CSE-250

Assignment-03

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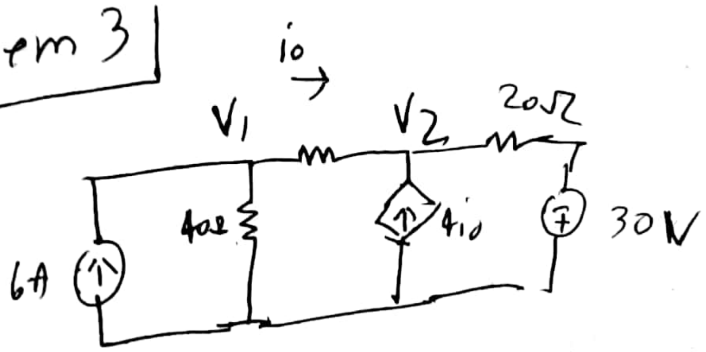
Sec : 07

Problem 3



$$i_o = \frac{V_1 - V_2}{10}$$

keeping 6A active,

$$V_1'\left(\frac{1}{40} + \frac{1}{10}\right) - 6 - \frac{V_2'}{10} = 0$$

$$\Rightarrow \frac{1}{8} V_1' - \frac{V_2'}{10} = 6 \quad \text{— (i)}$$

$$V_2'\left(\frac{1}{10} + \frac{1}{20}\right) - \frac{V_1'}{10} - \frac{4}{10}(V_1' - V_2') = 0$$

$$\Rightarrow -\frac{1}{2} V_1' + \frac{11}{20} V_2' = 0 \quad \text{— (ii)}$$

solving equation (i), (ii) we get,

$$V_1' = 176\text{ V} \quad , \quad V_2' = 160\text{ V}$$

$$i_o' = \frac{V_1 - V_2}{10} = 1.6\text{ A}$$

$$V_o' = V_1' - V_2'$$

$$= 16\text{ V}$$

Keeping 30 V active, we get,

$$V_1''\left(\frac{1}{40}+\frac{1}{10}\right) - \frac{V_2''}{10} = 0$$

$$\Rightarrow \frac{1}{8}V_1'' - \frac{V_2''}{10} = 6 \quad \text{— (i)}$$

$$V_2''\left(\frac{1}{10}+\frac{1}{20}\right) - \frac{V_1''}{10} - \frac{4}{10}(V_1''-V_2'') + \frac{30}{20} = 0$$

$$\Rightarrow -\frac{1}{2}V_1'' + \frac{11}{20}V_2'' = -\frac{3}{2} \quad \text{— (ii)}$$

By solving equation (i), (ii) we get,

$$V_1'' = -8, \quad V_2'' = -10 \qquad \Bigg| \qquad i_0'' = \frac{V_0''}{10} = 0.2$$

$$V_0'' = V_1'' - V_2'' = 2V$$

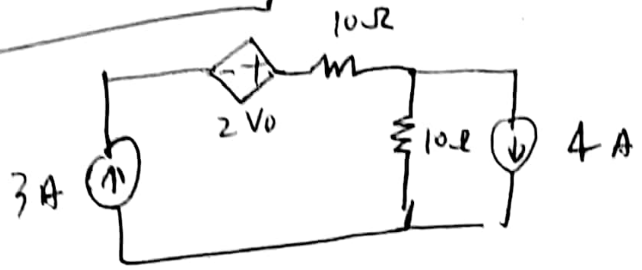
$$i_0 = i_0' + i_0'' = 1.6 + 0.2$$

$$= 1.8A$$

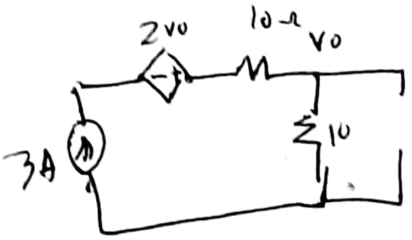
$$V_0 = V_0' + V_0'' = 16 + 2$$

$$= 18V$$

Problem 4



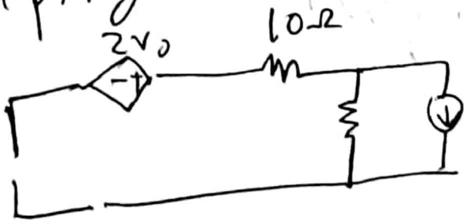
keeping 3A active only, we get,



$$V_o'\left(\frac{1}{10}\right) - 3 = 0$$

$$\therefore V_o' = 30V$$

keeping 4A active only, we get,



$$\frac{V_o''}{10} + 4 = 0$$

$$V_o'' = -40$$

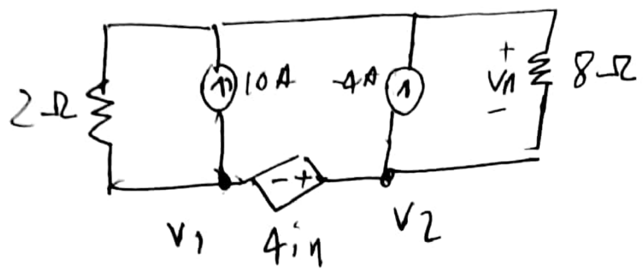
$$V_o = V_o' + V_o''$$

$$= 30 - 40$$

$$= -10V$$

(Ans)

