class Numericals

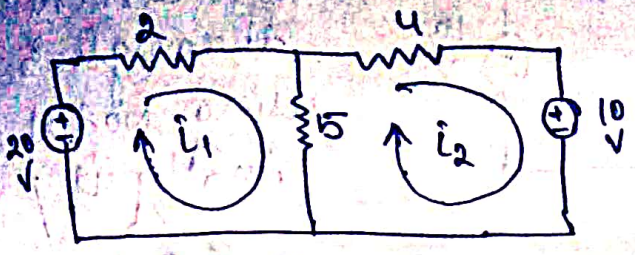
Q) 

fig-1

(current in 5Ω)? by Mesh Analysis

loop analysis

KVL

if you enter in a voltage source from '−' then '−' Answer, other case '+' Answer.

⇒ Applying mesh Analysis on fig-1

At loop-1: $5(i_1 - i_2) - 20 + 2i_1 = 0$

$\Rightarrow 7i_1 - 5i_2 = 20$ ——(i)

At loop-2: $4i_2 + 10 + 5(i_2 - i_1) = 0$

$\Rightarrow -5i_1 + 9i_2 = -10$ ——(ii)

solving (i) and (ii)

$35i_1 - 25i_2 = 100$ ((i) × 5)

$-35i_1 + 63i_2 = -70$ ((ii) × 7)

$38i_2 = 30$

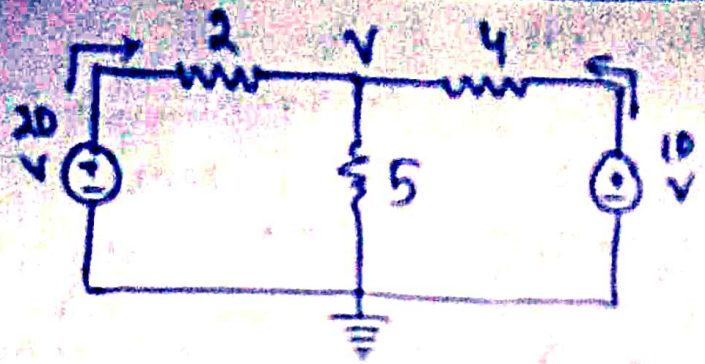
$i_2 = \frac{15}{19}$ A

$i_1 = \frac{20 + 5i_2}{7} = \frac{20 + \frac{75}{19}}{7}$

$= \frac{380 + 75}{19 \times 7} = \frac{455}{19 \times 7} = \frac{65}{19}$ A

So, current through 5Ω $= \frac{65}{19} - \frac{15}{19} = \frac{50}{19}$ A (↕)

02)



find current through 5Ω using nodal Analysis / KCL

Applying nodal analysis,

$$-\left(\frac{20-V}{2}\right)-\left(\frac{10-V}{4}\right)+\left(\frac{V-0}{5}\right)=0$$

$$\Rightarrow \frac{V-20}{2}+\frac{V-10}{4}+\frac{V}{5}=0$$

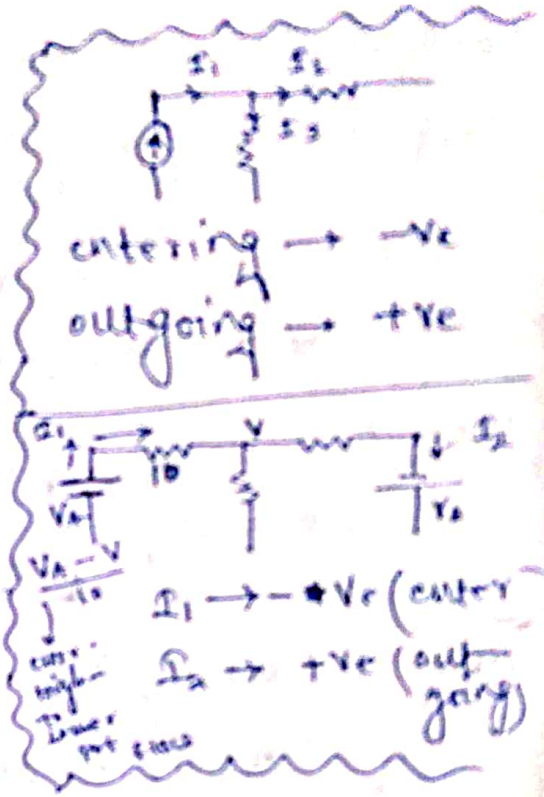
$$\Rightarrow 10V-200+5V-50+4V=0$$

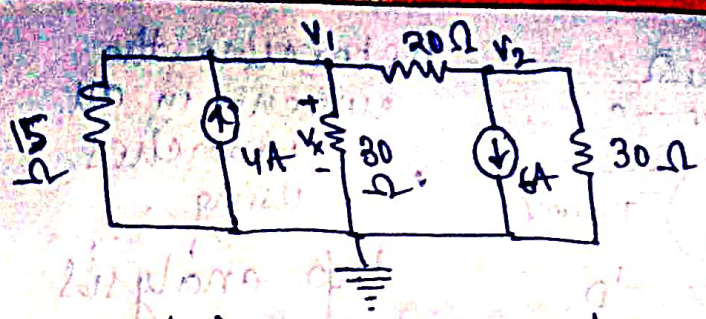
$$\Rightarrow 19V=250$$

$$V=\frac{250}{19}\ V$$

current through 5Ω

$$I=\frac{V}{R}=\frac{250}{19\times 5}=\frac{50}{19}\ V$$



Q) 

Determine V_x using Nodal Analysis

Applying KCL in Node-1 :

$$\frac{V_1}{15} - 4 + \frac{V_1}{30} + \frac{V_1 - V_2}{20} = 0$$

$$\Rightarrow \frac{4V_1 - 240 + 2V_1 + 3V_1 - 3V_2}{60} = 0$$

$$\Rightarrow 9V_1 - 3V_2 = 240$$

$$\Rightarrow 3V_1 - V_2 = 80 \quad \text{---(I)}$$

Applying KCL in Node-2

$$\frac{V_2}{30} + 6 + \frac{V_2 - V_1}{20} = 0$$

$$\Rightarrow \frac{2V_2 + 360 + 3V_2 - 3V_1}{60} = 0$$

$$\Rightarrow -3V_1 + 5V_2 = -360 \quad \text{---(II)}$$

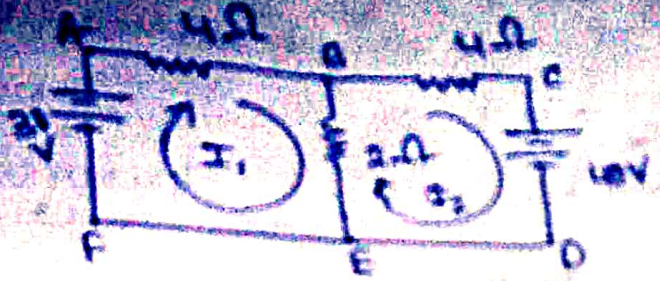
Solving (I) and (II) we get :

$$3V_1 - V_2 = 80$$
$$-3V_1 + 5V_2 = -360$$
$$\overline{4V_2 = -280}$$
$$V_2 = -70\ V$$

$$V_1 = \frac{80 + V_2}{3} = \frac{80 - 70}{3} = \frac{10}{3}\ V$$

So, the value of V_x is $\frac{10}{3}$ V.

6) Determine the current in all branches using loop analysis



Applying KVL in loop-1

$$-30 + 4I_1 + 2(I_1 - I_2) = 0$$

$$\Rightarrow 6I_1 - 2I_2 = 30$$

$$\Rightarrow 3I_1 - I_2 = 15 \quad \text{---(i)}$$

Applying KVL in loop-2

$$10 + 2(I_2 - I_1) + 4I_2 = 0$$

$$\Rightarrow -2I_1 + 6I_2 = -40$$

$$\Rightarrow -I_1 + 3I_2 = -20 \quad \text{---(ii)}$$

$\Rightarrow$ Solving (i) and (ii) $\times 3$

$$3I_1 - I_2 = 15$$

$$-3I_1 + 9I_2 = -60$$

$$8I_2 = -45$$

$$\Rightarrow I_2 = -5.625\ A$$

$$I_1 = 3.225\ A$$

$$I_1 = 3I_2 + 20$$

$$= -16.875 + 20$$

$$= 3.225\ A$$

Q) 

Find the current in branches -

Applying KVL at loop-1

$$+11 + 2I_1 + (I_1 - I_2) = 0$$

$$\Rightarrow \quad 3I_1 - I_2 = -11 \quad \text{---(1)}$$

Applying KVL at loop-2

$$7I_2 + (I_2 - I_3)2 + (I_2 - I_1) = 0$$

$$\Rightarrow -I_1 + 10I_2 - 2I_3 = 0 \quad \text{---(11)}$$

Applying KVL at loop-3.

$$13 + 2(I_3 - I_2) + 3I_3 = 0$$

$$\Rightarrow -2I_2 + 5.I_3 = -13 \quad \text{---(111)}$$

So, solving I_1, I_2, I_3 by cramer's rule

$$\begin{bmatrix} 3 & -1 & 0 \\ -1 & 10 & -2 \\ 0 & -2 & 5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -11 \\ 0 \\ -13 \end{bmatrix}$$

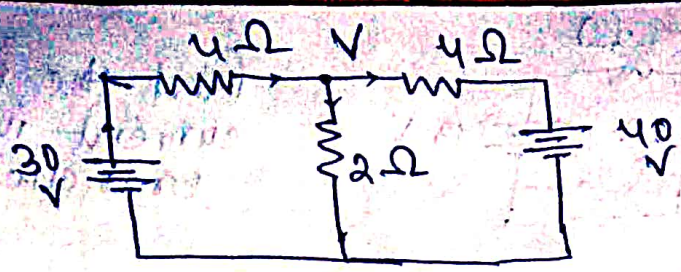
$$I_1 = \frac{\Delta}{\Delta_1} = \frac{\begin{vmatrix} 3 & -1 & 0 \\ -1 & 10 & -2 \\ 0 & -2 & 5 \end{vmatrix}}{\begin{vmatrix} -11 & -1 & 0 \\ 0 & 10 & -2 \\ -13 & -2 & 5 \end{vmatrix}} = \frac{3 \times 46 + 1(45)}{11 \times 46 + 1(-26)} = \frac{183}{480}$$

From eq^n (1) $I_1 = \dfrac{I_2 - 11}{3}$, From (111) $I_3 = \dfrac{2I_2 - 13}{5}$

Putting in (11) we get $133I_2 = -133$

$I_2 = -1\,A$
$I_3 = -3\,A$
$I_1 = -4\,A$

} clockwise direc^n

8) 

Find the current through 2Ω resistance.

