$$i_{2\Omega} = \frac{k_1 i_x - v_1}{2}$$

$$2 = \frac{k_1 i_x - v_1}{2}$$

$$k_1 i_x - v_1 = 4 \quad \text{———} \quad (1)$$

$$i_x = \frac{8 - v_1}{3}$$

$$3 i_x + v_1 = 8 \quad \text{———} \quad (2)$$

$$v_1 : \quad \frac{v_1 - 8}{3} + \frac{v_1 - k_1 i_x}{2} + \frac{v_1 - 0}{1} = 0$$

$$11 v_1 - 3 k_1 i_x = 16 \quad \text{———} \quad (3)$$

put $i_x = \frac{8 - v_1}{3}$ in (1) & (3)

$$k_1 \left(\frac{8 - v_1}{3}\right) - v_1 = 4$$

$$8 k_1 - k_1 v_1 - 3 v_1 = 12 \quad \text{———} \quad (4)$$

$$11 v_1 - \cancel{3} k_1 \left(\frac{8 - v_1}{\cancel{3}}\right) = 16$$

$$11 v_1 - 8 k_1 + k_1 v_1 = 16 \quad \text{———} \quad (5)$$

from (4) ~~put~~

$$8 k_1 - v_1 (k_1 + 3) = 12$$

$$8 k_1 - 12 = v_1 (k_1 + 3)$$

$$v_1 = 4 \frac{(2 k_1 - 3)}{(\ldots)} \quad \text{put in (5)}$$

$$11\left(\frac{8R_L-12}{R_L+3}\right) - 8R_L + R_L\left(\frac{8R_L-12}{R_L+3}\right) =$$

$$\frac{88R_L-132}{R_L+3} - 8R_L + \frac{8R_L^2-12R_L}{R_L+3}$$

$$88R_L - 132 - \cancel{8R_L^2} - 24R_L + \cancel{8R_L^2} - 12$$

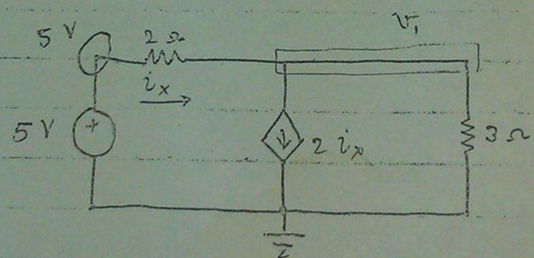
$$.16R$$

$$88R_L - 24R_L - 12R_L - 16R_L = 48 + 13$$

$$36R_L = 180$$

$$\boxed{R_L = 5\ \Omega}$$

$\boxed{5.3}$



$$v_1: \quad \frac{v_1-5}{2} + 2i_x + \frac{v_1-0}{3} = 0$$

$$3v_1 - 15 + 12i_x + 2v_1 = 0$$

$$5v_1 + 12i_x = 15 \quad \text{——— (1)}$$

$$i_x = \frac{5-v_1}{2}$$

$$v_1 + 2i_x = 5 \quad \text{——— (2)}$$

put $i_x = \frac{5 - v_1}{2}$ in ①

$$5v_1 + \cancel{12}^{\,6}\left(\frac{5 - v_1}{\cancel{2}}\right) = 15$$

$$5v_1 + 30 - 6v_1 = 15$$

$$30 - 15 = v_1$$

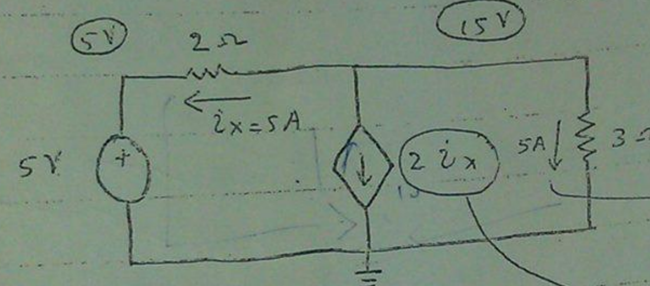
$$15 = v_1$$

$$\boxed{v_1 = 15\ V}$$

put in ②

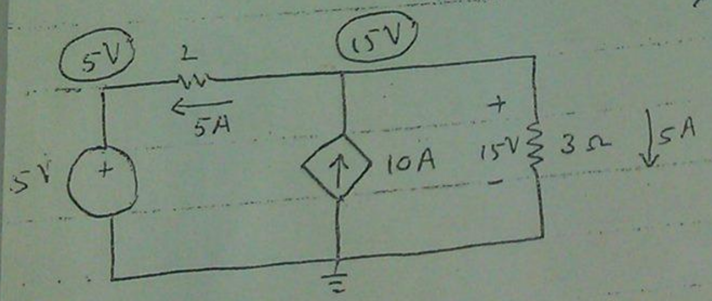
$$\boxed{i_x = -5A}$$

Now,



by $i = \frac{15 - 0}{3} = 5A$;

$2(-5) = -10\ A$ It means direction should be reversed.



$P_{5V} = 5 \times 5 = 25\ W$ (absorbed)

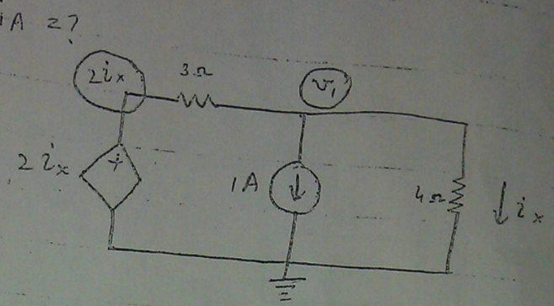
$P_{2\Omega} = (5)^2 \times 2 = 50\ W$ (absorbed)

$P_{3\Omega} = (5)^2 \times 3 = 75\ W$ (absorbed)

$P_{10A} = 15 \times 10 = 150\ W$ (released).

5.4

$v_{1A} = ?$



$$i_x = \frac{v_1 - 0}{4} = \frac{v_1}{4}$$

$$i_x = \frac{v_1}{4} \quad \text{——} \; (1)$$

v_1 :

$$\frac{v_1 - 2i_x}{3} + 1 + \frac{v_1 - 0}{4} = 0$$

$$4v_1 - 8i_x + 12 + 3v_1 = 0$$

$$7v_1 - 8i_x = -12 \quad \text{——} \; (2)$$

put $i_x = \frac{v_1}{4}$ in (2)

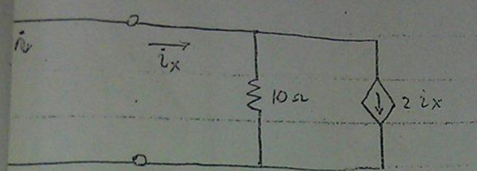
$$7v_1 - \cancel{8}^{2}\left(\frac{v_1}{\cancel{4}}\right) = -12$$

$$5v_1 = -12$$

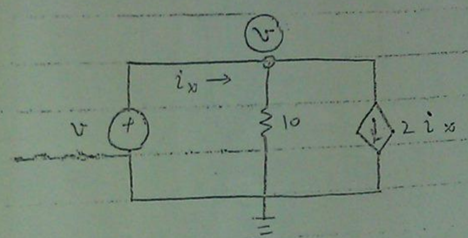
$$\boxed{v_1 = -\frac{12}{5}\ \text{V}}$$

* Ans is corr
cheacked by pow
conservation.

$R_{eq} = ?$



as we can see that $i = ix$. So we have to find $R_{eq} = \frac{v}{ix}$



$v:$

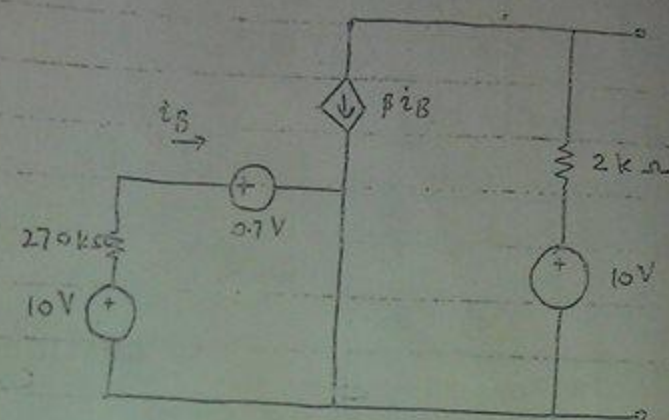
$$\frac{v-0}{10} + 2ix = ix$$

$$\frac{v}{10} = -ix$$

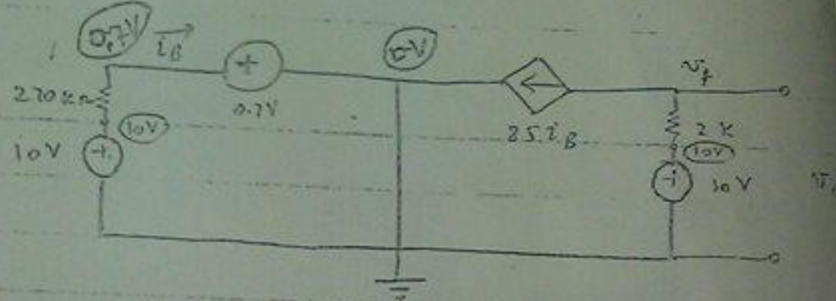
$$\frac{v}{ix} = -10$$

$$\boxed{R_{eq} = -10\Omega}$$

$\boxed{5.6}$



(a) $\beta = 85$ find $v_0 = ?$



v_1 : $\dfrac{v_1 - 10}{2} + 85\, i_B = 0$

$$v_1 - 10 + 170\, i_B = 0$$

$$v_1 + 170\, i_B = 10 \quad \text{———} \quad (1)$$

$$i_B = \frac{10 - 0.7}{270}$$

$$\boxed{i_B = 0.034 \text{ mA}}$$

5.6

$$\boxed{i_C = 85 i_B = 2.927 \text{ mA}}$$

put $i_B = 0.034$ mA in 1

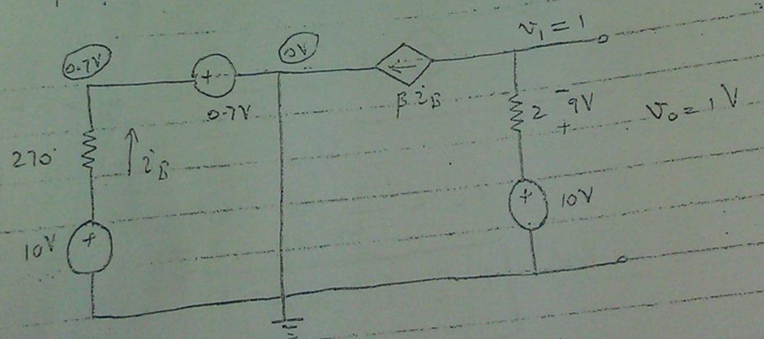
$$v_1 + 170(0.034) = 10$$

$$\boxed{v_1 = 4.22 \text{ V}}$$

$$v_0 = v_1 - 0 = 4.22 - 0$$

$$\boxed{v_0 = 4.22 \text{ V} \quad \binom{+}{-}}$$

(b) $\beta = ?$ if $v_0 = 1$ V



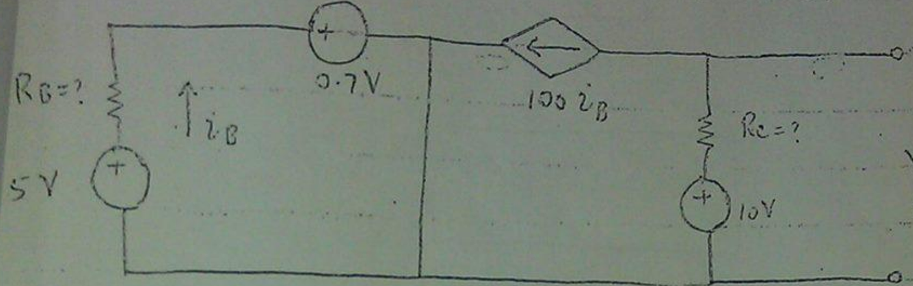
$$i_B = \frac{10 - 0.7}{270} = 0.034 \text{ mA}$$

$$\boxed{i_B = 0.034 \text{ mA}}$$

$R_B = ?$

$R_C = ?$

Power dissipated in transistor $= i_C v_o$



$v_o = 10 - i_C R_C$

$5 = 10 - i_C R_C$

As $v_o = 10 - i_C R_C$

$$5 = 10 - 100\, i_B R_C$$

$$1 = 2 - 20\, i_B R_C$$

$$20\, i_B R_C = 2 - 1$$

$$i_B R_C = \frac{1}{20} \quad \text{———} \quad (1)$$

$$P_T = i_C v_o$$

(given) $10\,mW = i_C (5)$

$$2\,m = i_C$$

$$100\, i_B = 2\,m$$

$$\boxed{i_B = 0.02\,mA}$$

put in (1)

$$R_C = \frac{1}{20 \times 0.02\,m}$$

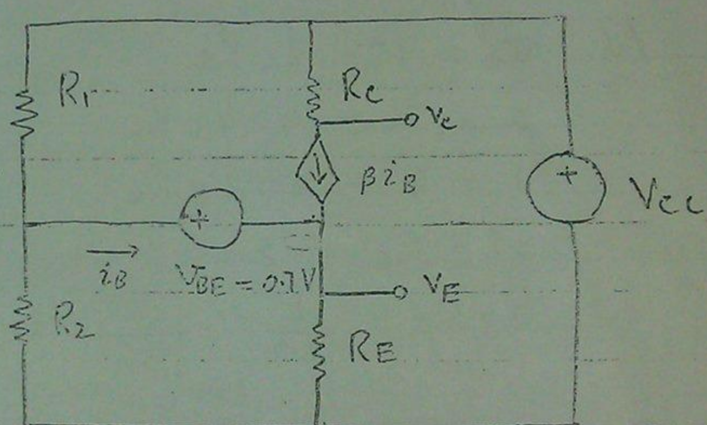
$$\boxed{R_C = 2.5\,k\Omega}$$

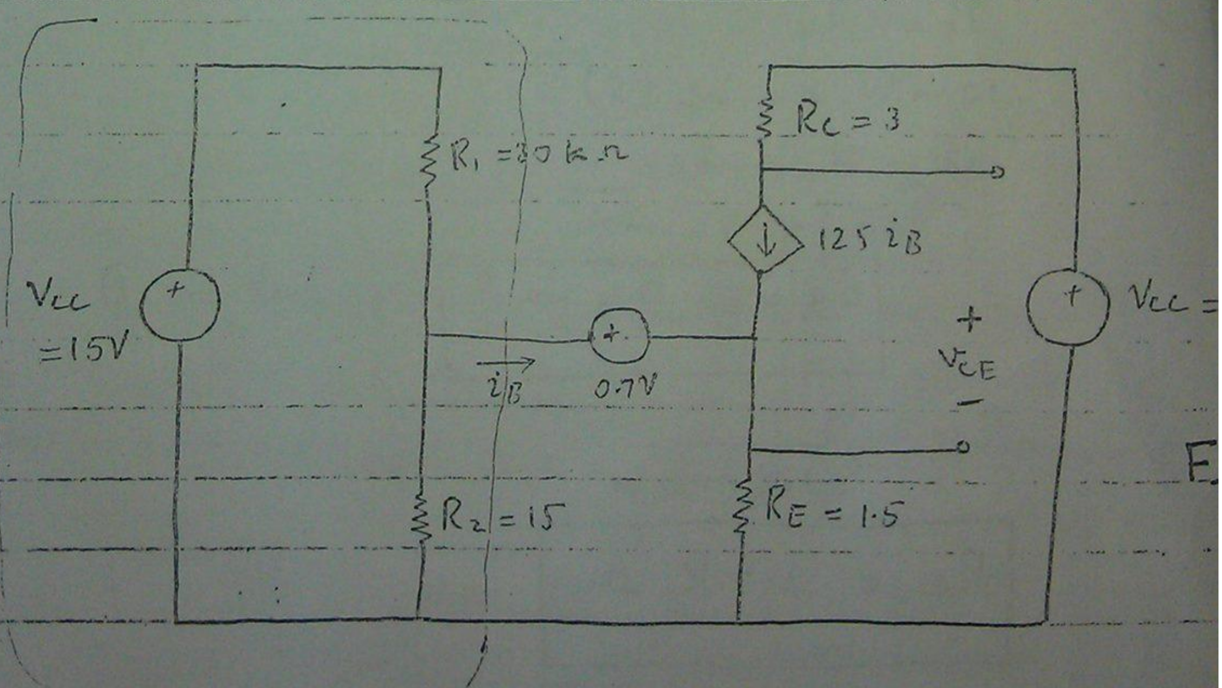
$$i_B = \frac{5-0.7}{R_B}$$

$$R_B = \frac{5-0.7}{i_B} = \frac{5-0.7}{0.02m} = 215\ k$$

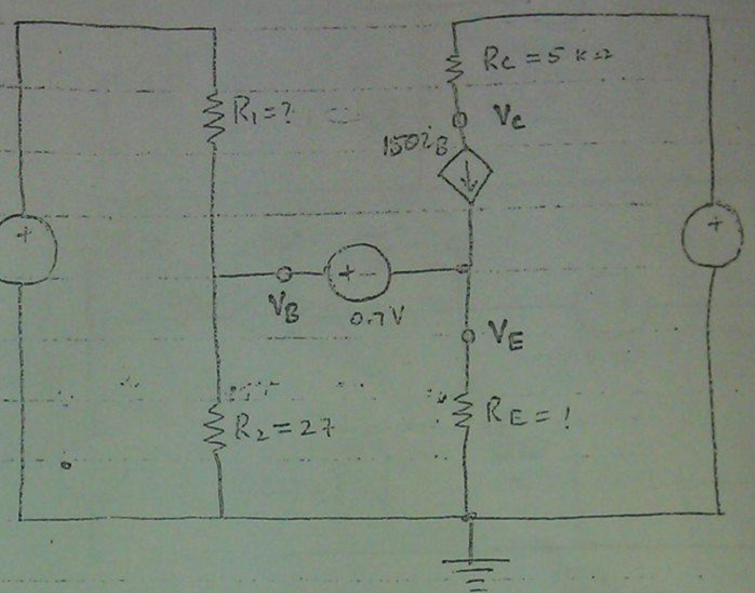
$$\boxed{R_B = 215\ k\Omega}$$

5.8





$\boxed{5.8}$



We can see that and we know f

the theory-

$$V_C = V_{CC} - i_C R_C \quad \text{———} \quad (1)$$

$$V_E = (\beta + 1)\, i_B\, R_E \quad \text{———} \quad (2)$$

$$V_B = V_E + V_{BE} = V_I - i_B R_B$$

For details visit

www. Page # 208, Exp# 5.

edu. pk

given

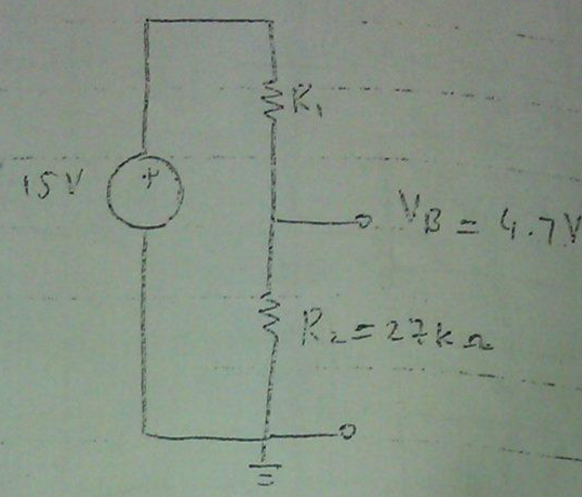
$$V_C = 9V$$

$$V_B = 4.7V$$

To find:

R_1 & R_E

Now for R_1



$$V_B = \frac{R_2}{R_1 + R_2} \times 15$$

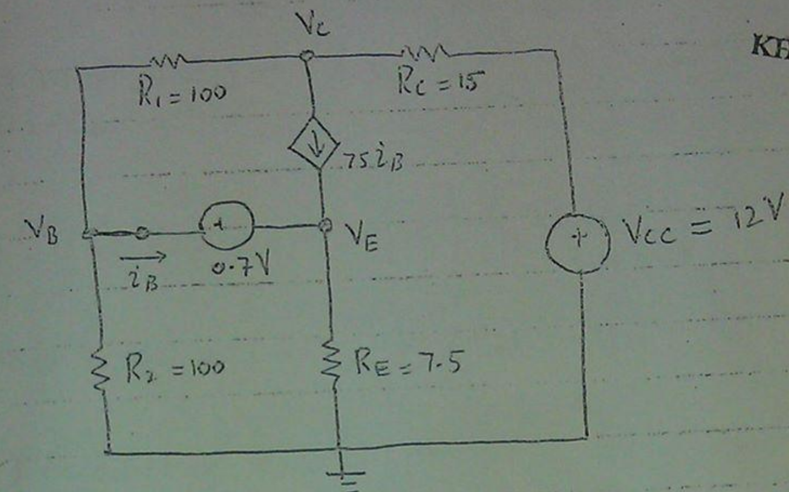
$$4.7 = \frac{27}{R_1 + 27} \times 15$$

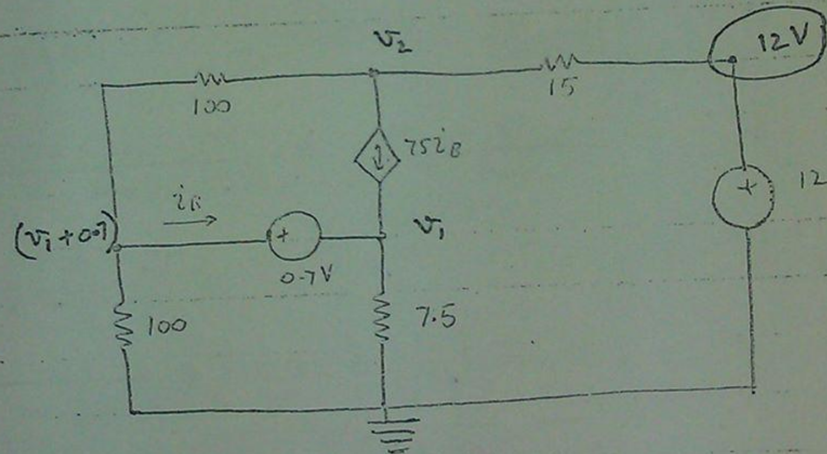
$$4.7 R_1 + 126.9 = 405$$

$$4.7 R_1 = 278.1$$

$$R_1 = 59.2 \text{ k}\Omega$$

$$\boxed{R_1 = 59.2 \text{ k}\Omega}$$





$$v_1: \quad 75 i_B = \frac{v_1 - 0}{7.5} + \frac{(v_1 + 0.7) - 0}{100} + \frac{(v_1 + 0.7) - v_2}{100} = 0$$

$$750 \times (75 i_B) = (100 v_1) + (7.5 v_1 + 5.25) + (7.5 v_1 + 5.25 - 7.5 v_2) = 0$$

$$56250 i_B = 115 v_1 - 7.5 v_2 + 10.5 \quad \text{———} \quad (1)$$

$$562502 i_B = 115 v_1 - 7.5 v_2 + 10.5$$

v_2 :

$$\frac{v_2 - (v_1 + 0.7)}{100} + 75 i_B + \frac{v_2 - 12}{15} = 0$$

$$15 v_2 - 15 v_1 - 10.5 + 112500 i_B + 100 v_2$$

$$115 v_2 - 15 v_1 + 1210.5 + 112500 i_B$$

$$15 v_1 - 115 v_2 + 1210.5 = 112500 i_B$$

$$i_B = \frac{0 - (v_1 + 0.7)}{100} + \frac{v_2 - (v_1 + 0.7)}{100}$$

$$100 i_B = -v_1 - 0.7 + v_2 - v_1 - 0.7$$

$$v_2 - 2 v_1 - 1.4 = 100 i_B \quad \text{—— (3)}$$

from (3)

$$i_B = \frac{v_2 - 2 v_1 - 1.4}{100} \quad \text{put in (1)}$$

$$562.5 (v_2 - 2 v_1 - 1.4) = 115 v_1 - 7.5 v_2 + 10.5$$

$$562.5 v_2 - 1125 v_1 - 787.5 = 115 v_1 - 7.5 v_2 +$$

$$(562.5 + 7.5) v_2 - (1125 + 115) v_1 - (787.5 + 10.5) = 0$$

$$570 v_2 - 1240 v_1 - 79.8 = 0$$

$$2.85 v_2 - 62...$$

-115

v_1 -115

225

2265

265

9105

19.

from (3)

$$i_B = \frac{v_2 - 2v_1 - 1.4}{100} \quad \text{put in (2)}$$

$$-115 v_2 + 1210.5 = 112500 \left(\frac{v_2 - 2v_1 - 1.4}{\cancel{100}} \right)$$

$$-115 v_2 + 1210.5 = 1125 v_2 - 2250 v_1 - 1575$$

$$2250) v_1 - (115 + 1125) v_2 + (1210.5 + 1575) = 0$$

$$265 v_1 - 1240 v_2 + 2785.5 = 0 \quad \text{—— (5)}$$

from (4)

$$v_2 = \frac{620 v_1 + 399}{285} \quad \text{put in (5)}$$

$$65 v_1 - \overset{248}{\cancel{1240}} \left(\frac{620 v_1 + 399}{\underset{57}{\cancel{285}}} \right) + 2785.5 = 0$$

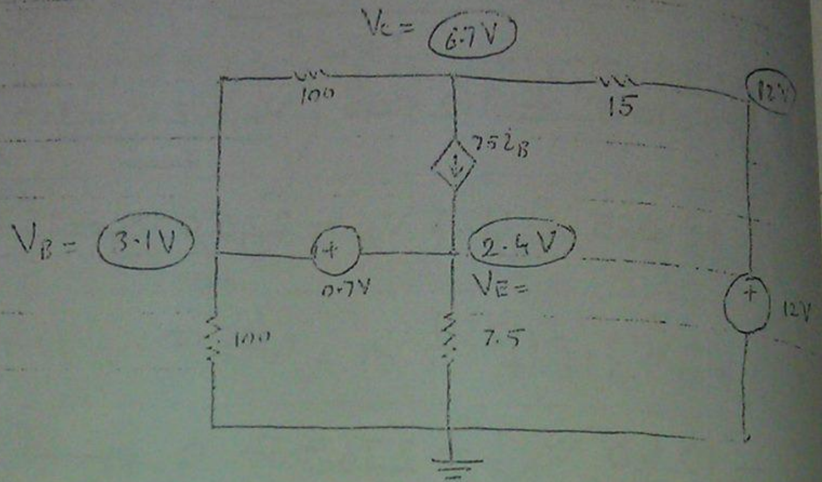
$$105 v_1 - 153760 v_1 - 98952 + 158773.5 = 0$$

$$-24655 v_1 + 59821.5 = 0$$

$$v_1 = \frac{59821.5}{24655}$$

$$\boxed{v_1 = 2.426\,V} \quad \text{put in (4)}$$

$$\boxed{v_2 = 6.678\,V} \Rightarrow \boxed{\begin{array}{l} v_1 = 2.4\,V \\ v_2 = 6.7\,V \end{array}}$$



$$\boxed{\begin{aligned} V_C &= 6.7V \\ V_B &= 3.1V \\ V_E &= 2.4V \end{aligned}}$$

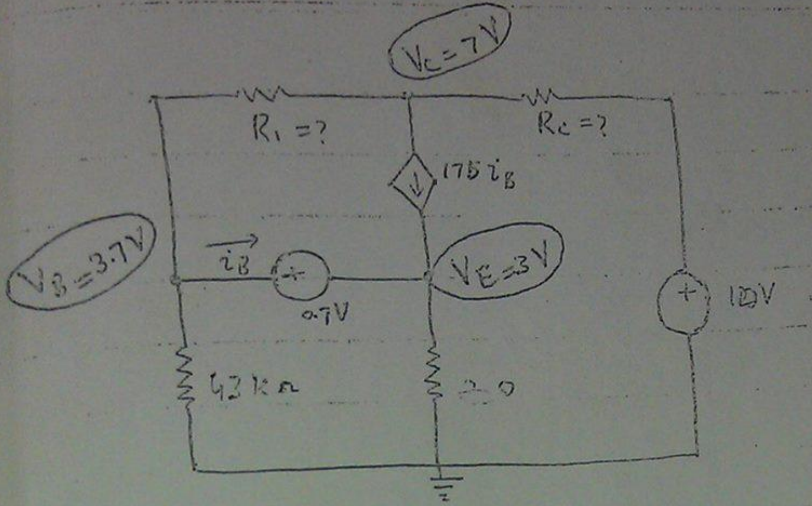
Cheack:-

$$i_C = \frac{V_C - V_{CC}}{15K}$$

$$\boxed{i_C = 0.35\ mA}$$

$$i_B = \frac{i_C}{\beta} = \frac{i_C}{75}$$

$$\boxed{i_B = 4.6\ \mu A}$$



$V_C = 7V$

$V_E = 3V$ given

* $V_{CE} = 7 - 3 = 4\ V$
* $V_B = V_E + V_{BE} = 3 + 0.7 = 3.7\ V$
* As we know

$V_E = (i_B + i_C)\, R_E$

$V_E = 176\, i_B\, R_E$

$3 = 176 \times 2k\ i_B$

$i_B = \frac{3}{352k} = 8.5 \times 10^{-3}\ mA$

$$\boxed{i_B = 8.5\,\mu A}$$

* As we know

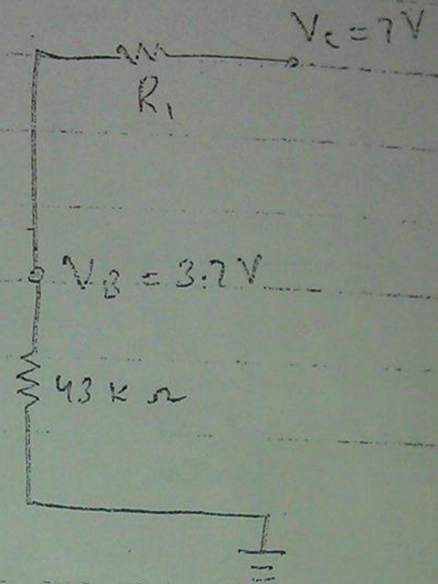
$V_C = 10 - i_C R_C$

$7 = 10 - i_C R_C$

$i_C R_C = 3$

$R_C = \frac{3}{185\, i_B} = \frac{3}{175 \times 8.5\,\mu} = 2.0 \times 10^{-3}$

* For R_1



$$V_B = \frac{43}{R_1 + 43} \times 7$$

$$3.7\,(R_1 + 43) = 301$$

$$3.7R_1 + 159.1 = 301$$

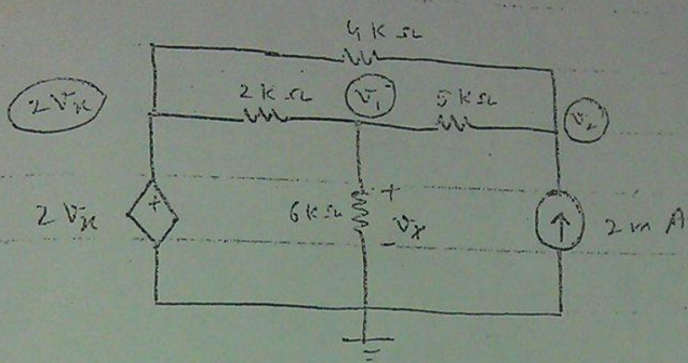
$$R_1 = \frac{301 - 159.1}{3.7} = 38.35$$

$$\boxed{R_1 = 38.4\ k\Omega}$$

2 Circuit Analysis with Dependent Sources:-

2 $P_{5k\Omega} = ?$

$[mA], [k\Omega], [V]$



: $$\frac{v_1 - 2v_x}{2} + \frac{v_1 - 0}{6} + \frac{v_1 - v_2}{5} = 0.$$

$$15v_1 - 30v_x + 5v_1 + 6v_1 - 6v_2 = 0$$

$$26v_1 - 6v_2 = 30v_x \quad \text{——— (1)}$$

: $$\frac{v_2 - 2v_x}{4} + \frac{v_2 - v_1}{5} = 2$$

$$5v_2 - 10v_x + 4v_2 - 4v_1 = 40$$

$$9v_2 - 4v_1 = 40 + 10v_x \quad \text{——— (2)}$$

~~from~~

x: $v_x = (v_1 - 0)$

$\boxed{v_x = v_1}$ — (3) put in (1) & (2)

$$26v_1 - 6v_2 = 30v_1$$

$$-6v_2 = 4v_1$$

24

$$9V_2 - 4V_1 = 40 + 10V_1$$

$$9V_2 - 14V_1 = 40 \quad \text{———} \quad (5)$$

from (4) $v_1 = \frac{-3}{2} v_2$

$$9V_2 - \cancel{14}^{7}\left(\frac{-3}{\cancel{2}} V_2\right) = 40$$

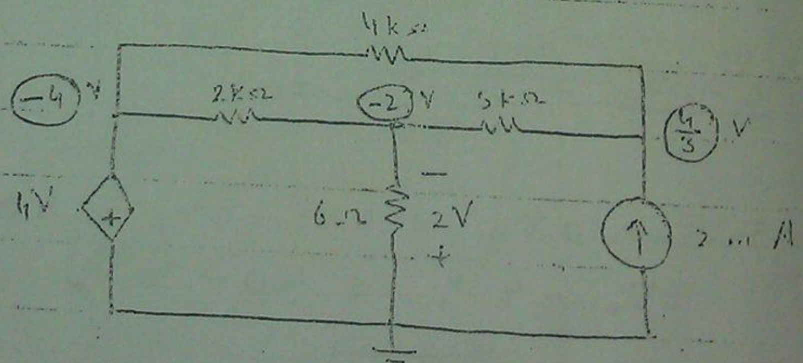
$$9V_2 + 21V_2 = 40$$

$$30V_2 = 40$$

$\boxed{V_2 = \frac{4}{3}}$ put in (4)

$$V_1 = -\frac{3}{\cancel{2}}\left(\frac{\cancel{4}^{2}}{\cancel{3}}\right)$$

$\boxed{V_1 = -2}$ $\Rightarrow$ $\boxed{V_x = -2}$



$$\therefore \; V_{4k\Omega} = \frac{4}{3} - (-4) = \frac{4}{3} + 4 = \frac{16}{3}$$

$$P_{4k\Omega} = \frac{(16/3)^2}{4k} = \frac{64}{9}$$

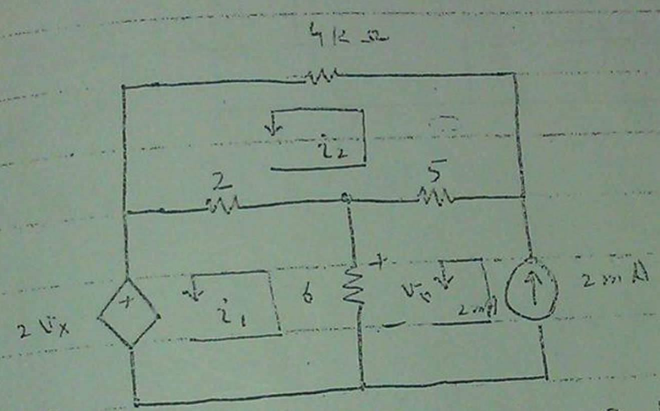
P

3. : $P_{6k\Omega} = ?$

[mA], [kΩ], [V]

Wrong Method:- (For Concept)

We should have to solve this q? by taking the direction of i_1 & i_2 as shown in the fig



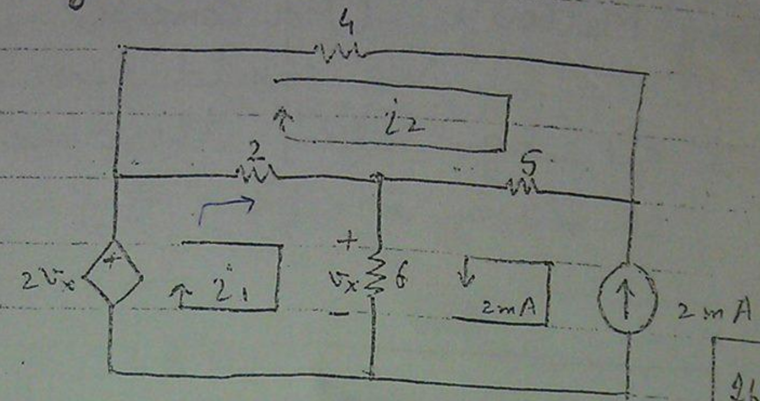
But in this way 6kΩ is potential raising as we are assuming v_x $\pm$ and $(i_1 - 2)$ ↑ and 2 v_x is potential droping.

The answer will be wrong in this way because we can never take a resistive component as an active component.