Problem 5



Keeping 10A active we get,

$$V_1'\left(\frac{1}{2}\right) + 10 + V_2'\left(\frac{1}{8}\right) = 0$$

$$\Rightarrow \frac{V_1'}{2} + \frac{V_2'}{8} = -10 \quad \text{— (I)}$$

$$\therefore V_2' - V_1' = -2V_1'$$

$$\therefore V_1' + V_2' = 0 \quad \text{— (II)}$$

solving the equation we get,

$$\therefore V_1' = -26.67$$

$$V_2' = 26.67$$

Now, keeping ~~10A~~ -4A active;

$$\frac{V_1''}{2} - 4 + V_2''\left(\frac{1}{8}\right) = 0$$

$$\Rightarrow \frac{V_1''}{2} + \frac{V_2''}{8} = 4 \quad \text{— (III)}$$

$$V_2'' - V_1'' = -2V_1''$$

$$\Rightarrow V_1'' + V_2'' = 0 \quad \text{—— (IV)}$$

By solving eq (III), (IV) we get,

$$V_1'' = 10.67\ V$$

$$V_2'' = -10.67\ V$$

$$V_2 = V_2' + V_2''$$

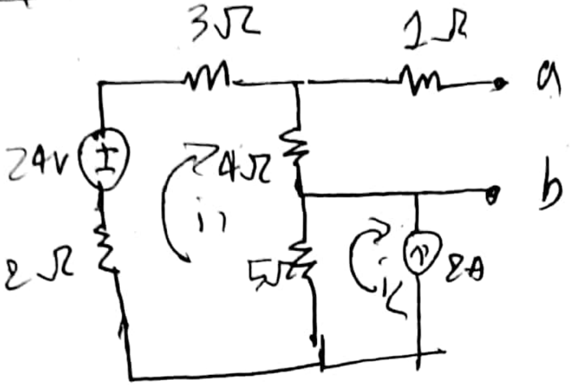
$$= 16\ V$$

[position are opposite]

As $V_1 = -V_2$

$$= -16\ V$$

Problem 3



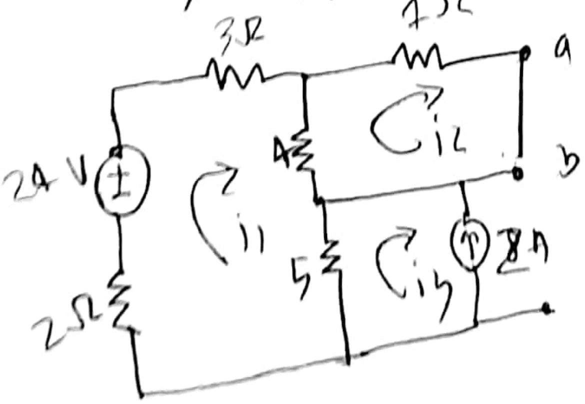
Here, $i_2 = -2$

mesh 1, $2i_1 - 24 + 3i_1 + 4i_1 + 5(i_1+2) = 0$

$\Rightarrow i_1 = 1A$

$\therefore V_{th} = 4 \times i_1 = 4V$

For, R_{th}



Here, $i_3 = -2A$

$\Rightarrow 2i_1 - 24 + 3i_1 + 4(i_1 - i_2) + 5(i_1 + 2) = 0$

$\Rightarrow 14i_1 - 4i_2 - 14 = 0$ ——— (I)

$4(i_2 - i_1) + i_2 = 0$

$\Rightarrow -4i_1 + 5i_2 = 0$ ——— (II)

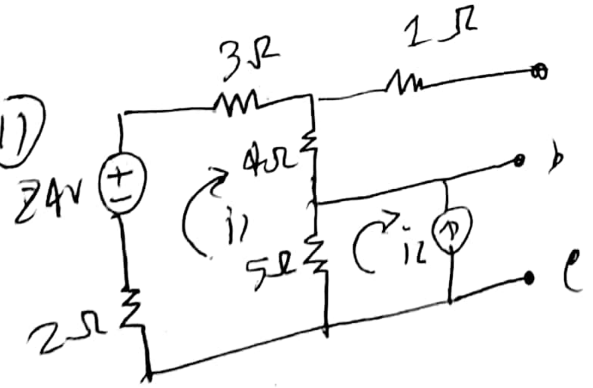
solving (I) and (II) we get,

$i_1 = 1.29A$, $i_2 = 1.037A$

Here, $i_{sc} = 1.037A$

$\therefore R_{th} = \frac{V_{th}}{i_{sc}} = 3.857\,\Omega$

(III)



