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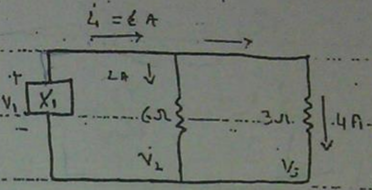
Chapter no. 2

Resistive Circuits

2.1 Resistance:



2.1 Solution:

a)

$$V_3 = 3 \times 4 = 12\,V$$

$$R_{eq} = \frac{1}{6} + \frac{1}{3} = \frac{3\times 6}{3+6} = \frac{18}{9} = 2\,\Omega$$

As $3\,\Omega$ and $6\,\Omega$ are in parallel, so

$$V_3 = V_2 = V_1 = 12\,V$$

So

$$\boxed{V_1 = 12\,V}$$

$$V_1 = i\,R_{eq}$$

$$i = \frac{V_1}{R_{eq}} = \frac{12}{2} = 6A$$

$$\boxed{i_1 = 6\,A}$$

By KCL

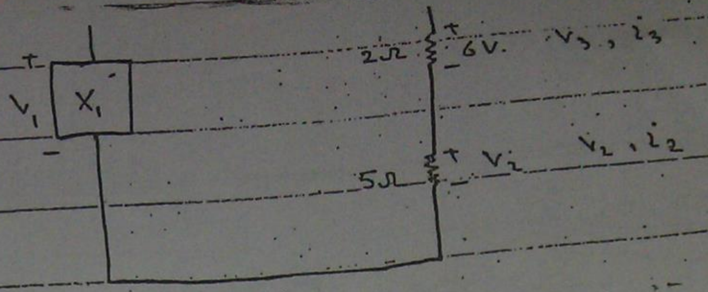
$$\boxed{i_2 = 2A \downarrow}$$

b)

Power released = 12 × 6 = 72 watt

Power absorbed = 12×4 + 12×2 = 48 + 24 = 72 watt

Hence law of power conservation proved.



$V_3 = 6V$

$R_3 = 2\Omega$

$i_3 = \frac{V_3}{R_3} = \frac{6}{2} = 3A.$

As in series

$i_1 = i_3 = i_2$

$\boxed{i_2 = 3A}$ $\boxed{i_1 = 3A}$

$R_{eq} = 2 + 5 = 7\Omega$

$V_1 = i_1 R_{eq} = 3 \times 7 = 21V$

By KVL

$V_1 - V_2 - V_3 = 0$

$21 - V_2 - 6 = 0$

$\boxed{V_2 = 15 V}$ ✓

Power released $= 21 \times 3 = 63 W$

Power absorbed $= 6 \times 3 + 15 \times 3 = 63 W$

$\Rightarrow$ Power released = Power absorbed

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2.3

a) Given:

$p_1 = 10\,W$, $p_2 = 1\,W$, $p_3 = 1/8\,W$

$R = 1 \times 10^3\,\Omega$

Solution:

We know

$$p = vi = i^2 R = \frac{V^2}{R}$$

So,

$p_1 = i_1^2 R$; $p_1 = \frac{V^2}{R}$

$\Rightarrow i^2 = \frac{p_1}{R}$

$i = \sqrt{\frac{p_1}{R}}$; $p_1 R = V^2$

$V = \sqrt{p_1 R} = \sqrt{10 \times 10^3}$

$i = \sqrt{\frac{10}{1000}} = \sqrt{\frac{1}{100}}$; $V = \sqrt{10000}$

$\boxed{i_1 = \frac{1}{\sqrt{10}}\ Amp} \boxed{= 0.1\ Amp}$; $\boxed{V_1 = 100\,V}$

Similarly

$p_2 = i_2^2 R$; $p_2 = \frac{V_2^2}{R}$

$i_2 = \sqrt{\frac{p_2}{R}}$; $V_2^2 = \sqrt{p_2 R}$

$V_2 = \sqrt{1 \times 10^3}$

$\boxed{i_2 = \frac{1}{\sqrt{1000}}\ Amp} \boxed{= 31.6\ mA}$; $\boxed{V_2 = \sqrt{1000}\ V} \boxed{= 31.6}$

Also

$p_3 = i_3^2 R$; $p_3 = \frac{V_3^2}{R}$

2.2 $i_3 = \sqrt{\frac{P_3}{R}}$; $V_3 = \sqrt{P_3 R}$

$\boxed{i_3 = \sqrt{1/8 \times 10^{-3}}\ Amp \ \Big|\ = 11.2\,mA}$; $\boxed{V_3 = \sqrt{1/8 \times 10^{3}}\ V \ \Big|\ = 11.2\,V}$

b) $R = 10\,\Omega$

As $i = \sqrt{\frac{P}{R}}$; $V = \sqrt{PR}$

$i_1 = \sqrt{\frac{10}{10}} = \sqrt{1}$

$\boxed{i_1 = 1\ Amp}$

$V_1 = \sqrt{10 \times 10} = 10\,V$

$\boxed{V_1 = 10\,V}$

$i_2 = \sqrt{\frac{1}{10}}$

$\boxed{i_2 = \frac{1}{\sqrt{10}}\ Amp \ \Big|\ 0.316\,A}$

$V_2 = \sqrt{1 \times 10} = \sqrt{10} = 3.16\,V$

$\boxed{V_2 = \sqrt{10}\ V \ \Big|\ = 3.16\,V}$

$i_3 = \sqrt{\frac{1/8}{10}}$

$\boxed{i_3 = \sqrt{1/8 \times 10^{1}}\ Amp \ \Big|\ = 11.2\,mA}$

$V_3 = \sqrt{1/8 \times 10}$

$\boxed{V_3 = \sqrt{10/8}\ V \ \Big|\ = 1.12\,V}$

4 Given:

a) $P = 1\,W$, $V = 12\,V$

As

$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{144}{1}$

$\boxed{R = 144\,\Omega}$

b) $P = 1\,W$, $V = 220\,V$

$R = \frac{V^2}{P} = \frac{(220)^2}{1} = 48400$

$\boxed{R = 48400\,\Omega}$

c) $R = 2 \times 10^{3}\,\Omega$, $I = 10 \times 10^{-3}\,A$

$P_{max} = ?$ $V = ?$

$P = I^2 R$ V

$P = 100 \times 10^{-6} \times 2 \times 10^{3}$

$P = 200 \times 10^{-3}$

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$$\boxed{P = 200\,mW}$$

$P = \frac{V^2}{R} \Rightarrow V = \sqrt{PR}$

$V = \sqrt{200 \times 10^{-3} \times 2 \times 10^{3}}$

$V = \sqrt{400}$

$$\boxed{V = 20\,V}$$

2.5

a) $l = 1m$, $d = 1 \times 10^{-3} m$, $r = 0.5 \times 10^{-3}\,m$

$\rho = 2.8 \times 10^{-6}\,\Omega\text{-cm}$

$\rho = 2.8 \times 10^{-8}\,m$

Solution:

$R = \rho \frac{l}{A}$

$R = \frac{2.8 \times 10^{-8} \times 1}{3.14 \times 25 \times 10^{-8}}$ πr^2

$R = 35.65 \times 10^{-3}\,\Omega$ $2.275\,\Omega$

$$\boxed{R = 35.65\,m\Omega}$$

$$\rho = \frac{10\times5\times10^{-12}}{1\times10^{-3}}$$

$$\rho = 50\times10^{-9}\ \Omega\ m$$

$$\boxed{\rho = 50\times10^{-7}\ \Omega\text{-}cm}$$

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2.7

$l = 10\,mm = 1\,cm$ (of cylinder)

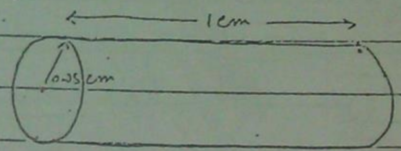
$d = 1\,mm = 0.1\,cm$ (of cylinder)

$r = 0.05\,cm$

$\rho = 3\times10^{-3}\ \Omega\text{-}cm$ (of material to be coated)

~~required~~ $R = 100\ \Omega$ (required resistance)

* Film thickness = ?



~~volume of cylinder =~~

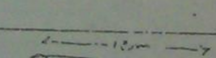
⇒ Surface Area of cylinder $= 2\pi r l$

$S = 0.31415\ cm^2$ cylinder

⇒ We know that

$R = \rho\frac{l}{A}$ (of applied material)

$100 = 3\times10^{-3} \times \frac{1}{A}$



$A = 0.03\times10^{-3}\ cm^2$

$$\boxed{A = 0.03\times10^{-3}\ cm^2}$$

∴ This is the cross sectional area of the material wire which is to be coated on the given cylinder

* volume of applied material $= V = A\times l$

$V = 0.03\times10^{-3}\times1 = 0.03\times10^{-3}\ cm^3$

⇒ Now we want to apply this volume V (of applied material)

b) on the surface of the cylinder. So for this that we can find the thickness of the film.

For this

c $\Rightarrow$ thickness of film $= \dfrac{\text{Volume of applied material}}{\text{surface area of cylinder}}$

$$= \frac{V}{S} = \frac{0.03 \times 10^{-3}\ \cancel{cm^3}}{0.31415\ \cancel{cm^2}}$$

$$= 0.09549 \times 10^{-3}\ cm$$

$$= 0.0955 \times 10^{-5}\ m$$

$$= 0.955 \times 10^{-6}\ m$$

$$\boxed{\text{Thickness of film} = 0.955\ \mu m}$$

$\boxed{2.8}$

2 (a) $R_1 = 5\,\Omega$, $R_2 = ?$, $R_3 = 20\,\Omega$, when $R_{eq} = 3\,\Omega$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$R_{eq} = \frac{R_1 \cdot R_2 \cdot R_3}{R_2R_3 + R_1R_3 + R_1R_2} = \frac{5 \times 20 \times R_2}{20R_2 + 100 + 5R_2} \quad (1)$$

$$3 = \frac{100\,R_2}{100 + 25R_2} \Rightarrow 300 + 75R_2 = 100R_2$$

$$R_2 = \frac{300}{25} = 12\,\Omega \qquad \boxed{R_2 = 12\,\Omega}$$

(b) when $R_{eq} = 2\,\Omega$ put in (1) we get

$$2 = \frac{5 \times 20 \times R_2}{20R_2 + 100 + 5R_2}$$

$$100R_2 - 50R_2 = 200$$

$$R_2 = \frac{200}{50} = 4\,\Omega \qquad \boxed{R_2 = 4\,\Omega}$$

2.9 $R_1 = 5\,k\Omega \pm 5\%$

a) $R_2 = 20\,k\Omega \pm 10\%$

$R_{1T} = 5\% = \frac{5 \times 5}{100} = 0.25\,k\Omega$ ($\because R_{1T} = R_1$ tolerance)

$R_{2T} = 10\% = 20 \times \frac{10}{100} = 2\,k\Omega$

In series

$R_s = R_1 + R_2 = 5 + 20 = 25\,k\Omega$

$x = R_{1T} + R_{2T} = 0.25 + 2 = 2.25\,k\Omega$

$x\% = \frac{2.25}{25} \times 100 = 9\%$

$x\% = 9\%$

Hence

$R_{eq} = R_s \pm x\%$

$\boxed{R_{eq} = 25\,k\Omega \pm 9\%}$

b) In parallel:

$\frac{R_1 R_2}{R_1 + R_2}$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{R_2 + R_1}{R_1 R_2} = \frac{25}{100}$

$\frac{250 \times 2000}{2250}$

$= 222.2\,\Omega$

$R_p = \frac{100}{25} = 4\,k\Omega$

and

$y = \frac{R_{1T} R_{2T}}{R_{1T} + R_{2T}} = \frac{0.25 \times 2}{2.25} = 0.222$

$y\% = \frac{0.22}{4} \times 100 = 5.5\%$

So,

$R_{eq} = R_p \pm y\% = 4\,k\Omega \pm 5.5\%$

$\boxed{R_{eq} = 4\,k\Omega \pm 5.5\%}$

2.10

a) $R_1 = mR$, $R_2 = \frac{R_1}{m-1}$ $m>1$

By connecting them in parallel

$$R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2}$$

$(\because R_1 = mR)$

$$'' = \frac{mR \cdot \frac{mR}{m-1}}{mR + \frac{Rm}{m-1}} = \frac{\frac{mR^2}{(m-1)}}{\frac{m^2R - mR + mR}{(m-1)}}$$

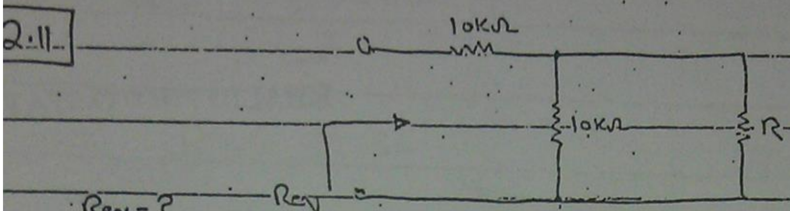
$$'' = \frac{m^2R^2}{R(m^2 - m + m)}$$

$$R_1 \parallel R_2 = R$$

Hence proved.

b)

2.11



Req = ?

a) when $R = 30k\Omega$

$$R_{eq} = 10 + \left[\frac{10 \times 30}{10+30}\right]$$

$$R_{eq} = 10 + 7.5$$

$$\boxed{R_{eq} = 17.5\ k\Omega}$$

b) R = ? when $R_{eq} = 18\ k\Omega$

$$R_{eq} = 10 + \left[\frac{10 \times R}{10+R}\right]$$

$$18 = 10 + \left[\frac{10R}{10+R}\right]$$

$$8(10+R) = 10R$$

$$80 + 8R = 10R$$

$$2R = 80$$

$$\boxed{R = 40\ k\Omega}$$

c) R = ? when $R_{eq} = R$.

$$R_{eq} = 10 + \left[\frac{10R}{10+R}\right]$$

$$(R - 10) = \frac{10R}{10+R}$$

$$(R-10)(R+10) = 10R$$

$$R^2 - 100 = 10R$$

$$R^2 - 10R - 100 = 0 \implies a = 1,\ b = -10,\ c = -100$$

$$R = \frac{10 \pm \sqrt{100 + 400}}{2}$$

$$R = \frac{10 \pm \sqrt{500}}{2}$$

$$R = \left(\frac{1.23}{2}\right) R_1$$

$$R = 0.615\, R_1 \quad \text{---(i)}$$

b) when $R_1 = 10\,k\Omega$

Find $R = ?$

putting in Eq. (i)

$$R = 0.615 \times 10$$

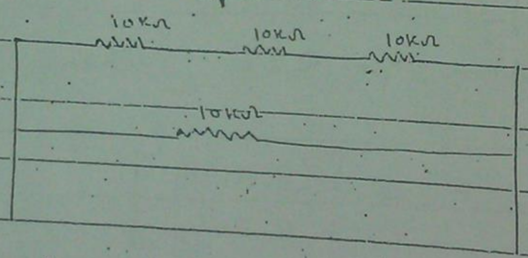
$$R = 6.15\,k\Omega$$

$\boxed{2.13}$ $R = 10\,k\Omega$

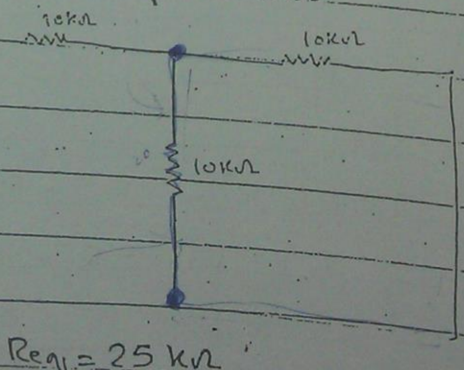
a) when $R_{eq} = 7.5\,k\Omega$

$10+10+10 = 30$

$\frac{30 \times 10}{30+10} = 7$



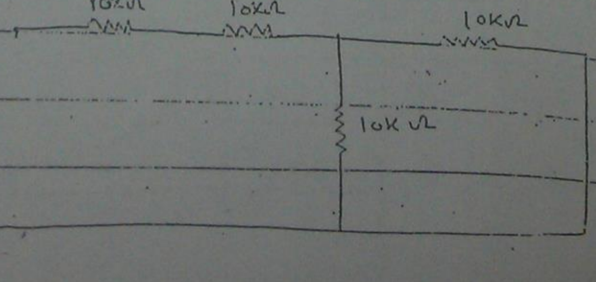
b) when $R_{eq} = 15\,k\Omega$



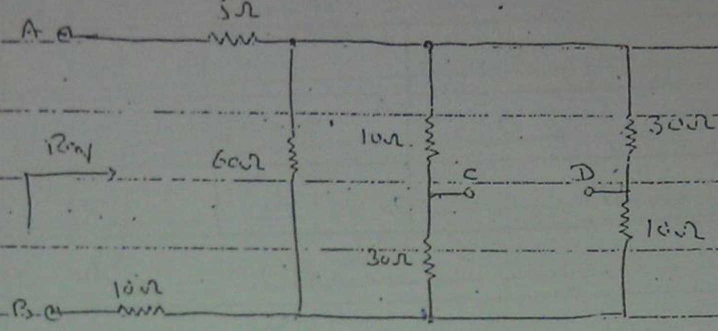
$\frac{10 \times 10}{10+10} = 5$

$10 + 5 = 15$

c) when $R_{eq} = 25\,k\Omega$



2.14



$$R_{eq} = 5 + \left[\frac{1}{60} + \frac{1}{40} + \frac{1}{40}\right]^{-1} + 10$$

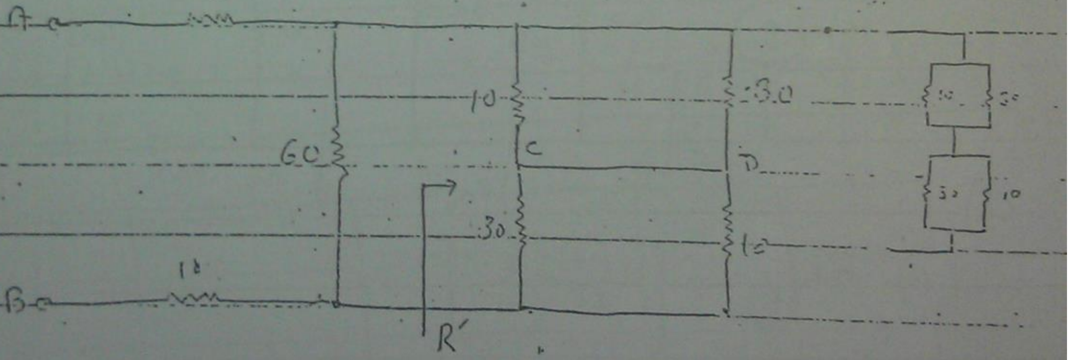
$$R_{eq} = 5 + \left[\frac{2+3+3}{120}\right]^{-1} + 10$$

$$R_{eq} = 5 + 15 + 10$$

$$\boxed{R_{eq} = 30\,\Omega}$$

When C and D short circuited

b)



$$R' = \left[\frac{1}{10} + \frac{1}{30}\right]^{-1} + \left[\frac{1}{30} + \frac{1}{10}\right]^{-1}$$

$$R' = 7.5 + 7.5 = 15$$

P-T-O

$$R_{eq_3} = \left[\frac{1}{20} + \frac{1}{60}\right]^{-1}$$

$$R_{eq_3} = \frac{20 \times 60}{20 + 60} = \frac{1200}{80}$$

$$R_{eq_3} = 15\,\Omega$$

$$\Rightarrow \quad R_{eq} = R_{eq_3} + 10 = 25\,\Omega$$

$$R_{eq} = 10 + 15 = 25\,\Omega$$

b)

$$R_{eq} = 25\,\Omega \quad , \quad V = 15\,V$$

$$P = \frac{V^2}{R} = \frac{225}{25}$$

$$P = 9 \text{ watt}$$

$\boxed{2.16}$ proportionality Analysis $\Rightarrow$ X (Not done)

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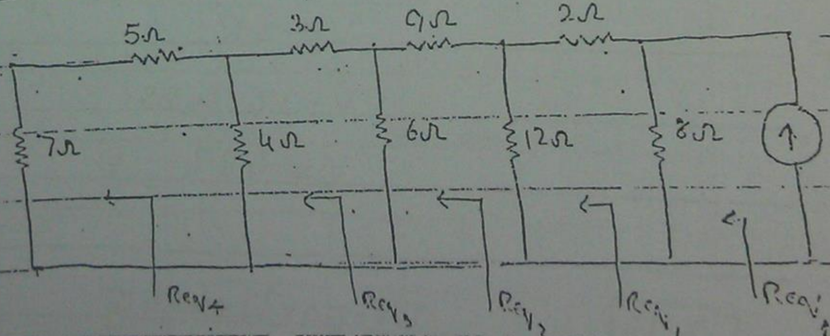
$\boxed{2.17}$



a)

$$R_{eq_1} = \left[\frac{1}{10} + \frac{1}{12}\right]^{-1}$$

$$R_{eq_1} = \frac{10 \times 12}{10 + 12} = \frac{120}{22} = 5.45$$

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الٹا کیا ہوا ہے۔ آپ
لوگ خود حل کر لیے ہو

$$R_{eq_2} = \left[\frac{1}{14.45} + \frac{1}{6}\right]^{-1}$$

$$\Rightarrow R_{eq_2} = \frac{14.45 \times 6}{14.45 + 6} = \frac{86.7}{20.45} = 4.24$$

$$R_{eq_3} = \left[\frac{1}{7.24} + \frac{1}{4}\right]^{-1}$$

$$\Rightarrow R_{eq_3} = \frac{7.24 \times 4}{7.24 + 4} = \frac{28.96}{11.24} = 2.57$$

$$R_{eq} = \left[\frac{1}{7.57} + \frac{1}{7}\right]^{-1}$$

$$R_{eq} = \frac{7.57 \times 7}{7.57 + 7} = \frac{52.99}{12.57} = 4.03\,\Omega$$

$$R_{eq} = 4.03\,\Omega$$

b)