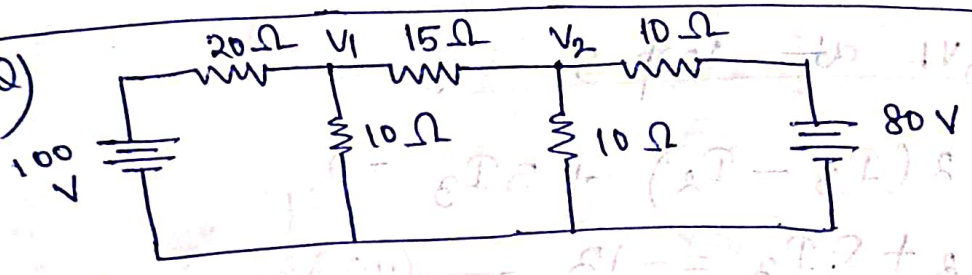
$$-\left(\frac{30-V}{4}\right)+\frac{V}{2}+\frac{V-40}{4}=0$$

$$\Rightarrow \frac{V-30+2V+V-40}{4}=0$$

$$\Rightarrow 4V = 70$$

$$V = 17.5\ V$$

$$\text{current}\left(I\Big|_{5\Omega}\right) = \frac{17.5}{2} = 8.75\ A.$$

Q) 

Find current in all branches using KCL

Applying KCL in node-1

$$\frac{V_1-100}{20}+\frac{V_1}{10}+\frac{V_1-V_2}{15}=0$$

$$\Rightarrow \frac{3V_1-300+6V_1+4V_1-4V_2}{60}=0$$

$$\Rightarrow 13V_1-4V_2=300 \quad \text{---(I)}$$

Applying KCL in node-(II)

$$\frac{V_2-80}{10}+\frac{V_2}{10}+\frac{V_2-V_1}{15}=0$$

$$\Rightarrow \frac{3V_2-240+3V_2+2V_2-2V_1}{30}=0$$

$$\Rightarrow -2V_1+8V_2=240$$

$$\Rightarrow -V_1+4V_2=120 \quad \text{---(II)}$$

Solving (i) − (ii) × 13

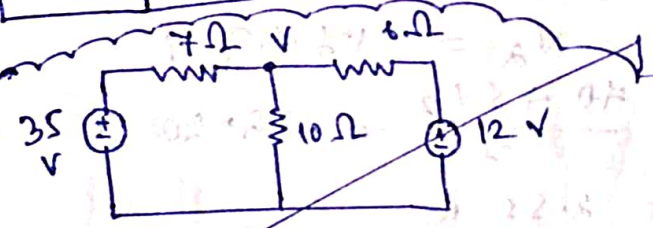
$$13V_1 - 4V_2 = 300$$
$$-13V_1 + 52V_2 = 1560$$
$$48V_2 = 1860$$
$$V_2 = \frac{1860}{48} = 38.75\ V$$
$$V_1 = 4V_2 - 120$$
$$= 35\ V$$

current through 20Ω = −3.25 A (↓)
" due to (V_1) in 10Ω = 3.5 A
" " " (V_2) - 10Ω = −4.125 A
" " " " - 10Ω = 3.875 A
" 15Ω = 0.25 A (←)

Q)



Determine the Nodal voltage and current through 2Ω



Applying KCL $\frac{V-35}{7} + \frac{V}{10} + \frac{V-12}{6} = 0$

$$\Rightarrow \frac{60V - 2100 + 42V + 70V - 840}{420} = 0$$
$$\Rightarrow 172V = 2940$$
$$V = \frac{2940}{172} = 17.09\ V$$

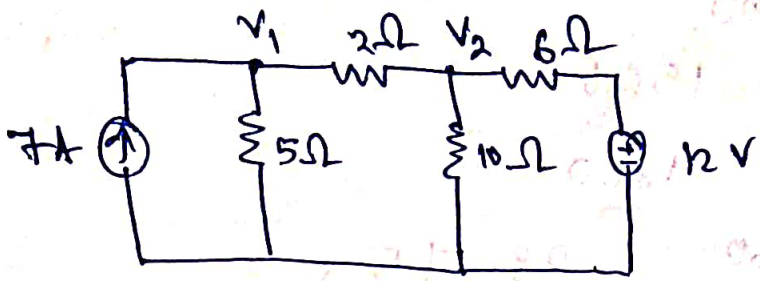
$I_1 = 7A$

$(I_2 - I_1)5 + 2I_2 + 10(I_2 - I_3) = 0$
$\Rightarrow 17I_2 - 10I_3 = 35$ —(i)

$6I_3 + 10(I_3 - I_2) = 12$
$\Rightarrow -10I_2 + 16I_3 = 12$ —(ii)
$\Rightarrow -5I_2 + 8I_3 = 6$, $I_2 = \frac{8I_3 - 6}{5} = 4A$, $V_{2\Omega} = 8V$

$170I_2 - 100I_3 = 350$
$-170I_2 + 270I_3 = 204$
$170I_3 = 554$
$I_3 = 3.25\ A$

* By Nodal Analysis -



$$\frac{V_1}{5} - 7 + \frac{V_1 - V_2}{2} = 0$$

$$\Rightarrow \quad 2V_1 - 70 + 5V_1 - 5V_2 = 0$$

$$\Rightarrow \quad 7V_1 - 5V_2 = 70 \quad \text{---(1)}$$

$$\frac{V_2}{10} + \frac{V_2 - V_1}{2} + \frac{V_2 - 12}{6} = 0$$

$$\Rightarrow \quad 3V_2 + 15V_2 - 15V_1 + 5V_2 - 60 = 0$$

$$\Rightarrow \quad -15V_1 + 23V_2 = 60 \quad \text{---(11)}$$

$$\Rightarrow \quad 105V_1 - 75V_2 = 1050$$
$$-105V_1 + 161V_2 = 420$$
$$\overline{\qquad\qquad\qquad\qquad}$$
$$86V_2 = 1470$$

$$V_2 = 17.09 \text{ V}$$

$$V_1 = \frac{70 + 5V_2}{7} = 22.20 \text{ V}$$

$$I_{2\Omega} = \frac{V_1 - V_2}{2} = 2.55 \text{ A}$$

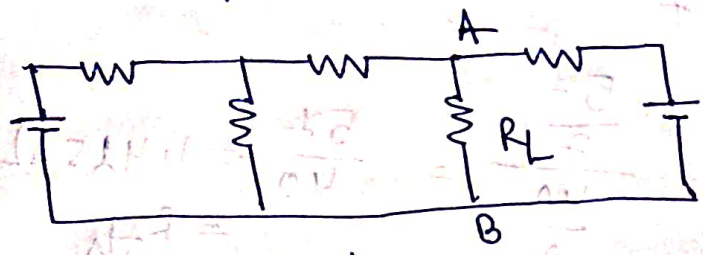
8)

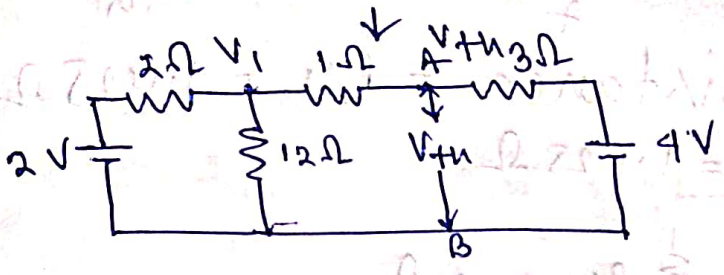


Find I across 2Ω using thevenin theorem -

⇒ Applying thevenin's theorem.

here, $R_L = 2\Omega$ across A, B





Applying KCL

$$\frac{V_1 - 2}{2} + \frac{V_1}{12} + \frac{V_1 - V_{th}}{1} = 0$$

$$\Rightarrow \quad 6V_1 - 12 + V_1 + 12V_1 - 12V_{th} = 0$$

$$\Rightarrow \quad 19V_1 - 12V_{th} = 12 \quad \text{---(1)}$$

and $$\frac{V_{th} - 4}{3} + \frac{V_{th} - V_1}{1} = 0$$

$$\Rightarrow \quad V_{th} - 4 + 3V_{th} - 3V_1 = 0$$

$$\Rightarrow \quad -3V_1 + 4V_{th} = 4 \quad \text{---(11)}$$

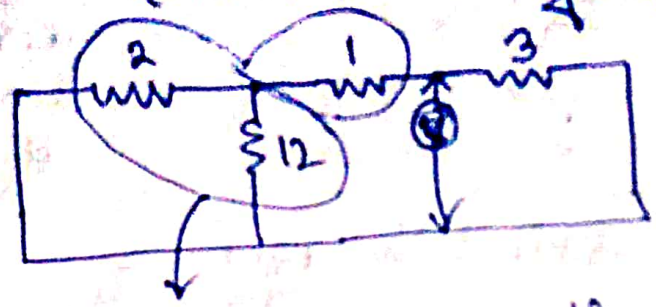
⇒ solving (1) + (11) × 3

$$19V_1 - 12V_{th} = 12$$
$$-9V_1 + 12V_{th} = 12$$
$$10V_1 = 24$$
$$V_1 = 2.4\ V$$

$$V_{th} = \frac{4 + 3V_1}{4}$$
$$= \frac{4 + 7.2}{4}$$
$$= \frac{11.2}{4}$$
$$= 2.8\ V$$

NOW, thevenin's voltage (V_{th}) = 2.8 V

NOW,

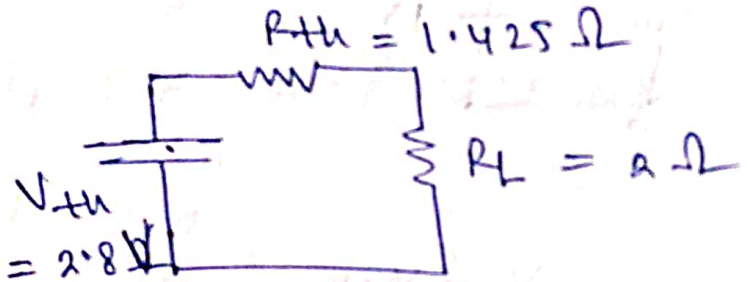


$$\frac{12 \times 2}{14} = \frac{24}{14} = \frac{12}{7}\ \Omega \quad , \quad \frac{12}{7} + 1 = \frac{19}{7}\ \Omega$$

$$\frac{\frac{19}{7} \times 3}{\frac{19}{7} + 3} = \frac{\frac{57}{7}}{\frac{40}{7}} = \frac{57}{40} = 1.425\ \Omega = R_{th}$$

thevenin's resistance = $R_{th} = 1.425\ \Omega$

NOW,



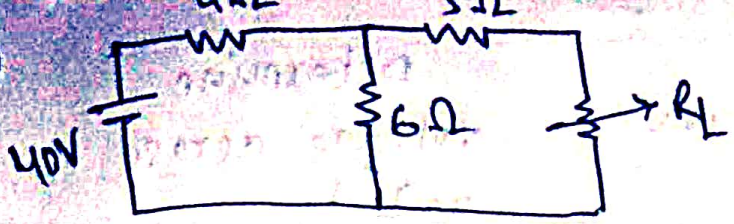
current through 2Ω $= \frac{2.8}{1.425 + 2}$

$= \frac{2.8}{3.425}$

$= 0.817$ A

(Ans.)