Hen $i_2 = -2A$

$\Rightarrow 2i_1 - 24 + 3i_1 + 4(i_1) + 5(i_1 + 2) = 0$ ——— (III)

$\cancel{14i_1 - 4i_2 - 14 = 0}$

$$\cancel{4(i_2 - i_1) + i_2 = 0}$$

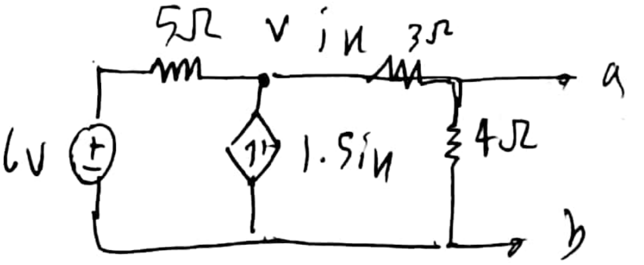
$$\cancel{\Rightarrow -4i_1 + 5i_2 = 0} \quad \text{—— (iv)}$$

$$\therefore i_1 = 1A$$

$$\therefore V_{th} = 5(\overset{i_1}{1} + \overset{i_2}{2})$$

$$= 15\ V$$

Problem 4)



Here, $i_n' = \frac{v'}{7}$

$v'\left(\frac{1}{5} + \frac{1}{7}\right) - \frac{6}{5} - 1.5 \times \frac{v'}{7}$

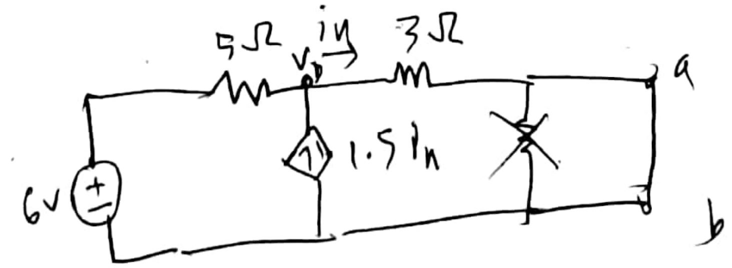
$\Rightarrow \frac{9}{70} v' = \frac{6}{5}$

$\therefore v' = 9.34 \text{ V}$

$\therefore V_{th} = 9.34 \times \frac{4}{3+4}$

$= 5.333 \text{ V}$

As, $V_{th} \neq 0$



Here, $i_n'' = \frac{v''}{3}$

$\therefore V''\left(\frac{1}{5}+\frac{1}{3}\right)-\frac{6}{5} - 1.5 \times \frac{V}{3} = 0$

$\frac{V''}{30} = \frac{6}{5}$

$\therefore V'' = 36$

$\therefore i_n'' = \frac{36}{3} = 12A$

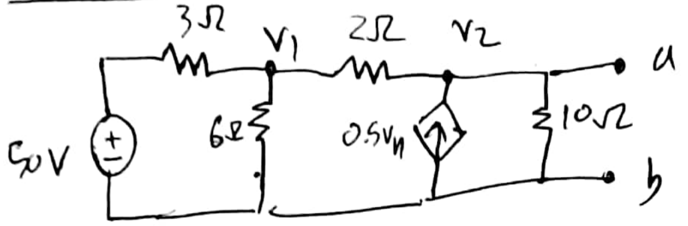
Here, $i_{sc} = i_n = 12A$

$\therefore R_{th} = \frac{V_{th}}{I_{sc}} = \frac{5.333}{12} = 0.44\,\Omega$

$\therefore V_{th} = 5.333\,V$

$R_{th} = 0.44\,\Omega$

Problem 5



$$V_1'\left(\frac{1}{3}+\frac{1}{6}+\frac{1}{2}\right) - \frac{50}{3} - \frac{V_2'}{2} = 0$$

$$\Rightarrow V_1' - \frac{V_2'}{2} = \frac{50}{3} \quad \text{—— (I)}$$

$$V_2'\left(\frac{1}{2}+\frac{1}{10}\right) - \frac{V_1'}{2} - \frac{V_1'}{2} = 0$$ [Here $V_H = V_1$