$R_{eq} = 4.03\,\Omega$, $I = 12\ A$

$V = ?$

$$V = IR$$

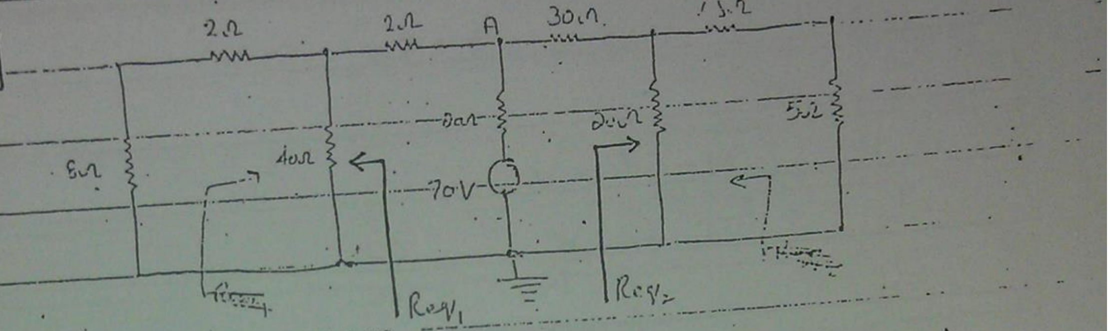
$$V = 12 \times 4.03$$

$$V = 48.4\ V$$

$\boxed{2.18}$ proportionality

X (Not done)

2.19



First we reduce resistances from left of A.

$$R_{eq_1} = \left[\frac{1}{\underset{(8+2)}{10}} + \frac{1}{40}\right]^{-1} + 2$$

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$$R_{eq_1} = \frac{10 \times 40}{10+40} + 2$$

$$R_{eq_1} = 8 + 2 = 10\ \Omega$$

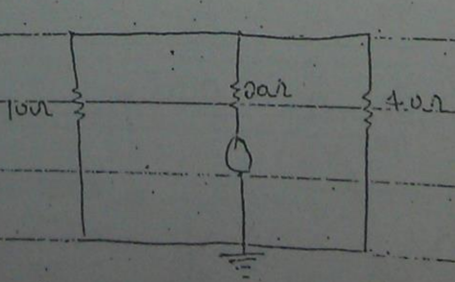
Now we reduce resistances from right of A

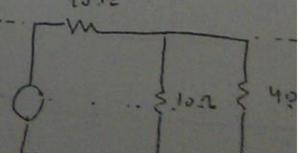
$$R_{eq_2} = \left[\frac{1}{\underset{(5+15)}{20}} + \frac{1}{20}\right]^{-1} + 30$$

$$R_{eq_2} = \frac{20 \times 20}{20+20} + 30$$

$$R_{eq_2} = 10 + 30 = 40\ \Omega$$

Now circuit becomes :-





So,

$$R_{eq} = \left[\frac{1}{\ } + \frac{1}{\ }\right]^{-1} + 20$$

$$R_{eq} = 8 + 20 = 28\,A$$

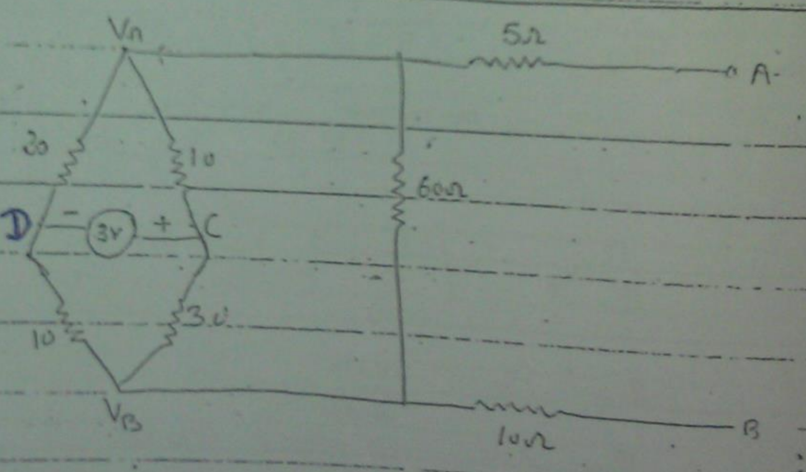
$$V = 70\,V$$

$$I = \frac{V}{R_{eq}} = \frac{70}{28}$$

$$\boxed{I = 2.5\,A}$$

$\boxed{2.20}$
$\boxed{2.21}$ } X (Not done)

$\boxed{2.22}$

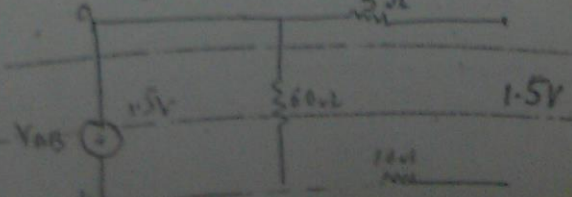


$$V_A = \frac{30}{40} \times 3 = \cancel{0.75\,V} = 2.25\,V$$

$$V_B = \frac{10}{40} \times 3 = \cancel{2.25\,V} = 0.75$$

$$= 2.25 - 0.75 = 1.5$$

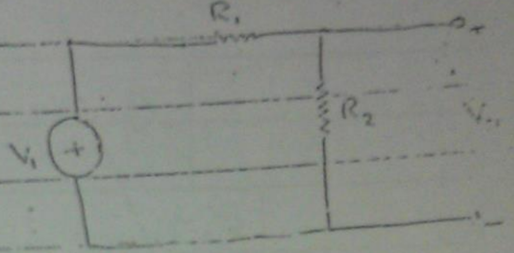
$$V_{AB} = V_A - V_B = \cancel{0.75 - 2.25 \quad -1.5}$$



Voltage and Current Dividers

2.24 $R_1 = 15\,k\Omega$, $R_2 = 3\,k\Omega$

a) $V_0 = ?$ if $V_1 = 12V$



$$V_0 = \frac{3}{15+3} \times 12$$

$$V_0 = \frac{1}{6} \times 12 = 2V$$

b) find $V_1 = ?$ when $V_0 = 1V$

$$V_0 = \frac{R_2}{R_1+R_2} \times V_1$$

$$1 = \frac{3}{18} \times V_1$$

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$$6 = V_1$$

$$V_1 = 6V$$

2.25 $R_1 = 1\,k\Omega \pm 5\%$

$R_2 = 3\,k\Omega \pm 5\%$

$$\text{Gain} = \frac{V_0}{V_1} = \frac{1}{1+\frac{R_1}{R_2}} = \frac{R_2}{R_1+R_2}$$

$$R_1' = \frac{1000 \times 5}{100} = 50\Omega$$

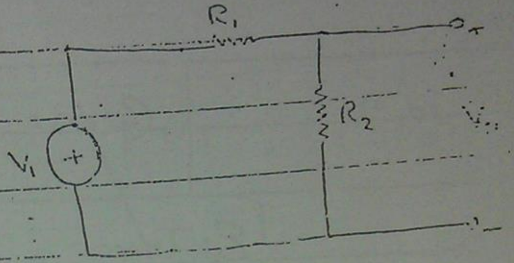
$$R_2' = 3000 \times \frac{5}{100} = 150\Omega$$

$$R_1 + R_2 = 4\,k\Omega \pm 200\Omega$$

Voltage and Current Dividers.

2.24 $R_1 = 15\,k\Omega$, $R_2 = 3\,k\Omega$

a) $V_o = ?$ if $V_1 = 12V$



$$V_o = \frac{3}{15+3} \times 12$$

$$V_o = \frac{1}{6} \times 12 = 2V$$

b) find $V_1 = ?$ when $V_o = 1V$

$$V_o = \frac{R_2}{R_1 + R_1} \times V_1$$

$$1 = \frac{3}{18} \times V_1$$

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$$6 = V_1$$

$$V_1 = 6V$$

2.25 $R_1 = 1\,k\Omega \pm 5\%$

$R_2 = 3\,k\Omega \pm 5\%$

$$Gain = \frac{V_o}{V_1} = \frac{1}{1 + \frac{R_1}{R_2}} = \frac{R_2}{R_1 + R_2} \quad \text{——— (i)}$$

$$R_1' = \frac{1000 \times 5}{100} = 50\Omega$$

$$R_2' = 3000 \times \frac{5}{100} = 150\Omega$$

$$R_1 + R_2 = 4\,k\Omega \pm 200\Omega$$

$$4R_1 + 8 = 20$$

$$4R_1 = 12$$

$$R_1 = 3\,k\Omega$$

c) $V_0 = 5V$, $P_{V_1} = 50 \times 10^{-3}\,W$, $R_1 = ?$, $R_2 = ?$

$V_1 = 10V$

$$P_{V_1} = \frac{(V_1)^2}{R}$$

$$50 \times 10^{-3} = \frac{100}{R_1 + R_2} \quad \text{——— (i)}$$

Also

$$V_0 = \frac{R_1}{R_1 + R_2} \times V_1$$

$$5 = \frac{10R_1}{R_1 + R_2}$$

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$$5R_1 + 5R_2 = 10R_1$$

$$5R_2 = 5R_1$$

$$R_2 = R_1 \quad \text{——— (ii)}$$

From Eq. (i)

$$50 \times 10^{-3}(R_1 + R_2) = 100$$

$$R_1 + R_2 = 2 \times 10^3 \quad \text{——— (iii)}$$

From Eq. 2 put $R_2 = R_1$ in Eq. (iii)

