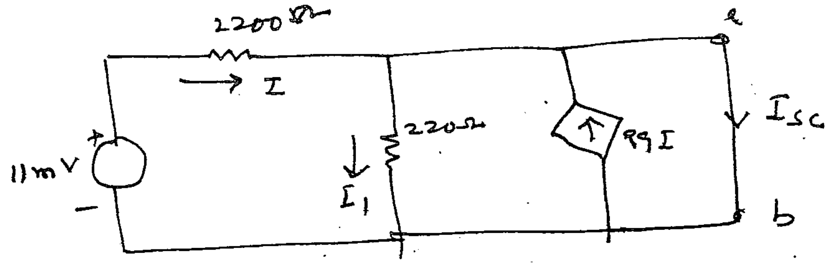
$242I_1 = 11\times10^{-3}$

$I_1 = \frac{11\times10^{-3}}{242} = \frac{1\times10^{-3}}{22} = \frac{1000\times10^{-6}}{22} = 45.5\mu A$

$$I_1 = 45.5\,\mu A$$

$$V_{oc} = 220 \cdot I_1 = 10\,mV$$

<u>For SC</u>



$V_{ab} = 0$ $I_1 = 0$

KCL gives

$-I - 99I + I_{sc} = 0$ $I_{sc} = 100I$

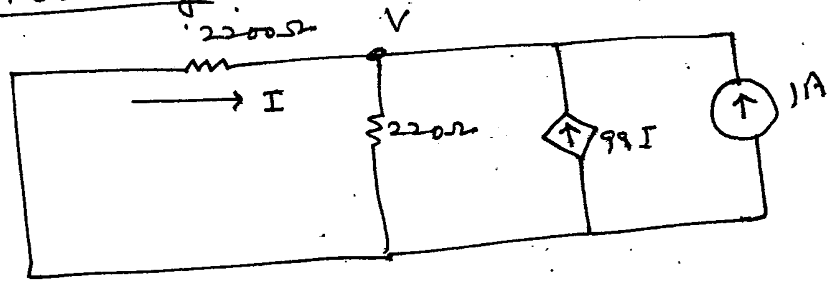
KVL on outer loop.

$-11 \times 10^{-3} + I \times 2200 = 0$

$I = 5\,\mu A$ $I_{sc} = 100I = 500\,\mu A$

$R_{Th} = \dfrac{V_{oc}}{I_s} = \dfrac{10 \times 10^{-3}}{500 \times 10^{-6}} = \underline{20\,\Omega}$ Ans.

<u>Alternatively</u>



$\dfrac{V}{2200} + \dfrac{V}{220} - 99I - 1 = 0$ $\left[I = \dfrac{-V}{2200} \right]$

$\dfrac{V}{2200} + \dfrac{V}{220} + 99\dfrac{V}{2200} = 1$

$\dfrac{100V}{2200} + \dfrac{V}{220} = 1$

$\dfrac{V}{22} + \dfrac{V}{220} = 1$

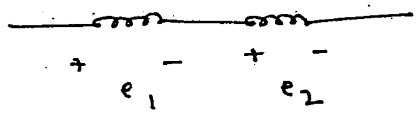
$\dfrac{V}{220}\left[10 + 1\right] = 1$

$\dfrac{11V}{220} = 1$ $\therefore \dfrac{V}{20} = 1$ $\therefore V = 20$ volts

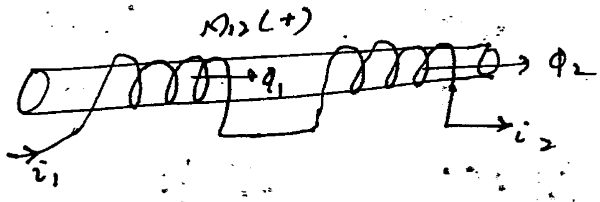
$R_{Th} = \dfrac{20}{1} = \underline{20\,\Omega}$ Ans.