$$\Rightarrow -V_1' + \frac{3}{5} V_2' = 0 \quad \text{—— (II)}$$

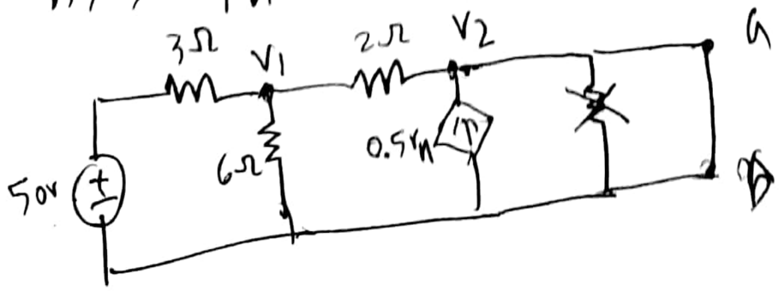
After solving (I), (II) we get,

$V_1' = 100\ V$

$V_2' = 166.67\ V$

$\therefore V_{th} = V_2' = 166.67\ V$

As, $V_{th} \neq 0$, Now,



$$V_1''\left(\frac{1}{3}+\frac{1}{6}+\frac{1}{2}\right)-\frac{50}{3}=0$$

$$\Rightarrow V_1''=\frac{50}{3}=16.67\ V$$

$$\therefore \cancel{I_{sc}=\frac{V_1''}{R_{10}}=\frac{16.67}{10}=1.667}$$

$\therefore$ ~~Rth =~~

$$\therefore I_1=\frac{V_1''}{R_2}=\frac{16.67}{2}=8.3335\ A$$

$$0.5V_u=0.5.V_1''=0.5\times16.67=8.3335\ A$$

$$\therefore I_{sc}=I_1+0.5V_u=8.3335+8.3335$$

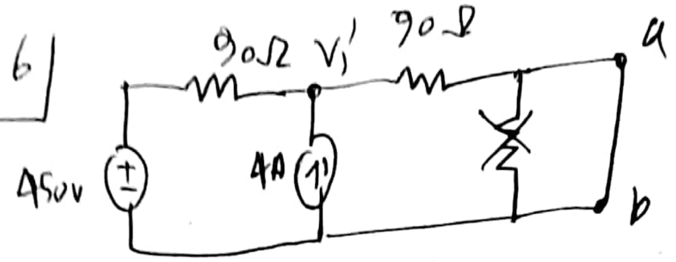
$$=16.667$$

$$R_{th}=\frac{V_{th}}{I_{sc}}=10\Omega$$

$$\therefore V_{th}=166.67\ V$$

(Ans)

Problem 6)



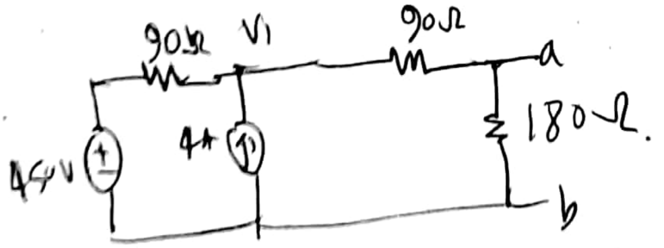
$$V_1'\left(\frac{1}{90}+\frac{1}{90}\right)-\frac{450}{90}-4=0$$

$$\Rightarrow \frac{1}{45}V_1' = 9$$

$$\Rightarrow V_1' = 405V$$

$$\therefore I_N = \frac{405}{90\Omega} = 4.5A$$

As, $I_N \neq 0$



$$V_1''\left(\frac{1}{90}+\frac{1}{270}\right)-\frac{450}{90}-4=0$$

$$\Rightarrow \frac{2}{135}V_1'' = 9$$

$$\therefore V_1'' = 607.5\ V$$

$\therefore$ ~~$V_{oc} = 607.5 \times \frac{180}{270}$~~

$$V_{oc} = 607.5 \times \frac{180}{90+180}$$

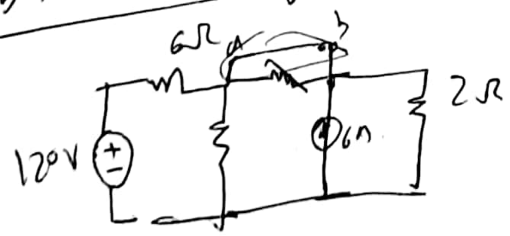
$$= 405$$

$$\therefore R_{TH} = \frac{405}{4.5} = 90\,\Omega$$

$$I_N = 4.5\,A$$

(Ans)

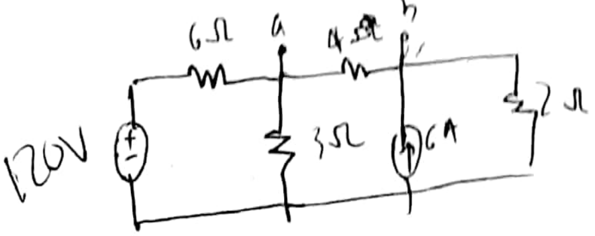
Problem 7 | (i)



$$V'\left(\frac{1}{6} + \frac{1}{3} + \frac{1}{2}\right) - \frac{120}{6} - 6 = 0$$

$$\therefore V' = 26\,V$$

$$\therefore I_N = \frac{26}{2} - 6 = 7$$



As, $I_N \neq 0$,

$$V_1''\left(\frac{1}{3}+\frac{1}{4}+\frac{1}{6}\right)-\frac{120}{6}-\frac{V_2''}{4}=0$$