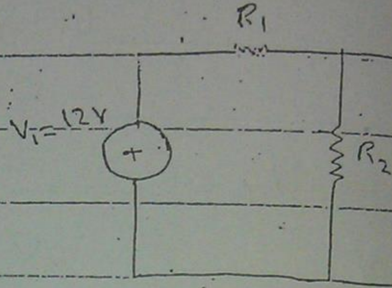
$$R_1 + R_1 = 2 \times 10^3$$

$$R_1 = 1 \times 10^5$$

$$R_1 = R_2 = 1\,k\Omega$$

2.27 $V_1 = 12V$, $P_{V_1} = 100\,mW$

$V_0 = 5V$



We know

$$P_{V_1} = \frac{V_1^2}{R}$$

$$100 \times 10^{-3} = \frac{144}{R_1 + R_2}$$

$$R_1 + R_2 = 1.44 \times 10^3 \quad \text{---(i)}$$

Also

$$V_0 = \frac{R_2}{R_1 + R_2} \times V_1$$

$$5(R_1 + R_2) = 12R_2$$

$$5R_1 + 5R_2 = 12R_2$$

$$R_1 = \frac{7}{5} R_2 \quad \text{---(ii)}$$

put in Eq: (i)

$$R_2 + \frac{7}{5} R_2 = 1.44 \times 10^3$$

$$\frac{12}{5} R_2 = 1.44 \times 10^3$$

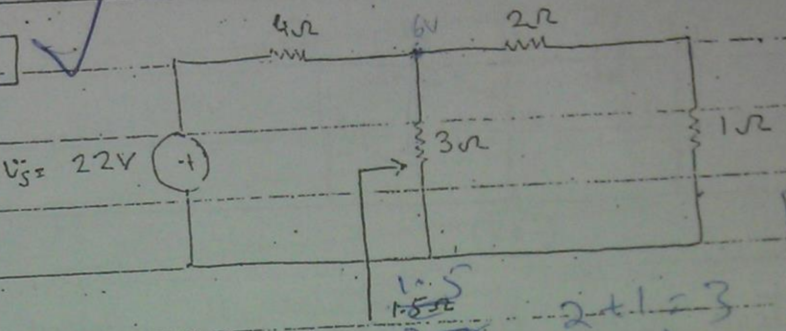
$$\boxed{R_2 = 600\,\Omega}$$

put in Eq. (ii)

$$R_1 = \frac{7}{5} \times 600$$

$$\boxed{R_1 = 840\,\Omega}$$

2.28



3||2

2+1 = 3

3||3 = 1.5

$V_4 = \frac{4}{1.5+4} \times 22\ (V_s)$

$\boxed{V_4 = 16\ V}$ across 4Ω

$V_{1.5} = \frac{1.5}{1.5+4} \times 22$

$\boxed{V_{1.5} = 6\ V}$

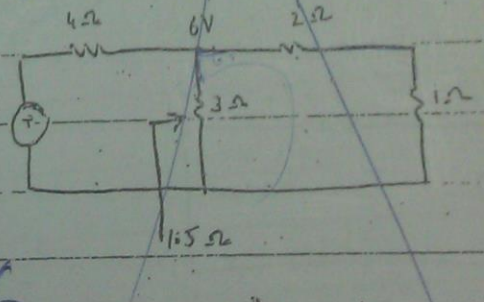
$V_4 = \frac{4}{2.75+4} \times 22$

$V_4 = 13V$

$V_2 = \frac{2}{2+1} \times 13$

$V_2 = 8.6 = 9V$

$V_{1.5} = \frac{1.5 \times 22}{4+1.5} = 6V$



$V_4 = \frac{4}{1.5+4} \times 22$

$= 16V$

$V_{2\Omega} = \frac{2}{2+1} \times 6$

$V_2 = \frac{2}{2+1} \times 6 = \frac{2}{3} \times 6 = 4V$

$V_{2\Omega} = 4V$

$\boxed{V_2 = 4V}$

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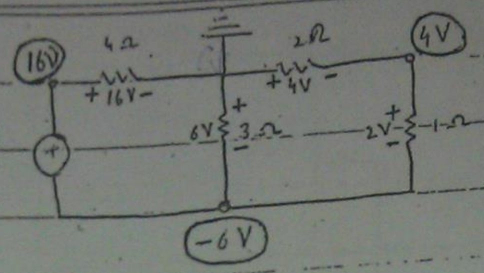
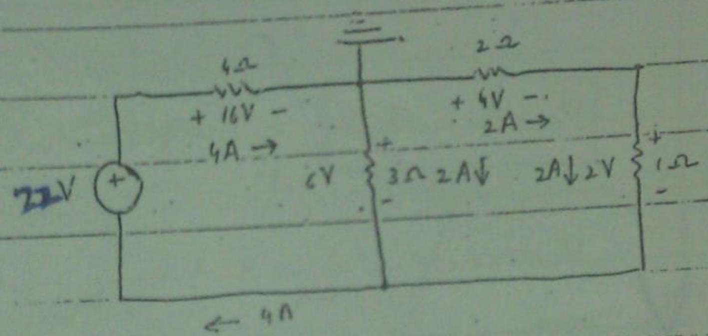
2.29

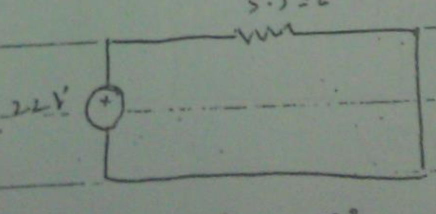


Took Helped from $\boxed{2.28}$ in $V_4 = 16$ V $V_2 = 4$ Ω

(By Black colour)



By Ohm's law we can write branch currents. (By Black colour)

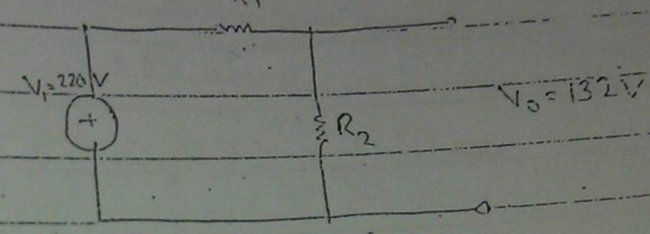


$$P = \frac{V^2}{R_{eq}} = \frac{(22)^2}{5.5} = 88\text{ W}$$

Power delevered by source = P = 88 W

$\boxed{2.30}$ $V_1 = 220V$

$V_o = 132V$



a) $10k\Omega \parallel$ with R_2 then $V_o = 60V$

From 1st circuit

$$V_o = \frac{R_2}{R_1 + R_2} \times V_1$$

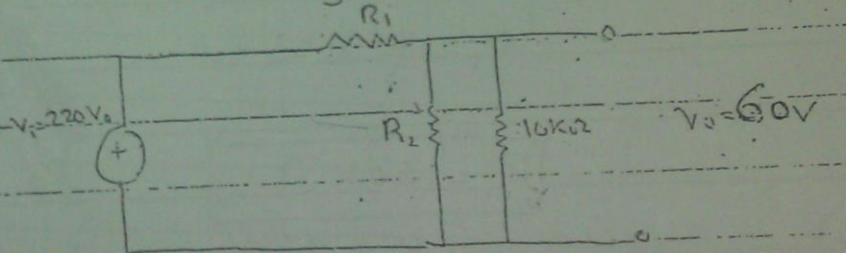
$$132(R_1 + R_2) = 220R_2$$

$$132R_1 + 132R_2 = 220R_2$$

$$132R_1 = 88R_2$$

$$R_1 = \frac{2}{3}R_2 \quad \text{------------ (i)}$$

Now



$$V_o = \frac{\dfrac{10\times10^3 R_2}{10\times10^3 + R_2}}{R_1 + \dfrac{10\times10^3 R_2}{10\times10^3 + R_2}} \times 220$$

$$V_o = \frac{10\times10^3 R_2}{(10\times10^3 + R_2)R_1 + 10\times10^3 R_2} \times 220$$

$$V_o = \frac{10\times10^3 R_2}{10\times10^3 R_1 + R_1R_2 + 10\times10^3 R_2} \times 220$$

$$60 = \frac{10\times10^3 R_2}{10\times10^3 R_1 + R_1R_2} \times 220$$

$$\frac{3}{11} = \frac{10\times10^3 R_2}{10\times10^3 R_1 + R_1R_2}$$

$$30\times10^3 R_1 + 3R_1R_2 = 110\times10^3 R_2 \quad \text{------ (ii)}$$

From Eq (i) put $R_1 = \frac{2}{3}R_2$ in Eq (ii)

$$\overset{10}{\cancel{30}}\times10^3\left(\frac{2}{\cancel{3}}R_2\right) + \cancel{3}\left(\frac{2}{\cancel{3}}R_2\right)R_2 = 110\times10^3 R_2$$

$$20\times10^3 R_2 + 2R_2^2 = 110\times10^3 R_2$$

$$2R_2^{\cancel{2}} = 90\times10^3 \cancel{R_2}$$

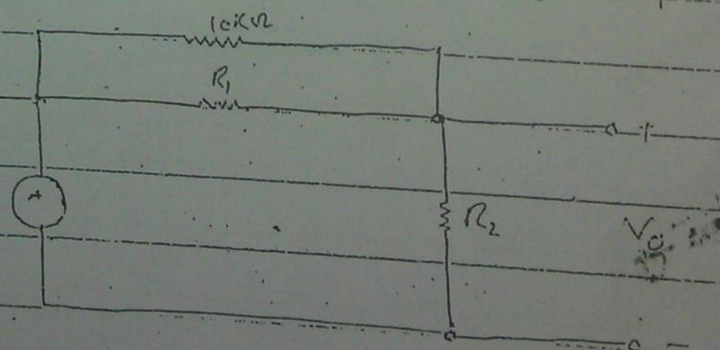
$$\boxed{R_2 = 45\,K\Omega}$$

put in Eq (i)

$$R_1 = \frac{2}{3}\times45\,K\Omega$$

$$\boxed{R_1 = 30\,K\Omega}$$

b) $R_1 = 30K\Omega$, $R_2 = 45K\Omega$, $V_o = ?$, $V_i = 220V$



$$V_o = \frac{R_2}{\frac{R_1\times10\times10^3}{R_1+10\times10^3} + R_2}\times 220$$

$$V_o = \frac{R_2(R_1+10\times10^3)}{R_1 \ldots}$$

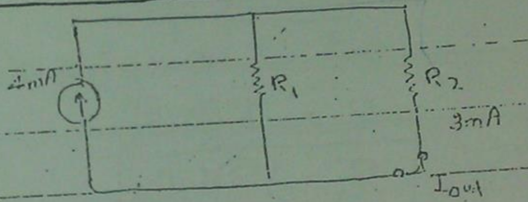
$$V_o = \frac{45\,(10\times10^3 + 30)}{10\times10^3\times 30 + 45\,(10\times10^3 + 30)} \times 220$$

$$V_o = \frac{45\,(40)}{300 + 1800} \times 220$$

$$V_o = \frac{1800}{2100} \times 220$$

$$\boxed{V_o = 188.5\ V}$$

2.31



$$I_{out} = \frac{R_p}{R_o} \times I_{in}$$

$$I_{out} = \frac{(R_1 \parallel R_2)}{R_2} \times I_{in}$$

By Haseeb Shahid
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$$I_{out} = \frac{R_1 \times \cancel{R_2}}{(R_1 + R_2)\cancel{R_2}} \times I_{in}$$

