Benha University
Benha Faculty of Engineering
Electrical Engineering Technology (E1105)
1st term 2016-2017

Civil Department
1st Year Civil
Time: 3 Hrs
Dr. Abdelhady Mahmoud

Question (1):

Find the equivalent resistance R_{ab} for the circuits in Fig.1.

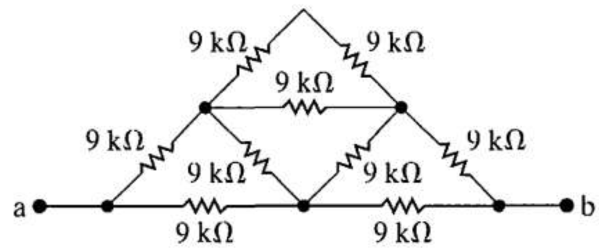
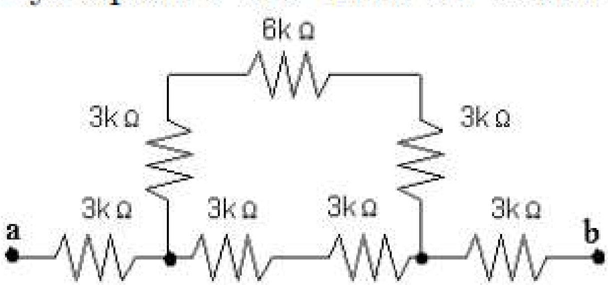


Fig.1

Ans:

The top of the pyramid can be replaced by a resistor equal to $R_1 = \dfrac{(18)(9)}{27} = 6\ \text{k}\Omega$

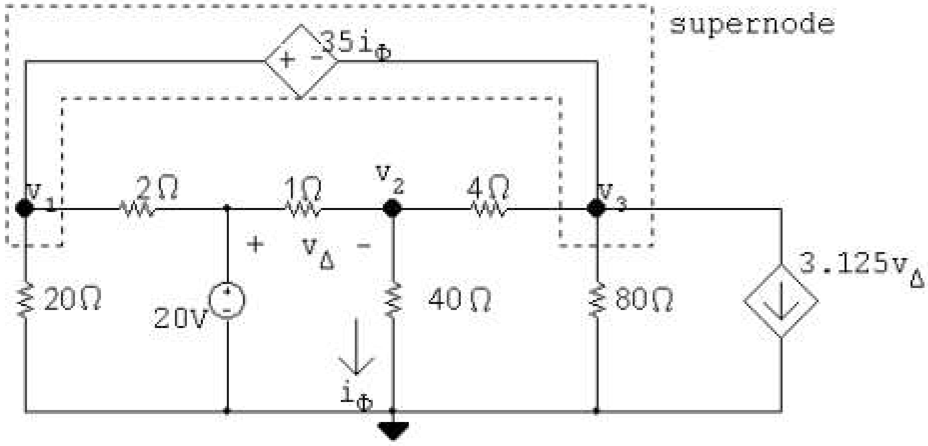
The lower left and right deltas can be replaced by wyes. Each resistance in the wye equals 3 kΩ. Thus our circuit can be reduced to



Now the 12 kΩ in parallel with 6 kΩ reduces to 4 kΩ.

$$\therefore\quad R_{ab} = 3\text{ k} + 4\text{ k} + 3\text{ k} = 10\text{ k}\Omega$$

Question (2):
Use the node-voltage method to find V_o in the circuit in Fig.2.



Node equations:

$$\frac{v_1}{20} + \frac{v_1 - 20}{2} + \frac{v_3 - v_2}{4} + \frac{v_3}{80} + 3.125v_\Delta = 0$$

$$\frac{v_2}{40} + \frac{v_2 - v_3}{4} + \frac{v_2 - 20}{1} = 0$$

Constraint equations:

$$v_\Delta = 20 - v_2$$

$$v_1 - 35i_\phi = v_3$$

$$i_\phi = v_2/40$$

Solving, $v_1 = -20.25$ V; $v_2 = 10$ V; $v_3 = -29$ V

Let i_g be the current delivered by the 20 V source, then

$$i_g = \frac{20 - (20.25)}{2} + \frac{20 - 10}{1} = 30.125 \text{ A}$$

$$p_g \text{ (delivered) } = 20(30.125) = 602.5 \text{ W}$$

Question (3): [a]