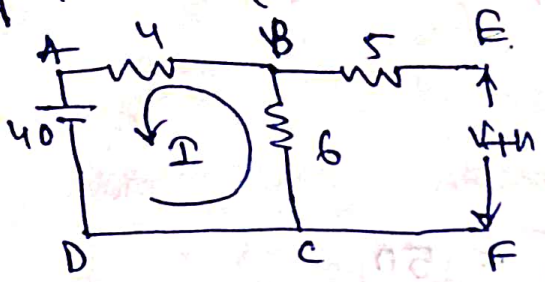
Q)



Determine I_L ? (using thevenin's)

⇒ Applying thevenin's theorem

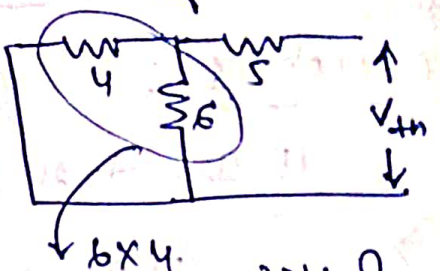
solving for thevenin's voltage



$$I = \frac{V}{R} = \frac{40}{6+4} = 4A$$

$$V_{EF} = V_{BC} = V_{th} = 6 \times 4 = 24\ V$$

solving for R_{th}



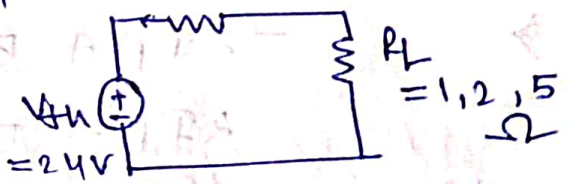
$$\frac{6 \times 4}{10} = 2.4\ \Omega$$

$$2.4 + 5 = 7.4\ \Omega = R_{th}$$

$R_{th} = 7.4\ \Omega$

NOW,

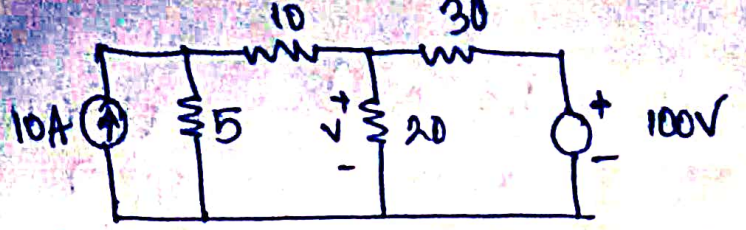
$$I_L\big|_{1\Omega} = \frac{24}{7.4+1} = \frac{24}{8.4} = 2.85A$$

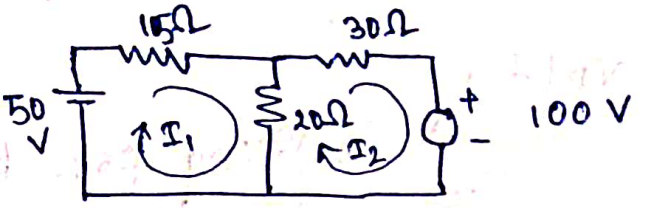


$$I_L\big|_{2\Omega} = \frac{24}{9.4} = 2.55A$$

$$I_L\big|_{5\Omega} = \frac{24}{12.4} = 1.93\ A$$

Q) Determine voltage across 20Ω





For loop-1 :-

$$15I_1 + 20(I_1 - I_2) = 50$$

$$\Rightarrow 7I_1 - 4I_2 = 10 \quad \text{——(1)}$$

for loop-2 :-

$$30I_2 + 20(I_2 - I_1) = -100$$

$$\Rightarrow -2I_1 + 5I_2 = -10$$

$$\Rightarrow 2I_1 - 5I_2 = 10 \quad \text{——(11)}$$

(1) × (5) − (11) × 4, we get

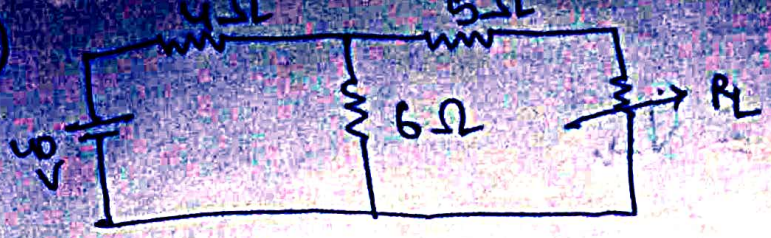
$$35I_1 - 20I_2 = 50$$
$$-8I_1 - (-20I_2) = -40$$
$$27I_1 = 10$$

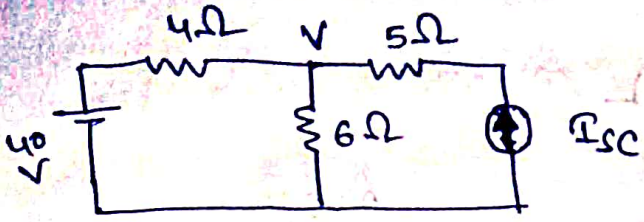
$$I_1 = \frac{10}{27}\,A, \quad I_2 = \frac{7I_1 - 10}{4} = -\frac{50}{27}\,A$$

$$V_{20\Omega} = 20(I_1 - I_2)$$

$$= 20\left(\frac{60}{27}\right) = \frac{400}{9} = 44.4\ V$$

Q) Find R_L using thevenin's Norton





$$\Rightarrow \frac{V-40}{4} + \frac{V}{6} + \frac{V}{5} = 0$$

$$V = 16.21 \text{ V}$$

$$I_{SC} = \frac{V}{R} = \frac{16.21}{5} = 3.24 \text{ A}$$

$$I_L = \frac{R_N \times I_{SC}}{R_L + R_N}$$

$$= \frac{7.4 \times 3.24}{5 + 7.4} = 1.89 \text{ A}$$

R_N :

$$\frac{5 \times 6}{11} + 4$$

$$= 2.72 + 4$$

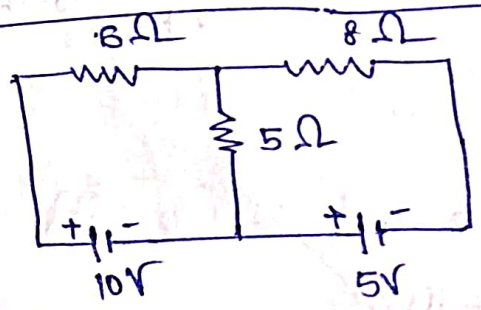
$$= 6.72 \ \Omega$$

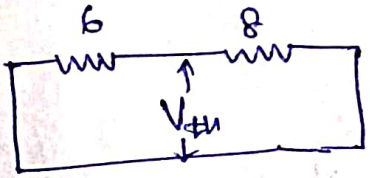
$$\frac{4 \times 1}{4+6} + 5$$

$$= 2.4 + 5$$

$$= 7.4 \ \Omega$$

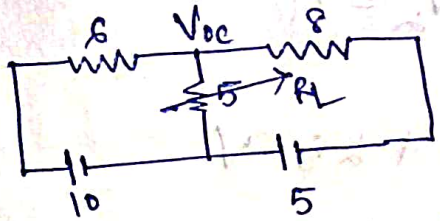
Q) Find thevenin's equivalent circuit → and I|5Ω





$$R_{TH} = \frac{8 \times 6}{8+6} = \frac{48}{14} = \frac{24}{7}$$

$$= 3.42 \ \Omega$$



$$\frac{V_{OC} - 10}{6} + \frac{V_{OC} + 5}{8} = 0$$

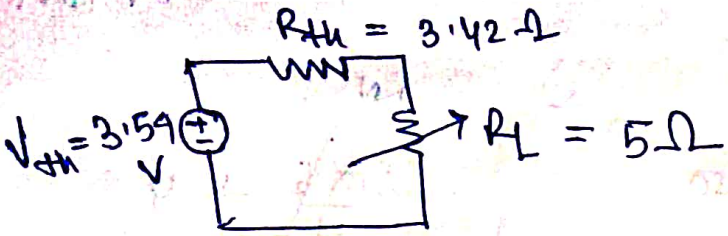
$$\Rightarrow 8V_{OC} - 80 + 6V_{OC} + 30 = 0$$

$$\Rightarrow 14V_{OC} = 50$$

$$\Rightarrow V_{OC} = 3.57 \text{ V}$$

$R_{Th} = 3.42\ \Omega$

$V_{OC} = 3.54\ V = V_{Th}$

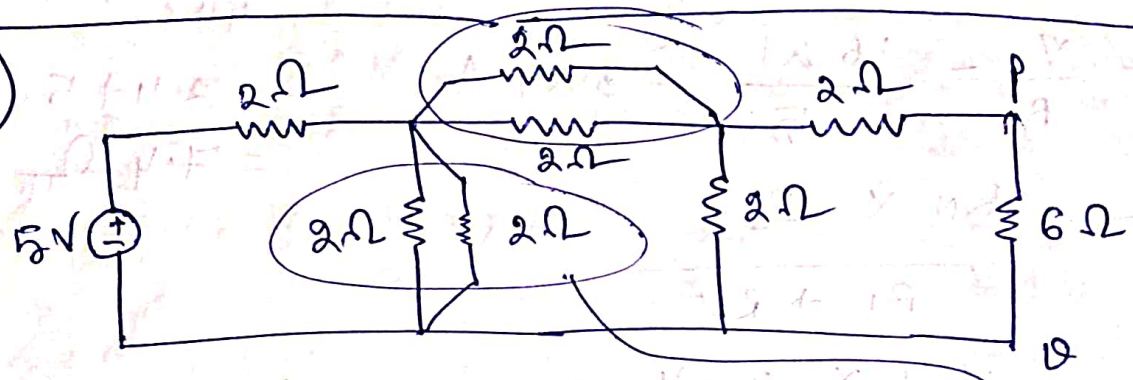


I_L i.e. $I\Big|_{5\Omega}$ i.e. $I_{Th} = \dfrac{3.54}{3.42 + 5}$

$= 0.420$ A

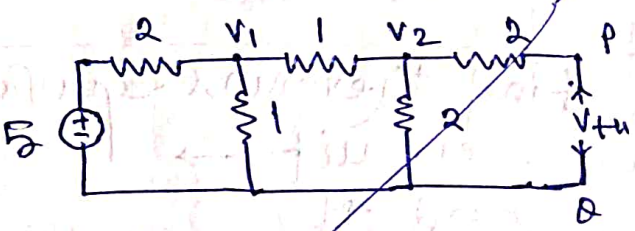
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b)