So we will do this q? as:

QS.23

Right Method :-



i_1 :

$$2v_x = 6(i_1+2) + 2(i_1 - i_2)$$

i_2 :

$$4i_2 + 5(i_2+2) + 2(i_2 - i_1) = 0$$

v_x :

$$v_x = 6(i_1+2)$$

On solving the above eqns by MS graphing Calculator we get

$$v_x = -2$$

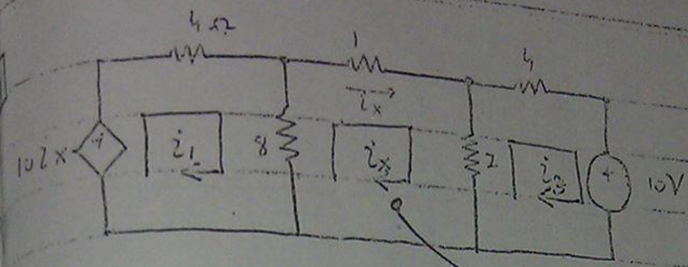
$$i_1 = -\frac{7}{3}$$

$$i_2 = -\frac{4}{3}$$

$$i_{6k\Omega} = i_1 + 2 = -\frac{7}{3} + 2 = -\frac{1}{3}$$

$$P_{6k\Omega} = v_x \cdot i_{6k\Omega} = (-2)\left(-\frac{1}{3}\right) = \frac{2}{3}$$

P



∵ $i_2 = i_x$ so I named it as i_x directly and I took the direction of currents clockwise due to i_x.

$$10 i_x = 4 i_1 + 8(i_1 - i_x)$$

i_x:

$$8(i_x - i_1) + i_x + 2(i_x - i_3) = 0$$

i_3:

$$2(i_3 - i_x) + 4 i_3 + 10 = 0$$

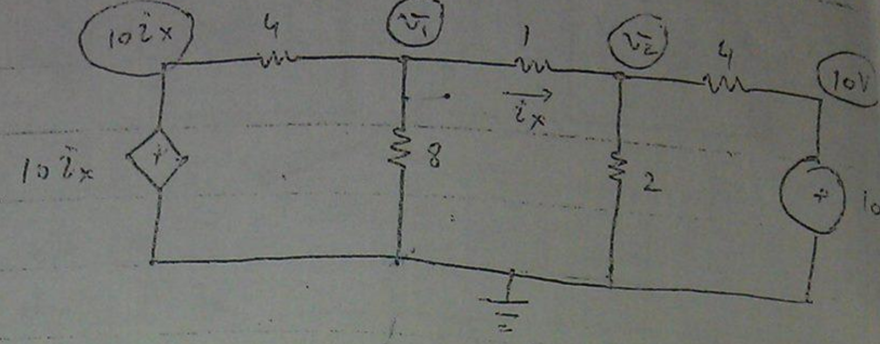
$$\boxed{\begin{array}{l} i_x = 2 \\ i_1 = 3 \\ i_3 = -1 \end{array}}$$

$v_{ccvs} = 10 i_x = 20V$ (+ at top)

$v_{8\Omega} = 8(3-2) = 8V$ (+ at top)

$v_{2\Omega} = 2(2-(-1)) = 2(2+1) = 2(3) = 6V$ (+ at top)

5.15



$$i_x = \frac{v_1 - v_2}{1} = v_1 - v_2$$

For V_1:-

$$\frac{v_1 - 10\, i_x}{4} + \frac{v_1 - 0}{8} + \frac{v_1 - v_2}{1} = 0$$

For V_2:-

$$\frac{v_2 - 10}{4} + \frac{v_2 - 0}{2} + \frac{v_2 - v_1}{1} = 0$$

$$\boxed{\begin{aligned} i_x &= 2\ A \\ v_1 &= 8\ V \\ v_2 &= 6\ V \end{aligned}}$$

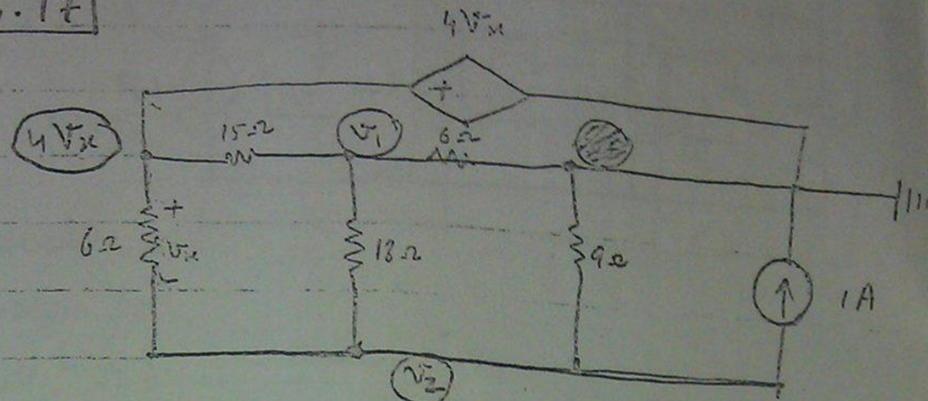
$v_{ccvs} = 10\, i_x = 20\ V$

$v_{8\Omega} = 8\ V$

$v_{2\Omega}$ $6\ V$

all + at top

$\boxed{5.17}$



$$v_x = \underline{4V_x - v_2}$$

$$\frac{v_1 - 4v_x}{15} + \frac{v_1 - v_2}{18} + \frac{v_1 - 0}{6} = 0$$

$$\frac{v_2 - v_1}{18} + \frac{v_2 - 4v_x}{6} + 1 + \frac{v_2 - 0}{9} = 0$$

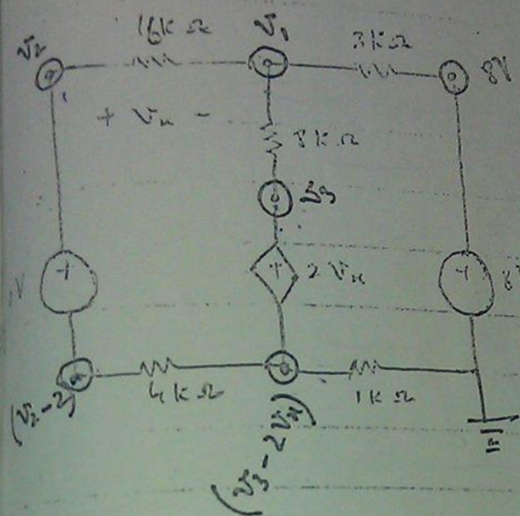
$$\cancel{\boxed{\begin{array}{l} v_x = 12\,V \\ v_1 = 18\,V \\ v_2 = 36\,V \end{array}}} \qquad \boxed{\begin{array}{l} v_x = -4\,V \\ v_1 = -6\,V \\ v_2 = -12\,V \end{array}}$$

~~$v_{1A} = v_2 - 0 = 36 - 0 = 36\,V$ (+ at~~

$v_{1A} = 0 - v_2$

$v_{1A} = 0 + 12\,V = 12\,V$ (+ at top)

$P_{8k\Omega} = ?$ $\quad [mA], [k\Omega], [V]$



$v_x = v_2 - v_1$

$$\frac{v_1 - 8}{3} + \frac{v_1 - v_2}{16} + \frac{v_1 - v_3}{8} = 0$$

$$\frac{v_2 - v_1}{16} + \frac{(v_2 - 2) - (v_3 - 2v_x)}{4} = 0$$

$$\frac{v_3 - v_1}{8} + \frac{(v_3 - 2v_x) - (v_2 - 2)}{4} + \frac{(v_3 - 2v_x) - 0}{1}$$

$v_x = -\frac{8}{5}$ V

$v_1 = 5$ V

$v_2 = 17/5$ V

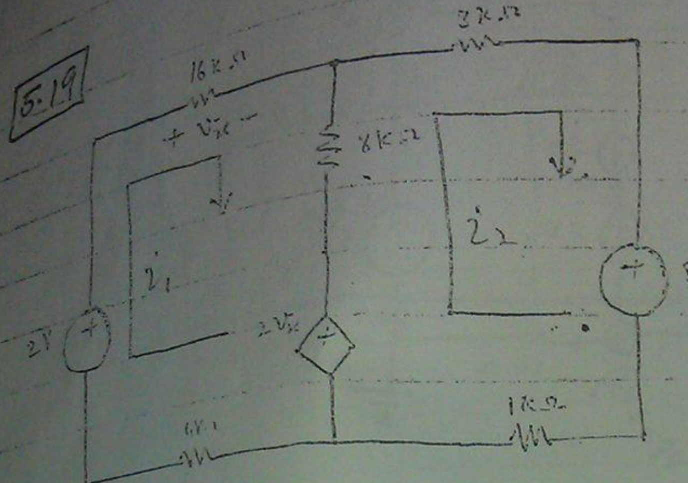
$v_3 = -11/5$ V

$v_{8k\Omega} = V_1 - V_3 = 5 + \frac{11}{5} = \frac{36}{5} = 7.2$ mW

this some...
beca...

...tential d...
...olarities.

5.19



* I chose the ...
of currents ...
16 kΩ dissipat...

5.20
5.21

$$16 i_1 + 8(i_1 - i_2) + 2v_x + 4 i_1 = 2 \quad \text{—}$$

$$3 i_2 + 8(i_2 - i_1) + 8 + i_2 = 2 v_x \quad \text{—}$$

$$v_x = 16 i_1 \quad \text{———} \ (3)$$

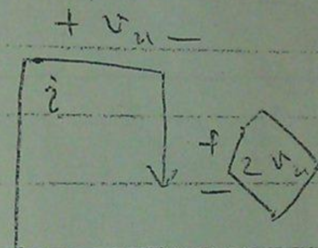
$$\boxed{\begin{aligned} v_x &= -\frac{8}{5}\ \text{V} \\ i_1 &= -1/_{10}\ \text{mA} \\ i_2 &= -1\ \text{mA} \end{aligned}}$$

$$v_{VCVS} = 2 v_x = 2\left(-\frac{8}{5}\right) = -\frac{16}{5}\ \text{V}$$

$$i_{VCVS} = i_1 = -1/_{10}\ \text{mA}$$

The answer given in the book is wrong. this source can never be releasing. beacause ~~they are~~

$v_{10\Omega} = +\ v_x -$ this [po]tential drop & $2v_x$ dependent source has same [po]larities.



5.20 5.21

do yourself.

$i = \frac{v - v_1}{15}$ — (1)

At V_1

$\frac{V_1 - V}{15} + 4V_x + \frac{V_1 - V_x}{10} = 0$

$5V_1 + 117V_x - 2V = 0$ — (2)

At V_x

$\frac{V_x - V_1}{10} + \frac{V_x}{5} = 0$ $\boxed{5.22}$

$3V_x - V_1 = 0$

(1)' $V_x = V_1/3$

(2) =>

$5V_1 + 117\left(\frac{V_1}{3}\right) - 2V = 0$ $\frac{V}{i} = 15.7\Omega$

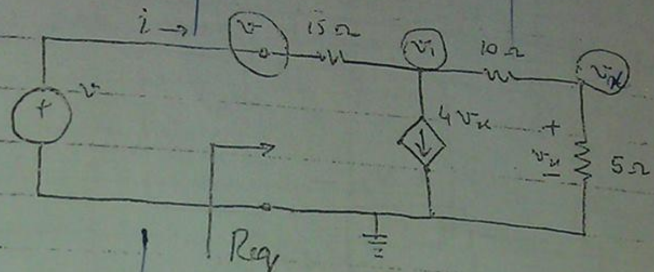
$44V_1 - 2V = 0$

$V_1 = \frac{V}{22}$

(1) => $15i = V - V_1$ 34

$15i = V - \frac{V}{22}$

Req = ?



(2)'

(3)'

$Req = \frac{v}{i}$

$\frac{v_1 - v}{15} + \frac{v_1 - v_x}{10} + 4v_x = 0$

$\frac{v_x - v_1}{10} + \frac{v_x - 0}{5} = 0$

$v_x = \frac{v_2 - 0}{[illegible]} = \frac{v_2}{[illegible]}$

$i = \frac{v - v_1}{15}$

from (1), (2) & (2)

$+i = \frac{V_1 - V}{15} + 4V_x + \frac{V_1 - V_x}{10}$

$+30i = 5V_1 - 2V + 117V_x$ — (1)

$\frac{V_x}{5} + \frac{V_x - V_1}{10} = 0$

$3V_x - V_1 = 0$

$V_x = V_1/3$ — (2)

(1)' put (2) into (1)

$+30i = 5V_1 - 2V + 117\left(\frac{V_1}{3}\right)$

$+30i = 5V_1 - 2V + 39V_1$

$+30i = 44V_1 - 2V$

But $i = \frac{V_1 - V}{15}$

(5) $15i = V_1 - V$

$V_1 = 15i + V$

(1) => s

$+30i = 44(15i + V) - 2V$

$v_1 = \frac{v}{4 + 5\left(\frac{-1}{10} + 3\left(\frac{1}{10} + \frac{1}{15}v\right) + \frac{1}{15}\right.}$

$v_2 = \frac{v}{3\left(4 + 5\left(\frac{-1}{10} + 3\left(\frac{1}{10} + \frac{1}{15}v + \frac{1}{15}(1-v)\right)\right.\right.}$

from ①

$5 v_1 - 3 v_2 + 120 v_x = 2 V$ ——— ①'

from ②

$v_2 = v_1/3$ ——— ②'

from ③

$v_x = \frac{v_2}{5}$ ——— ③'

yourself

from ②' & ③' put in ①

$5 v_1 - \cancel{3}\left(\frac{v_1}{\cancel{3}}\right) + \overset{24}{\cancel{120}}\left(\frac{v_2}{\cancel{5}}\right) = 2 V$

$\cancel{5 v_1} - v_1 + 24 v_2 = 2 V$

from ③' $v_x = \frac{v_2}{5}$ put in ①'

$5 v_1 - 3 v_2 + \overset{129}{\cancel{120}}\left(\frac{v_2}{\cancel{5}}\right) = 2 V$ ——— ⑤

$5 v_1 - \cancel{117} v_2 = 2 V$

from ②' $v_2 = \frac{v_1}{3}$ put in ⑤

$5 v_1 - \overset{39}{\cancel{117}}\left(\frac{v_1}{\cancel{3}}\right) = 2 V$

$-2 v_1 = 2 V$

$-v_1 = V$

$\boxed{v_1 = -V}$ put in ④

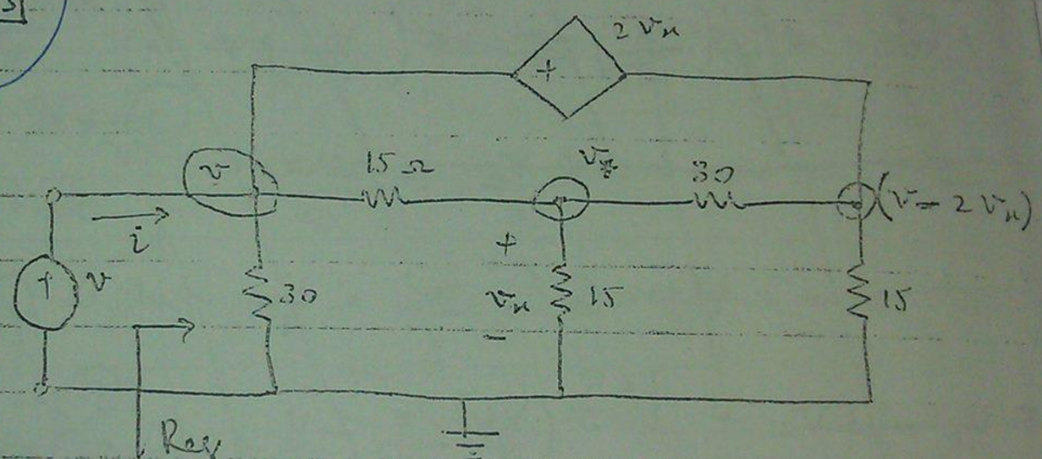
$i = \frac{v - (-v)}{15}\ \Omega, \quad i = \frac{2v}{15}$

$\frac{15}{2} = \frac{v}{i}$

$R_{eq} = \frac{v}{i} = \frac{15}{2}\ \Omega$

$\boxed{R_{eq} = 7.5\ \Omega}$

$\boxed{5 \cdot 23}$



$v_1 = v_x - 0$

$\boxed{v_1 = v_x}$ ——— ①

v:

$i = \frac{v - 0}{30} + \frac{v - v_1}{15} + \frac{(v - 2v_x) - 0}{15} + \frac{(v - 2v_x) - v_1}{30}$

$30 i = (v) + (2v - 2v_1) + (2v - 4v_x) + (v-$

$30 i = 6v - 6v_x - 3v_1$

from ① $v_1 = v_x$ put in above

$$\frac{v_1 - v_0}{15} + \frac{v_1 - (v - 2v_x)}{30} + \frac{v_1 - 0}{15} = 0$$

$$2v_1 - 2v + v_1 - v + 2v_x + 2v_1 = 0$$

$$5v_1 + 2v_x - 3v = 0$$

as from ① $v_1 = v_x$ put in above

$$5v_x + 2v_x - 3v = 0$$

$$7v_x = 3v$$

$$\boxed{v_x = \frac{3v}{7}} \text{ —— ③}$$

put in ②

$$30i = 6v - 9\left(\frac{3v}{7}\right)$$

$$210i = 42v - 27v$$

$$210i = 15v$$

$$\frac{210}{15} = \frac{v}{i}$$

$$\frac{v}{i} = 14$$

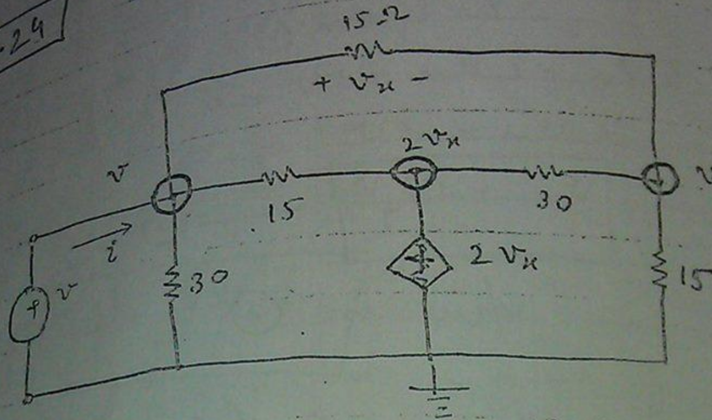
$$\boxed{R_{eq} = 14\,\Omega}$$

5.

