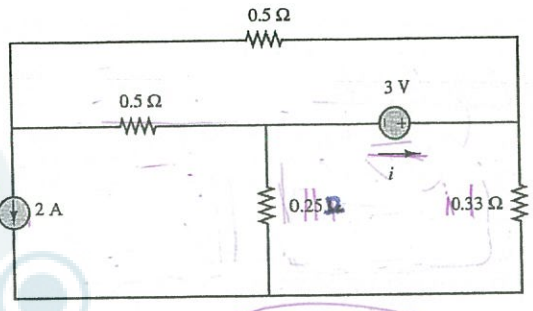
Q8- Use **Mesh Analysis** to find the value of ***i*** in the shown circuit.



$0.5I_2 + 3 + 0.5(I_2 - \frac{I_1}{2}) = 0$

$I_1 = 2A$

$0.25(i_3 - I_1) + 0.33i - 3 = 0$

$0.25(i - 2) + 0.33i - 3 = 0$

$0.58i = 3 + (2 * 0.25)$

$i = 6.03\ A$

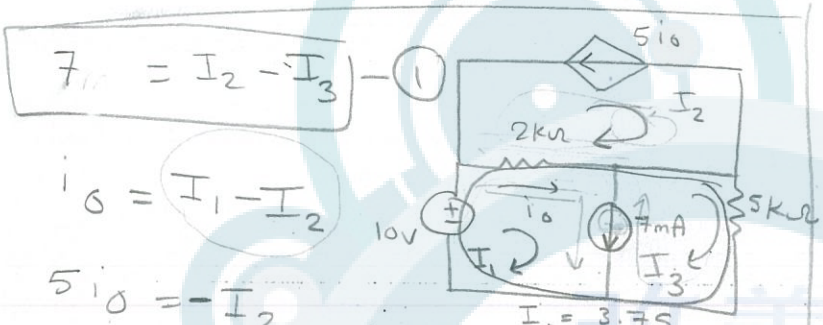
$0.25(i + 2) - 3 + 0.33i = 0$

$0.58i + 0.5 - 3 = 0$

$0.58i = 2.5$

$i = 4.3A$

$i = 4.3A$



$7 = I_2 - I_3$ — (1)

$i_0 = I_1 - I_2$

$5i_0 = -I_2$

$5(I_1 - I_2) = -I_2$ — (2)

$-10 + 2(I_1 - I_2) + 5I_3 = 0$ — (3)

$2I_1 - 2I_2 + 5I_3 = 10$

$5I_1 - 4I_2 + 0I_3 = 0$

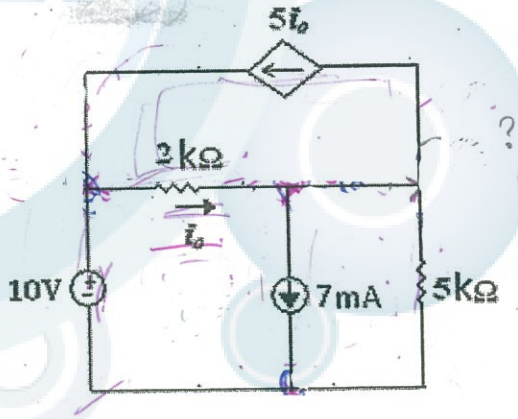
$0I_1 + I_2 - I_3 = 7$

$I_1 = 3.75$

$I_2 = 4.6875$

$i_0 = 0.9375$

Q9- **Find** i_o in the shown circuit with an **appropriate** method (*Mesh or Nodal analysis*).



$i_0 =$

Good Luck

Don't cry ☹, Just try ☺ ...