⇒ Determine R_{Th} across PQ :-

$\dfrac{2 \times 2}{2+2} = 1\ \Omega$



$\dfrac{V_1 - 5}{2} + V_1 + V_1 - V_2 = 0$

$\Rightarrow 5V_1 - 2V_2 = 5$ ——(1)

$V_2 - V_1 + \dfrac{V_2}{2} + \dfrac{V_2}{2} = 0$

$\Rightarrow 2V_2 - V_1 = 0 \Rightarrow 2V_2 = V_1$

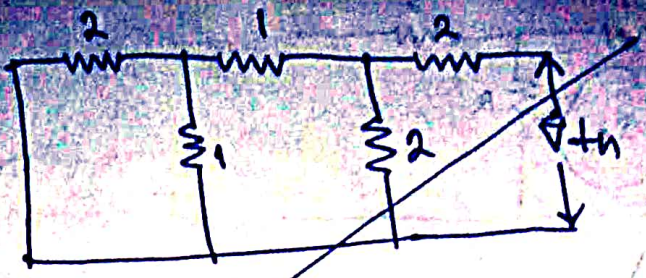
In eqn (1) $5V_1 - V_1 = 5$

$V_1 = \dfrac{5}{4} = 1.25$ V

$V_2 = 2.5$ V

$= V_{Th}$

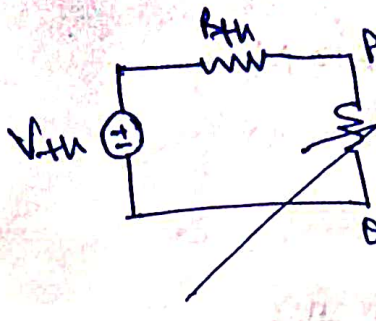
R_{th}:-



$$\frac{2\times1}{2+1}+2$$

$$\frac{8}{3}\Omega = R_{th}$$

$$= 2.66\,\Omega$$



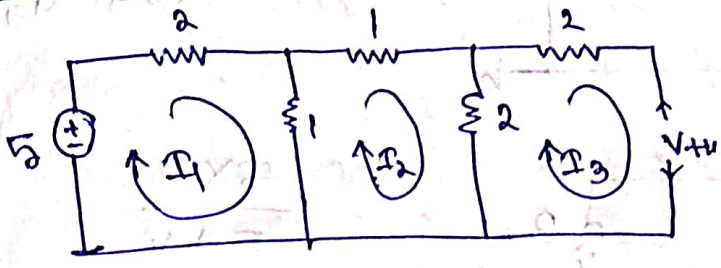
$$I_L = \frac{V_{th}}{R_L + R_{th}}$$

$$= \frac{2.5}{2.66+6}$$

$$= 0.288\ A$$

---

b)



Applying KVL,

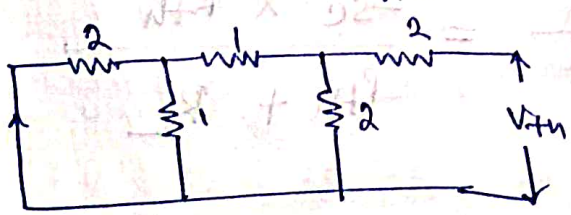
$I_3 = 0$ (open ckt)

$$2I_1 + (I_1 - I_2) = 5 \Rightarrow 3I_1 - I_2 = 5 \quad \text{---(i)}$$

and $$2I_2 + I_2 - I_1 + I_2 = 0 \Rightarrow 4I_2 = I_1 \quad \text{---(ii)}$$

$$\Rightarrow I_2 = 0.45\ A$$

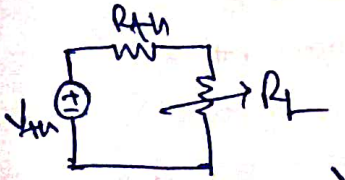
$$V_{th} = I_2 \times 2 = 0.90\ A$$



$$\frac{2\times1}{2+1}+1 = \frac{5}{3}$$

$$\frac{\frac{5}{3}\times2}{\frac{5}{3}+2} + 2 = \frac{10}{11} + 2$$

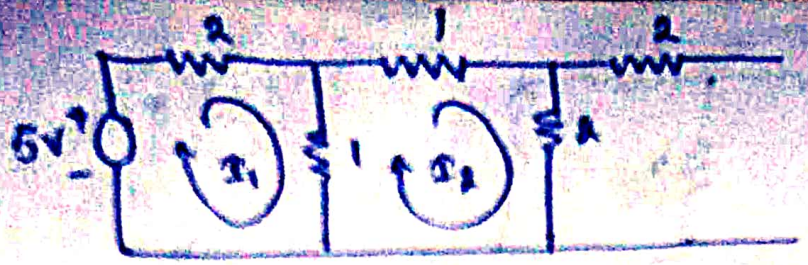
$$= 2.909\,\Omega$$



$$I_L\,|\,I_{6\Omega} = \frac{V_{th}}{R_L + R_{th}} = \frac{0.909}{2.909+6}$$

$$= 0.102\ A$$

Q)



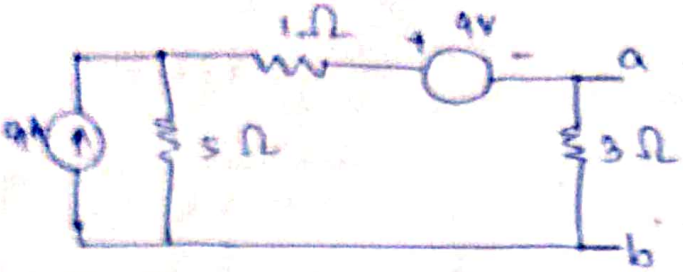
↳ previous problem

$V_{th} = I_2 \times 2$

$R_{th} =$

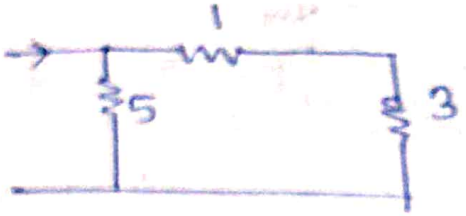
$I_{th} =$

Q)



Find the Norton's eqv ckt from a, b

→ R_{th} :

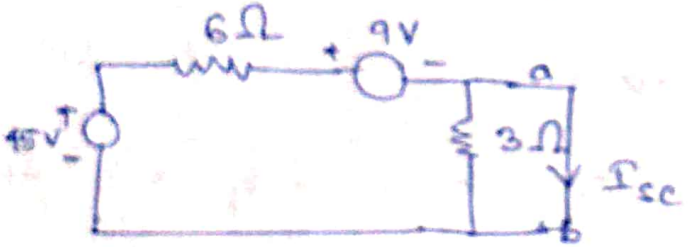


$$\frac{5 \times 4}{5+4}$$

$= 2.22\ \Omega$

$= R_{th}$

→

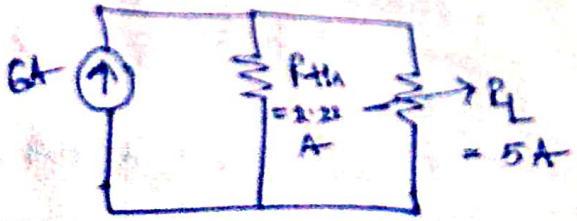


current always choose low resistive path

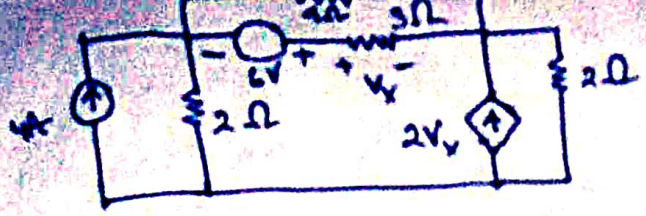
so $I_{sc} = \frac{45-9}{6} = 6\ A$

$$I_L = \frac{6 \times 2.22}{2.22+3} = \frac{I_{sc} \times R_{th}}{R_{th} + R_L}$$

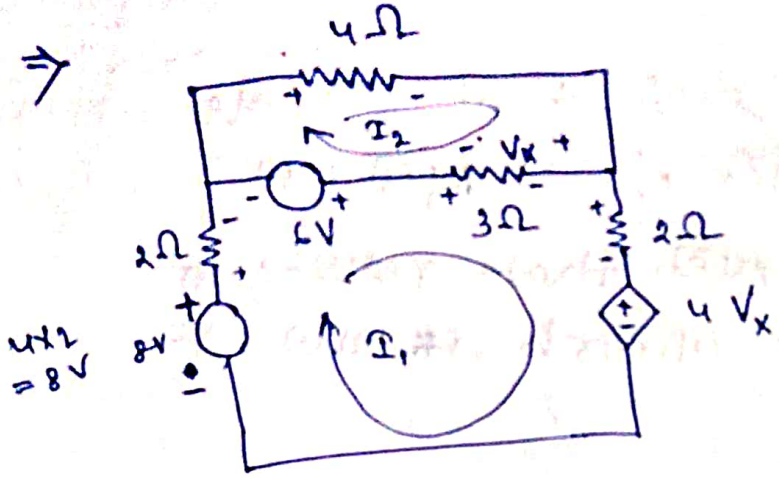
$= 2.55\ A$



Q) Find the value of V_x ?



⇒



here, $V_x = 3(i_1 - i_2)$

$$9I_2 + 3(I_2 - I_1) = 6 \quad \text{—(1)}$$

$$\Rightarrow \boxed{-3I_1 + 7I_2 = 6}$$

$$2I_1 + 12(I_1 - I_2) + 8 + 2(I_1) + 6 + 3(I_1 - I_2) = 0 \quad \text{—(ii)}$$

$$\Rightarrow \boxed{19I_1 - 15I_2 = -14}$$

(i) × 15 + (ii) × 7

$$-45I_1 + 105I_2 = 90$$
$$133I_1 - 105I_2 = -98$$

$$88I_1 = -8$$

$$I_1 = -\frac{1}{11} \text{ A}$$

$$I_2 = \frac{6 + (-\frac{3}{11})}{7} = 0.818 \text{ A}$$

$$V_x = 3(I_1 - I_2) = -2.727 \text{ A} \ (\rightarrow)$$

9)



A) Determine 'R' such that source delivers a power of 4 ~~MW~~ KW

B) Determine R such that results in 10 KΩ res. to absorb 16 mW of power

c) Replace 'R' by a voltage source that will cause no power to be absorbed by any resistor.