v

$R_{eq} = ?$

5.24



$$v_x = \frac{v - v_1}{15} \quad \text{———} \ (1)$$

$$v_1 = v - v_x \quad \text{———} \ (1)'$$

at v:

$$i = \frac{v - 2v_x}{15} + \frac{v - 0}{30} + \frac{v - v_1}{15}$$

from (1) $v_x = v - v_1$

$$i = \frac{v - 2v_x}{15} + \frac{v - 0}{30} + \frac{v_x}{15}$$

$$30\,i = 2v - 4v_x + v + 2v_x$$

$$30\,i = 3v - 2v_x \quad \text{———} \ (2)$$

v_1:

$$0 = \frac{v_1 - v}{15} + \frac{v_1 - 2v_x}{30} + \frac{v_1 - 0}{15}$$

put $v_1 = v - v_x$ in above

$$0 = \frac{(\cancel{v} - v_x) - \cancel{v}}{15} + \frac{v - v_x - 2v_x}{30} + \frac{v - v_x}{15}$$

$$0 = \frac{-v_x}{15} + \frac{v - 3v_x}{30} + \frac{v - v_x}{15}$$

$$0 = -2v_x + v - 3v_x + 2v - 2v_x$$

$$0 = 3v - 7v_x$$

$$7v_x = 3v$$

$$\boxed{v_x = \frac{3v}{7}} \text{ — (3) put in (2)}$$

$$30i = 3v - 2\left(\frac{3v}{7}\right)$$

$$210i = 21v - 6v$$

$$210i = 15v$$

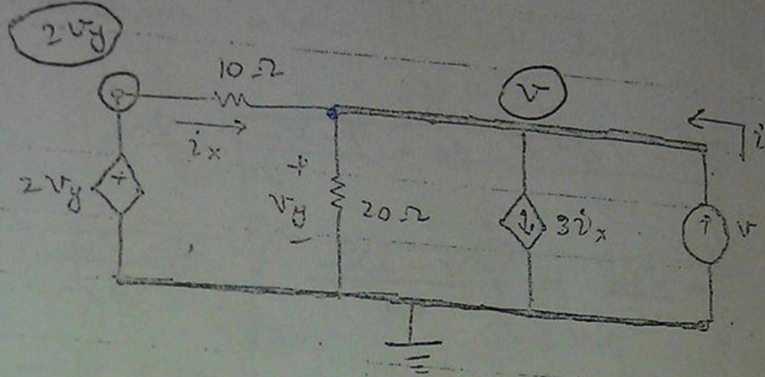
$$14i = v$$

$$\frac{v}{i} = 14$$

$$\boxed{R_{eq} = 14\ \Omega}$$

$\boxed{5.25}$

$R_{eq} = ?$



$$v_y = v - 0$$

$$\boxed{v = v_y} \quad \text{—— (1)}$$

$$i_x = \frac{2v_y - v}{10}$$

from (1) $v = v_y$

$$i_x = \frac{2v_y - v_y}{10}$$

$$\boxed{i_x = \frac{v_y}{10}} \quad \text{—— (2)}$$

at v:

$$i = 3i_x + \frac{v - 0}{20} + \frac{v - 2v_y}{10}$$

$$i = 3i_x + \frac{v}{20} + \frac{v - 2v_y}{10}$$

$$20i = 60i_x + v + 2v - 4v_y$$

$$20i = 60i_x + 3v - 4v_y$$

from (2) $i_x = \frac{v_y}{\ }$

$$20i = 6\cancel{0}\left(\frac{v_y}{\cancel{10}}\right) + 3v - 4v_y$$

$$20i = 6v_y + 3v - 4v_y$$

from ① $v = v_y$ put in above

$$20i = 6v + 3v - 4v$$

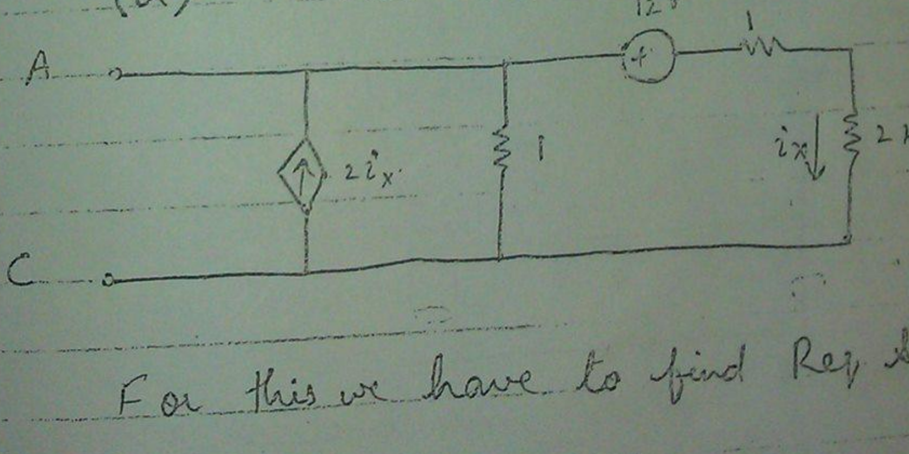
$$4\,\cancel{20}\,i = \cancel{5}\,v$$

$$\frac{v}{i} = 4$$

$$\boxed{R_{eq} = 4\ \Omega}$$

$\boxed{26}$ [kΩ], [mA], [V]

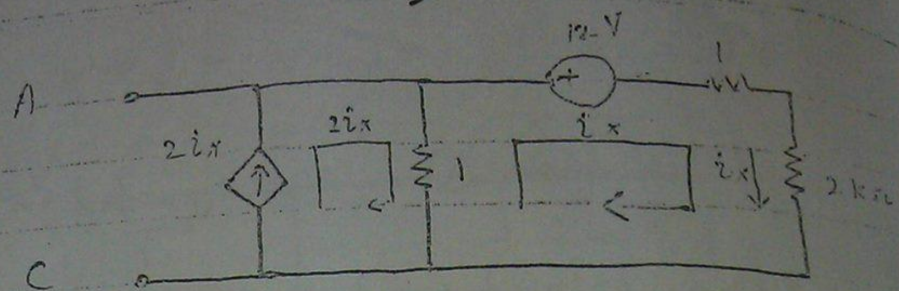
(a)



For this we have to find R_{eq} & v_{oc}

For v_{oc} by loop Method -

42



loop I :

$$12 + i_x + 2 i_x + (i_x - 2 i_x) = 0$$

$$12 + i_x + \cancel{2 i_x} + i_x - \cancel{2 i_x} = 0$$

$$12 + 2 i_x = 0$$

$$2 i_x = -12$$

$$\boxed{i_x = -6 \ A}$$

$$v_{1\Omega} = 1 (i_x - 2 i_x)$$

$$= (-6 - 2(-6))$$

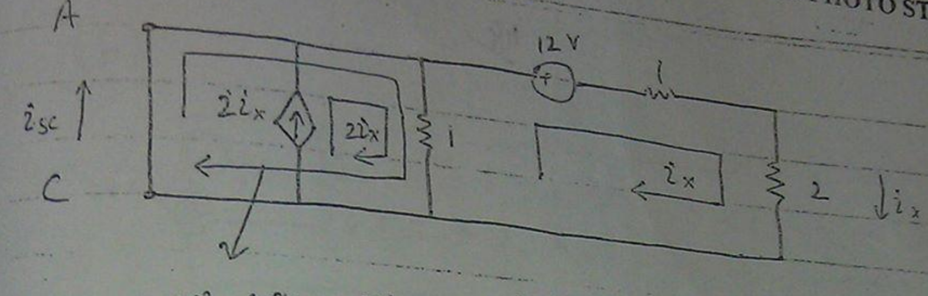
$$= -6 + 12$$

$$\boxed{v_{1\Omega} = 6 \ V \ \binom{-}{+}}$$ as i_x ↑

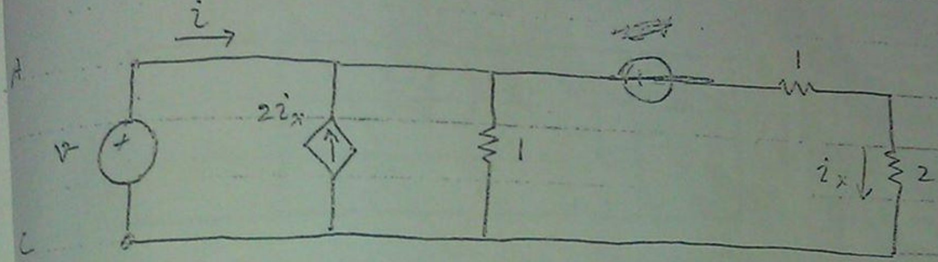
as 1Ω ressistance & $2i_x$ source are in parallel.

$$\boxed{v_{oc} = v_{1\Omega} = 6 V \ \binom{-}{+}}$$

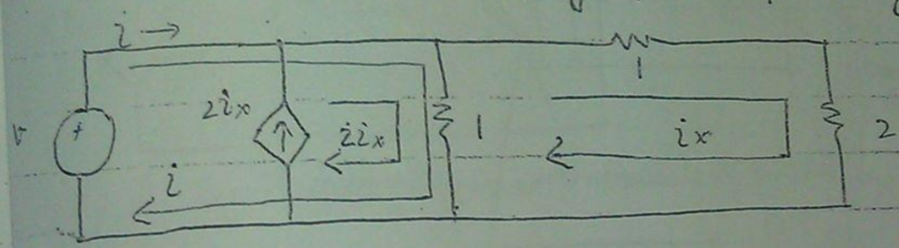
→ For Req ckt find i_x ...



we can assume this loop. So we will find Req by 2nd Method.



Now applying loop analysis



loop I:

$$\cancel{(i_x - 2i_x) + i_x + 2i_x = 0}$$

$$i_x + 2i_x + (i_x - (i + 2i_x)) = 0$$

$$3i_x + i_x - i - 2i_x = 0$$

$$2i_x - i = 0 \quad \text{—— } 1$$

loop II:

$$v = (i + 2i_x)$$

$$v = i + 2i_x \quad \text{—— } 2$$

$$2i_x - i = 0 \quad (1)$$

$$v = i + 2i_x \quad (2)$$

from (1)

$$i_x = \frac{i}{2} \text{ put in } (2)$$

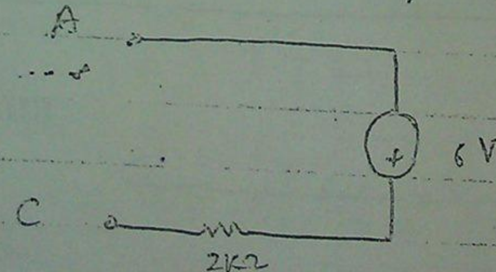
$$v = i + \cancel{2}\left(\frac{i}{\cancel{2}}\right)$$

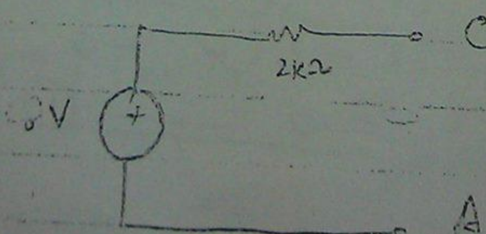
$$v = 2i$$

$$\frac{v}{i} = 2$$

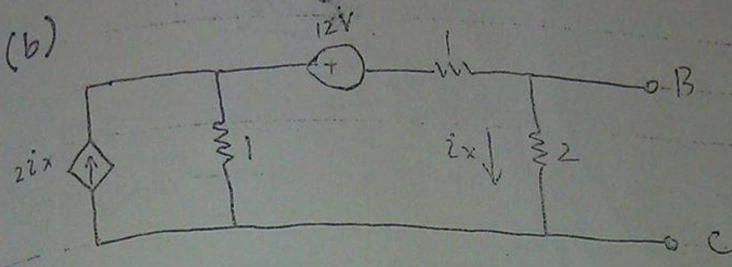
$$\boxed{R_{eq} = 2k\Omega}$$

Now Thevinin equivalent

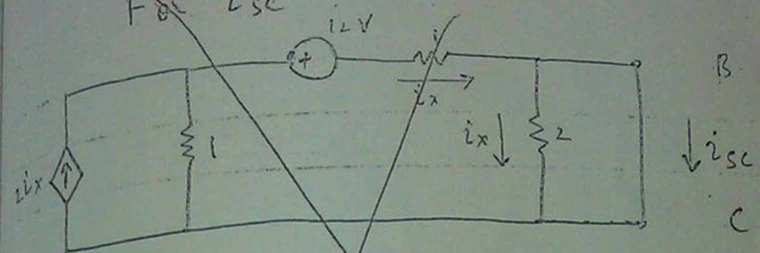


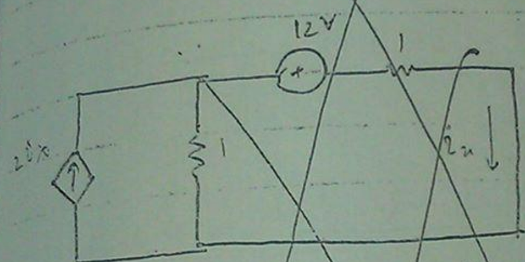


(b)

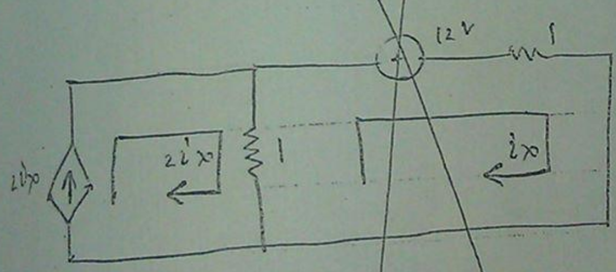


For i_{sc}



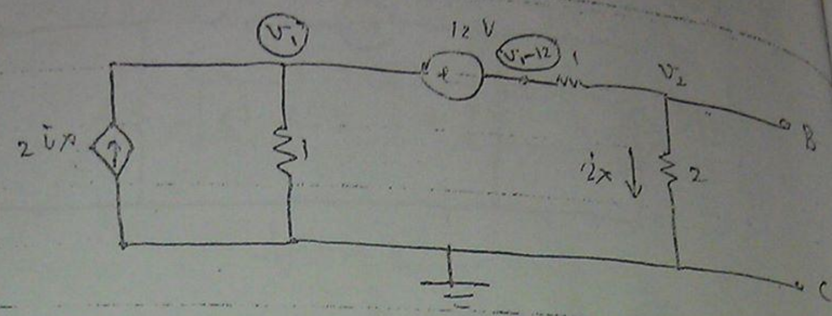


By applying loop method



loop I:
$$12 + i_x + (i_x - 2i_x) = 0$$
$$12 + i_x + i_x - 2i_x = 0$$
$$12 \neq 0$$

b)



at v_1:

$$2i_x = \frac{v_1 - 0}{1} + \frac{(v_1-12) - v_2}{1}$$

$$2i_x = v_1 + v_1 - 12 - v_2$$

$$2i_x = 2v_1 - v_2 - 12$$

$$2v_1 - v_2 = 2i_x + 12 \quad \text{——— (1)}$$

at v_2:

$$\frac{v_2 - 0}{2} + \frac{v_2 - (v_1 - 12)}{1} = 0$$

$$v_2 + 2v_2 - 2v_1 + 24 = 0$$

$$3v_2 - 2v_1 = -24 \quad \text{——— (2)}$$

i_x :

$$i_x = \frac{v_2 - 0}{2} = \frac{v_2}{2}$$

$$\boxed{i_x = \frac{v_2}{2}} \quad \text{——— (3)}$$

$v_1 = -6$ V

$v_2 = -12$ V

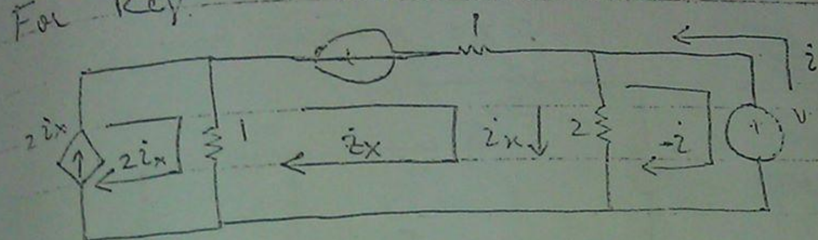
$v_{oc} = v_2 - 0$

$= -12 - 0$

$v_{oc} = -12$ V

$$\boxed{v_{oc} = 12\text{ V} \quad \binom{-}{+}}$$

For Req



loop I:

$i_x + (i_x - 2i_x) + 2(i_x - (-i)) = 0$

$i_x + i_x - \cancel{2i_x} + \cancel{2i_x} + 2i = 0$

$2i_x + 2i = 0$

$i_x + i = 0$

loop II:

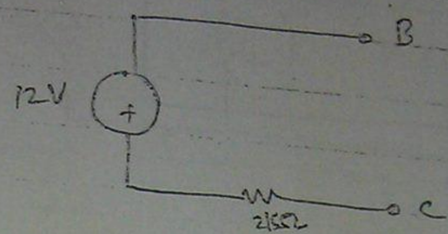
$2(-i) + v = 0$

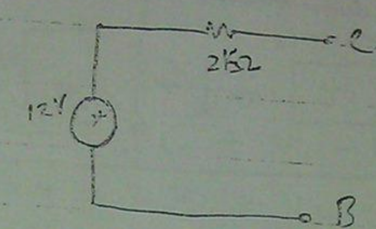
$-2i + v = 0$

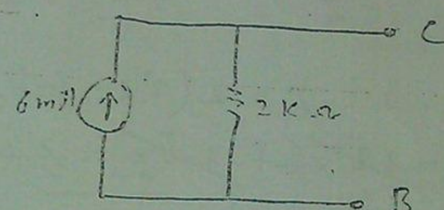
$v = 2i$

$\frac{v}{i} = 2$

$$\boxed{R_{eq} = 2k\Omega}$$

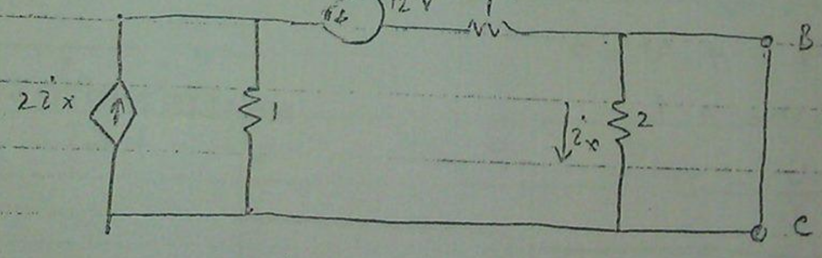






Alternate :-

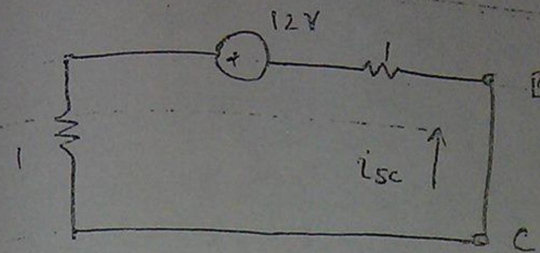
For i_{sc} :-



In this case $i_x = 0$, then  is also 0. when current is zero It means that circuit is open.

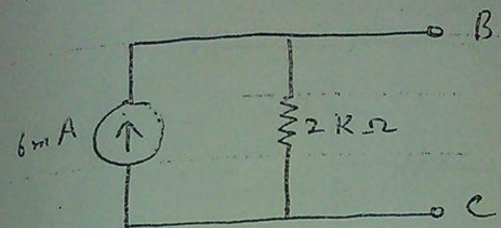
So our circuit will become.