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$$3\times10^{-3} = \frac{R_1}{R_1 + R_2} \times 4\times10^{-3}$$

$$3R_1 + 3R_2 = 4R_1$$

$$\boxed{R_1 = 3R_2} \quad \text{——— (i)}$$

Also

$$P = I_{in}^2\, R_p$$

$$60mW = (4m)^2 \left(\frac{R_1R_2}{R_1+R_2}\right)$$

$$60m(R_1+R_2) = 16m^2 R_1R_2$$

$$60R_1 + 60R_2 = 16m R_1R_2$$

$$60(3R_2) + 60R_1 = 16m(3R_2)(R_2)$$

$$240R_2 = 48mR_2^2$$

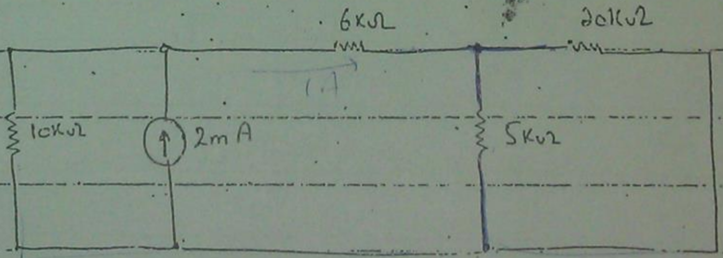
$$\boxed{R_2 = 5K\Omega}$$

put in Eq. (i)

$$R_1 = 3(5K)$$

$$\boxed{R_1 = 15K\Omega}$$

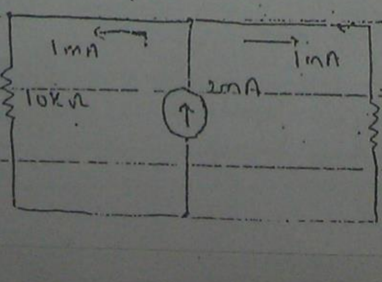
2:32



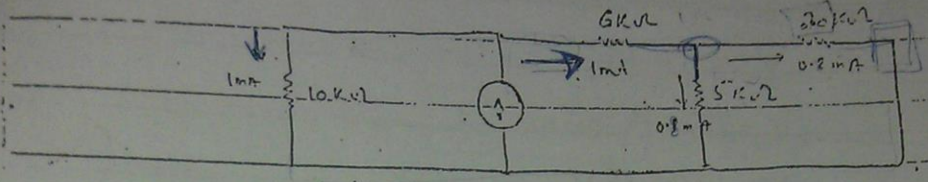
$$R_{eq_1} = 6 + \left[\frac{1}{5} + \frac{1}{20}\right]^{-1}$$

$$R_{eq_1} = 6 + \left[\frac{5\times20}{5+20}\right] = 6 + \frac{100}{25} = 6+4 = 10K\Omega$$

New circuit is:



$$I_? = \frac{R}{R_1+R_2} I_1$$



$$\frac{5}{5+20}$$

By again current divider

$$= \frac{i_1 R_1 R_2}{R_1+R_2}$$

$$= \frac{V}{\cancel{R_0}}\left[\frac{R_1 R_2}{R_1+R_2}\right]$$

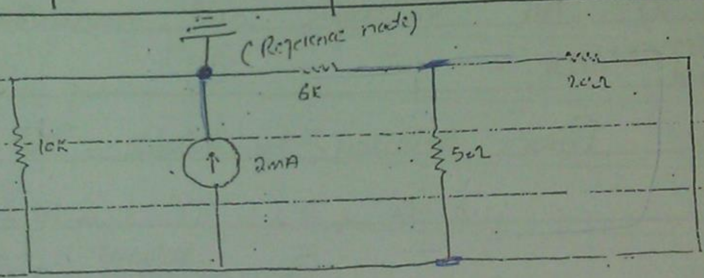
$$= \frac{5}{5+20} \times 1\times10^{-3}$$

$$I_5 = \frac{20}{20+5} \times 1\times10^{-3}$$

$$I_5 = \frac{20}{25} \times 10^{-3}$$

$$\boxed{I_5 = 0.8\,m\,Amp}$$

$\boxed{2.33}$

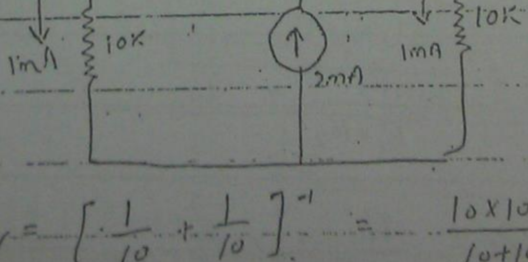


$$R_{eq_1} = 6 + \left[\frac{1}{5} + \frac{1}{20}\right]^{-1}$$

$$R_{eq_1} = 6 + \left[\frac{5\times20}{5+20}\right]$$

$$R_{eq_1} = 6 + 4 = 10\,K\Omega$$

So, circuit becomes



$$R_{eq} = \left[\frac{1}{10} + \frac{1}{10}\right]^{-1} = \frac{10\times10}{10+10} = \frac{100}{20}$$

$$R_{eq} = 5\,K\Omega$$

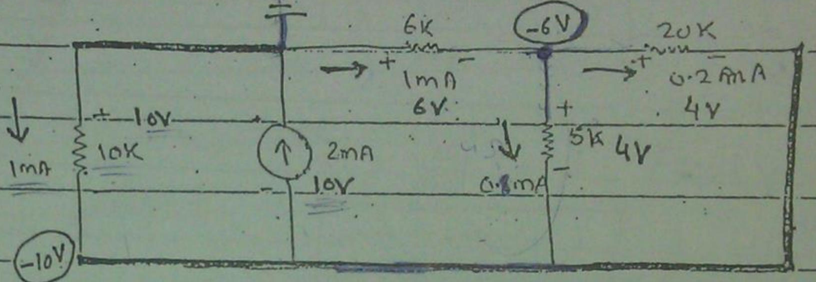
$V = I R_{eq}$

$V = 2mA \times 5k\Omega$

$V = 10 m\overset{k}{V} = 10V$

Also

$I_5 = 0.8$ Amp ; $I_{20} = 0.2$ Amp



*) All voltages are measured using ohm's law

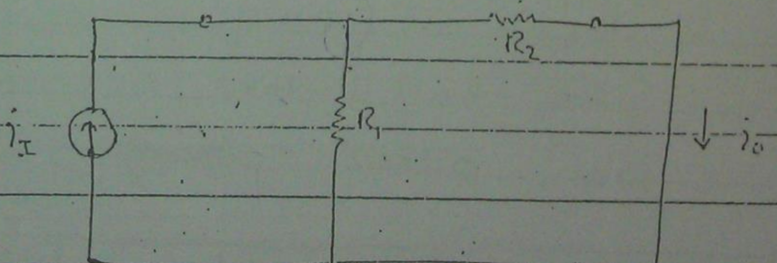
And

Power released by source = Vi

$= 10 \times 2m$

$\text{Power}_{\text{released}} = 20mW$

$\boxed{2.34}$



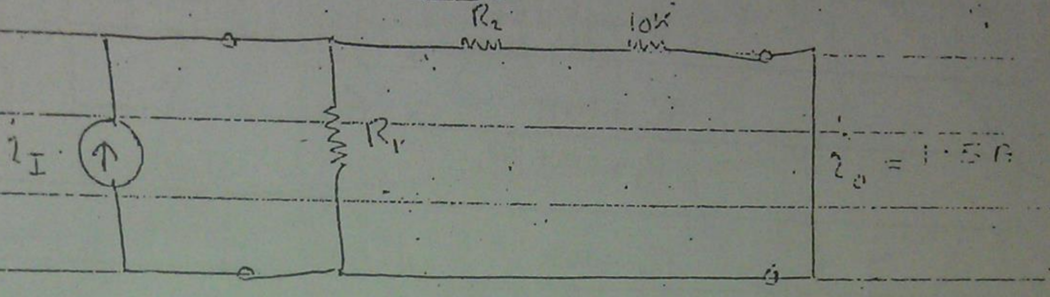
$$i_o = \frac{R_1}{R_1 + R_2} \times i_I$$

$$2 = \frac{R_1}{R_1 + R_2} \times 6$$

$$2R_1 + 2R_2 = 6R_1$$

$$2R_2 = 4R_1$$

$$\boxed{R_2 = 2R_1} \text{ ——— (i)}$$



$$i_o = \frac{R_1}{R_2 + 10k + R_1} \times i_I$$

$$1.5 = \frac{R_1}{R_1 + R_2 + 10} \times 6$$

$$1.5R_1 + 1.5R_2 + 15 = 6R_1$$

$$1.5R_2 + 15 = 4.5R_1$$

putting $R_2 = 2R_1$ from Eq. (i)

$$1.5(2R_1) + 15 = 4.5R_1$$

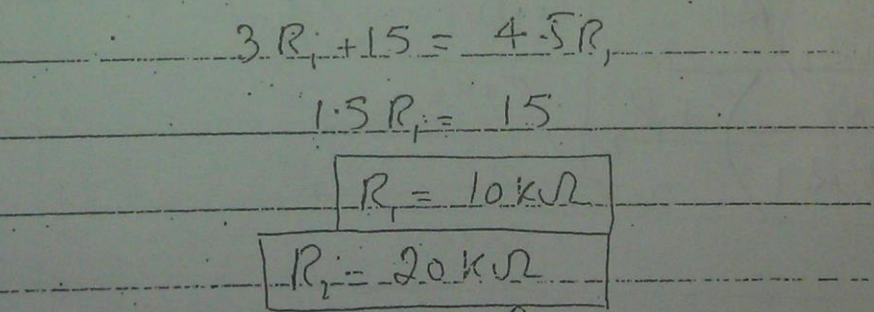
$$3R_1 + 15 = 4.5R_1$$

$$1.5R_1 = 15$$

$$\boxed{R_1 = 10k\Omega}$$

$$\boxed{R_2 = 20k\Omega}$$

b)



$$i_o = \frac{R_1 + 10K}{R_1 + 10K + R_2} \times i_I$$

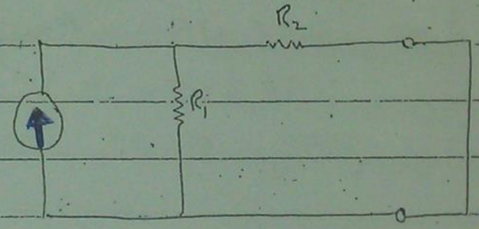
$$i_o = \frac{R_1 + 10K}{R_1 + 10K + 2R_1} \times 6 \qquad (\because R_2 = 2R_1)$$

$$i_o = \frac{R_1 + 10K}{3R_1 + 10K} \times 6$$

$$i_o = \frac{20}{40} \times 60 \qquad (\because R_1 = 10K\Omega)$$

$$\boxed{i_o = 30\,A}$$

2.35



$$R_p = R_1 = \frac{2.4R_1}{2.4 + R_1}$$

Current divider

$$1.5 = \frac{\left(\frac{2.4R_1}{2.4+R_1}\right)R_1}{\left(\frac{2.4R_1}{2.4+R_1}\right) + R_2}$$

$$i_o = \frac{R_1}{R_1 + R_2} \times i_I$$

$$2 = \frac{R_1}{R_1 + R_2} \times 10$$

$$v = i_1 \frac{(R_1 + R_2)2.4}{R_1 + R_2 + 2.4}$$

$$i_o = \frac{i_1}{R_2}\left[\frac{(R_1 + R_2)2.4}{R_1 + R_2 + 2.4}\right]$$

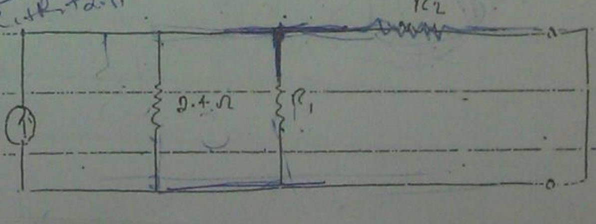
$$\boxed{\begin{aligned} R_1 &= 1\Omega \\ R_2 &= 4\Omega \end{aligned}}$$

$$2R_1 + 2R_2 = 10R_1$$

$$R_2 = 4R_1 \qquad (1)$$

$$v = \frac{i_1 \times R_1 \times R_2 \times 2.4}{R_1 + R_2 + 2.4}$$

$$R_2 i_o = \frac{v_1}{R_2}$$



$$i_0 = \frac{R_p}{R_p + R_2} \times I_1$$

$$1.5 / R_2 = \left[\frac{1}{2.4 + R_1 + R_2}\right] \times i_1$$

$$1.5 R_2 =$$

$$R_2 i_0 = \left[\frac{R_1 \times R_2 \times 2.4}{R_1 + R_2 + 2.4}\right] \times 10$$

$$1.5 R_2 (R_1 + R_2 + 2.4) = R_1 \times R_2 \times 24$$

$1.5R_2R_1 + 3.6R_2 + 1.5R_2^2 = 24R_1R_2$ .... Eq (1.)