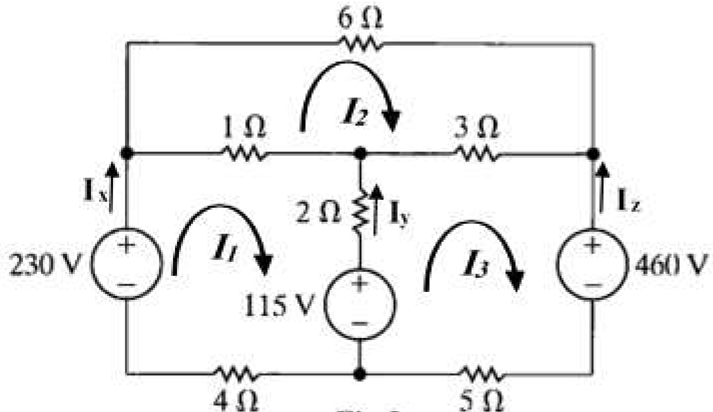


Fig.3

$$230 - 115 = 7i_1 - 1i_2 - 2i_3$$

$$0 = -1i_1 + 10i_2 - 3i_3$$

$$115 - 460 = -2i_1 - 3i_2 + 10i_3$$

Solving, $i_1 = 4.4$ A; $i_2 = -10.6$ A; $i_3 = -36.8$ A

$i_x = i_1 = 4.4$ A, $i_y = i_3 - i_1 = -41.2$ A and $i_z = -i_3 = 36.8$ A

$$p_{230} = -230i_1 = -1012 \text{ W(del)}$$

$$p_{115} = 115(i_1 - i_3) = 4738 \text{ W(abs)}$$

$$p_{460} = 460i_3 = -16{,}928 \text{ W(del)}$$

$$\therefore \sum p_{\text{dev}} = 17{,}940 \text{ W}$$

[b] $p_{6\Omega} = (10.6)^2(6) = 674.16$ W

$$p_{1\Omega} = (15)^2(1) = 225 \text{ W}$$

$$p_{3\Omega} = (26.2)^2(3) = 2059.32 \text{ W}$$

$$p_{2\Omega} = (41.2)^2(2) = 3394.88 \text{ W}$$

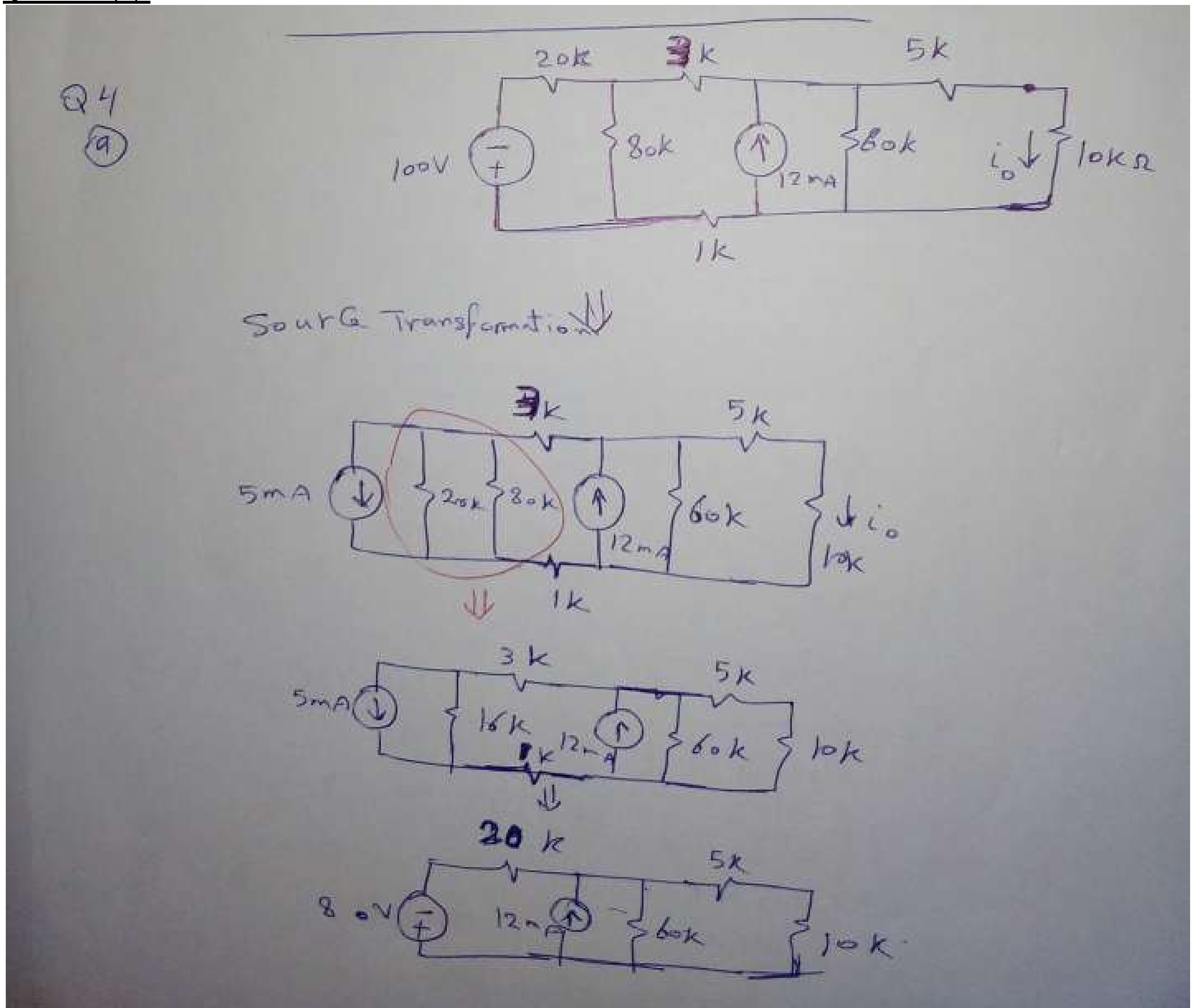
$$p_{4\Omega} = (4.4)^2(4) = 77.44 \text{ W}$$