7



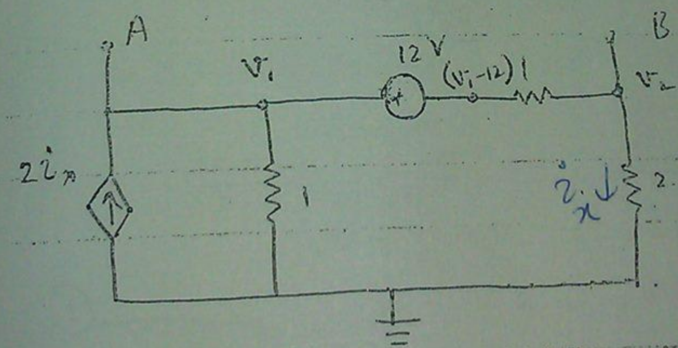
$i_{sc} = 6\ mA$ by Ω's law

and $R_{eq} = 2\ k\Omega$



KHALID PHOTO STATE
U.E.T

7



KHALID PHOTO STATE
U.E.T

$$2i_x = \frac{v_1 - 0}{1} + \frac{(v_1 - 12) - v_2}{1} \quad \text{——— (1)}$$

$$\frac{v_2 - 0}{2} + \frac{v_2 - (v_1 - 12)}{1} = 0 \quad \text{——— (2)}$$

$$i_x = \frac{v_2 - 0}{2} = \frac{v_2}{2} \quad \text{——— (3)}$$

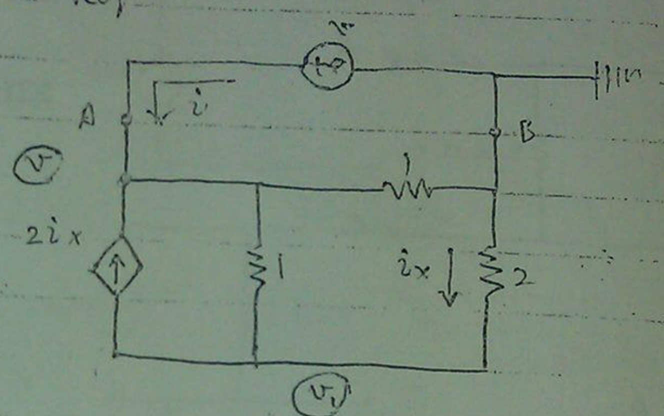
$$\boxed{\begin{aligned} v_1 &= -6\ V \\ v_2 &= -12\ V \end{aligned}}$$

$v_{oc} = v_A - v_B$

$= -6 - (-12) = 6V$

$$\boxed{v_{oc} = 6V}$$

For R_{eq}



at v:

$$i + 2i_x = \frac{v-0}{1} + \frac{v-v_1}{1}$$

$$i + 2i_x = v + v - v_1$$

$$i + 2i_x = 2v - v_1 \quad \text{——— (1)}$$

at v_1:

$$2i_x + \frac{v_1 - v}{1} + \frac{v_1 - 0}{2} = 0$$

$$4i_x + 2v_1 - 2v + v_1 = 0$$

$$3v_1 - 2v = -4i_x \quad \text{——— (2)}$$

i_x :

$$i_x = \frac{0 - v_1}{2}$$

put $v_1 = -2 i_x$ in ①

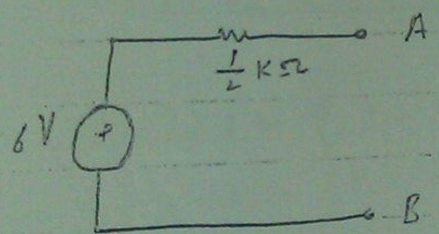
$$i + 2i_x = 2v - (-2i_x)$$

$$i + \cancel{2i_x} = 2v + \cancel{2i_x}$$

$$i = 2v$$

$$\frac{v}{i} = \frac{1}{2}$$

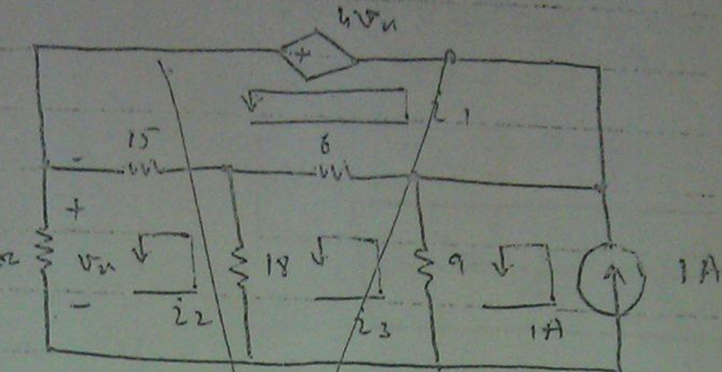
$$\boxed{R_{eq} = \frac{1}{2}\ k\Omega}$$



$$P_{max} = \frac{1}{4}\frac{v_s^2}{R_s} = \frac{1}{\cancel{4}\,2}\frac{36}{\cancel{1/2}} = 18\ mW$$

$$\boxed{P_{max} = 18\ mW}$$

$\boxed{5.28}$ (a)



i_1 :

$$4v_x = 15(i_1 - i_2) + 6(i_1 - i_3)$$

i_2 :

$$6i_2 + 15(i_2 - i_1) + 18(i_2 - i_3) = 0$$

i_3 :

$$18(i_3 - i_2) + 6(i_3 - i_1) + 9(i_3 - 1) = 0$$

v_x :

$$v_x = 6i_2$$

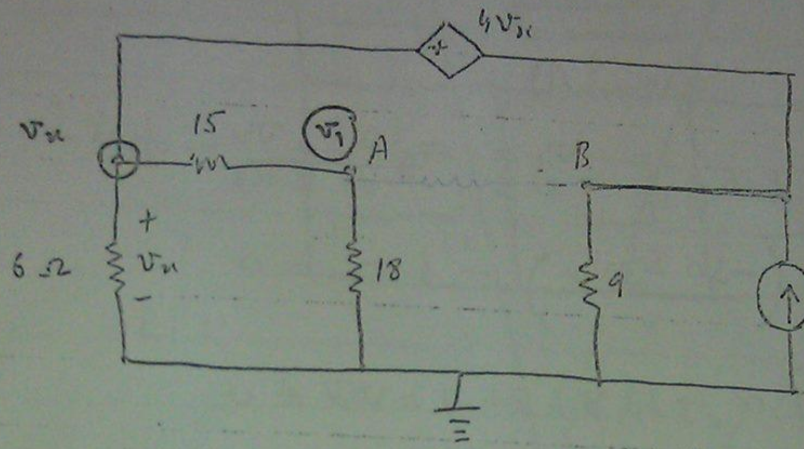
$$\boxed{\begin{aligned} v_x &= -4\,V \\ i_1 &= -\frac{4}{3}\,A \\ i_2 &= -\frac{2}{3}\,A \\ i_3 &= -\frac{1}{3}\,A \end{aligned}}$$

$$v_{18\Omega} = 18(i_3 - i_2) =$$

By here $P_{6\Omega} = (i_3 - i_1)^2 R = \frac{-1}{3} + \frac{4}{3} = \frac{3}{3} = (1)^2 R$

$= 1 \times 6 = (\ldots) W$

$\boxed{5.28}$



$v_x - 4v_x = -3v_x$

at v_x:

$$1 = \frac{v_x - 0}{6} + \frac{v_x - v_1}{15} + \frac{-3v_x - 0}{9}$$

$$90 = 15v_x + 6v_x - 6v_1 - 30v_x$$

$$90 = -9v_x - 6v_1$$

$$-30 = 3v_x + 2v_1$$

$$2v_1 + 3v_x = -30 \quad \text{———} \quad (1)$$

at v_1:

$$\frac{v_1 - v_x}{15} + \frac{v_1 - 0}{18} = 0$$

$$18v_1 - 18v_x + 15v_1 = 0$$

$$33v_1 - 18v_x = 0$$

$$11v_1 - 6v_x = 0 \quad \text{———} \quad (2)$$

$$2v_1 + 3v_x = -30 \quad \text{——— (1)}$$
$$11v_1 - 6v_x = 0 \quad \text{——— (2)}$$

from (1)

$$v_1 = \frac{-30 - 3v_x}{2} \quad \text{put in (2)}$$

$$11\left(\frac{-30 - 3v_x}{2}\right) - 6v_x = 0$$

$$-330 - 33v_x - 12v_x = 0$$
$$45v_x = -330$$
$$\boxed{v_x = -\frac{22}{3}\ \text{v}} \quad \text{put in (1)}$$

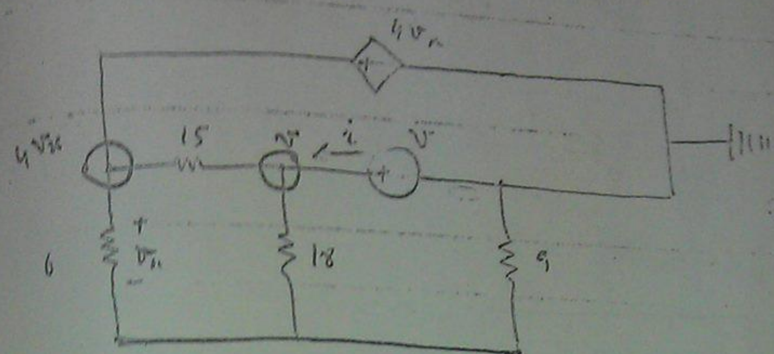
$$2v_1 + \cancel{3}\left(\frac{-22}{\cancel{3}}\right) = -30$$

$$2v_1 - 22 = -30$$
$$2v_1 = -30 + 22$$
$$2v_1 = -8$$
$$\boxed{v_1 = -4\,\text{V}}$$

$$v_{oc} = v_1 - (-3v_x)$$
$$= -4 + 3v_x = -4 + \cancel{3}\left(\frac{-22}{\cancel{3}}\right)$$
$$= -4 - 22 = -26\ \text{V} \quad (+\ -)$$

$$\boxed{v_{oc} = 26\ \text{V} \quad (-\ +)}$$

For Req



$4v_x - v_x = 3v_x$

at v:

$$i = \frac{v - 3v_x}{18} + \frac{v - 4v_x}{15}$$

$$270i = 15v - 45v_x + 18v - 72v_x$$

$$270i = 33v - 117v_x \quad \text{———} \quad (1)$$

at $3v_x$:

$$\frac{3v_x - 4v_x}{6} + \frac{3v_x - v}{18} + \frac{3v_x - 0}{9} = 0$$

$$(9v_x - 12v_x) + (3v_x - v) + 6v_x = 0$$

$$(-\cancel{3v_x} + \cancel{3v_x}) - v + 6v_x = 0$$

$$+6v_x - v = 0$$

$$6v_x - v = 0$$

$$v = 6v_x$$

$$\boxed{v_x = \frac{v}{6}}$$ put in (1)

$$270i = 33v - 117\left(\frac{v}{6}\right)$$

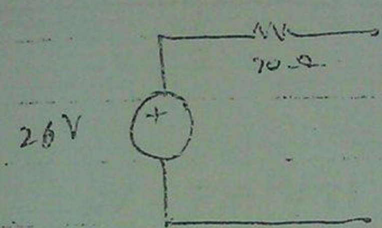
$$1620i = 198v - 117v = 81v$$

$$1620\, i = 81\, v$$

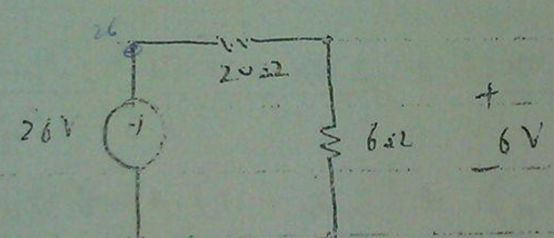
$$\frac{1620}{81} = \frac{v}{i}$$

$$20 = \frac{v}{i}$$

$$\boxed{R_{eq} = 20\ \Omega}$$



(a) $P_{6\Omega} = ?$



$$P_{6\Omega} = \frac{(6)^2}{6} = 6$$

$$\boxed{P_{6\Omega} = 6\ W}$$

(b) For max Power transfer

$$R_L = R_s$$

So $6\ \Omega$ should be Replaced by $20\ \Omega$

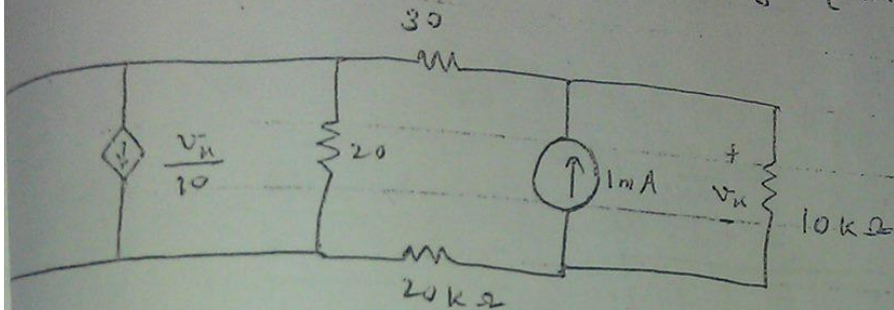
and the max power will be

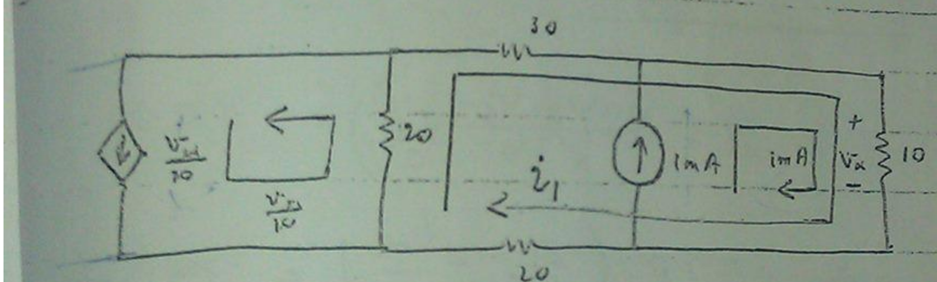
$$\boxed{P_{max} = 8.45\,W}$$

5·29 do yourself.

5·30 $P_{max} = ?$

[kΩ], [mA], [V]





loop I :

$$10(i_1+1) + 20 i_1 + 30 i_1 + 20\left(i_1 + \frac{v_x}{10}\right) = 0$$

$$10 i_1 + 10 + 50 i_1 + 20 i_1 + 2 v_x = 0$$

$$80 i_1 + 2 v_x + 10 = 0$$

$$40 i_1 + v_x + 5 = 0 \quad \text{—— (1)}$$

v_x :

$$v_x = 10(i_1 + 1)$$

$$v_x = 10 i_1 + 10 \quad \text{—— (2)}$$

put in (1)

$$40 i_1 + 10 i_1 + 10 + 5 = 0$$

$$i_1 = \frac{-15}{50} = \frac{-3}{10}$$

$$\boxed{i_1 = \frac{-3}{10}\ mA}$$

$$v_x = 10\, i_1 + 10$$
$$= 10\left(\frac{-3}{10}\right) + 10$$
$$= -3 + 10$$

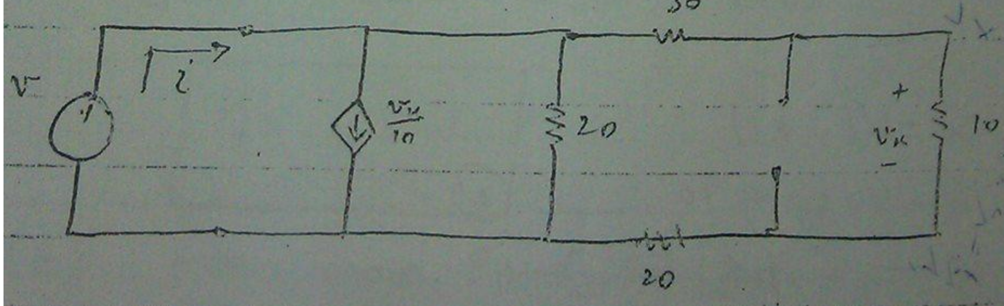
$$\boxed{v_x = 7\ V}$$

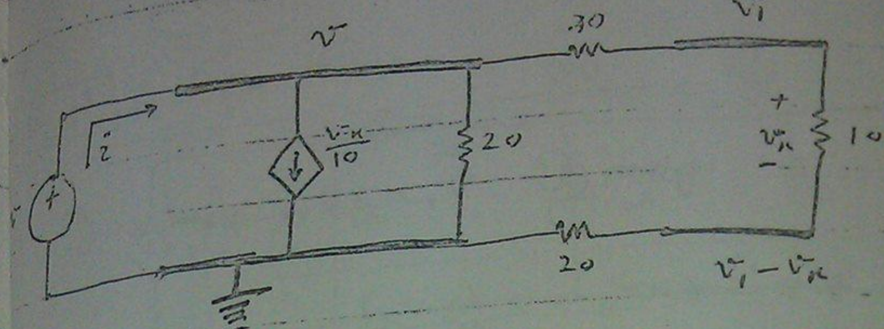
$$v_{oc} = v_{20,c} = 20\left(i_1 + \frac{v_x}{10}\right)$$

$$= 20\left(\frac{-3}{10} + \frac{7}{10}\right) = 2\cancel{0}\left(\frac{4}{\cancel{10}}\right)$$

$$\boxed{v_{oc} = 8\ V}$$

For Req :-





at v:

$$i = \frac{v_x}{10} + \frac{v-0}{20} + \frac{v-v_1}{30}$$

$$60i = 6v_x + 3v + 2v - 2v_1$$

$$60i = 5v + 6v_x - 2v_1 \quad \text{———} \quad (1)$$

at v_1:

$$\frac{v_1 - v}{30} + \frac{\overbrace{(v_1 - (v_1 - v_x))}^{-v_x}}{10} = 0$$

$$v_1 - v + 3v_x = 0$$

$$v_1 - v + 3v_x = 0 \quad \text{———} \quad (2)$$

at $(v_1 - v_x)$:

$$\frac{(v_1 - v_x) - 0}{20} + \frac{(v_1 - v_x) - v_1}{10} = 0$$

$$\frac{v_1 - v_x}{20} + \frac{-v_x}{10} = 0$$

$$v_1 - v_x - 2v_x = 0$$

$$v_1 - 3v_x = 0 \quad (3)$$

from (3) $v_1 = 3v_x$ put in (1)

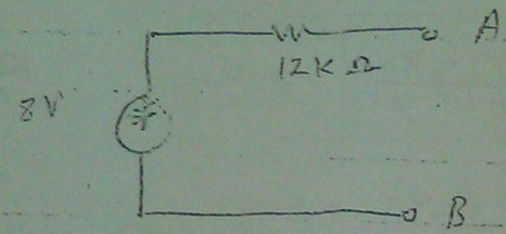
$$60i = 5v + 6v_x - 2(3v_x)$$

$$60i = 5v + \cancel{6v_x} - \cancel{6v_x}$$

$$60i = 5v$$

$$\frac{v}{i} = \frac{60}{5} = 12$$

$$\boxed{R_{eq} = 12\,k\Omega}$$

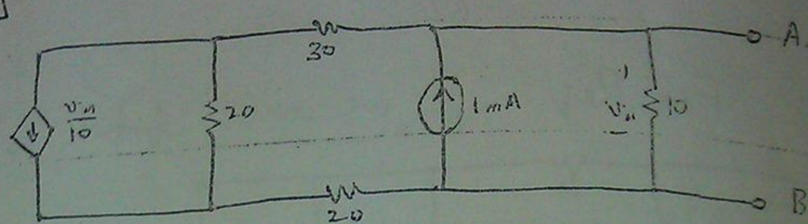


$$P_{max} = \frac{1}{4}\frac{V_s^2}{R_s} = \frac{(8)^2}{12} \times \frac{1}{4} = \frac{\cancel{64}}{\cancel{12}} \times \frac{1}{\cancel{4}}$$

$$\boxed{P_{max} = \frac{3}{2}\ mW}$$

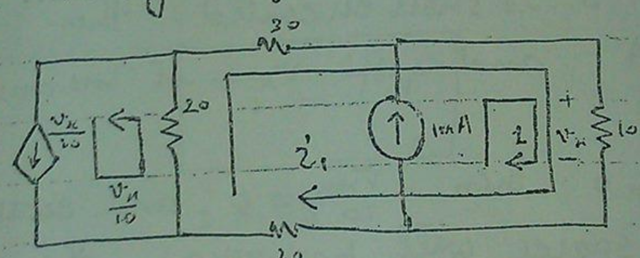
$\boxed{5.31}$ For this

①



For v_{oc}

By loop Method



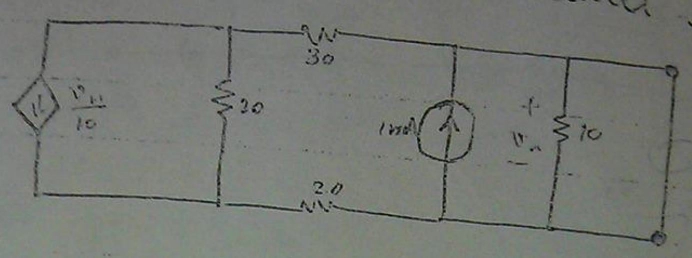
By loop I & by v_x from $\boxed{5.30}$ @ P57

$i_1 = \frac{-3}{10}$ mA
$v_x = 7V$

$v_{oc} = v_x = 7V$

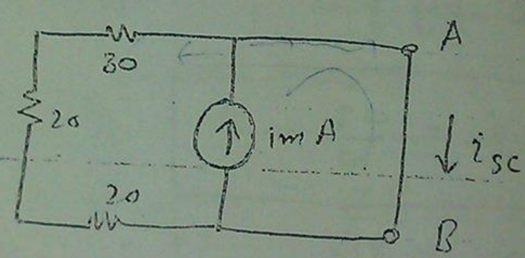
$\boxed{v_{oc} = 7V}$

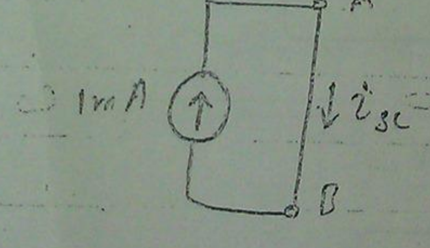
For Req we will find i_{sc}



when A B is short circuited then $i_{10k\Omega} = 0$ mA and no v_x it means $v_x = 0$.