$1.5R_2^2 + 3.6R_2 - 22.8R_1R_2 = 0$; $R_2 = 4R_1$

$R_2(1.5R_2 + 3.6 - 22.5(R_1))$; $[R_1 + 4R_1 + 2.4] = R_1 4R_1 \cdot 24$

$1.5(4R_1) + 3.6 - 22.5(R_1) = 0$

$R_1 = 0.2\,\Omega$; $6R_1^2 + 24R_1^2 + 2.4R_1 = 4R_1^2 \cdot 24$

$R_2 = 0.8\,\Omega$; $6R_1^2 + 24R_1 - 4R_1^2 + 2.4R_1 = 24$

$$26R_1^2 + 2.4R_1 - 24 = 0$$

$$13R_1^2 + 1.2R_1 - 12 = 0$$

$$R_1 = \frac{-1.2 \pm \sqrt{1.44 - 624}}{26}$$

$$R_1 = \frac{-1.2 \pm \sqrt{622.56}}{26}$$

$R_1 = \frac{-1.2 + 25}{26}$; $R_1 = \frac{-1.2 -}{26}$

$R_1 = \frac{23.75}{26}$

$R_1 = 1\,\Omega$ Neglecting

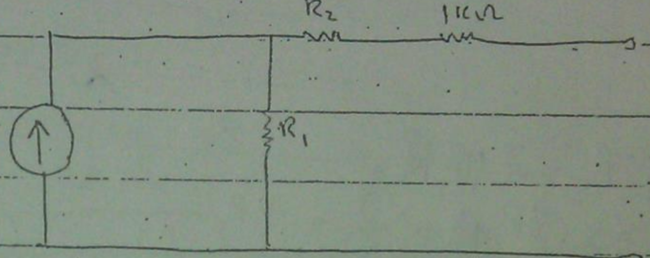
$R_2 = 4R_1$

$R_2 = 4(1)$

$R_2 = 4\ \Omega$

$\boxed{R_1 = 1\Omega}$, $\boxed{R_2 = 4\Omega}$

2.36



2

$I_1 = 5mA$; $i_o = 1mA$

$$i_o = \frac{R_1}{R_1+R_2} \times i_1$$

$$1 = \frac{R_1}{R_1+R_2} \times 5$$

$R_1+R_2 = 5R_1$

$R_2 = 4R_1$ ——— (1)

$$0.75 = \frac{R_1}{R_1+1+R_2} \times 5$$

$0.75R_1 + 0.75 + 0.75R_2 = 5R_1$

$0.75 + 3R_1 = 4.25R_1$

$0.75 = 1.25R_1$

$\boxed{R_1 = 0.6k\Omega}$

$R_2 = 4R_1$

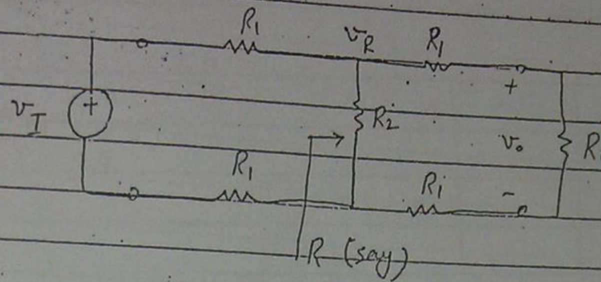
$R_2 = 4(0.6)$

$\boxed{R_2 = 2.4k\Omega}$

Remaining

Q3.

For v_o



$$R = \left((2R_1 + R_L)^{-1} + R_2^{-1}\right)^{-1}$$

$$R = \frac{R_2(2R_1 + R_L)}{2R_1 + R_L + R_2}$$

$$v_R = \frac{R}{2R_1 + R} v_I$$

$$= \frac{R_2(2R_1+R_L)/(2R_1+R_L+R_2)}{2R_1 + R_2(2R_1+R_L)/(2R_1+R_L+R_2)} v_I$$

$$= \frac{R_2(2R_1+R_L)}{2R_1(2R_1+R_2+R_L) + R_2(2R_1+R_L)} v_I$$

$$= \frac{R_2(2R_1+R_L)}{4R_1^2 + 2R_1R_2 + 2R_1R_L + 2R_1R_2 + R_2R_L} v_I$$

$$v_R = \frac{R_2(2R_1+R_L)}{4R_1^2 + 4R_1R_2 + 2R_1R_L + R_2R_L} v_I$$

$$v_o = \frac{R_L}{2R_1 + R_L} \times v_R$$

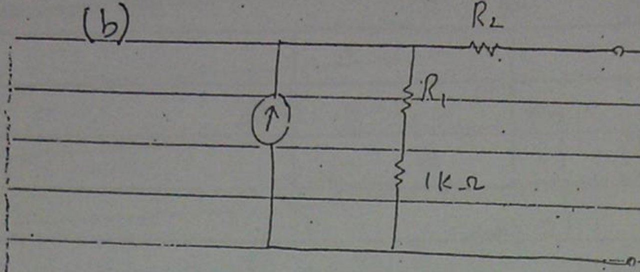
$$= \frac{R_L}{\cancel{(2R_1+R_L)}} \cdot \frac{R_2\cancel{(2R_1+R_L)}}{(4R_1^2 + 4R_1R_2 + 2R_1R_L + R_2R_L)} v_I$$

$R_2 = 4(0.6)$

$\boxed{R = 2.4\,k\Omega}$

$\boxed{R_1 = \text{[illegible]}}$

(b)



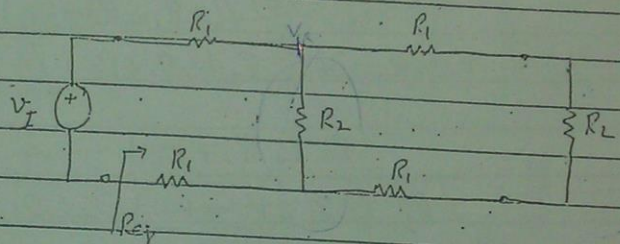
By M. Haris Altaf
06-CE-14

$$i_o = \frac{R_1 + 1}{R_1 + 1 + R_1} \times 5$$

$$= \frac{1.6}{4} \times 5 = 2\ mA$$

$$\boxed{i_o = 2\ mA}$$

2.37 (a)



$$R_{eq} = \left((2R_1 + R_L)^{-1} + R_2^{-1} \right)^{-1} + 2R_i$$

$\because R_{eq} = R_L$

$$R_L = \frac{R_2(2R_1 + R_L)}{2R_1 + R_L + R_2} + 2R_1$$

$$(R_L - 2R_1)\ (2R_1 + R_L + R_2) = R_2(2R_1 + R_L)$$

$$\cancel{2R_1 R_L} + R_L^2 + \cancel{R_L R_2} - 4R_1^2 - \cancel{2R_1 R_L} - 2R_1 R_2 = 2R_1 R_2 + \cancel{R_L R_2}$$

$$R_L^2 - 4R_1^2 - 2R_1 R_2 = 2R_1 R_2$$

$$R_L^2 = 4R_1(R_1 + R_2)$$

$$\boxed{R_L^2 = 4R_1(R_1 + R_2)} \quad ①$$

$$\frac{v_o}{v_I} = \frac{R_2 R_L}{4R_1^2 + 4R_1 R_2 + 2R_1 R_L + R_2 R_L)}$$

from ① $R_L^2 = 4R_1^2 + 4R_1R_2$

$$\frac{v_o}{v_I} = \frac{R_2 R_L}{R_L^2 + 2R_1R_L + R_2R_L}$$

$$\boxed{\frac{v_o}{v_I} = \frac{R_2}{R_L + 2R_1 + R_2}} \quad \text{②}$$

(b) $R_2 = 600\ \Omega$

$\frac{v_o}{v_I} = 0.5\ \frac{V}{V}$ $\quad R_1 = ?\ \&\ R_2 = ?$

putting in ① & ②

$360000 = 4R_1(R_1 + R_2)$

$90,000 = R_1^2 + R_1R_2$

$R_1^2 + R_1R_2 = 90,000$ — ①′

$$0.5 = \frac{R_2}{600 + 2R_1 + R_2}$$

$300 + R_1 + 0.5R_2 = R_2$

$R_1 - 0.5R_2 = 300$ — ②′

$R_2 = 2R_1 + 600$ put in ①′

$R_1^2 + 2R_1^2 + 600R_1 = 90,000$

$3R_1^2 = 89400$

$R_1^2 = 29800$

$3R_1^2 + 600R_1 - 90,000 = 0$

$R_1^2 + 200R_1 - 30,000 = 0$ — ③′

$$R_1 = \frac{-200 \pm \sqrt{40{,}000 + 120{,}000}}{2}$$

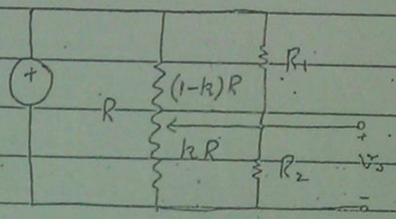
$R_1 = 100$ $\qquad\qquad$ $R_1 = -300$ neglecting

$$\boxed{R_1 = 100\,\Omega}$$

put in ②′

$$\boxed{R_2 = 800\,\Omega}$$

$\boxed{2\text{-}38}$



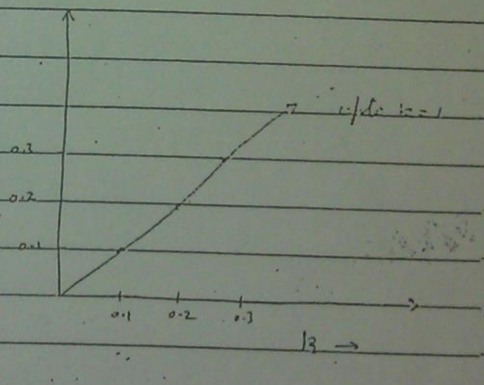
(a) $R_1 = R_2 = \infty$

$$v_o = \frac{kR}{kR + (1-k)R}$$

$$v_o = \frac{kR}{R}\, v_I$$

$$\boxed{\frac{v_o}{v_I} = k}$$ So the

graph will be a straight line



(b) $R_1 = \infty$, $R_2 = 0.1R$

$$\text{(say) } R_2' = \frac{(0.1R)(kR)}{0.1R + kR} = \frac{0.1kR}{0.1+k}$$

$$v_o = \frac{\frac{0.1kR}{0.1+k}}{(1-k)R + \frac{0.1kR}{0.1+k}} = \frac{0.1kR}{(1-k)R(0.1+k) + 0.1kR}$$

$$= \frac{0.1k}{0.1 + k - \cancel{0.1k} - k^2 + \cancel{0.1k}}$$

$$\boxed{\frac{v_o}{v_I} = \frac{0.1k}{0.1 + k - k^2}}$$

k	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
$\frac{v_o}{v_I}$	0	0.05	0.07	0.09	0.11	0.14	0.17	0.22	0.30	0.47	1