EE 211
Midterm Exam

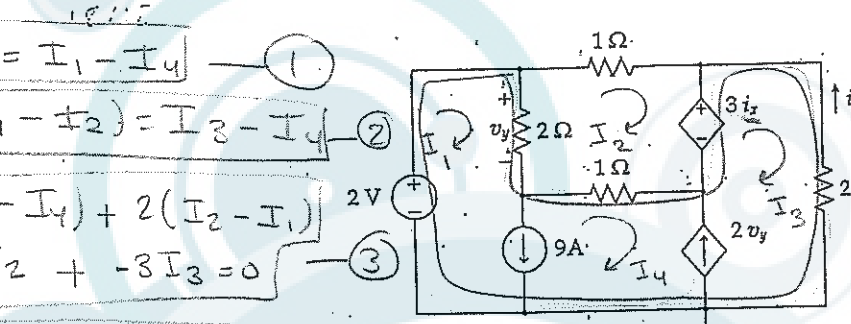
University of Jordan
Electrical Engineering

November 25, 2006
Time: 1 Hr, 40 Min

Student Name: عبدالله وصال عيسى ID#: ٠٠٥٧٣١٨

- This exam is *closed book* and notes.
- Read *all* of the questions before starting (Total of 100 points).
- *Don't* write anything on this exam sheet. Solutions *must be* on the answer sheet.

Q1. [18 points] Use **mesh analysis** in the circuit below to calculate v_y. **DON'T** solve the equations you obtain; just write them in their *final form*.



$9 = I_1 - I_4$ — (1)

$4(I_1 - I_2) = I_3 - I_4$ — (2)

$1(I_2 - I_4) + 2(I_2 - I_1) + I_2 + -3I_3 = 0$ — (3)

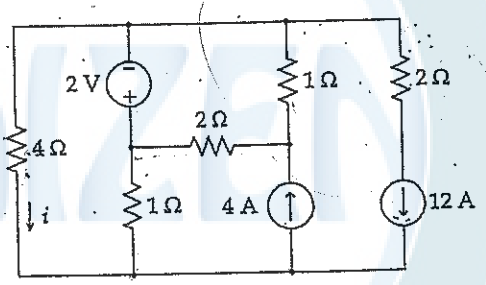
$-2 + 2(I_1 - I_2) + (I_4 - I_2) + 3I_3 + 2I_3 = 0$ — (4)

$v_y = 2(I_1 - I_2)$

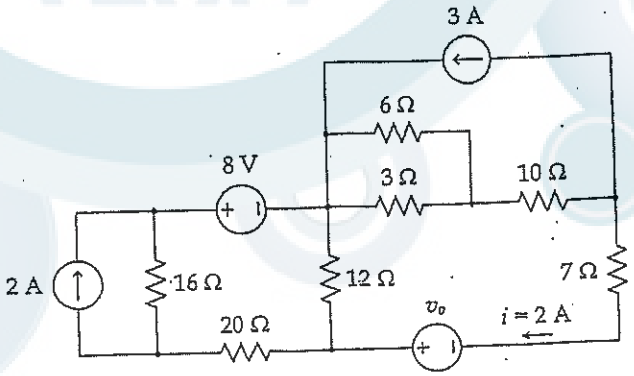
$2v_y = I_3 - I_4$

$I_3 = -i_x$

Q2. [18 points] Use **superposition** in the circuit below to calculate the current i. **IMPORTANT:** During your solution, you can only use current division, voltage division, Ohm's law, KCL and KVL, parallel and series combinations.



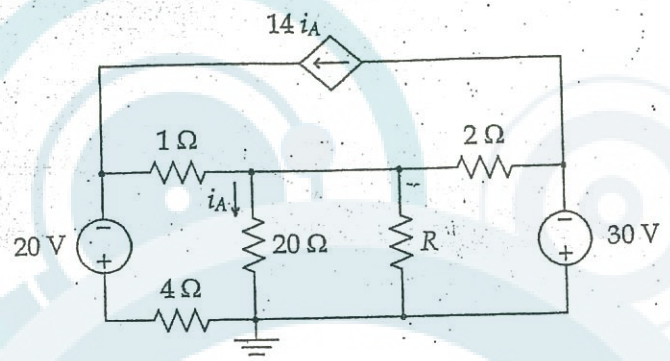
Q3. [18 points] Use **source transformation** in the circuit below to find the value of the voltage v_o given that $i = 2$ A.