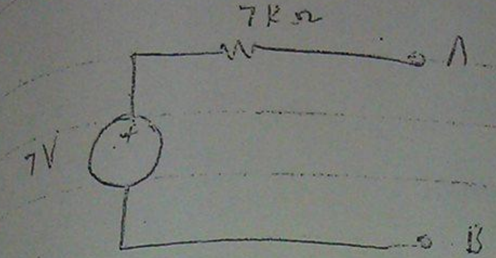
If $v_x = 0$ then $\frac{v_x}{10} = 0$ and current of dependent source will be zero. then circuit will be



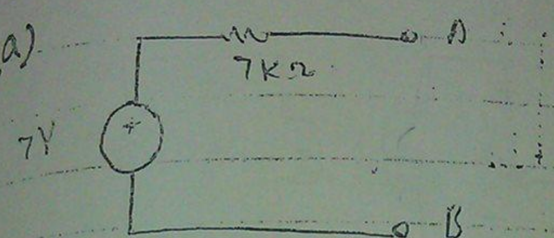


$$\boxed{i_{sc} = 1\ mA}$$

$$R_{eq} = \frac{v_{oc}}{i_{sc}} = \frac{7\,V}{1\,mA} = 7\ k\Omega$$



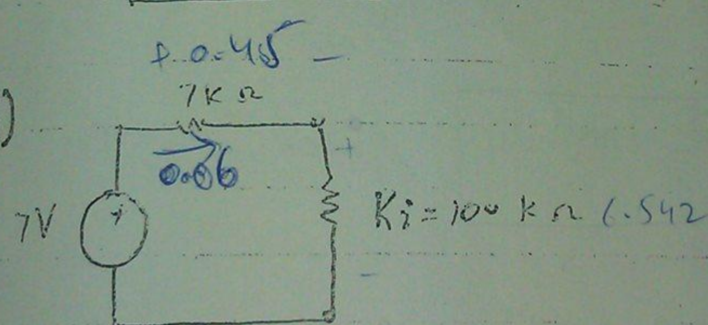
(a)



$R_i = \infty$

$$\boxed{v_i = 7\text{ V}}$$

(b)



$$v_i = \frac{100}{107} \times 7 = 6.542$$

$$\boxed{v_i = 6.542\text{ V}}$$

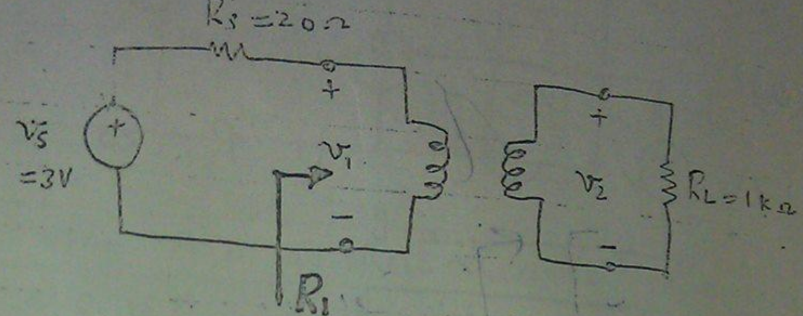
5.3 The Ideal Transformer :-

$v_2 = n v_1$

$i_2 = i_1 / n$

$R_2 = n^2 R_1$

$\boxed{5.32}$



(a) $\boxed{P = 100\ mW}$ given

$R_1 = \dfrac{R_L}{n^2} = \dfrac{1k}{n^2}$ — (1)

$R_{eq} = R_1 + R_S$ — (2)

$$\frac{P}{v} = \frac{(v_S)^2}{R_{eq}}$$

$$\frac{100\ mW}{(3V)^2} = \frac{1}{R_{eq}}$$

$$R_{eq} = \frac{9}{100m}$$

$$R_1 + R_S = \frac{9}{100m}$$

$$R_1 = \frac{9}{100m} - R_S$$

$$\frac{1K}{n^2} = \frac{9}{100m} - 20$$

$$n^2 = 1k \times \left(\frac{100\,m}{9 - 2000m}\right)$$

$$= \frac{100}{9-(2k)m} = \frac{100}{9-2}$$

5.

$\boxed{5.}$

$$n^2 = \frac{100}{7}$$

$$n = 3.779$$

$$\boxed{n = 3.8}$$

(b) For max Power

For this $R_s = R_i$

$$R_s = \frac{R_L}{n^2}$$

$$20 = \frac{1k}{n^2}$$

$$n^2 = \frac{100\cancel{0}}{2\cancel{0}} = \frac{100}{2}$$

$$n = 7.07$$

$$\boxed{n = 7}$$

$P = 100\,mW$

$V_s = ?$

$P = \dfrac{V_s^2}{R_{eq}}$

$P = \dfrac{V_s^2}{R_1 + R_s}$

$R_1 = \dfrac{R_L}{n^2}$

$R_1 = 2.5\,k\Omega$

$V_s^2 = P(R_1 + R_s)$

$V_s^2 = 100 \times 10^{-3}(2.5 \times 10^3 + 15)$

$\boxed{V_s = 15.8\,V}$

$\eta = \dfrac{R_1}{R_s + R_1}$

$\eta = \dfrac{2.5 \times 10^3}{2.5 \times 10^3 + 15} \times 100$

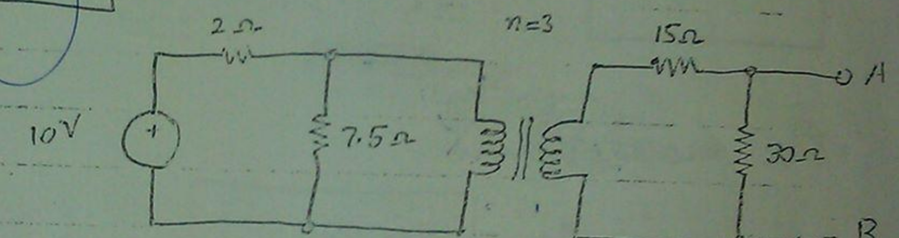
$\eta = 99.4\%$

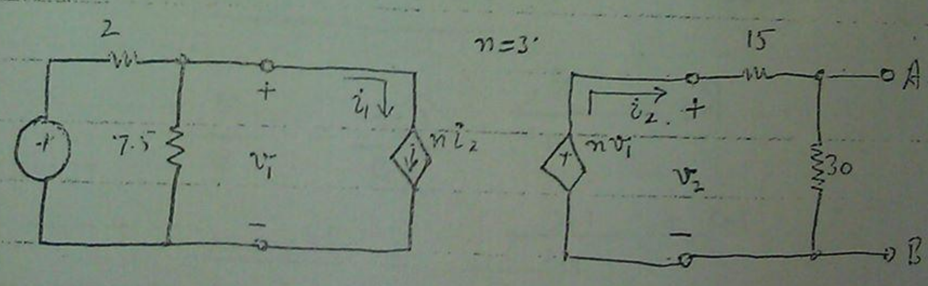
15.8 $\boxed{5.33}$ do yourself :-

Hint: Find R_1 as in $\boxed{5.32}$ then for (b) consult chapter 4 and use the formula

$$\eta = \frac{R_1}{R_s + R_1} \quad \text{(for voltage source)}$$

$\boxed{5.34}$





$v_1 = v_{7.5\Omega} = \dfrac{7.5}{2 + 7.5} \times 10 = 7.89$

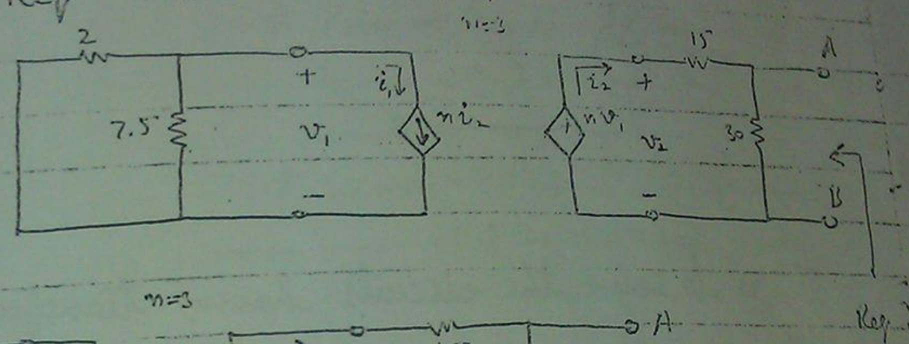
$\boxed{v_1 = 7.9\,V}$

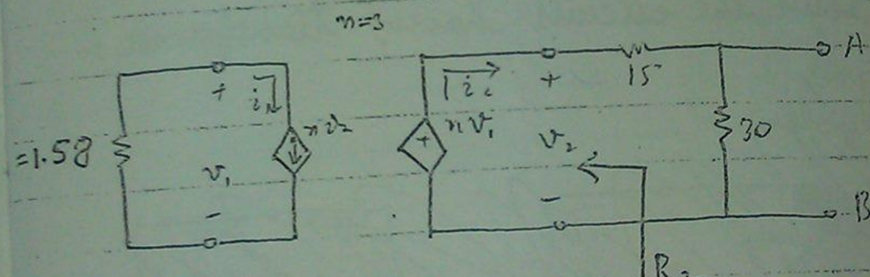
$v_2 = n\,v_1 = 3(7.9) = 23.7\,V$

$v_{oc} = v_{AB} = v_{30\Omega} = \frac{30}{15+30}\overset{v_2}{(23.7)} = 15.8$

$\boxed{v_{oc} = 15.8\ V}$

For Req

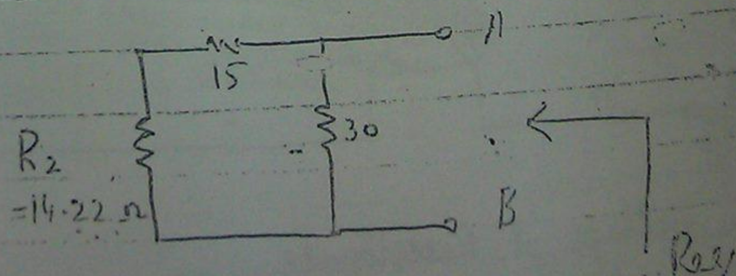




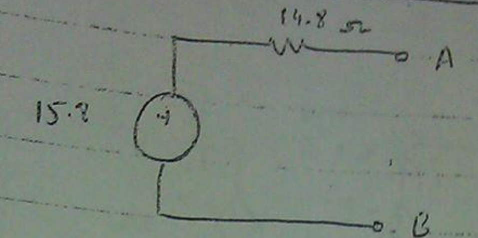
$R_2 = n^2 R_1$

$= 9(1.58) = 14.22$

$\boxed{R_2 = 14.22\ \Omega}$

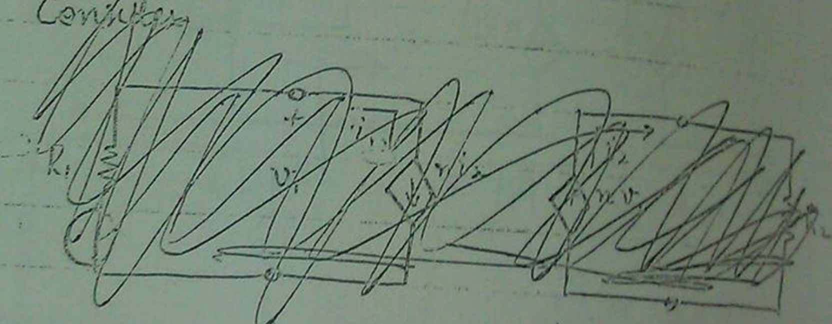


$$\boxed{R_{eq} = 14.8\ \Omega}$$

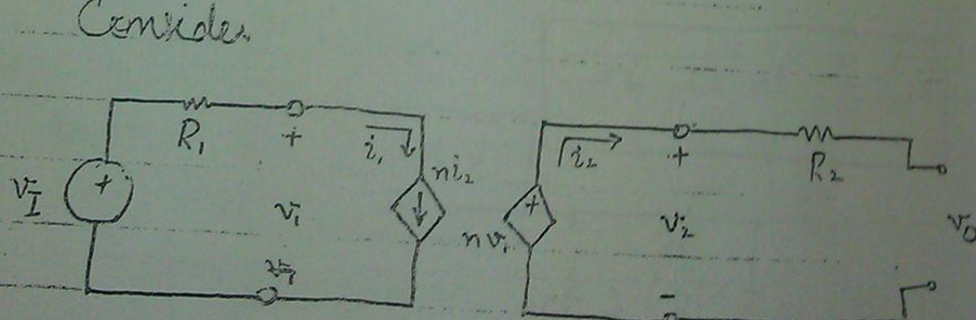


Tips to solve the circuits having transformer :-

~~Configu~~



Consider



I: * For voltage & Resistance

* Prim. ⟶ Second. ⊗ by n or n^2

e.g. $v_2 = n v_1$

☆ Second. → Prim. ÷ by n or n^2

e.g. $v_1 = \frac{v_2}{n}$

$R_1 = \frac{R_2}{n^2}$

II: ☆ For current :

It is reversed i.e.

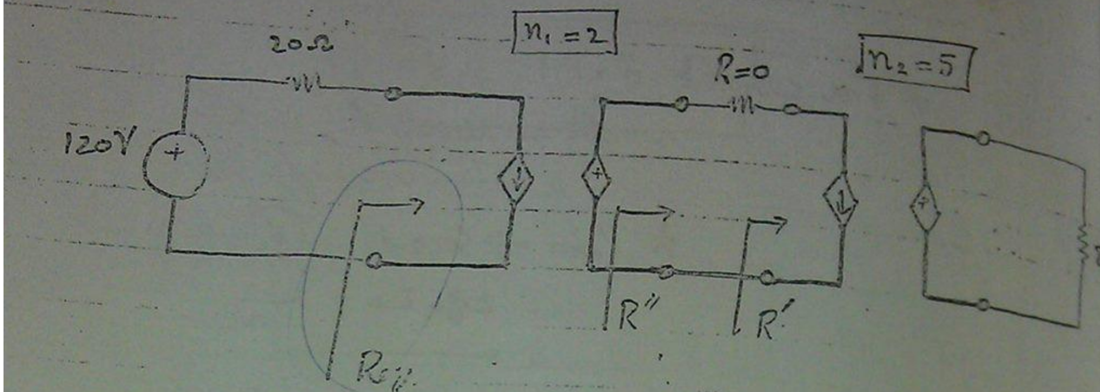
☆ Prim → Second. ÷ by n

e.g. $i_2 = \frac{i_1}{n}$

☆ Second. → Prim. × by n

e.g. $i_1 = n i_2$

$\boxed{5{:}35}$



Find Req = ?

$$R' = \frac{8K}{(n_2)^2} = \frac{8K}{25} = 320$$

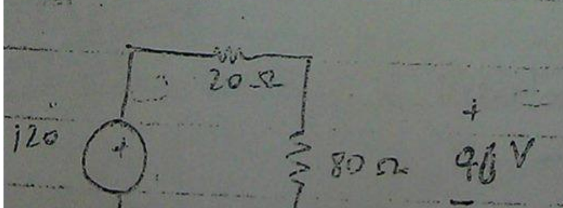
$$\boxed{R' = 320\ \Omega}$$

$$R'' = R' + R = 320 + 0 = 320$$

$$\boxed{R'' = 320\ \Omega}$$

$$Req = \frac{R''}{(n_1)^2} = \frac{320}{4} = 80$$

$$\boxed{Req = 80\ \Omega}$$



$v_{80\Omega} = 96\ V$

$P_{8K\Omega} = P_{80\Omega} = \frac{(96)^2}{80} = 115.2\ mW$

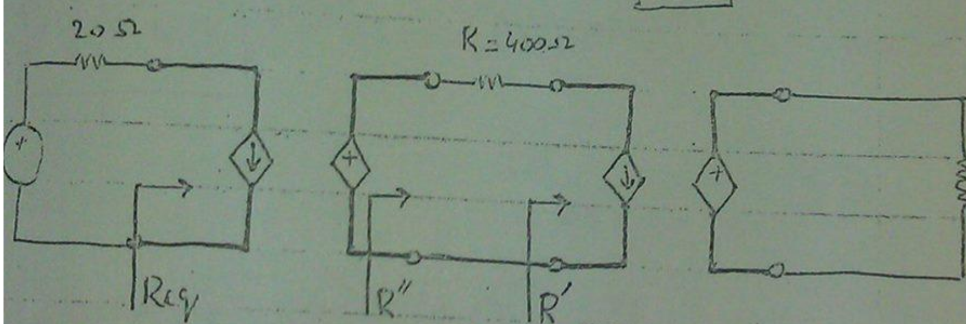
$\boxed{P_{8K\Omega} = 115.2\ mW}$

$\because R = 0$

$\because$ No power is dissipated across $R = 0\ \Omega$. If $R \neq 0\ \Omega$ then we will go reverse to find $v_{8K\Omega}$ then we will find $P_{8K\Omega}$

$\boxed{5.36}$

$\boxed{n_1 = 2}$ $\boxed{n_2 = 5}$



$R' = \frac{8K}{(n_2)^2} = \frac{8000}{25} = 320\ \Omega$ $\boxed{R' = 320\ \Omega}$

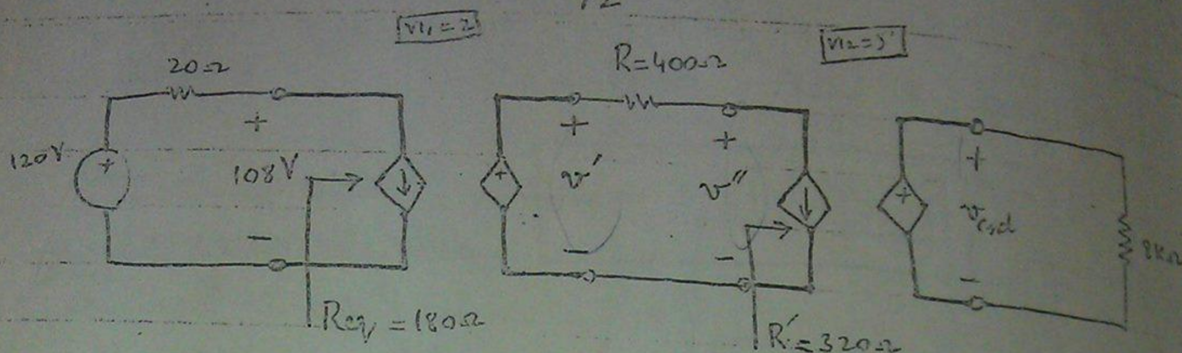
$R'' = R' + R = 320 + 400 = 720\ \Omega$ $\boxed{R'' = 720\ \Omega}$