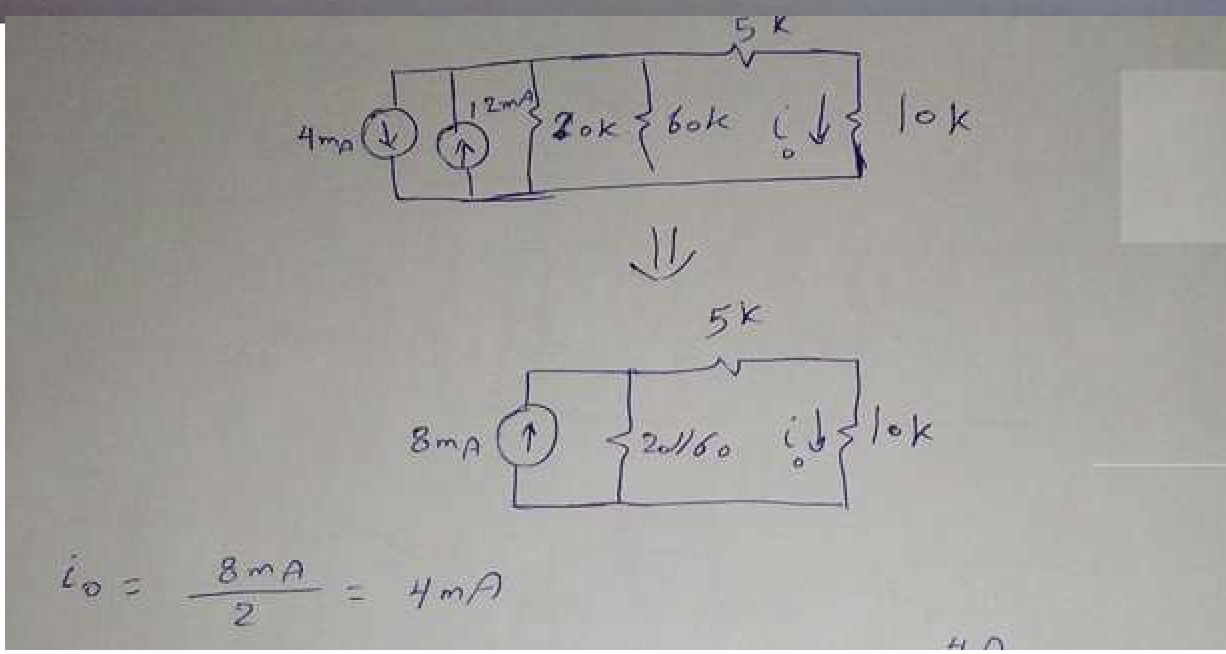
$$p_{5\Omega} = (36.8)^2(5) = 6771.2 \text{ W}$$