$$\Rightarrow \frac{3}{4}V_1''-\frac{V_2''}{4}=20 \quad \text{--- (i)}$$

$$V_2''\left(\frac{1}{4}+\frac{1}{2}\right)-\frac{V_1''}{4}-6=0$$

$$\Rightarrow -\frac{V_1''}{4}+\frac{3}{4}V_2''=6 \quad \text{--- (ii)}$$

$\therefore$ Solving eq (i), (ii) we get,

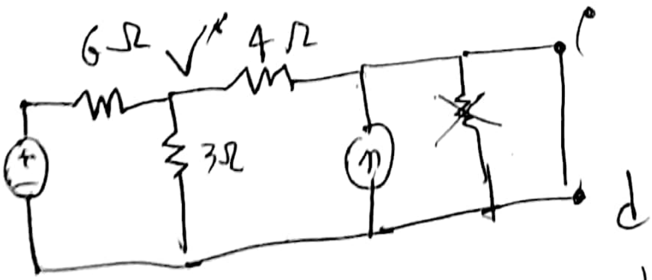
$V_1''=33\,V$, $V_2=19\,V$

$V_{oc}=V_1''-V_2''=14\,V$

$$\therefore R_N=\frac{V_{oc}}{I_N}=\frac{14}{7}=2\,\Omega$$

(Ans)

(ii)



$$\therefore V'\left(\frac{1}{6}+\frac{1}{3}+\frac{1}{4}\right)-\frac{120}{6}-6=0$$

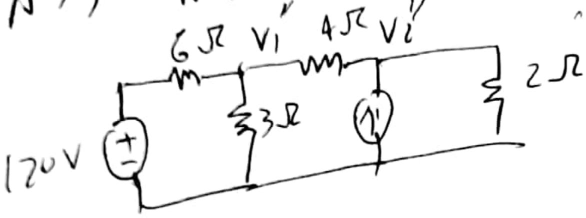
$$\Rightarrow \frac{3}{4}V'=20$$

$$\therefore V'=26.667\,V$$

$$i_N = \frac{26.667}{4} + 6$$

$$= 12.667 \text{ A}$$

As, $i_N \neq 0$,



$$V_1''\left(\frac{1}{6} + \frac{1}{3} + \frac{1}{4}\right) - \frac{120}{6} - \frac{V_2''}{4} = 0$$

$$\frac{3}{4}V_1'' - \frac{V_2''}{4} = 20 \quad \text{— (iii)}$$

$$V_2''\left(\frac{1}{4} + \frac{1}{2}\right) - \frac{V_1''}{4} - 6 = 0$$

$$-\frac{V_1''}{4} + \frac{3}{4}V_2'' = 6 \quad \text{— (iv)}$$

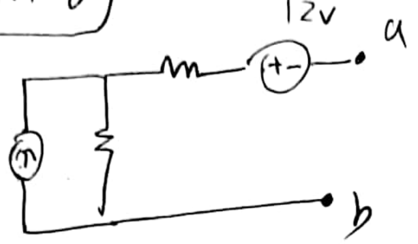
$\therefore V_1'' = 33\text{v}, \quad V_2'' = 19\text{ v}$

$\therefore V_{oc} = 19\text{ v}$

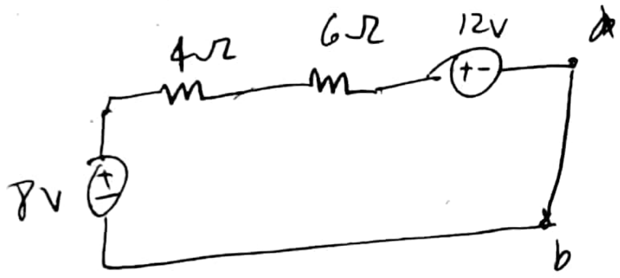
$$R_N = \frac{V_{oc}}{I_N} = 1.5\,\Omega$$