$R_{eq} = \frac{R''}{(n_1)^2} = \frac{720}{4} = 180\ \Omega$ $\boxed{R_{eq} = 180\ \Omega}$

$v_{R_{eq}} = \frac{180}{20+180} \times 120 = 108\ V$ $\boxed{v_{R_{eq}} = 108\ V}$

For Reff fig (a)

initial 351



$$v' = (n_1)(108) = 2(108) = 216\text{V}$$ $\boxed{v' = 216\text{V}}$

$$v'' = \frac{R'}{R+R'}\,v' = \frac{320}{400+320} \times 216 = 96\text{V}$$ $\boxed{v'' = 96\text{V}}$

$$v_{end} = (n_2)(v'') = 5(96) = 480\text{ V}$$ $\boxed{v_{end} = 480\text{V}}$

$$v_{8k\Omega} = v_{end} = 480\text{ V}$$

$$P_{8k\Omega} = \frac{(v_{8k\Omega})^2}{R_{8k\Omega}} = \frac{(480)^2}{8K} = 28.8\text{ mW}$$

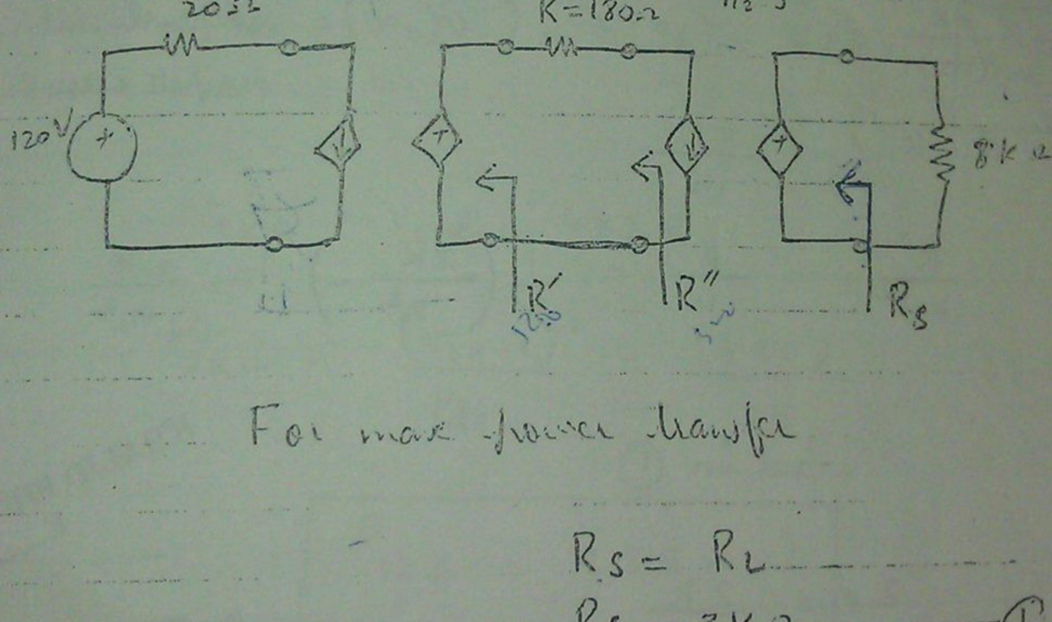
$$\boxed{P_{8k\Omega} = 28.8\text{ mW}}$$

$\cancel{n_2 = 5}$

$\cancel{R' = \frac{8K}{(n_2)^2} = \frac{8K}{25} = 320}$

$\cancel{R'' = R' + R = 20 + 180 =}$

(b)



For max power transfer

$$R_S = R_L$$

$$R_S = 8K\Omega \quad \text{—— (1)}$$

$$R' = (n_1)^2\, 20$$

$$R'' = R + R' = 180 + 20n_1^2$$

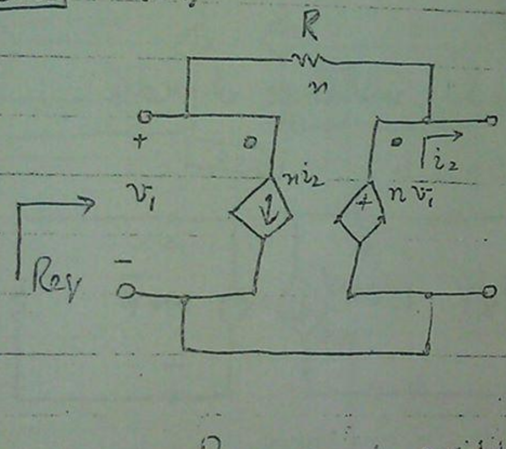
$$R_S = (n_2)^2 R'' = (25)(180 + 20n_1^2)$$

Note:-

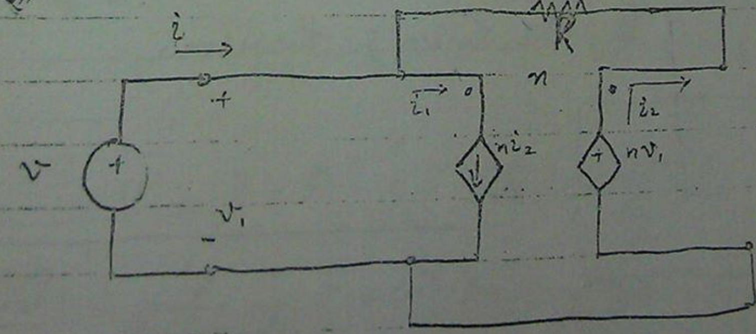
The answer of part(b) is wrong in the book as some power is also dessipated by $R = 180\,\Omega$. but we want to transfer maximum p. to $8\,k\Omega$.

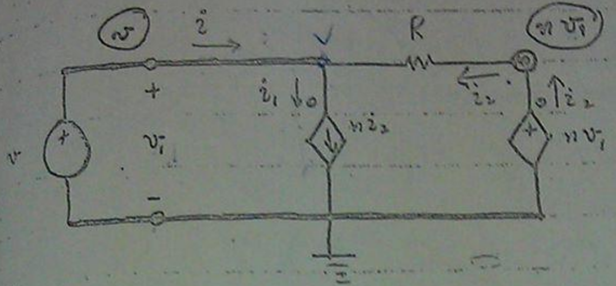
For this first find thevenin equivalent at $8K\Omega$ then find max power transfer to $8K\Omega$.

$\boxed{5.38}$ (a)



By 2nd Method





$nv_1 - 0 = nv_1$

Fig (a)

at v :

$$i = i_1 + \frac{v - nv_1}{R}$$

$$i = ni_2 + \frac{v - nv_1}{R} \quad \text{——— } ①$$

v_1 :

$\boxed{v_1 = v}$ ② put in ①

$$i = ni_2 + \frac{v - nv}{R}$$

$$i = ni_2 + \frac{1-n}{R}\, v \quad \text{——— } ③$$

i_2 :

$$i_2 = \frac{nv_1 - v}{R}$$

from ②

$$i_2 = \frac{nv - v}{R} = \frac{n-1}{R}\, v$$

$$\boxed{i_2 = \frac{n-1}{R}\, v} \quad \text{——— } ④$$

put in ③

$$i = n\left(\frac{n-1}{R}v\right) + \left(\frac{1-n}{R}v\right)$$

$$= \frac{v}{R}\left[n(n-1) + (1-n)\right]$$

$$= \frac{v}{R}\left(n^2 - n + 1 - n\right)$$

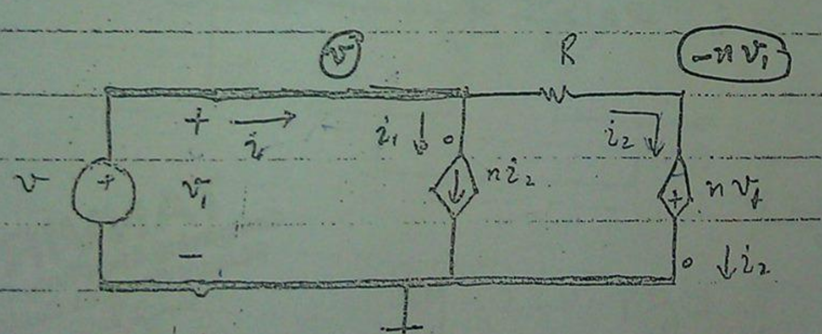
$$i = \frac{v}{R}\left(n^2 - 2n + 1\right)$$

$$\frac{v}{i} = \frac{R}{(n^2 - 2n + 1)}$$

$$\boxed{R_{eq} = \frac{R}{(n-1)^2}}$$

(b)

from fig (a)



$-nV_1 + 0 = 0$

v_1 : $\boxed{v_1 = v}$ —— ①

at v:

$$i = n i_2 + \frac{v - (-n v_1)}{R}$$

from ①

$$i = n i_2 + \left(\frac{1+n}{R}\right) v \quad \text{--- (2)}$$

i_2:

$$i_2 = \frac{v - (-n v_1)}{R}$$

$$\boxed{i_2 = \frac{v + n v}{R}} \quad \text{(3) from (1) } v_1 = v$$

~~at v.~~

$$\cancel{i = i_1 = \frac{v - (-nv)}{R} = \frac{v + nv}{R}}$$

$$\cancel{i = n i_2 = \frac{v + nv}{R}}$$

from (3) put in (2)

$$i = n\left(\frac{v + nv}{R}\right) + \left(\frac{(1+n)\,v}{R}\right)$$

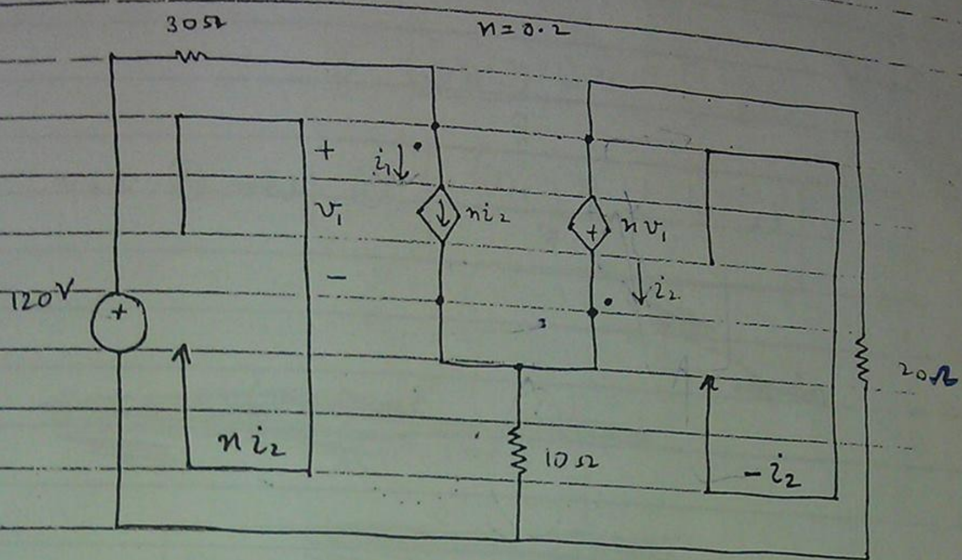
$$= \frac{v}{R}\left(n(1+n) + (1+n)\right)$$

$$i = \frac{v}{R}\left(n^2 + 2n + 1\right)$$

$$\frac{v}{i} = \frac{R}{(n+1)^2}$$

$$\boxed{R_{eq} = R}$$

$\boxed{5.39}$ $P_{10\Omega} = ?$



loop I :

$$120 = 30\,n i_2 + v_1 + 10(n i_2 + i_2)$$

$$120 = 30 n i_2 + v_1 + 10(n+1)\, i_2$$

put $n = 0.2$ (given)

$$120 = 6 i_2 + v_1 + 12 i_2$$

$$120 = 18 i_2 + v_1$$

$$v_1 + 18 i_2 = 120 \quad \text{——} \quad (1)$$

loop II :

$$n v_1 + 20(-i_2) + 10(-i_2 - n i_2) = 0$$

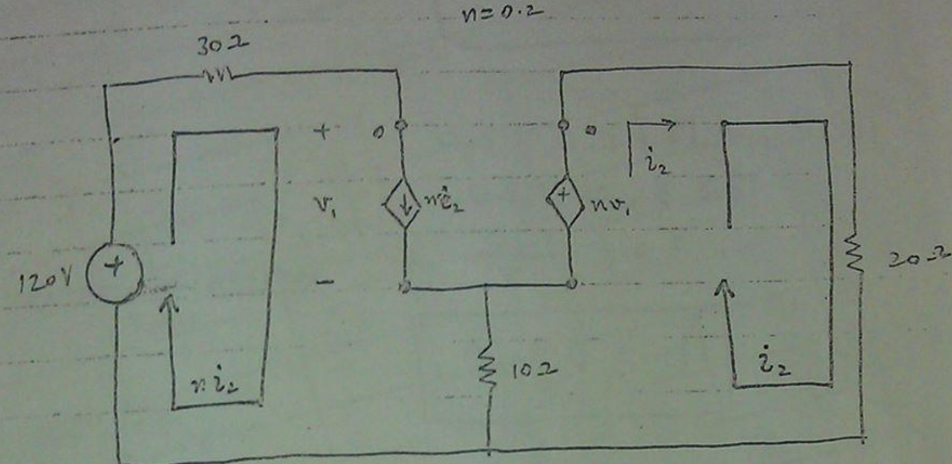
$$n v_1 - 20 i_2 - 10 i_2 (1+n) = 0$$

put $n = 0.2$

$$0.2 v_1 - 20 i_2 - 12 i_2 = 0$$

5.4

$n = 0.2$



loop I:

$$120 = 30ni_2 + v_1 + 10(ni_2 - i_2)$$

$$120 = 6i_2 + v_1 - 8i_2$$

$$120 = v_1 - 2i_2$$

$$v_1 - 2i_2 = 120 \quad \text{———} \quad (1)$$

loop II:

$$nv_1 = 20i_2 + 10(i_2 - ni_2)$$

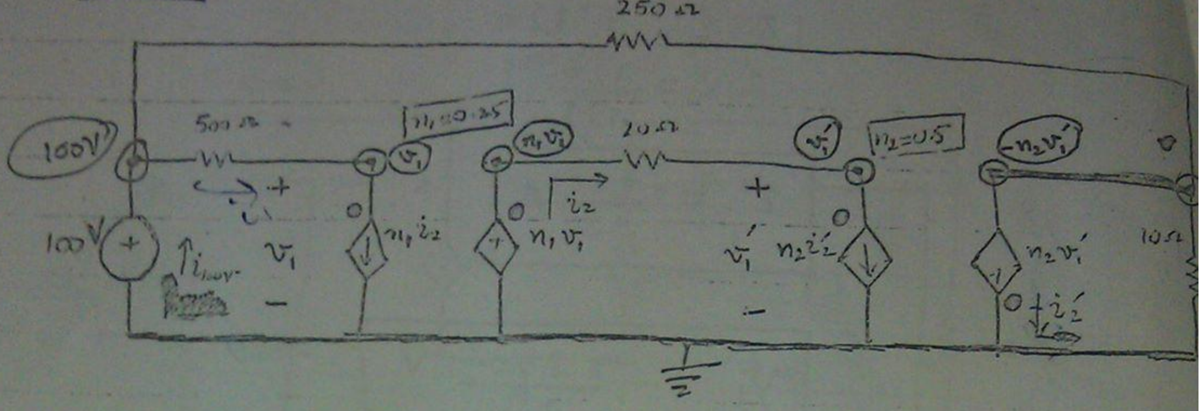
$$0.2v_1 = 20i_2 + 8i_2$$

$$0.2v_1 = 28i_2$$

$$v_1 = \frac{28i_2}{0.2}$$

$$\boxed{v_1 = 140i_2} \quad \text{———} \quad (2)$$

5.41



at v_1:

$$\frac{v_1 - 100}{500} + n_1 i_2 = 0$$

$$v_1 - 100 + (500)(0.25)\, i_2 = 0$$

$$v_1 + 125 i_2 = 100 \quad \text{——— } (1)$$

at v_1':

$$\frac{v_1' - n_1 v_1}{20} + n_2 i_2' = 0$$

$$v_1' - n_1 v_1 + 20\, n_2 i_2' = 0$$

$$v_1' - 0.25 v_1 + 10 i_2' = 0 \quad \text{——— } (2)$$

at $n_1 v_1$:

$$i_2 = \frac{n_1 v_1 - v_1'}{20}$$

$$20 i_2 = n_1 v_1 - v_1'$$

$$20 i_2 = 0.25 v_1 - v_1' \quad \text{——— } (3)$$

5

at $-n_2 v_1'$:

$$0 = i_2' + \frac{-n_2 v_1' - 100}{250} + \cancel{\frac{-n_2 v_1' - 0}{10}}$$

$$0 = 250 i_2' - n_2 v_1' - 100 - 25 n_2 v_1'$$

$$0 = 250 i_2' - 0.5 v_1' - 100 - 12.5 v_1'$$

$$250 i_2' - 13 v_1' = 100 \quad (4)$$

100V

$$\cancel{i_2' = \frac{n_2 v_1'}{10} + \frac{n_2 v_1' - 100}{250}}$$

$$250 i_2' = 25 n_2 v_1' + n_2 v_1' - 100$$

$$250 i_2' = 12.5 v_1' + 0.5 v_1' - 100$$

$$250 i_2' = 13 v_1' - 100$$

$$\boxed{v_1 = \frac{50800}{933}\ V \quad v_1' = \frac{5900}{933}\ V \quad i_2 = \frac{340}{933}\ A \quad i_2' = \frac{680}{933}\ A}$$

$$\boxed{n_1 i_2 = \frac{85}{933}\ A \quad n_2 i_2' = \frac{340}{933}\ A}$$

$$\boxed{n_1 v_1 = \frac{12700}{933}\ V \quad n_2 v_1' = \frac{2950}{933}\ V}$$

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$$v_{250\Omega} = (100 + n_2 v_1') = \frac{96250}{933}\ V \qquad (100 - (-n_2 v_1'))$$

$$v_{500\Omega} = (100 - v_1) = \frac{42500}{933}\ V$$

$$v_{20\Omega} = (n_1 v_1 - v_1') = \frac{6800}{933}\ V$$

$$v_{10\Omega} = 0 - (-n_2 v_1') = \frac{2950}{933}\ V$$

Power

$P_{250\Omega} = 42.57\ W$

$P_{500\Omega} = 4.15\ W$

$P_{20\Omega} = 2.66\ W$

$P_{10\Omega} = 1\ W$

~~source - for this we will find ... we want to find power absorbed by ...~~

~~$P = (100)\left(\frac{85}{933}\right) = 9.11\ W$~~

For P_{100V} find $i_{100V} = ?$

at $\frac{1}{=}$:

$$i_{100V} + i_2 + i_{10\Omega} = n_1 i_2 + n_2 i_2' + i_2'$$

$$i_{100V} = n_1 i_2 + n_2 i_2' + i_2' - i_2 - i_{10\Omega}$$

$$= \frac{85}{933} + \frac{340}{933} + \frac{680}{933} - \frac{340}{933} - \frac{0-(-n_1 v_1')}{10}$$