$$\therefore \sum p_{\text{abs}} = 4738 + 674.16 + 225 + 2059.32 + 3394.88$$

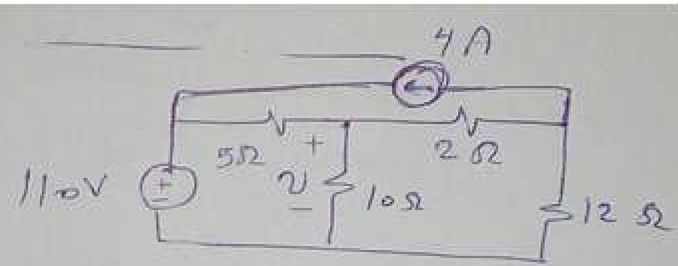
$$+77.44 + 6771.2 = 17{,}940 \text{ W}$$

Question (4):


Q4
(a)
20k
3k
5k
100V
80k
12mA
60k
i_o
10kΩ
1k
Source Transformation
5mA
20k
80k
60k
i_o
10k
16k
8.0V
30k

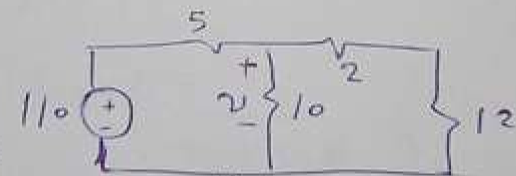

5k
4mA
12mA
20k
60k
i_o
10k
8mA
20//60
$i_o = \frac{8mA}{2} = 4mA$

4 (b)



$v = v_{110V} + v_{4A}$

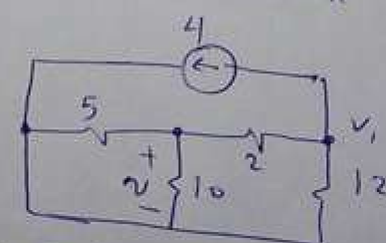
For 110 V only active $\Rightarrow$ 4A open Circuit



$v_{10V} = \frac{140}{24} * \frac{110}{\frac{140}{24} + 5}$

$= 59.23$ V

For 4A only 110 V short Circuit



$\frac{v}{5} + \frac{V - V_1}{2} + \frac{v}{10} = 0$

$\frac{V_1 - V}{2} + \frac{V_1}{12} + 4 = 0$

$6V_1 - 6V + V_1 = -48$

$7V_1 - 6V = -48 \rightarrow (2)$

$2V + 5V - 5V_1 + V = 0$

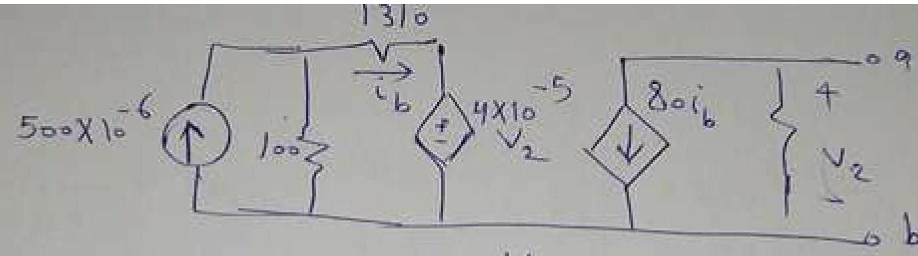
$8V = 5V_1$

$\Rightarrow V_1 = \frac{8}{5}V \rightarrow (1)$

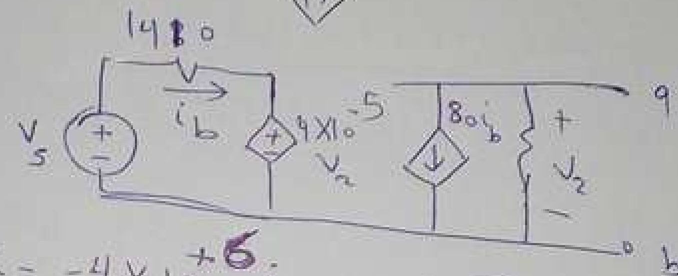
Sub. (1) in (2) $\frac{56}{5}V - 6V = -48 \Rightarrow V = -9.23$