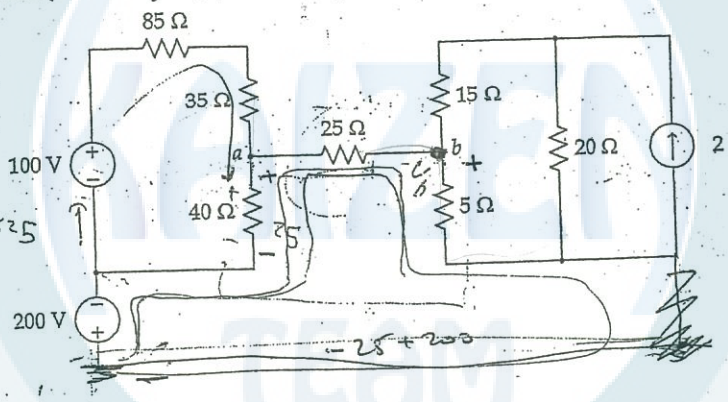
Q4. [28 points]

(a) Find the **Thevenin Equivalent** of the circuit below as seen by the resistor R. **IMPORTANT:** You must use **nodal analysis** to analyze the circuit as you evaluate the Thevenin Equivalent. Use the provided reference point.

(b) Calculate the *maximum* power that can be delivered from the circuit to R.

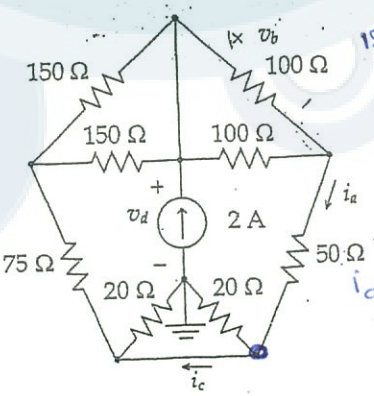


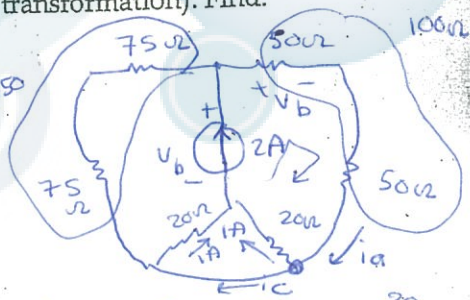
Q5. [8 points] Use **only** current division, voltage division, Ohm's law, KCL and KVL, parallel and series combinations to find the voltage between node b and the ground. (Do NOT use nodal analysis, mesh analysis, superposition or source transformation).



Q6. [10 points] Use **only** current division, voltage division, Ohm's law, KCL and KVL, parallel and series combinations to analyze the following circuit (i.e., do NOT use nodal analysis, mesh analysis, superposition or source transformation). Find:

(a) i_a (b) v_b (c) i_c (d) v_d





$i_a = \frac{150}{100} = 2 \qquad \frac{150}{250} = \frac{30}{25}$

$v_b = \frac{30}{25} * 50 = 60\,V$

$\frac{30}{25} = 1 + i_c$

$-v_d + \frac{30}{25} * 100 + 1 \times 25 = 0$

Midterm Exam

Time 90 Minutes

University of Jordan
Electrical Engineering Department
Circuit Analysis

Dr. Hisham Hamdan
Dr. Ghasan Halasa
Dr. Mahmoud Al-Husari

Total Marks 100

17/11/2007

Name (Arabic): راشد احمد مصطفى ابو عجلة
Reg. Number: 0066897
Section Number: 01
Instructor name: غسان حلاسه