$$= \frac{85 + 340 + 680 - 340}{933} - \frac{295}{933}$$

$$= \frac{85 + 340 + 680 - 340 - 295}{933}$$

$$\boxed{i_{100V} = \frac{470}{933}\ A}$$

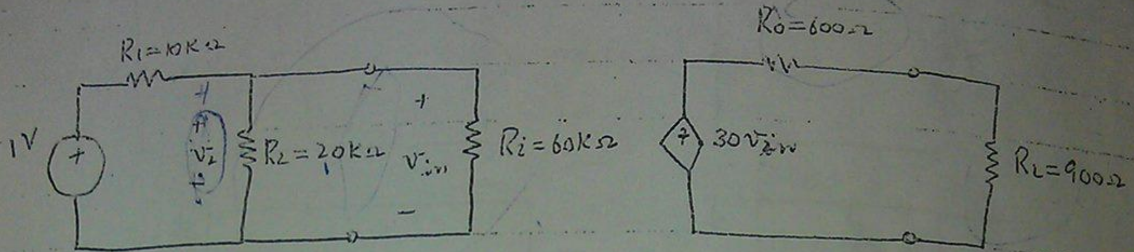
$$P_{100V} = 100 \times \frac{470}{933} = 50.375\ W$$

$$\boxed{P_{100V} = 50.375\ W}$$

* Power is conserved

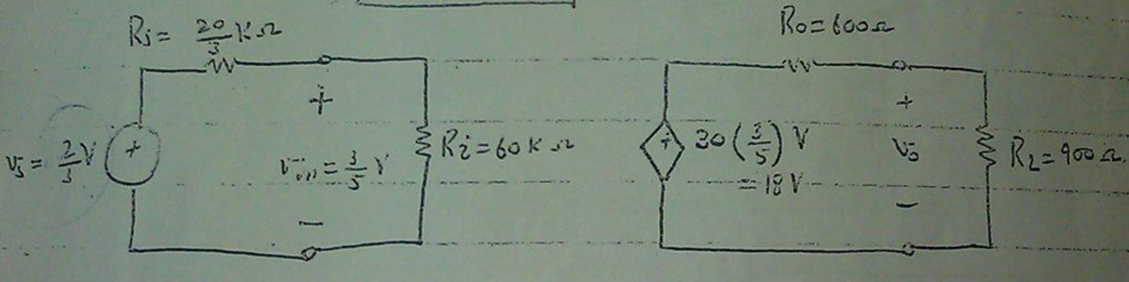
5.4 Amplifiers

5.42



$$v_2 = \frac{R_2}{R_1+R_2}\times(1) = \frac{20}{10+20}\times(1) = \frac{2}{3}V$$

$$\boxed{v_2 = \frac{2}{3}V}$$

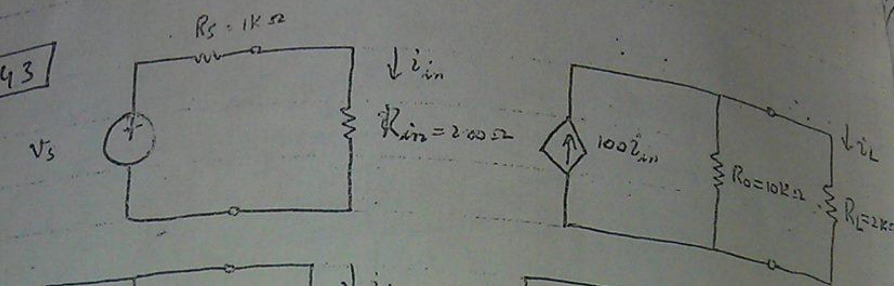


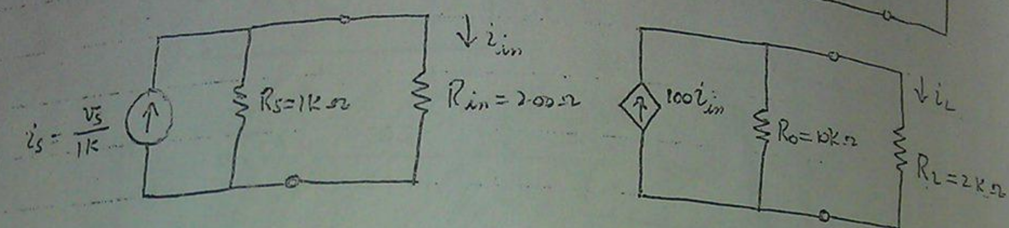
$$v_o = v_L = \frac{900}{600+900}\times 18V = 10.8V$$

$$\boxed{v_L = 10.8V}$$

It can be varify by gain formula also

5.43





we want to find

$$\frac{v_L}{v_S} = ?$$

$$\frac{v_L}{v_S} = \frac{i_L R_L}{i_S R_S} = \frac{i_L}{i_S} \times \frac{2K}{1K}$$

$$\boxed{\frac{v_L}{v_S} = 2\,\frac{i_L}{i_S}} \quad \text{--- } (1)$$

Now apply the formula for current amplifier.

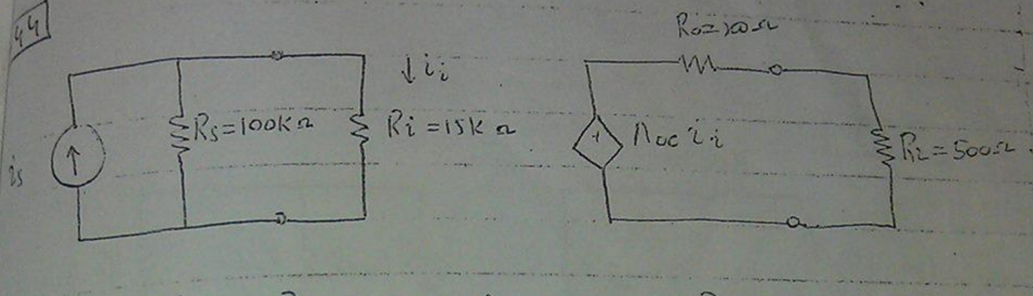
$$\frac{i_L}{i_S} = \frac{R_S}{R_{in} + R_S}\, A_{sc}\, \frac{R_o}{R_o + R_L}$$

$$= \frac{1K}{200 + 1K}\,(100)\,\frac{10K}{10K + 2K}$$

$$\frac{i_L}{i_S} = \frac{625}{9} \quad \text{put in } (1)$$

$$\boxed{\frac{v_L}{v_S} = \frac{1250}{9}}$$

44 5



$$\frac{v_L}{i_s} = \frac{R_s}{R_s + R_i} \; A_{oc} \; \frac{R_L}{R_L + R_o} \quad \text{———} \; (1)$$

(a)

$$\frac{v_L}{i_s} = \frac{100K}{100K + 15K} (1000) \frac{500}{500 + 100}$$

$$= \frac{100}{115} (1000) \frac{500}{600}$$

$$\boxed{\frac{v_L}{i_s} = \frac{500000}{69} \frac{V}{A}}$$

(b)

$$\frac{v_L}{i_s} = 1000 \frac{V}{A} \quad \text{put in (1)} \quad A_{oc} = ?$$

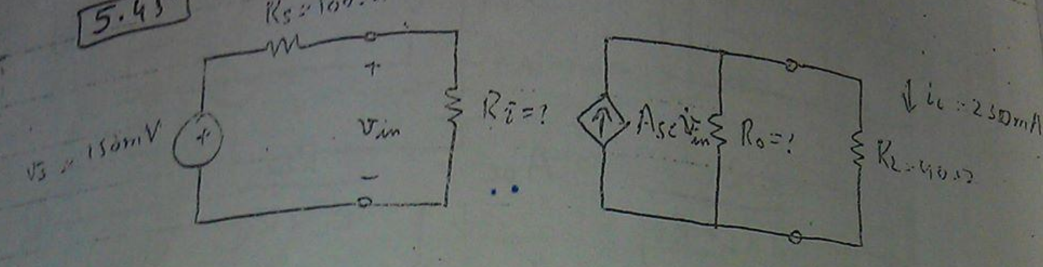
$$1000 = \frac{100k}{100K + 15K} A_{oc} \frac{500}{500 + 100}$$

$$1000 \times \frac{115}{100} \times \frac{600}{500} = A_{oc}$$

$$1380 = A_{oc}$$

$$\boxed{A_{oc} = 1380 \frac{V}{A}}$$

5.45



* If $R_L = 60\,\Omega$, $i_L = 220\,mA$

Find R_i , A_{sc} , R_o

We know that

$$\frac{i_L}{v_s} = \frac{R_i}{R_i + R_s} A_{sc} \frac{R_o}{R_o + R_L} \quad \text{—— (1)}$$

Case I :

$v_s = 150\,mV$, $i_L = 230\,mA$

$R_L = 40\,\Omega$, $R_s = 100\,\Omega$

$$\frac{23\cancel{0}\,\cancel{m}A}{15\cancel{0}\,\cancel{m}V} = \frac{R_i}{R_i + 100} A_{sc} \frac{R_o}{R_o + 40}$$

$$23\,(R_i + 100)(R_o + 40) = 15\,R_i R_o A_{sc} \quad \text{—— (2)}$$

Case II :

$v_s = 150\,mV$, $i_L = 220\,mA$

$R_L = 60\,\Omega$, $R_s = 100\,\Omega$

$$\frac{22\cancel{0}\,\cancel{m}A}{15\cancel{0}\,\cancel{m}V} = \frac{R_i}{R_i + 100} A_{sc} \frac{R_o}{R_o + 60}$$

$$22\,(R_i + 100)(R_o + 60) = R_i R_o A_{sc}\, 15 \quad \text{—— (3)}$$

eq^n III: $v_{in} = \frac{R_i}{R_i + R_s} 150\ mV$ ⑤

$v_{in} = \frac{R_i}{R_i + 100} 150\ mV$

$v_3 = 1!$

~~$A_{sc}\, v_{in} = \left(A_{sc} \frac{R_i}{R_i+100} 150\ mV\right)$~~

~~$\frac{R_o}{R_o+R_L}\left(A_{sc}\, v_{in}\right)$~~

$v_{in} = 125\ mV$ (given) put in above

$\cancel{125\ mV}^{5} = \frac{R_i}{R_i+100}\ \cancel{150\ mV}^{6}$

$5(R_i + 100) = 6R_i$

$5R_i + 500 = 6R_i$

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$500 = R_i$

$\boxed{R_i = 500\ \Omega}$ —— ④

Solving ②, ③ & ④

put $R_i = 500$ in ④

$23(600)(R_o + 40) = 7500\, R_o A_{sc}$

$13800\, R_o + 552000 = 7500\, R_o A_{sc}$

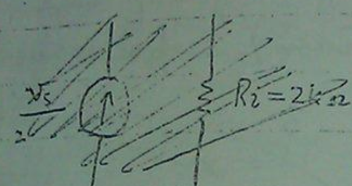
$138\, R_o + 5520 = 75\, A_{sc} R_o$ —— ⑤

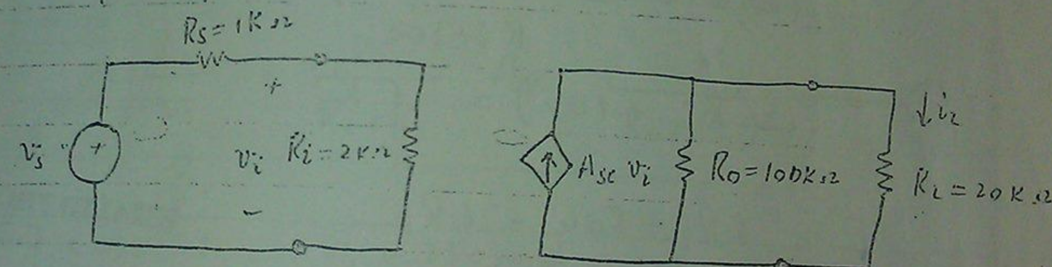
$22(600)(R_o + 60) = 7500\, R_o A_{sc}$

Solving (5) & (6)

$$\boxed{\begin{aligned} R_o &= 400\ \Omega \\ R_i &= 500\ \Omega \\ A_{sc} &= \frac{253}{125}\ \frac{A}{V} \end{aligned}}$$

5.46





$\therefore A_{sc} = 9m\ \frac{A}{V}$

We wana find $\frac{v_L}{v_s} = ?$

$$\frac{v_L}{v_s} = \frac{i_L R_L}{v_s} = R_L \frac{i_L}{v_s} \quad \text{——— (1)}$$

Now apply the formula

$$\frac{i_L}{v_s} = \frac{R_i}{R_i + R_s} \cdot A_{sc} \frac{R_o}{R_o + R_L}$$

putting the values

$$\frac{i_L}{v_s} = \frac{2\cancel{K}}{(2+1)\cancel{K}} \quad 9 \ldots \quad \frac{100\cancel{K}}{(100+20)\cancel{K}}$$

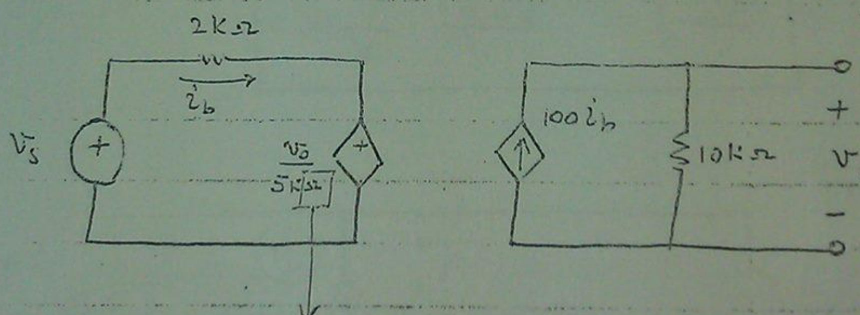
$$= \frac{2}{\cancel{3}} \; \overset{3}{\cancel{9}}m \; \frac{\overset{5}{\cancel{100}}}{\underset{6\,2}{\cancel{120}}}$$

$$\frac{i_L}{v_s} = 5m \quad \text{put in } (1)$$

$$\frac{v_L}{v_s} = (20\,K\Omega)\;(5m)$$

$$\boxed{\frac{v_L}{v_s} = 100\ \frac{V}{V}}$$

5.47



Corrected as: $\frac{v_o}{5K}$

In part 1 consider the loop containing i_b

$$v_s = 2K\Omega\, i_b + \frac{v_o}{5K} \quad \text{———} \quad (1)$$

In part 2:

$$v_o = (100 i_b)\,(10\,K\Omega) = 1000K\, i_b \quad \text{——} \quad (2)$$

from ②

$$i_b = \frac{v_o}{1000\,k\Omega} \quad \text{put in ①}$$

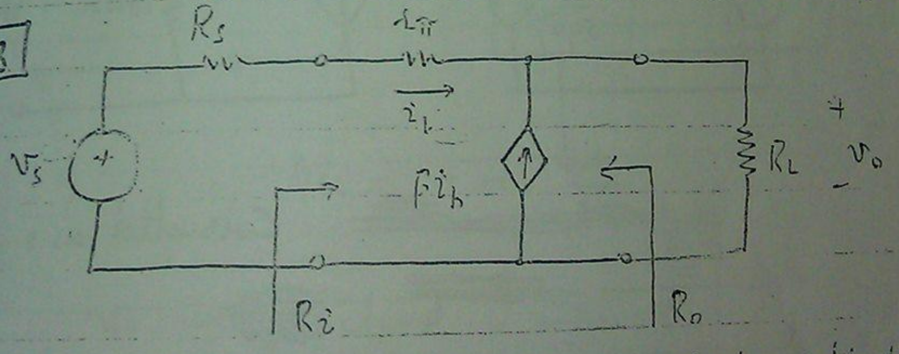
$$v_s = \cancel{1K}\,\frac{v_o}{\cancel{1000K}\,500} + \frac{v_o}{5K}$$

$$= v_o\left(\frac{1}{500} + \frac{1}{5000}\right)$$

$$v_s = v_o\left(\frac{11}{5000}\right)$$

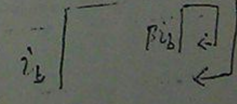
$$\boxed{\frac{v_o}{v_s} = \frac{5000}{11}\,\frac{V}{V}}$$

$\boxed{5.48}$



For $\frac{v_o}{v_s} = ?$

By loop Method



$$v_o = R_L\left(i_b + \beta i_b\right)$$

$$i_1 = \frac{v_o}{R_L(\beta+1)} \quad \text{——— ①}$$

$$v_s = i_b R_s + i_b r_\pi + v_o$$

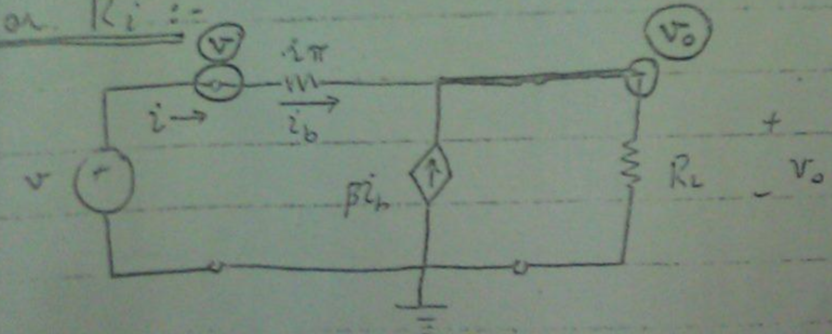
$$= \frac{v_o}{R_L(\beta+1)} R_s + \frac{v_o}{R_L(\beta+1)} r_\pi + v_o$$

$$= v_o \left[\frac{R_s}{R_L(\beta+1)} + \frac{r_\pi}{R_L(\beta+1)} + 1 \right]$$

$$v_s = v_o \left[\frac{R_s + r_\pi + R_L + \beta R_L}{R_L(\beta+1)} \right]$$

$$\boxed{\frac{v_o}{v_s} = \frac{R_L(\beta+1)}{R_s + R_L + r_\pi + R_L \beta}}$$

<u>For R_i :-</u>



$\therefore$ as we can see $i = i_b$ —— (a)

so

at v:

$$i = i_b = \frac{v - v_o}{r_\pi}$$

$\boxed{i_b = v - v_o}$ —— (1)

at v_o :

$$i_b + \beta i_b = \frac{v_o - 0}{R_L}$$

$$\boxed{v_o = R_L \left(i_b + \beta i_b \right)} \quad \text{—— (2)}$$

from (2) put in (1).

$$i_b = \frac{v - R_L \left(i_b + \beta i_b \right)}{r_\pi}$$

$$i_b = \frac{v}{r_\pi} - \frac{R_L \, i_b \, (1+\beta)}{r_\pi}$$

$$\frac{v}{r_\pi} = i_b + i_b \left(\frac{R_L (1+\beta)}{r_\pi} \right)$$

$$= i_b \left(1 + \frac{R_L (1+\beta)}{r_\pi} \right)$$

$$\frac{v}{\cancel{r_\pi}} = i_b \; \frac{r_\pi + R_L (1+\beta)}{\cancel{r_\pi}}$$

$$\frac{v}{i_b} = r_\pi + R_L (1+\beta)$$

$$\because \; i_b = i$$

$$R_i = \frac{v}{i} = r_\pi + R_L (1+\beta)$$