⇒ A) total Resistance of the ckt when V = 12 KV

$10 + 15 + R$

$= 25 + R$ KΩ

Power

$\Rightarrow P = \frac{V^2}{R} \Rightarrow 4 = \frac{12^2}{25+R} \Rightarrow R = 11\ K\Omega$

$\Rightarrow \boxed{100 + 4R = 144}$

B) $P_{10K\Omega} = I^2 R \Rightarrow 0.016 = I^2 \times 10$

$16\ mW = 0.016\ KW$

$1\ MW = 1000\ KW$

$I = \sqrt{0.0016}$

$= 0.04\ KA$

$V = IR$

$R = \frac{12}{0.04}$

b) $P|_{10K\Omega} = I^2 R$

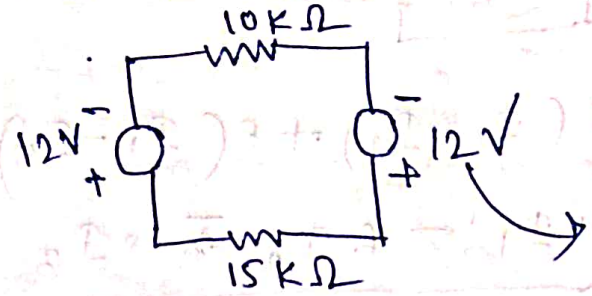
$\Rightarrow 16000 = I^2 \times 10 \Rightarrow I = 40KA$

$R = \frac{V}{I} = \frac{12\ V}{40\ KA} = 3 \times 10^{-4}\ K\Omega$

if 12 KV then $0.3\ K\Omega$

(c) No power to be absorbed

$P = 0$;



→ Replaced R

Q)

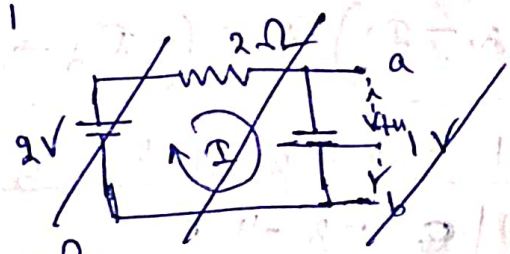


determine thevenin's equivalent circuit

$1A \times 1\Omega = 1V$

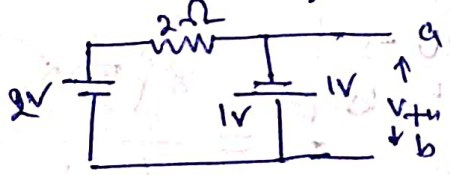
$R_{th} = \frac{1 \times 1}{1+1} = 0.5\ \Omega$

For V_{th} :



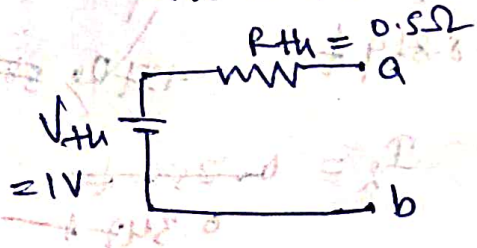
$2I - 1 + 2 = 0$

$I = 1.5A$

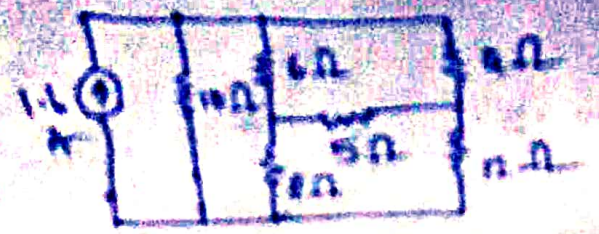


here voltage across ab will be 1V so,

$V_{th} = 1V$

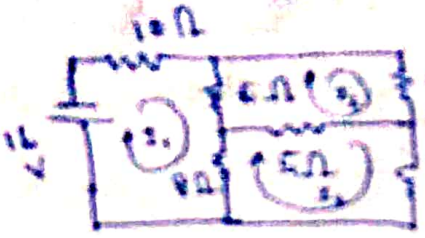


9)



Analyse the circuit by mesh analysis & calculate $I_{5\Omega}$

⇒



$$10I_1 + 6(I_1 - I_2) + 8(I_1 - I_3) = 16$$

$$\Rightarrow 24I_1 - 6I_2 - 8I_3 = 16$$

$$\Rightarrow \boxed{12I_1 - 3I_2 - 4I_3 = 8} \quad \text{---(I)}$$

$$9I_2 + 5(I_2 - I_3) + 6(I_2 - I_1) = 0$$

$$\Rightarrow \boxed{-6I_1 + 20I_2 - 5I_3 = 0} \quad \text{---(II)}$$

$$12I_3 + 8(I_3 - I_1) + 5(I_3 - I_2) = 0$$

$$\Rightarrow \boxed{-8I_1 - 5I_2 + 25I_3 = 0} \quad \text{---(III)}$$

$$\Rightarrow \text{Ti/7} \quad I_1 = \frac{\begin{vmatrix} 8 & -3 & -4 \\ 0 & 20 & -5 \\ 0 & -5 & 25 \end{vmatrix}}{\begin{vmatrix} 12 & -3 & -4 \\ -6 & 20 & -5 \\ -8 & -5 & 25 \end{vmatrix}} = \frac{8(500 - 25)}{12(475) + 3\begin{vmatrix} -150 & \\ -40 & \end{vmatrix} - 4(30 + 160)}$$

$$= 0.645\,A \quad 1.849\,A$$

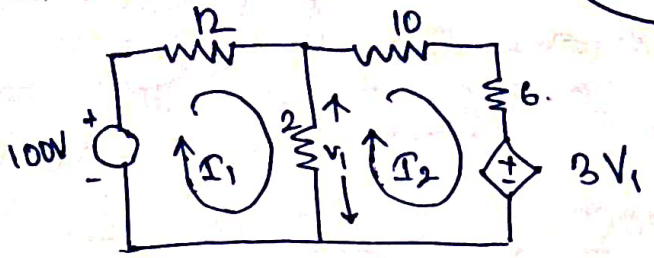
$$\begin{vmatrix} 12 & 8 & 4 \\ -6 & 0 & -5 \\ -8 & 0 & 25 \end{vmatrix} = -8(-190) = 1520 \qquad I_2 = 0.254\,A \quad 0.349\,A$$

$$\begin{vmatrix} 12 & -3 & 8 \\ -6 & 20 & 0 \\ -8 & -5 & 0 \end{vmatrix} = 8(190) = 1520 \qquad I_3 = 0.254\,A \quad 0.349\,A$$

$$I\big|_{5\Omega} = 0\,A$$

a) 

Determine V_1 using mesh analysis

⇒ 

$\rightarrow V_1 = 2(I_1 - I_2)$

$\Rightarrow 12I_1 + 2(I_1 - I_2) = 100$

$\Rightarrow 14I_1 - 2I_2 = 100$

$\Rightarrow \boxed{7I_1 - I_2 = 50}$ ——(1)

$\Rightarrow 16I_2 + 6(I_1 - I_2) + 2(I_2 - I_1) = 0$

$\Rightarrow 4I_1 + 12I_2 = 0$

$\Rightarrow I_1 + 3I_2 = 0 \Rightarrow \boxed{I_1 = -3I_2}$ ——(11)

$-21I_2 - I_2 = 50$

$I_2 = \left(\frac{50}{-22}\right) = \boxed{-2.272\ A = I_2}$

$\boxed{I_1 = +6.816\ A}$

$V_1 = 2(I_1 - I_2) = \cancel{13.6\ V}$

$= 2(6.816 + 2.272)$

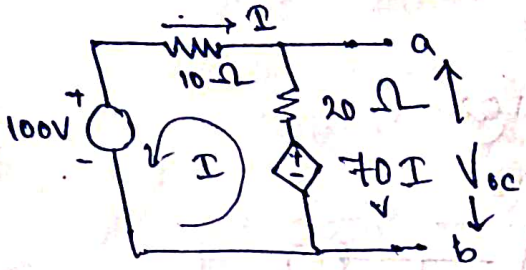
$= 18.2\ V$

Q) Find thevenin eqv which has dependent current generator —



Dependent source $R_{th} = \frac{V_{oc}}{I_{sc}}$

⇒

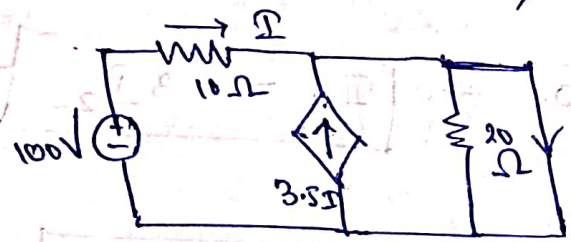


$-100 + 10I + 20I + 70I = 0$

$I = 1A.$

$V_{oc} = 100\,V - (10 \times 1)\,V = 90V$

⇒

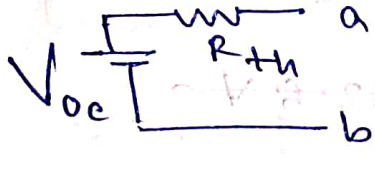


$I_{sc} = \frac{100}{10} + 3.5 \times 1$

$= 10 + 35$

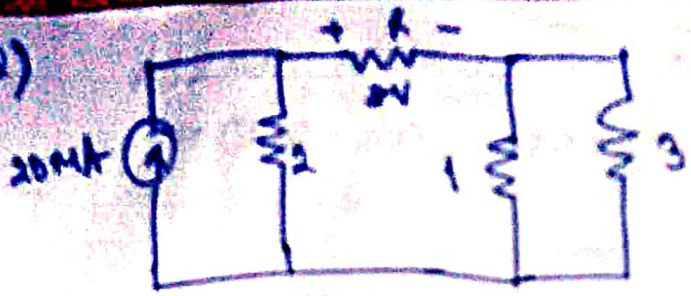
$= 45\,A$

$R_{th} = \frac{90}{45} = 2\Omega$



} thevenin's eqv circuit.

Q)

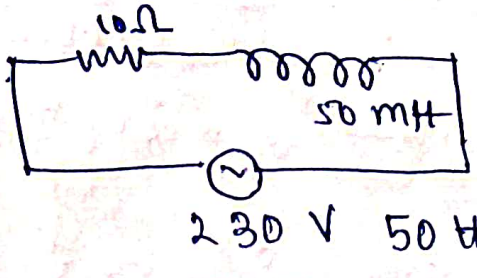


In the ckt, determine the power absorbed in the Resistor '3'.