$$I_N = 12.667 \text{ A}$$

Problem 8



We can draw the circuit for Norton



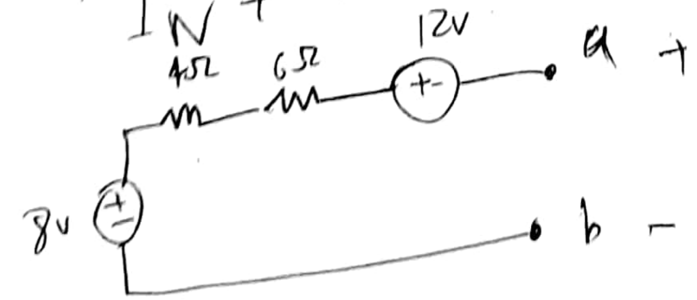
$\Rightarrow -8 + 4i + 6i + 12 = 0$

$\therefore i = -0.4\ A$

Here,

$I_N = i = -0.4\ A$

As, $I_N \neq 0$

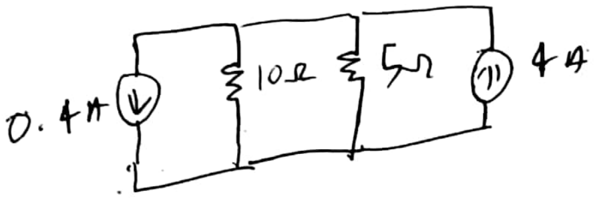


Here, net voltage $V = -4V$

$\therefore V_{oc} = -4V$

$\therefore R_N = \frac{V_{oc}}{i_N} = 10\,\Omega$

$\therefore$ ~~The~~ Norton equivalent circuit,



$\therefore i_5 = 3.6 \times \frac{3.33}{5}$

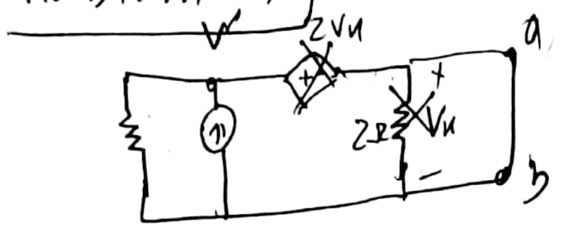
$= 2.4\ A$

$\therefore i = 2.4\ A$

$R_N = 10\,\Omega$

$i_N = -0.4\ A$

Problem – 9

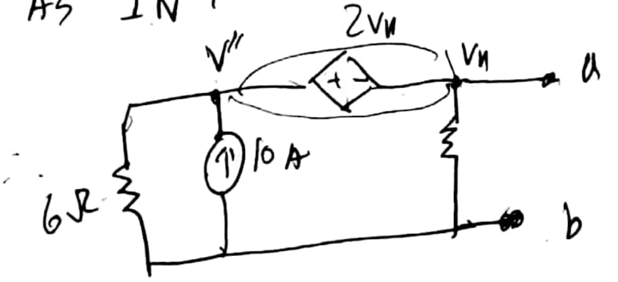


$$\frac{V'}{6} - 10 = 0$$

$$\Rightarrow V' = 60\,V$$

$$I_N = \frac{V'}{6} = 10\,A$$

As $I_N \neq 0$



$$V''\left(\frac{1}{6}\right) - 10 + \frac{V_x}{2} = 0$$

$$\therefore \frac{V''}{6} + \frac{V_x}{2} = 10 \quad \text{—— (i)}$$

$$\Rightarrow V'' - V_x = 2V_x$$

$$\Rightarrow V'' - 3V_x = 0 \quad \text{—— (ii)}$$

$\therefore$ ~~$V'' = 30\,V,\ V_x$~~

After solving eq (i), (ii) we get,

$$V'' = 30\,V, \quad V_x = 10\,V$$

Here,

$V_N = V_{oc}$

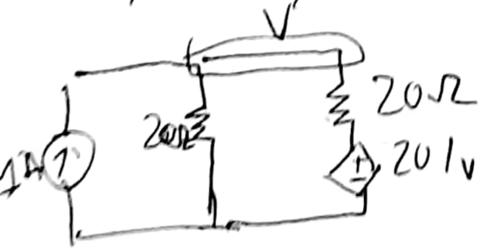
$\therefore V_{oc} = 10V$

$\therefore R_N = \frac{V_{oc}}{I_N} = \frac{10}{10} = 1\Omega$

Problem 10

$\therefore I_N = 1A$

As, $I_N \neq 0$



$V'(\frac{1}{20} + \frac{1}{20}) - 1 - \frac{V}{20} = 0$

$\Rightarrow \frac{V'}{20} = 1$

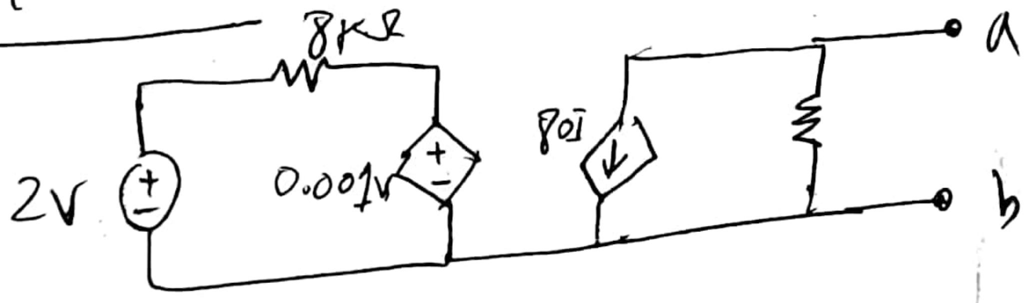
$V = 20V$

Here, $V_{oc} = V_N = 20V$

$$R_N = \frac{V_{oc}}{I_N} = 20\Omega$$

$$I_N = 1A$$

Problem 11 :