☆

$M = M_{12}(+)$



$e_1 + e_2$ = induced voltage



ϕ_1 & ϕ_2 are in the same direction

$$e_1 = L_1 \frac{di_1}{dt} + M_{12} \frac{di_2}{dt}$$

if $i_1 = i_2 = i$

$$e_1 = L_1 \frac{di}{dt} + M_{12} \frac{di}{dt}$$

$$= (L_1 + M_{12}) \frac{di}{dt}$$

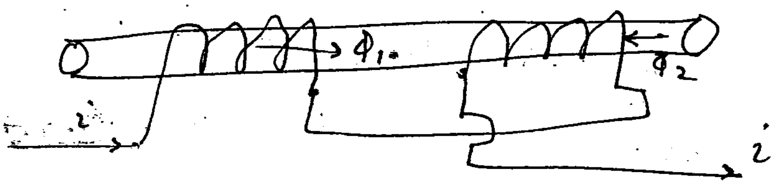
Also $$e_2 = (L_2 + M_{12}) \frac{di}{dt}$$

$$e_T = e_1 + e_2 = (L_1 + M_{12}) \frac{di}{dt} + (L_2 + M_{12}) \frac{di}{dt}$$

$$= (L_1 + L_2 + M_{12} + M_{12}) \frac{di}{dt}$$

$$L_{T(+)} = L_1 + L_2 + 2 M_{12} \quad \text{— (1)}$$

But if coils are ~~wound~~ connected in the opposite direction



ϕ_1 & ϕ_2 are in opposite direction

$$L_{T(-)} = L_1 + L_2 - 2 M_{12} \quad (2)$$

From eqs. (1) and (2)

$$M = \frac{1}{4}\left[L_{T(+)} - L_{T(-)} \right] \quad \text{— 3}$$

$$q = 10\sin\omega t - 17.3\cos\omega t$$

$$= 20\left[\frac{1}{2}\sin\omega t - \frac{\sqrt{3}}{2}\cos\omega t\right]$$

$$= 20\left[\cos 60^\circ \sin\omega t - \sin 60 \cos\omega t\right]$$

$$= 20\left[\sin(\omega t - 60^\circ)\right]$$ why not $\pi/3$?

$$Q_m = \underline{20} \qquad Q_{rms} = \frac{20}{\sqrt{2}} = \underline{14.14}$$ Discuss

Example 4: An emf is given by $e = 170\sin 314t$

Determine

(i) maximum value

(ii) rms value

(iii) frequency

(iv) radians through which its vector has gone when $t = 0.001$ sec and

(v) value of e at the above instant

Soln:

(i) $E_m = \underline{170}$ (ii) $E_{rm} = \frac{170}{\sqrt{2}} = \underline{120.23\,V}$

(iii) $f = \frac{\omega}{2\pi} = \frac{314}{2 \times 3.14} = \underline{50\ Hz\ (c/s)}$

(iv) $\omega t = 2\pi f t = 2.\pi.50.0.001$

$= \underline{0.314 \text{ radians}}$

(v) $e = 170\sin 314t$

$= 170\sin 314 \times 0.001$

$= 170\sin(.314)$

$= 170\sin\left(\frac{.314 \times 180}{\pi}\right)$

$= 170\sin 18^\circ = 170 \times 0.31 = \underline{52.7\,V}$

Example 5 : ~~If $v = 141.42 \sin(157.08t + \pi/5)$~~

~~Find~~ If $i = 10 + 10 \sin 314t$

& Find I_{rms} & I_{av}

Soln

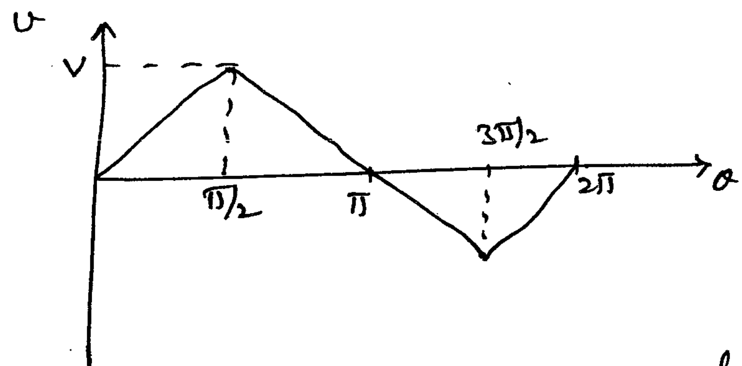
$$I_{rms} = \sqrt{10^2 + \left(\frac{10}{\sqrt{2}}\right)^2} = \sqrt{100 + 50}$$