A res of 10Ω is in series with a 50 mH inductor across a 230 V 50 Hz supply. calculate –

1) current ∓1000 in the ckt
2) phase Angle of current

⇒



R-L circuit

$$\Rightarrow i = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + X_L^2}}$$

$$= \frac{230}{\sqrt{100 + (15.7)^2}}$$

$$= \frac{230}{18.61} = 12.35 \text{ A}$$

$$X_L = 2\pi fL$$

$$= 2 \times 3.14 \times 50 \times \frac{50}{1000}$$

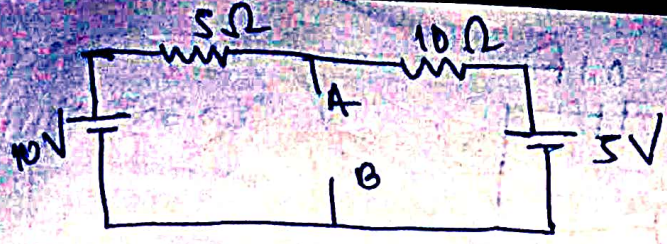
$$= 15.7 \ \Omega$$

$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{15.7}{10}\right) = 57.72^\circ$$

lagging.

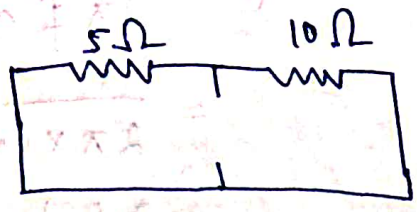
i	12.35 A
ϕ	57.50°

Q)



Obtain Norton eqv circuit wrt AB and find I_L if $R_L = 5\Omega$ at AB.

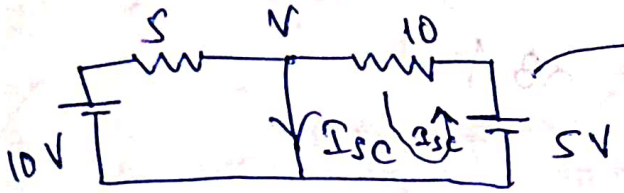
⇒ R_{TH} :



$$R_{TH} = \frac{5 \times 10}{15}$$

$$= \frac{50}{15} = 3.33\ \Omega$$

⇒



$10 I_{SC}' = 5 \Rightarrow I_{SC}' = 0.5$

I_{SC} / I_N

$\frac{10}{5}\left(\frac{V}{R}\right)$

$= 2 + 0.5$

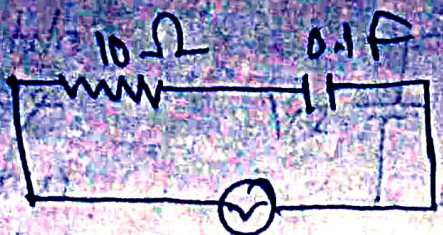
$= 2.5\ \Omega$

$$I_L = \frac{I_N \times R_N}{R_L + R_N}$$

$$= \frac{2.5 \times 3.3}{5 + 3.33} = 0.999\ A \approx 1\ A$$

Q) A 10Ω res is connected in series with a $100\ \mu F$ capacitor to a 230V, 50Hz supply - find

1) the impedence
2) current
3) power factor
4) phase Angle
5) voltage across the resistor and capacitor



1) $Z = \sqrt{R^2 + X_C^2}$

$= \sqrt{100 + (0.031)^2}$

$= 10.000004805\ \Omega$

$X_C = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi \times 50 \times 0.}$

$= 0.031$

2) $I = \frac{V}{Z} = \frac{230}{10} = 23\,A$

3) R-L ckt PF (lagging always) as $X_L > X_C$

R-C ckt PF (leading always) ($X_L = 0$, $X_C > X_L$)

Power factor

$\cos\phi = \frac{R}{Z} = \frac{10}{0.031} = 322.580$

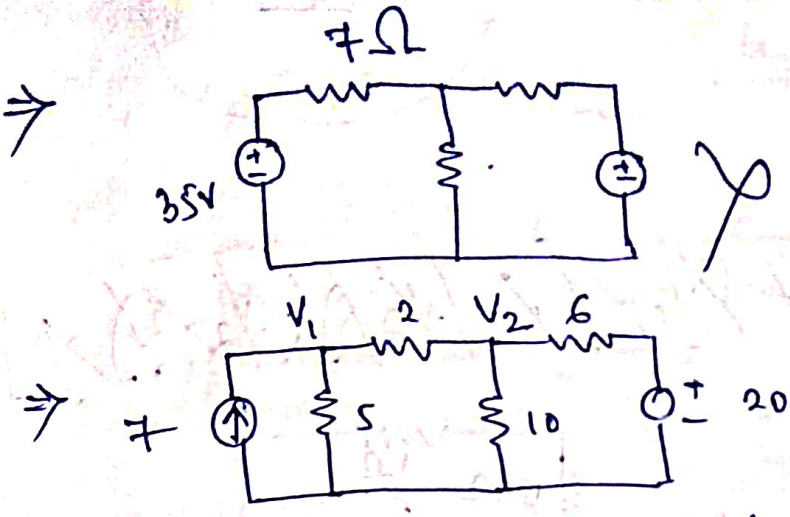
4) $\phi = \cos^{-1}(322.580)$

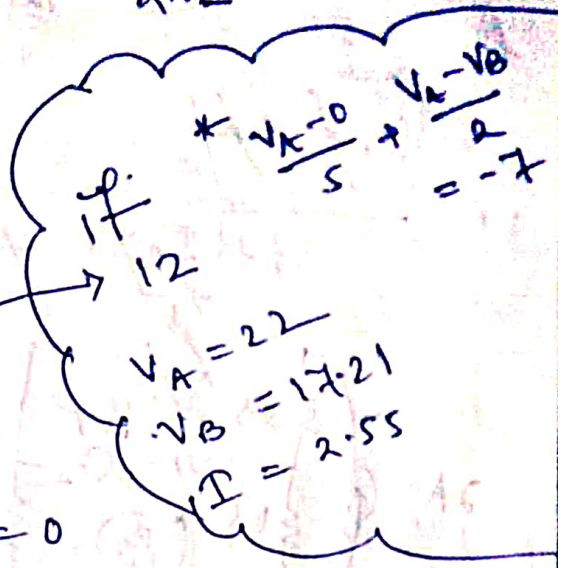
5) $V_{10\Omega} = ?$

$V_{0.1F} = ?$

Q) Find the Nodal Voltages and I ?







eq1 $\quad -7 + \frac{V_1}{5} + \frac{V_1 - V_2}{2} = 0$

$\Rightarrow \quad 2V_1 + 5V_1 - 5V_2 = 7$

$\Rightarrow \quad 7V_1 - 5V_2 = 7 \quad \text{---} (1)$

eq2 $\quad \frac{V_2 - 20}{6} + \frac{V_2}{10} + \frac{V_2 - V_1}{2} = 0$

$\Rightarrow \quad 5V_2 - 100 + 3V_2 + 15V_2 - 15V_1 = 0$

$\Rightarrow \quad -15V_1 + 23V_2 = 100 \quad \text{---} (11)$

$\Rightarrow \quad (1) \times 15 + (11) \times 7$

$105V_1 - 75V_2 = 105$

$-105V_1 + 161V_2 = 700$

$86V_2 = 805$

$V_2 = 9.36 \text{ V}$

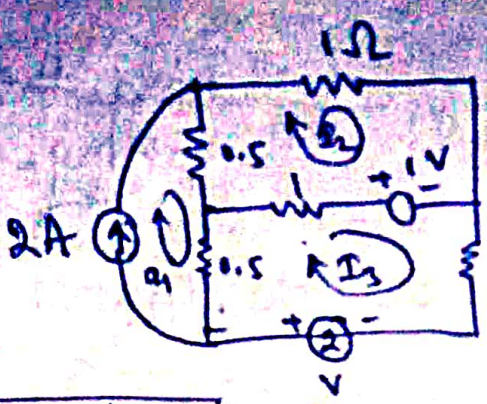
$V_1 = \frac{7 + (5 \times 9.36)}{7}$

$= 7.68 \text{ V}$

$I|_{2\Omega} = 0.837 \text{ A}.$

$\downarrow$

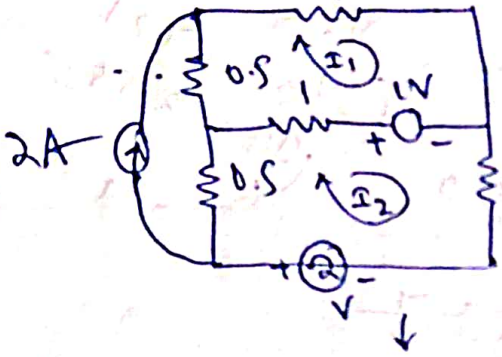
$\left(\frac{V_1 - V_2}{2}\right)$

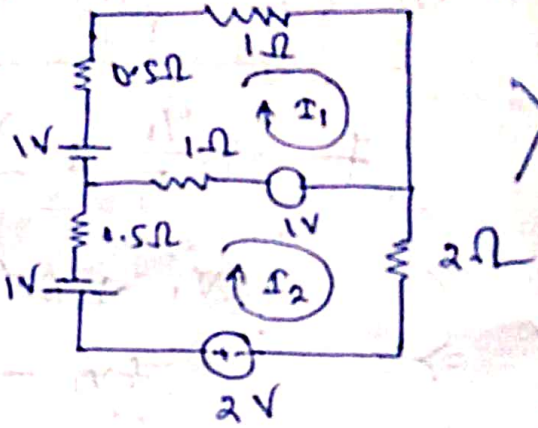


determine
$I_{2\Omega}$

$I_1 \neq 2A$

$I_2 \times 1 + 1V + (I_2 - I_3) \times 0.5 + (I_2 - 2) \times 2 = 0$





$0.5(I_1 - 2) + I_1 - 1 + I_1 - I_2 = 0$

$\Rightarrow \quad 5I_1 - 2I_2 = 4 \quad \text{—— (1)}$

$0.5(I_2 - 2) + I_2 - I_1 + 1 - 2 + 2I_2 = 0$

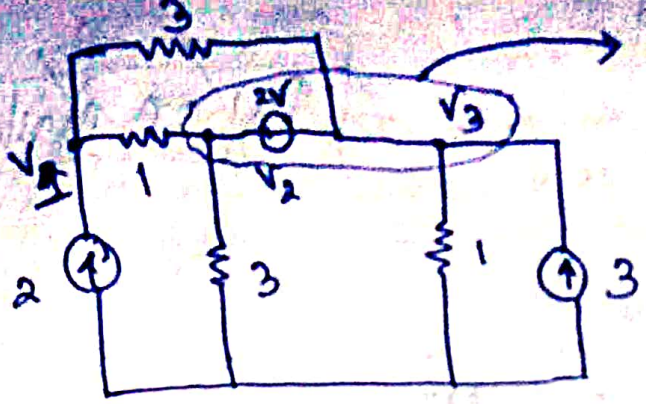
$\Rightarrow \quad 7I_2 - 2I_1 = 4 \quad \text{—— (1)}$