We can write,

$$-2+8i+0.001V_{ab}=0 \quad \text{—— (i)}$$

$$V_{ab}=-80i\times 50$$

$$\Rightarrow 80i\times 50-V_{ab}=0 \quad \text{—— (ii)}$$

~~i = 0.5 mA~~

After solving eq (i), (ii) we get,

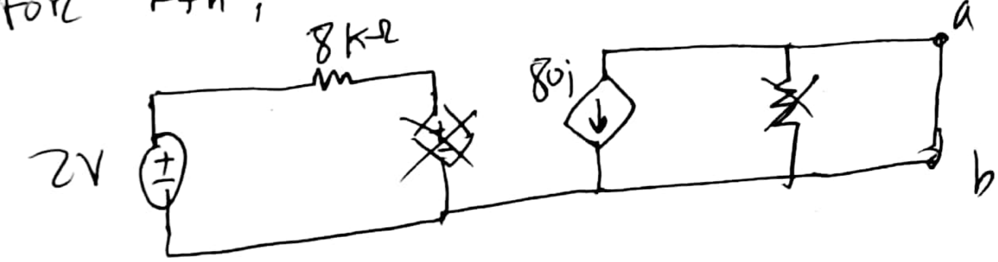
$i' = 0.5 mA$

$\therefore V_{ab} = -80 \times 0.5 \times 50$

$= -2000 V$

$\therefore V_{th} = 2000 V$ [As direction is opposite]

For R_{th},



$\therefore -2 + 8i'' = 0$

$\therefore i'' = \frac{1}{4}$

$I_N = -80 i''$

$= -80 \times \frac{1}{4}$

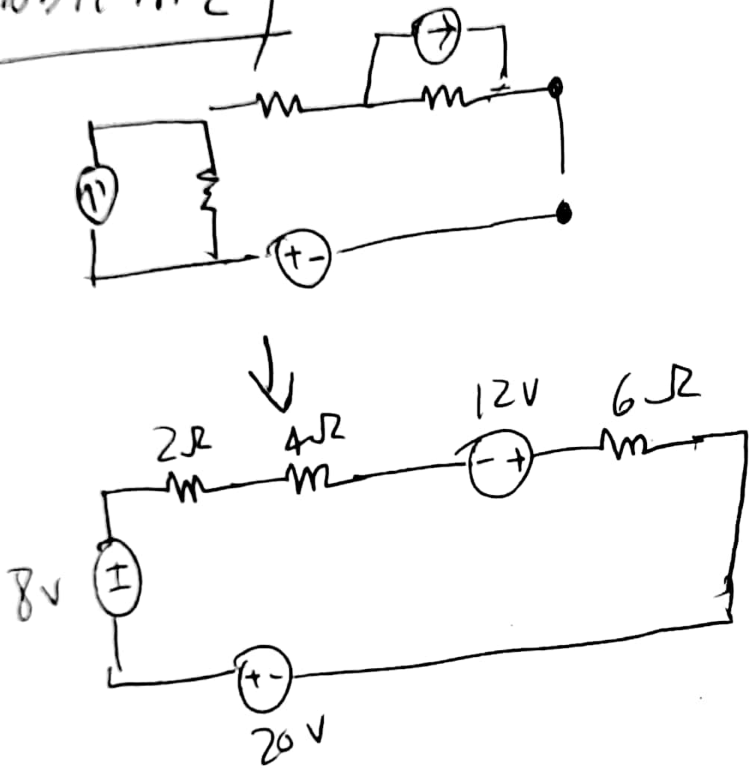
$= -20 mA$

$\therefore R_{th} = \frac{-2000}{-20} = 100 K\Omega$

$\therefore R_N = R_{th} = 1000 K\Omega$

Slide - 10

Problem 2)



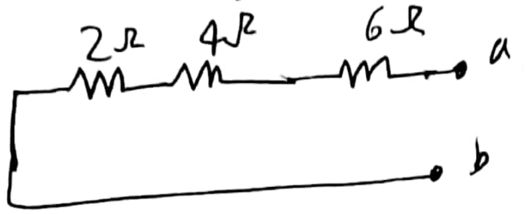
$$-20 - 8 + 2i + 4i - 12 + 6i = 0$$

$\therefore i = 3.33$

$\therefore i_N = 3.33A$

For, R_N

By romoving independent sources,



$\therefore R_N = 2 + 4 + 6$

$= 12\Omega$

$R_{th} = 12\,\Omega$ (Ans a)

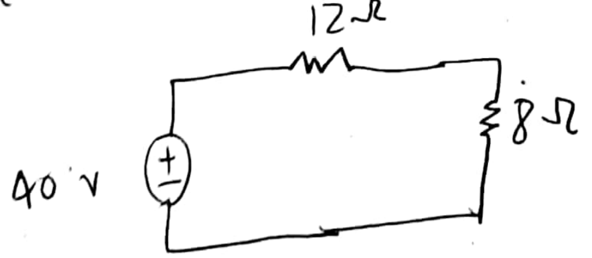
$V_{th} = i_N \times R_N$

$= 12 \times 3.333$

$= 40V$

$\therefore V_{th} = 40V$ (Ans a)