$$= \sqrt{150} = 12.25 \text{ A}$$

I_{av} : 10 A

As average value of $10 \sin 314t$ over the complete cycle is zero.

Example 6 : Determine the rms and average value of the wave form shown.



Soln.

$$V_{av} = \frac{\text{Area under the curve for I quarter}}{\text{base}}$$

$$= \frac{\frac{1}{2} V_m \cdot \pi/2}{\pi/2} = 0.5 V_m$$

V_{rms} : (Consider only I quarter)

$v = m\theta$ $\qquad$ m is slope $= \frac{2V_m}{\pi}$

$\therefore v = \frac{2V_m}{\pi}\theta$

Mean square value : $\frac{\text{Area under squared wave}}{\text{base}}$

$$= \frac{2}{\pi}\int_0^{\pi/2} v^2 d\theta = \frac{2}{\pi}\int_0^{\pi/2} \frac{4V_m^2}{\pi^2} \theta^2 \ldots$$

$$= \frac{2}{\pi}\int_0^{\pi/2} \frac{4V_m^2\theta^2}{\pi^2}\,d\theta$$

$$= \frac{2}{\pi}\cdot\frac{4V_m^2}{\pi^2}\int_0^{\pi/2}\theta^2\,d\theta$$

$$= \frac{8\,V_m^2}{\pi^3}\left[\frac{\theta^3}{3}\right]\Big|_0^{\pi/2}$$

$$= \frac{8\,V_m^2}{\pi^3.3}\left[\cancel{\theta}^3\right|_0^{\pi/2}$$

$$= \frac{8\,V_m^2}{3\pi^3}\left[\frac{\pi^3}{8} - 0\right]$$

$$= \frac{8\,V_m^2}{3\pi^3}\cdot\frac{\pi^3}{8} = \frac{V_m^2}{3}$$

$$V_{rms} = \sqrt{\frac{V_m^2}{3}} = \frac{V_m}{\sqrt{3}} = \underline{0.577V_m}$$

<u>Example: 7</u>

$$i_1 = 100\ \sin\ (\cancel{100t}$$

$$= 100\ \sin\ (314t)$$

$$i_2 = 100\ \sin\ (314t - 60^\circ)$$

(i) Draw these wave forms on a graph paper to the scale

(ii) Add them

(iii) Write down the expression for $(i_1 + i_2)$

<u>Soln:</u> Graphically - - - do as an assignment

<u>Analytically</u>

$$i_1 + i_2 = 100\ \sin\ (314t) + 100\ \sin\ (314t - 60^\circ)$$

~~= 100{1. Sin 314t + 1/2 Sin (~~

$$i_1 + i_2 = 100 \sin 314t + 100 \sin (314t - 60^\circ)$$

$$= 100 \left[2 . \sin (314t - 30^\circ) \cos 30^\circ \right]$$

$$= 100 \left[\frac{2\sqrt{3}}{2} \sin (314t - 30^\circ) \right]$$

$$= 100 \left[1.732 \sin (314t - 30^\circ) \right]$$

$$= 173.2 \sin (314t - 30^\circ)$$

Comment : So $(i_1 + i_2)$ is also a sinusoid with a phase angle changed.

Example : 8 $\quad i_1 = 100 \sin 314t$

$i_2 = 100 \sin 628t$

Repeat the example 7.

Soln: The result wouldn't be a pure sinusoid

Therefore, the sinusoidal quantities with different frequencies when added donot give pure sinusoid. So, it would be difficult to perform algebraic operations for them.