Plot yourself

(c) $R_1 = 0.1R$, $R_2 = \infty$

$$R_1' = \frac{(0.1R)(1-k)R}{0.1R + (1-k)R} = \frac{(0.1 - 0.1k)R}{1.1 - k}$$

$$v_o = \frac{R_1'}{kR + R_1'} v_I = \frac{(0.1 - 0.1k)R/(1.1-k)}{kR + (0.1 - 0.1k)R/(1.1-k)} v_I$$

$$\frac{v_o}{v_I} = \frac{(0.1 - 0.1k)R}{(1.1-k)kR + (0.1 - 0.1k)R} = \frac{0.1 - 0.1k}{1.1k - k^2 + 0.1 - 0.1k}$$

$$= \frac{0.1 - 0.1k}{0.1 + k - k^2}$$

$$\boxed{\frac{v_o}{v_I} = \frac{0.1(1-k)}{0.1 + k - k^2}}$$

Plot graph yourself

(d) $R_1 = R_2 = 0.1R$

$$\boxed{\begin{aligned} R_1' &= \frac{0.1(1-k)R}{1.1 - k} \\ R_2' &= \frac{0.1(k)R}{0.1 + k} \end{aligned}}$$ from above

$$\frac{v_o}{v_I} = \frac{R_2'}{R_1' + R_2'}$$

$$\frac{0.1kR/(0.1+k)}{\frac{0.1kR}{(0.1+k)} + \frac{(0.1)(1-k)R}{(1.1-k)}}$$

$$= \frac{0.1kR}{\frac{0.1kR(1.1-k) + 0.1(1-k)R(0.1+k)}{(1.1+k)}}$$

$$= \frac{0.1k\cancel{R}(1.1+k)}{[0.1k(1.1-k) + 0.1(1-k)(0.1+k)]\cancel{R}}$$

$$= \frac{k(1.1+k)\cancel{(0.1)}}{[k(1.1-k) + (1-k)(0.1+k)]\cancel{(0.1)}}$$

$$= \frac{k(1.1+k)}{1.1k - k^2 + 0.1 + k - 0.1k - k^2}$$

$$= \frac{k(1.1+k)}{0.1 + 2k - 2k^2}$$

$$\boxed{\frac{v_o}{v_I} = \frac{k(1.1+k)}{0.1+2k-2k^2}}$$

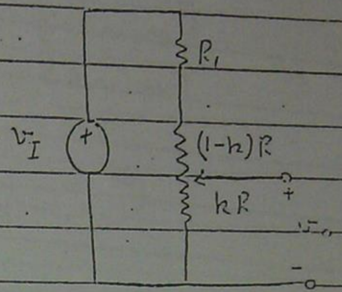
Plot graph yourself

By M. Hasis Altaf
06-CE-14

2.39

$R = 100\ k\Omega$

(a) $0 \rightarrow 0.75\ \frac{V}{V}$



For $0\ \frac{V}{V}$ whiper at bottom

For $0.75\ \frac{V}{V}$ we added R_1

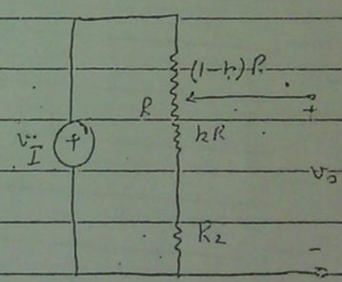
Now

$$\frac{v_O}{v_I} = \frac{R}{R + R_1}$$

$$0.75 = \frac{100}{100 + R_1}$$

$$\boxed{R_1 = 33.3\ K\Omega}$$

(b) $0.2\ \frac{V}{V} \rightarrow 1\ \frac{V}{V}$



For $1\ \frac{V}{V}$ whiper at top

For $0.2\ \frac{V}{V}$ we added R_2

Now

$$\frac{v_O}{v_I} = \frac{R_2}{R_2 + R}$$

$$0.2 = \frac{R_2}{R_2 + 100}$$

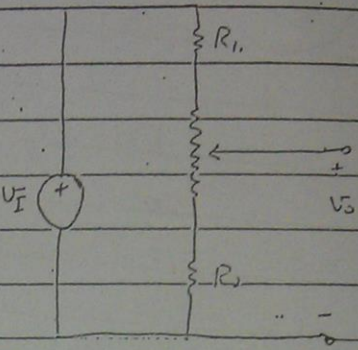
$$\boxed{R_1 = 25\ K\Omega}$$

(c) $0.1\ \frac{V}{V}$ to $0.9\ \frac{V}{V}$

use of power conservation proved.

For 0.1 $\frac{V}{V}$ we added R_2

For 0.9 $\frac{V}{V}$ we added R_1



$$\frac{v_o}{v_I} = \frac{R_2}{R+R_1+R_2}$$

$$0.1 = \frac{R_2}{100+R_1+R_2}$$

$$10 + 0.1R_1 - 0.9R_2 = 0 \quad \text{—— (1)}$$

$$\frac{v_o}{v_I} = \frac{R+R_2}{R_1+R+R_2}$$

$$0.9 = \frac{100+R_2}{100+R_1+R_2}$$

$$10 + 0.1R_2 - 0.9R_1 = 0 \quad \text{—— (2)}$$

from (1) & (2)

$$\boxed{\begin{array}{l} R_1 = 12.5\ K\Omega \\ R_2 = 12.5\ K\Omega \end{array}}$$

By M. Haris Altaf
06-CE-14

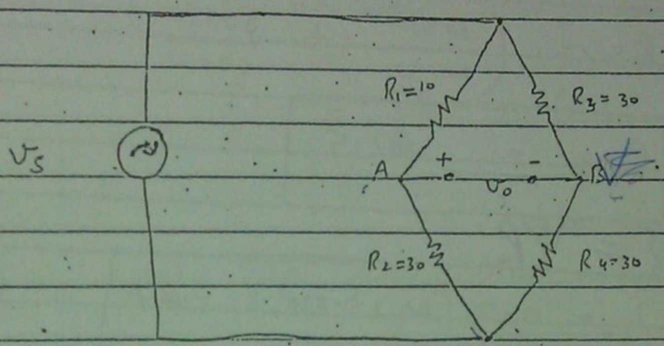
2.40 $v_s = 18 \cos 2\pi \times 10^3 t$ V

$R_1 = 10\ k\Omega$

$R_2 = R_3 = R_4 = 30\ k\Omega$

(a) $v_o = ?$ as func of t

as resistance is a linear component so the function (cos) will not change



$$v_A = \frac{R_2}{R_1+R_2}(v_s)$$

$$= \frac{30}{40}(18 \cos 2\pi \times 10^3 t)$$

$$v_A = 13.5(\cos 2\pi \times 10^3 t)$$

$$v_B = \frac{R_4}{R_3+R_4}(v_s)$$

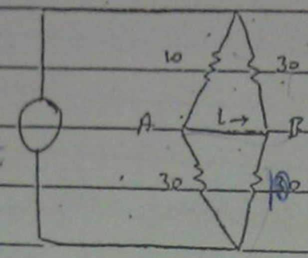
$$= \frac{30}{60}(18 \cos 2\pi \times 10^3 t)$$

$$v_B = 9 \cos 2\pi \times 10^3 t$$

$$v_o = v_A - v_B$$

$$\boxed{v_o = 4.5 \cos 2\pi \times 10^3 t \ \text{V}}$$

(b) circuit becomes $i_{AB} = ?$

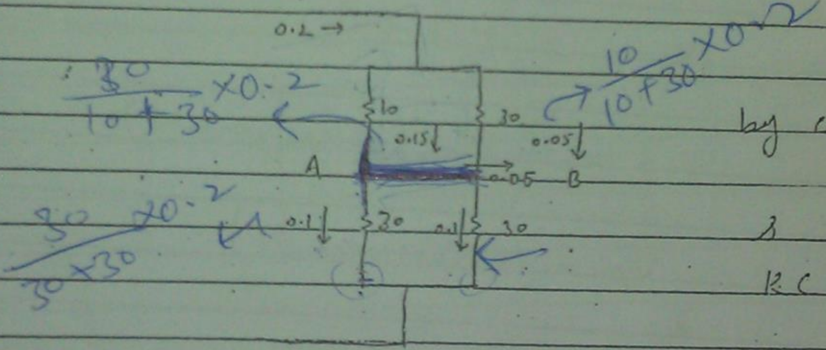


$$R_{eq} = \left(\frac{10 \times 30}{10 + 30} + \frac{30 \times 30}{30 + 30} \right)$$

$$\boxed{R_{eq} = 22.5}$$

$i = V/R$

$$\boxed{i = 0.2 \cos 2\pi \times 10^3 t \ \ mA}$$ by Ω's law



by current divider & KCL

From A to B

$0.15 - 0.1 = 0.05$

$$\boxed{i_{AB} = 0.05 \cos 2\pi \times 10^3 t \ \ mA}$$

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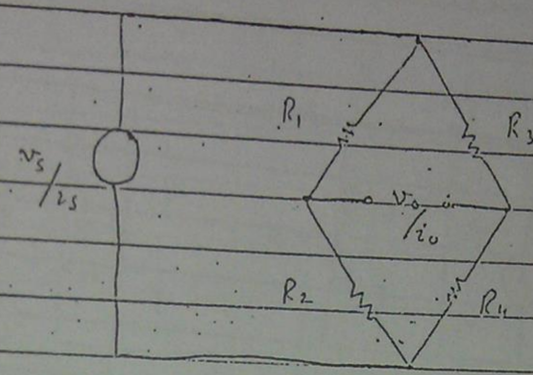
2.41



$10\,k\Omega$, $30\,k\Omega$

$40\,k\Omega$, $120\,k\Omega$

By M. Haris Akbar / 06 CE 14

(a) For balanced bridge

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \quad \wedge \;(<1)$$

only two possibilities are there

(i)	$\frac{10}{40} = \frac{30}{120}$	$R_{eq_1} = 37.5\,k\Omega$
(ii)	$\frac{10}{30} = \frac{40}{120}$	$R_{eq_2} = 30\,k\Omega$

(b) → $p = \frac{V^2}{R_{eq}}$ For our voltage source

As $R_{eq_1} > R_{eq_2}$ so (i) will consume less power

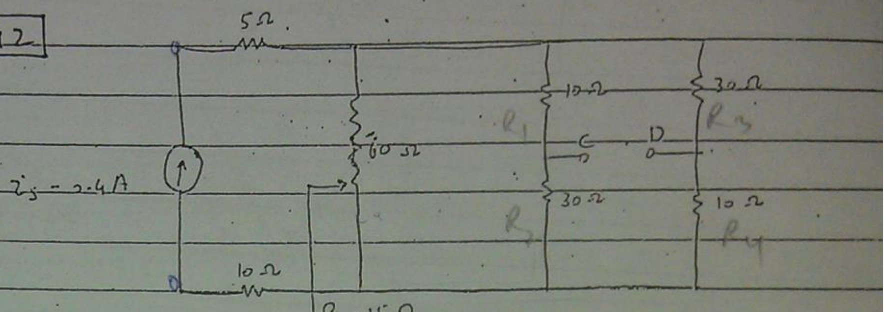
⇒ $p = i^2 R_{eq}$, For current source

As $R_{eq_2} < R_{eq_1}$ so (ii) will consume less power.