Thevnin ccircuit,



b) $I_8 = \left(\frac{V_{th}}{R_{th} + R_L}\right) = \frac{40}{12 + 8} = 2A$

c) we get maximum power at R_{th}

$\therefore R_L = 12\,\Omega$

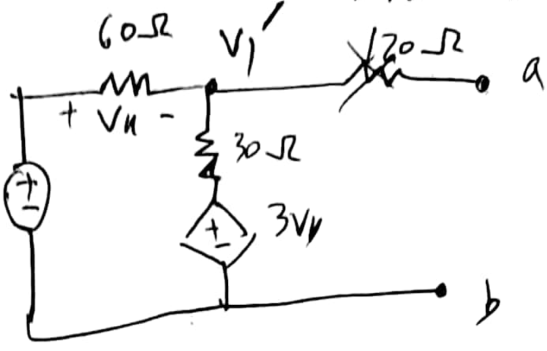
d) maximum power $P_W = \left(\frac{V_{th}}{R_{th}+R_L}\right)^2 \times R_L$

$$= \left(\frac{40}{12+12}\right)^2 \times 12$$

$$= 33.33\ W$$

slide - 10

problem 3



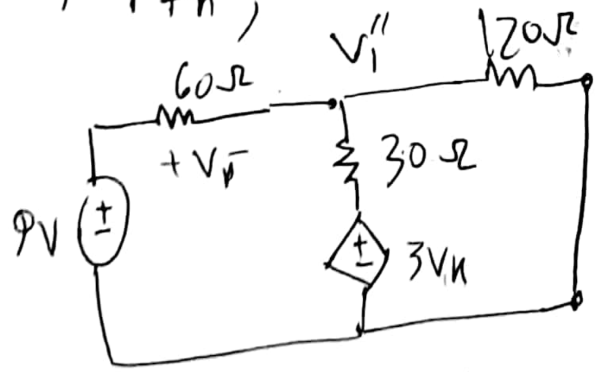
$$V_x = 9 - V_1'$$

$$V_1'\left(\frac{1}{60}+\frac{1}{30}\right) + \frac{9}{60} - \frac{3(9-V_1')}{30} = 0$$

$\therefore V_1' = 7\,V$

$\therefore V_{th} = 7\,V$

For, R_{th},



$$V_1''\left(\frac{1}{60}+\frac{1}{30}+\frac{1}{120}\right) - \frac{9}{60} - 3\left(\frac{9-V_1''}{30}\right) = 0$$

$$\Rightarrow \frac{7}{120}V_1 - \frac{3}{20} - \frac{9}{10} + \frac{V_1}{10} = 0$$

$\therefore V_1 = 6.63$

$$i_{se} = \frac{6.63}{120} = 0.0552\,A$$

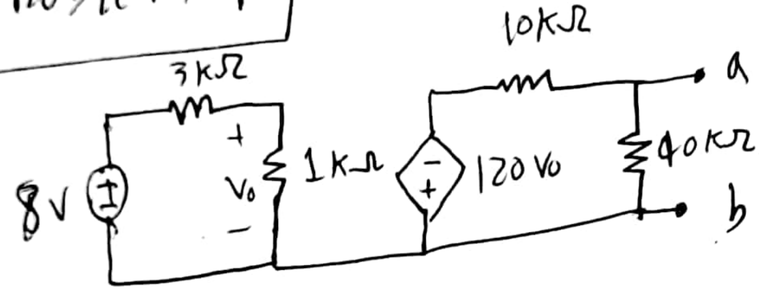
$$\therefore R_{th} = \frac{V_{th}}{I_{sc}} = \frac{7}{0.0552} \Omega$$

$$= 126.67 \Omega$$

$$P_{max} = \left(\frac{V_{th}}{R_{Th} + R_L}\right)^2 \times R_L$$

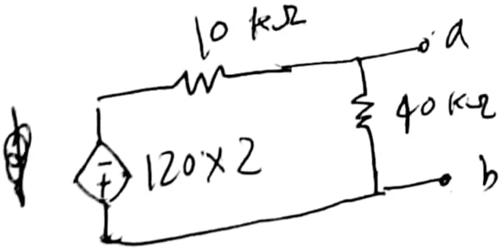
$$= \cancel{0.0} \; 96.7 \, mW$$

Problem 4)



Here, $V_o = \frac{1}{4} \times 8 = 2V$

∴



$$V_{th} = \frac{40}{50} \times -240$$

$$= -192V$$

To calculate R_{th} we need to remove all indipendent source from the circuit

equation we get,

$\cancel{24}\ 240 + 10 i_s = 0$

$\Rightarrow i_s = -24\ A$

$\therefore R_{th} = \dfrac{V_{th}}{i_s} = \dfrac{-192}{-24} = 8K\Omega$

$P_{max} = \left(\dfrac{V_{th}}{R_{th}+R_L}\right)^2 \times R_L$

$= \left(\dfrac{-192}{(8+8)\times 10^3}\right)^2 \times 8 \times 10^3$

$= 1.152\ W$

$\therefore V_{Th} = -192\ V$

$R_{Th} = 8\ K\Omega$