$I_2 = 0.903\ A$

$I_1 = \dfrac{4 + 2 \times 0.903}{5} =$

$I_{2\Omega} = 0.903\ A$

Q)



super node

Find V_1, V_2, V_3

From fig $V_2 - V_3 = 2$ —(1)

From super node $-4V_1 + 4V_2 + 4V_3 = 9$ —(II)

From node-1 $4V_1 - 3V_2 - V_3 = 6$ —(III)

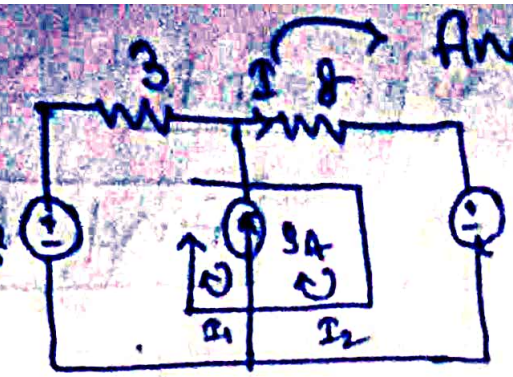
By cramer's rule:

$V_1 = 6.25\ V$

$V_2 = 5.25\ V$

$V_3 = 3.25\ V$

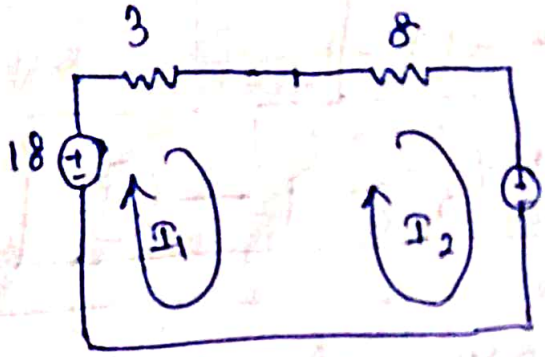
Q) Find I



Super mesh

$\Rightarrow \quad I_2 - I_1 = 3A \quad \text{---(1)}$

Now,



super mesh ✓

$-18 + 3I_1 + 8I_2 + 15 = 0$

$\Rightarrow \quad 3I_1 + 8I_2 = 3 \quad \text{---(11)}$

$\Rightarrow$

$3I_2 - 3I_1 = 9$

$8I_2 + 3I_1 = 3$

$I_2 = \frac{12}{11} \text{ A}$

$\hookrightarrow I.$

Q) A 300 KVA Tx having primary voltage of 3000 V at 50 Hz has 300 primary and 50 secondary turns calculate-

1) the full load primary and secondary current -
2) the no load ~~primary and~~ secondary ~~current~~ induced emf
3) the max flux in the core - (neglecting all losses)

→ $Q = 300$ KVA, $V_1 = 3000$ V, $f = 50$ Hz

$N_1 = 300$, $N_2 = 50$

1) $\boxed{I_1 V_1 = I_2 V_2 = Q \text{ KVA}}$

$$I_1 = \frac{Q \text{ KVA}}{V_1}$$

$$= \frac{300}{3000} \times 10^3 = 100 \text{ A}$$

NOW, $\boxed{\frac{N_2}{N_1} = \frac{I_1}{I_2}}$ $I_2 = \frac{N_1 \times I_1}{N_2}$

$$= \frac{300 \times 100}{50}$$

$$= 600 \text{ A}$$

So, the full load primary and secondary current is 100 A and 600 A

2) the No load secondary induced emf?

⇒ here the secondary is open circuited, so, the secondary terminal voltage will be the secondary induced emf.

so $\mathcal{E}_2 = V_2$

now, $\boxed{\frac{V_2}{V_1} = \frac{N_2}{N_1}}$ $\quad V_2 = \frac{N_2 \times V_1}{N_1}$

$= \frac{50 \times 3000}{300}$ (100)

$= 5000\ V$

3) the maximum flux in the core -

$\boxed{\mathcal{E}_1 = 4.44\ \phi_m N_1 f}$ here $\mathcal{E}_1 = V_1$

⇒ $3000 = 4.44 \times \phi_m \times 300 \times 50$

⇒ $\phi_m = \frac{1}{4.44 \times 5} = 0.04504\ Wb$

Q) An ideal 25 KVA tx has 500 turns on the primary side windings and 40 on sec. windings, the primary is connected to 3000 V, 50Hz supply, calculate -

(a) the primary and sec current on full load -

(b) sec emf

(c) the max core flux

(a) $I_1 V_1 = Q$ KVA

$$I_1 = \frac{25 \times 10^3}{3000} = \frac{25}{3} A = 8.33 A$$

$$\frac{N_2}{N_1} = \frac{I_1}{I_2} \Rightarrow I_2 = \frac{I_1 \times N_1}{N_2}$$

$$= \frac{25 \times 500}{40 \times 3}$$

$$= \frac{625}{6} A$$

$$= 104.166 A$$

(b) see emf — $(V_2 = \varepsilon_2)$

$$\Rightarrow \frac{V_2}{V_1} = \frac{N_2}{N_1}$$

$$\Rightarrow V_2 = \frac{N_2 \times V_1}{N_1}$$

$$= \frac{8}{} \frac{40 \times 3000}{500} = 240 V$$

(c) max core flux (ϕ_m)

$V_1 \leftarrow \varepsilon_1 = 4.44 \phi_m f N_1$

$$3000 = 4.44 \times \phi_m \times 50 \times 500$$

$$\phi_m = \frac{3}{4.44 \times 5 \times 5} = 0.02702 Wb$$

Q) A single phase Tx is connected to a 440V supply. the voltage/turn of Tx is 1.1V, the sec voltage of Tx is 220 V - Find -

a) Primary and sec turn -

b) cross sec^{n}al Area of the core if ϕ_m is 1.25 T (max flux density)

$\Rightarrow$ $V_1 = 440V$, $V_2 = 220V$

a) $\frac{N_2}{N_1} = \frac{V_2}{V_1} = 1.1$

$\frac{N_2}{N_2} = \frac{N_1}{V_1} = 1.1 \Rightarrow$ $N_2 = 1.1 \times V_2$

$= 1.1 \times 220$

$= 242$

$\frac{V_2}{N_2} = \frac{V_1}{N_1} = 1.1$ $N_1 = 1.1 \times V_1 = 1.1 \times 440$

$= 454$

$N_1 = \frac{V_1}{1.1} = \frac{440}{1.1} = 400$

$N_2 = \frac{V_2}{1.1} = \frac{220}{1.1} = 200$

b) $E_1 = 4.44 \phi_m f N_1$

$E_1 = 4.44 B_m A f N_1$

$\Rightarrow$ $440 = 4.44 \times 1.25 \times A \times 50 \times 400$

$A = 3.96 \times 10^{-3}$ m^2

Q) A 2000/200, 20 KVA Tx has 66 turns on the Lee windings, find -

1) Primary turns)

2) I_1 ?

3) I_2)

4) $E_1 = 2000$, $E_2 = 200$

$N_2 = 66$.

$$\frac{N_2}{N_1} = \frac{E_2}{E_1} \Rightarrow N_1 = \frac{N_2 \times E_1}{E_2}$$

$$= \frac{66 \times 2000}{200} = 660$$

3) $V_1 I_1 = V_2 I_2 = 20$ KVA

$$\Rightarrow I_1 = \frac{20}{2000} \text{ A}, \quad I_2 = \frac{20}{200} \text{ A}$$

Q) 1ϕ Tx 2200/250 (stepdown as $E_1 > E_2$) Net coal area of 36 sqcm and B_m 6 wb/mr flux density, calculate, N_1, N_2)

$$\Rightarrow \frac{N_2}{N_1} = \frac{E_2}{E_1} \qquad E = 4.44 B_m A f N_1$$

$$2200 = 4.44 \times 0.0036 \times 6 \times 50 \times N_1$$

$$N_1 = \frac{2200}{4.44 \times 0.0036 \times 6 \times 50}$$

$$= 458.7921$$

$$N_2 = \frac{250}{4.44 \times 0.0036 \times 6 \times 50} = 52.13$$

Q) the no load current of a 6000/400 V, 1φ 50 Hz tx is 0.05 A. It consumes 80 Wt power at no load, when supply is given to low voltage side and high voltage side is kept open. find

1) p.f at no load
2) Fe loss component of the current
3) Magnetising component

⇒

1) $W_0 = V_0 I_0 \cos\phi_0 \rightarrow$ p.f at no load

$$\cos\phi_0 = \frac{W_0}{V_0 I_0} = \frac{80}{6000 \times 0.05}$$

$$= 0.2666$$

2) I_{Fe} loss comp of $I \Rightarrow I_w = I_0 \cos\phi_0$

$$I_w = 0.05 \times 0.266 = 0.0133 \text{ A}$$

$$\phi_0 = 74.57°$$

3) I_μ (Magnetising comp)

$$= I_0 \sin\phi_0$$

$$= 0.05 \times \sin(74.57)$$

$$= 0.048 \text{ A}$$

Q) A 2200/220 V, 1φ tx takes a no load current of 1.5 A when high voltage winding is kept open. $I_{Fe} = 0.2$ A, find —

1) No load input power
2) I_M and $\cos\phi_0$ =?