$V = V_{4A} + V_{110V} = 50V$ #

Question (5):



open Circuit voltage



$V_{ab} = V_2 = V_{oc}$

$V_{ab} = -80\, i_b * 50k = -4\times10^{+6}\, i_b \rightarrow (1)$

$\because V_s = 500\times10^{-6} \times 100 = 5\times10^{-2}$ V (Source transformation)

so $4\times10^{-5}\, V_2 = V_s - 1410\, i_b$

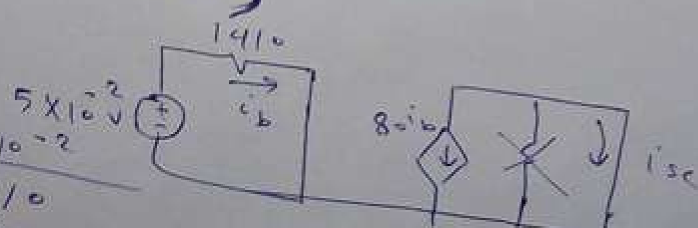
$4\times10^{-5}\, V_{ab} = V_s - 1410\left(\frac{-V_{ab}}{4\times10^{6}}\right)$

$10^{-5}\left(4 - \frac{1410}{40}\right) V_{ab} = V_s$

$V_{ab} = -\frac{5\times10^{-2}}{10^{-5}(31.25)} = -160\text{ V} = V_{th}$

$i_{sc} = -80\, i_b$

$= -80\, \frac{5\times10^{-2}}{1410}$



$i_{sc} = 2.83\times10^{-3}$

$R_{th} = \frac{V_{th}}{i_{sc}} = 56.4\text{ k}\Omega$

$V_2 = V_T$

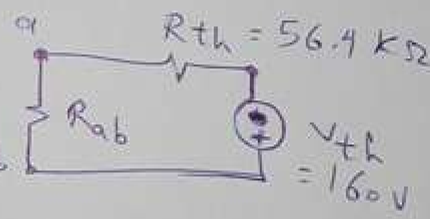
$$i_T = \frac{V_T}{50\times10^3} + 80\, i_b = \frac{V_T}{50\times10^3} + 80\left(-\frac{4\times10^{-5}}{141}\, V_T\right)$$

$$i_T = V_T\left[\frac{141 - 8\times4\times50\times10^{-2}}{50\times10^{3}\times141}\right]$$

$$\frac{V_T}{i_T} = R_{th} = 56.4\,k\Omega$$

(c) for max. power Transfer

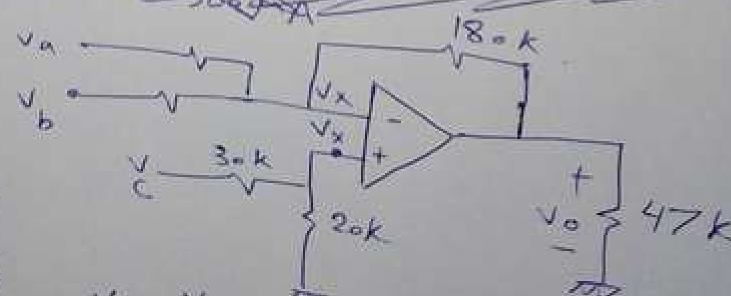
$R_{ab} = R_{th}$



so $P_{max} = \frac{V_{th}^2}{4R_{th}} = 0.1134$ watt

Question (6):

Q6 (a)



$$V_x = V_c \times \frac{20}{50} = 0.4V_c$$

$$\therefore \frac{V_x - V_b}{18k} + \frac{V_x - V_a}{20k} + \frac{V_x - V_o}{180k} = 0$$

$$\frac{0.4V_c - V_b}{18k} + \frac{0.4V_c - V_a}{20k} + \frac{0.4V_c - V_o}{180k} = 0$$

$$4V_c - 10V_b + 3.6V_c - 9.0V_a + 0.4V_c = V_o$$

$$8V_c - 10V_b - 9V_a = V_o$$

$$V_o = 8(3) - 10(2) - 9(1) = -5V$$

(b) $8V_c - 20 - 9 = V_o$

$$8V_c = 29 + V_o$$

$$V_c = \frac{29 + V_o}{8}$$

$$-V_{cc} \leq V_o \leq V_{cc}$$

$$\frac{29}{8} - \frac{V_{cc}}{8} \leq V_c \leq \frac{29}{8} + \frac{V_{cc}}{8}$$

$$\frac{29}{8} - \frac{V_{cc}}{8} \leq V_c \leq \frac{29}{8} + \frac{20}{8}$$

$$1.125 \leq V_c \leq 6.125$$

(c) Mathematical eqn:-

$$Z = -9W - 10X + 8Y$$