... of power conservation proved.

KHALID PHOTO STATE
U.E.T

2.42



$R_1 = 15\,\Omega$

$$R_{eq} = 5 + 10 + \left(60^{-1} + 40^{-1} + 40^{-1}\right)^{-1}$$

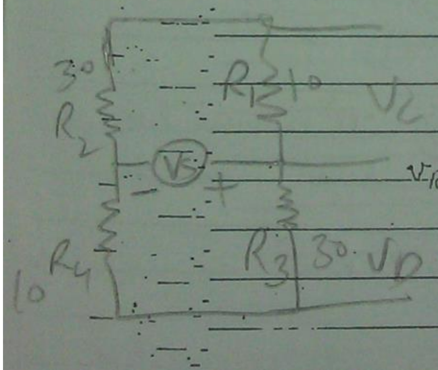
$$\boxed{R_{eq} = 30\,\Omega}$$

$$R_1 = \left(60^{-1} + 40^{-1} + 40^{-1}\right)^{-1}$$

$$\boxed{R_1 = 15\,\Omega}$$

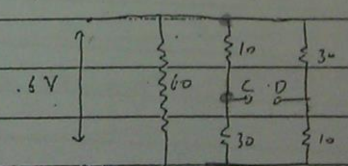
$$V_{AB} = i_s \times R_{eq} = 0.4 \times 30 = 12\,V$$

$$\boxed{V_{AB} = 12\,V}$$



$$V_{R_1} = \frac{R_1}{15 + R_1} \times V_{AB} = \frac{15}{30} \times 12 = 6$$

$$\boxed{V_{R_1} = 6\,V}$$



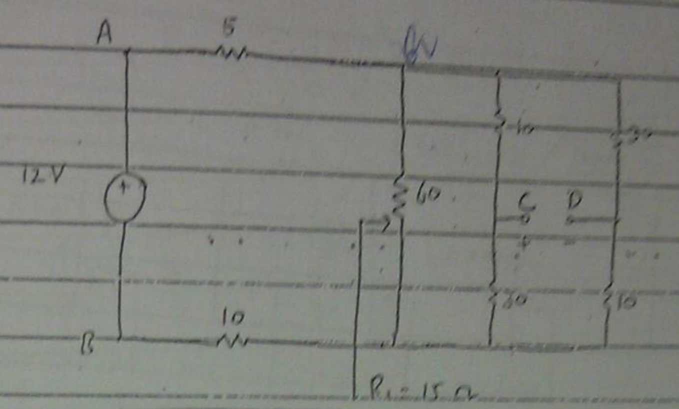
$$V_C = \frac{30}{40} \times V_{R_1} = \frac{3}{4} \times 6 = 4.5\,V$$

$$V_D = \frac{10}{40} \times V_{R_1} = \frac{1}{4} \times 6 = 1.5\,V$$

$$V_{CD} = V_C - V_D = 4.5 - 1.5\,V \qquad \boxed{V_{CD} = 3\,V}$$

By M. Hafis Altaf 96-CE-14

2.43



$$\boxed{\begin{aligned} R_{eq} &= 30\,\Omega \\ R_1 &= 15\,\Omega \end{aligned}}$$ from 2.42

$$V_{R_1} = \frac{15}{30} \times 12 = 6\,V$$

$$\boxed{V_{R_1} = 6\,V}$$

$$V_C = \frac{30}{40} \times 6 = 4.5\,V$$ ∵ Similar as 2.42

$$V_D = \frac{10}{40} \times 6 = 1.5\,V$$

$$V_{CD} = V_C - V_D = 4.5 - 1.5$$

$$\Rightarrow \boxed{V_{CD} = 3\,V}$$

$\Rightarrow$ Power supplied by source $= P = \frac{V^2}{R_{eq}} = \frac{144}{30}$

$$\boxed{P = 4.8\,W}$$

(a) $R_1 + R = \left(\frac{1-k}{k}\right) R + R$

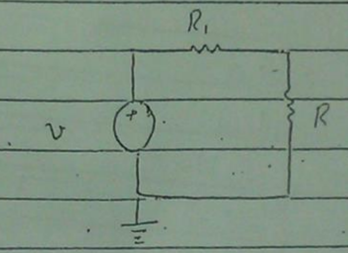
$= R \cdot \left(\frac{1-k+k}{k}\right)$

$$\boxed{R_1 + R = \frac{R}{k}} \quad \text{--- (1)}$$

$$R_2 \parallel (R_1+R) = \frac{\left(\frac{R}{1-k}\right)\left(\frac{R}{k}\right)}{\left(\frac{R}{1-k}\right) + \left(\frac{R}{k}\right)}$$

$$\boxed{R_2 \parallel (R_1+R) = R} \quad \text{--- (2)}$$

Now for Req the circuit will be:

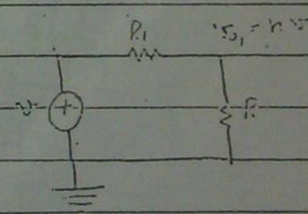


$R_{eq} = R_1 + R$

from (1)

$$\boxed{R_{eq} = \frac{R}{k}} \quad \text{--- (3)}$$

Now by voltage divider



$v_{o1} = \frac{R}{R_1+R} v$

b)

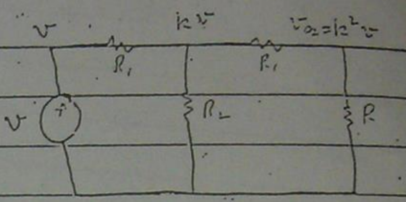
$= \frac{R}{R/k} v$

$$\boxed{v_{o1} = kv}$$

power conservation proved.

$$v_{o_2} = \frac{R}{R_1+R}(kv)$$

$$= k\,(kv)$$



$$\boxed{v_{o_2} = k^2 v}$$

Similarly;

$$\boxed{v_{o_3} = k^3 v}$$

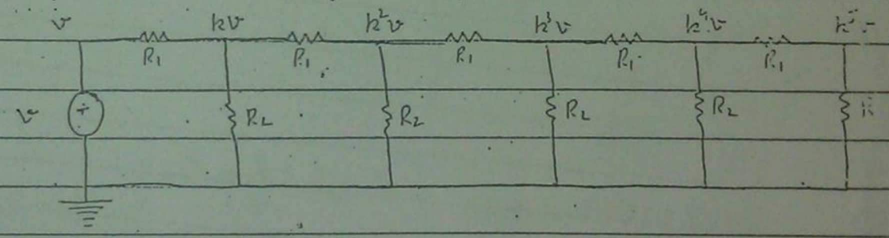
$$\boxed{v_{o_4} = k^4 v}$$

$$\boxed{v_{o_5} = k^5 v}$$

By M. Haris Altaf
06-CE-14

2

So, circuit is varified

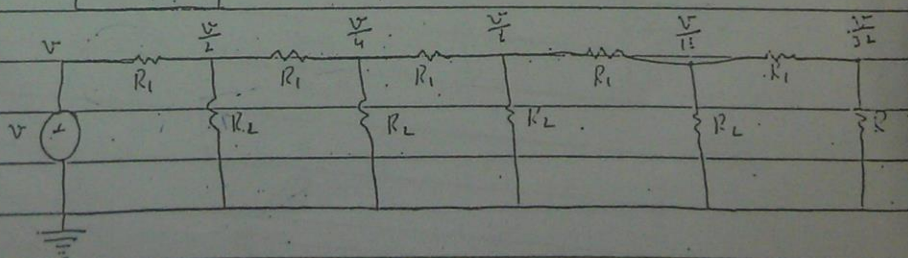


(b) $k = 0.5$

$R_1 = \left(\frac{1-k}{k}\right)R \Rightarrow$ $\boxed{R_1 = R}$

$R_2 = \frac{1}{1-k}(R) \Rightarrow$ $\boxed{R_2 = 2R}$

$\boxed{R_{eq} = 2R}$



$\boxed{2.47}$ (a) $k = 0.1$ $R_{eq} = 10\,k\Omega$

from $\boxed{2.46}$

$$R_{eq} = \frac{R}{k} \quad ①$$

$$R_1 = \left(\frac{1-k}{k}\right) R \quad ②$$

$$R_2 = \frac{1}{(1-k)} R \quad ③$$

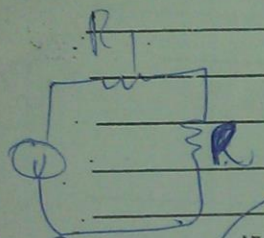
putting the values in ①

$$10\,k = \frac{R}{0.1}$$

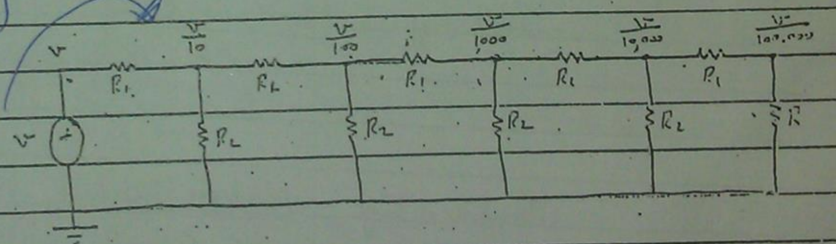
$$\boxed{R = 1\,k\Omega}$$ by putting in ② & ③ we get

$$\boxed{R_1 = 9\,k\Omega}$$

$$\boxed{R_2 = 1.1\,k\Omega}$$



$$\frac{R}{R_1 + R} \times V = \frac{1}{1+9} \times V = V/10$$



(b) $k = \frac{1}{4}$ $R_{eq} = 10\,k\Omega$

putting in ①

$$10\,k\Omega = \frac{R}{1/4}$$

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

Hence law of power conservation proved.