⇒ $I_0 = 1.5$ A $V_0 = 2200$ V

$I_{Fe} = I_0 \cos\phi_0$

✓ $\cos\phi_0 = \frac{0.2}{1.5} = 0.133$ (AM)

$\boxed{\phi_0 = 82.33°}$

✓ $I_M = I_0 \sin\phi_0 = 1.5 \times \sin(82.33)$

$= 1.48$ A

$W_0 = V_0 I_0 \cos\phi_0$

$= 2200 \times 1.5 \times 0.133$

$= 438.9$ W

Q) the eff. of a 1100 KVA, 110/220 V 1φ AC tx is 98.7%. at full load upf, find

1) fe loss } same as η_{max}
2) cu loss }
3) η_{max} at upf → $P_i = P_c$

⇒

$$\eta = \left(\frac{\text{x KVA} \times 10^3 \times \text{PF}}{\text{x KVA} \times 10^3 \times \text{PF} + x^2 P_c + P_i} \right) \times 100$$

(1100 → 1 ; 1 → Poutput)

(x KVA: 1100 ; PF: 1 ; $x^2 P_c$: 1 ; P_i: ??)

$$P_{out} = 1100 \times 1 = 1100 \text{ KW}$$
KVA pf

$$\eta = \frac{P_{out}}{P_{out} + P_{losses}}$$

$$P_{losses} = \frac{P_{out}}{\eta} - P_{out} = \frac{1100}{0.987} - 1100$$

($P_{losses} \rightarrow P_i + P_{cu}$)

$$= 14.78 \text{ KW}$$

$$P_i = P_{cu} = 7.39 \text{ KW (for max eff.)}$$

$$\eta_{max} = \frac{1100}{1100 + 14.78}$$

$$= 98.7\%$$

Q) A sinusoidally varying AC of freq 50 Hz has max value of 20A

1) eqn for inst. value
2) I after $\frac{1}{100}$ s
3) t to reach 10A
4) Avg and rms :

⇒ 1) $I = I_m \sin \omega t$, $\omega = 2\pi f$

$I = 20 \sin 314t$ $= 2\pi \times 50$

$= 100\pi$

2) $I = 20 \sin 100\pi t$

$= 20 \sin 100\pi \times \frac{1}{100}$

$= 0$

3) $10 = 20 \sin 100\pi t$

$t = \frac{1}{600}$ s

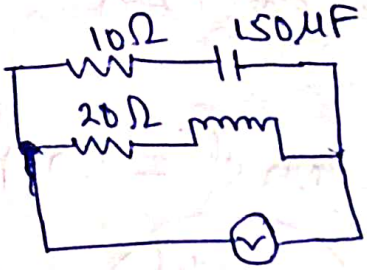
4) $I_{rms} = \frac{I_m}{\sqrt{2}} = 10\sqrt{2}$

$I_{avg} = 0$

4) A coil having R=20Ω, L=0.0382H in ll with 150 μF capacitor in series, with R=10Ω the arrangement is connected to 240V 50Hz supply, determine

I in each branch → total supply current?

⇒



$Z_1 = 10 + j(21.22)$

$Z_2 = 20 - j(12)$

$|Z_2| = \sqrt{20^2 + 12^2}$

$= 23.3$

$|Z_1| = \sqrt{10^2 + (21.2)^2}$

$= 23.44$

$\theta_1 = \tan^{-1}\left(\frac{21.22}{10}\right)$ → 64°

$\theta_2 = \tan^{-1}\left(\frac{-12}{20}\right)$ → $-30.96°$

⇒ $I_1 = \frac{V}{Z_1}$ $I_2 = \frac{V}{Z_2}$

$X_C = \frac{1}{2\pi f C} = 21.22\ \Omega$

$C \rightarrow 150 \times 10^{-6}\ F$

$X_L = 12\ \Omega$ as $2\pi f L$

$I_1 = \frac{240}{23.44}$ ✓ (9.87)

$I_2 = \frac{240}{23.3}$ ✓ (9.8)

✓

5) $V = 200 \sin 377t$ ✓

$I = 8 \sin(377t - 30)$

Determine power factor, true power, Apparent power, reactive power

→ $V_m = 200$, $I_m = 8$

$Z = \frac{V}{I}$ (impedence)

1) $\cos\phi = \frac{R}{Z} = \cos(-30°)$

$= 0.866$ ✓

lagging as $-30°$ → $\cos(-30)$ power factor

2) true power $= VI \cos\phi$

$= 200 \times 8 \times .866$

$= 1385.6$ W

3) Apparent Power $= VI = 200 \times 8$

4) Reactive power $= VI \sin\phi$

$= 200 \times 8 \times (\sin(-30))$

$= 800$ VAR

b) 300 KVA, 1φ tx 6600/660 V
R1, R2, X1, X2 given
calculate R and X of tx to high voltage winding-

$$\Rightarrow K = \frac{E_2}{E_1} = \frac{660}{6600} = \frac{1}{10}$$

$$R_1' = K^2 R_1 = \frac{1}{100} \times 1.6 = 0.016\ \Omega$$

$$R_2' = \frac{R_2}{K^2} = 1.5\ \Omega$$

R_2 → $\frac{R_2}{K^2}$ → R_1

$$R_{ep} = 1.6 + 1.5 = 3.1\ \Omega$$

Any

$$X_{ep} = X_1 + \frac{X_2}{K^2} = 9\ \Omega$$

---

a) $N_2 = 200$ $N_1 = 100$ $\frac{200}{100} = 2 = K$

$R_2 = 0.233\Omega, R_1 = 0.067\ \Omega$

$$\Rightarrow R_1' = K^2 R_1 = 4 \times 0.067$$
$$= 0.268\ \Omega$$

$$R_2' = \frac{R_2}{K^2} = \frac{0.233}{4} = 0.0058\ \Omega$$

$$R_{01} = R_1 + \frac{R_2}{K^2}$$
$$= 0.067 + 0.058$$
$$= 0.125\ \Omega$$

Q) $E_f = \frac{P\phi NZ}{120}$

P: pole

ϕ: flux/pole

Z = conductor/slot

N = slots × conductor/slot × slot

N = speed in rpm

Lap wound: $P = A$

wave wound: $A = 2$

$E_f = \frac{P\phi NZ}{60A}$

Q) $E_b = V + I_a(R_a + R_{sc}) + BCD$

$\downarrow$ $I_{sh} + I_L$

Q) $V = E_b - I_a R_a - B.C.D$

$I_L \neq I_a$ $\quad I_a = I_{sh} + I_L$

$I_a = \frac{E_b - V}{R_a}$ $\qquad \frac{V}{R_{sh}}$

$E_b = V + I_a R_a + BCD$

$\downarrow$

$I_L + I_{sh}$

Q) $R_a = 0.2\,\Omega$

$R_{sc} = 100\,\Omega$

~~$I_a = I_{sh} + I_L$~~

Q) the shaft torque of a diesel motor driving at 100 V DC shunt wound gen. is 25 N-m, the armature current of the generator is 16 A and this value of torque, if the shunt field regulator is adjust state, so that the flux is reduced by 15%, the torque rises to 35 N-m, determine the armature current at this new value of torque:-

Numerical DC Motor

T_1 (initial torque) = 25 N-m

I_{a1} (" I_a) = 16 A

Flux Reduction = 15 %

T_2 (New torque) = 35 N-m

We know, $T \propto \phi I_a$ → V.V.I

Torque, flux, armature current

$T_1 = K\phi_1 I_{a1}$

$25 = K\phi_1 \times 16$ → $K\phi_1 = \frac{25}{16}$

, now,

ϕ_2 (New flux) = $\phi_1 \times (1 - 0.15)$

$= \phi_1 \times 0.85$

so, $T_2 = K\phi_2 I_{a2}$

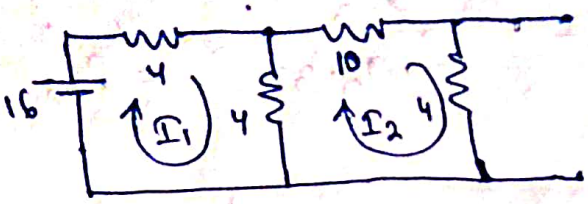
$35 = K(\phi_1 \times 0.85) \times I_{a2}$

$35 = \frac{25}{16} \times I_{a2}$

$I_{a2} = 26.35$ A



Deactivating 16A current source



$$4I_1 + 4(I_1 - I_2) = 16$$

$$8I_1 - 4I_2 = 16$$

$$2I_1 - I_2 = 4 \quad \text{---(1)}$$

$$10I_2 + 4I_2 + 4(I_2 - I_1) = 0$$

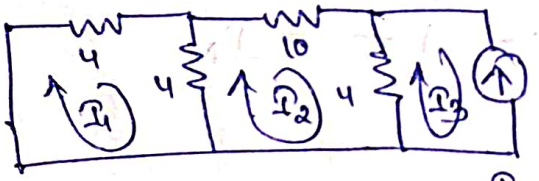
$$\Rightarrow \quad 18I_2 - 4I_1 = 0$$

$$9I_2 = 2I_1$$

$$2I_2 = I_1$$

$$I_2 = 0.5 \text{ A}$$

Deactivating voltage source



$$I_3 = 16 \text{ A}$$

$$4I_1 + 4(I_1 - I_2) = 0$$

$$\Rightarrow \quad 8I_1 = 4I_2 \quad \Rightarrow \boxed{2I_1 = I_2}$$

$$10I_2 + 4(I_2 - I_1) + 4(I_2 - 16) = 0$$

$$\Rightarrow \quad 18I_2 - 4I_1 = 64$$

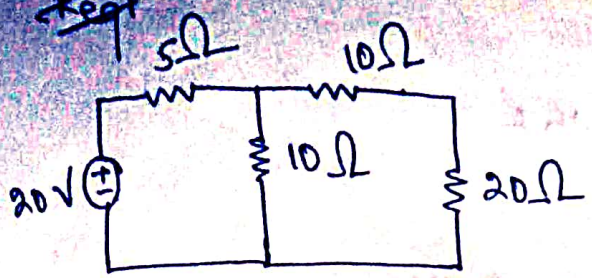
$$18I_2 - 2I_2 = 64$$

$$\boxed{I_2 = 4 \text{ A}}$$

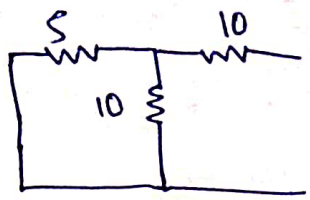
total current through 10Ω is $4 + 0.5$ or $(I_1 + I_2)$

$= 4.5$ A

Req



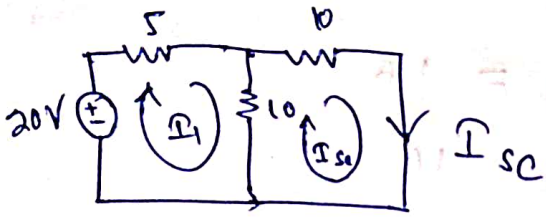
R_{th}



$\frac{5\times10}{15} + 10$

$= 13.33\ \Omega = R_{th}$

I_{sc}



$5I_1 - 20 + 10(I_1 - I_{sc}) = 0$

$15I_1 - 10I_{sc} = 20$

$3I_1 - 2I_{sc} = 4$ —(1)

$10I_{sc} + 10(I_{sc} - I_1) = 0$

$\Rightarrow \quad 20I_{sc} - 10I_1 = 0$

$2I_{sc} = I_1$ —(11)

$3I_1 - I_1 = 4$

$I_1 = 2\ A$

$I_{sc} = 1\ A = I_N$

Norton's eqv ckt