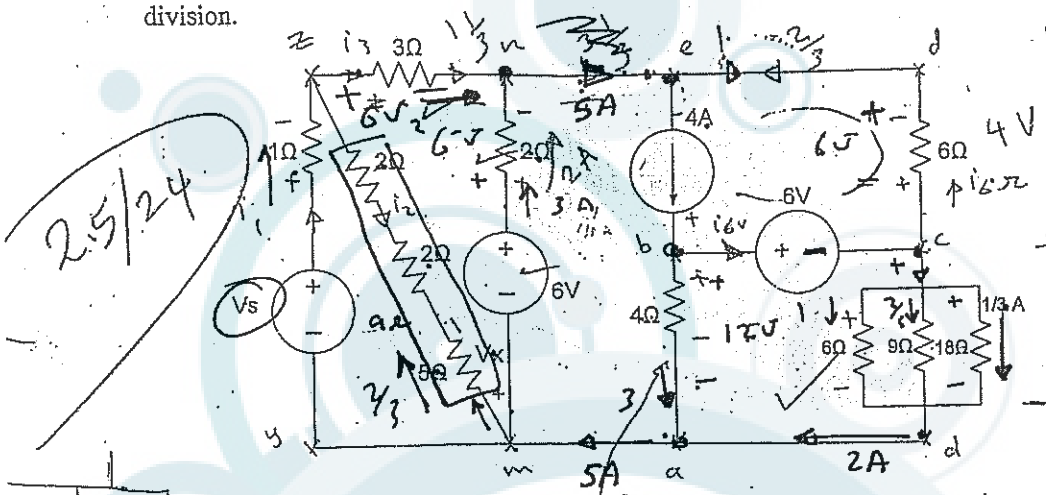
Question Number	Marks
Q1 (24 Marks)	2.5 + 12.5
Q2 (17 Marks)	15
Q3 (17 Marks)	17
Q4 (24 Marks)	14
Q5 (18 Marks)	15

23

19/30

63.5 + 12.5 = 76

Question1. (24 marks) In the circuit shown below find the source voltage V_s and the voltage V_x across the 5 Ω resistor using only simple KCL, KVL, voltage and current division.



2.5/24

$V_{18\Omega} = R_{18} \cdot I_{18} = \frac{18}{3} = 6$ volts

Since they ($9\Omega, 6\Omega, 18\Omega$) parallel

$V_{9\Omega} = V_{6\Omega} = V_{18\Omega} = 6$ Volts

KVL abcda

$-V_{4\Omega} + 6 + V_{9\Omega} = 0$

$V_{4\Omega} = 6 + V_{9\Omega}$

$6 + 6 = 12$ Volts

$I_{4\Omega} = \frac{V_{4\Omega}}{R_{4\Omega}} = \frac{12}{4} = 3$ A.

Applying KCL at Node(b)

$-4 + 3 + i_{6V} = 0$

$i_{6V} = 1$ A

KCL at Node (c)

$i_3 - 1 + i_{6\Omega} = 0$

$i_{6\Omega} = 0.666$ A

KVL [bcdeab]

$V_{4A} - V_{6\Omega} - 6 = 0$

$V_{4A} = V_{6\Omega} + 6$

$V_{4A} = 4 + 6 = 10$ Volts

KVL [mneqam]

$-6 + V_{2\Omega} - V_{4A} + V_{4\Omega} = 0$

$V_{2\Omega} = 6 + V_{4A} - V_{4\Omega}$

$V_{2\Omega} = 6 + 10 - 12$

$V_{2\Omega} = 4$ Volts

KVL (yzmy)

$-V_s + V_{1\Omega} + V_{2\Omega} + V_{2\Omega} + V_{5\Omega} = 0$

$-V_s + i_1 + 2i_2 + 2i_2 + 5i_2 = 0$

$V_s = i_1 + 9i_2$

KVL (mnzm)

$-6 + V_{2\Omega} - V_{3\Omega} + V_{2\Omega} + V_{2\Omega} + V_{5\Omega} = 0$

$-6 + 4 - 3i_3 + 2i_2 + 2i_2 + 5i_2 = 0$

$9i_2 - 3i_3 = 2$

$-V_y + 6 - 6 = 0$

$V_y = 0$

$-6 + V_{2\Omega} + 0 + 6 = 0$

$V_{2\Omega} = 6$ V

$-V_{4\Omega} + 6 + 6 = 0$

$V_{4\Omega} = 12$ V

$i_1 = i_2 + i_3$

applying KCL at Node (ned)

$-i_3 + i_{2\Omega} + 4 - i_{6\Omega} = 0$

$i_3 = -i_{2\Omega} + 4 - i_{6\Omega}$

$i_3 = -2 + 4 - 0.666$

$i_3 = 1.334$ A

$i_2 = \frac{2 + 3i_3}{9} = 0.666$ A

$V_x = -i_2 \cdot R_2$

$= 0.666 \cdot 5$

$V_x = -3.33$ Volts

$i_1 = 1.334 + 0.666$

$i_1 = 1.999$ A

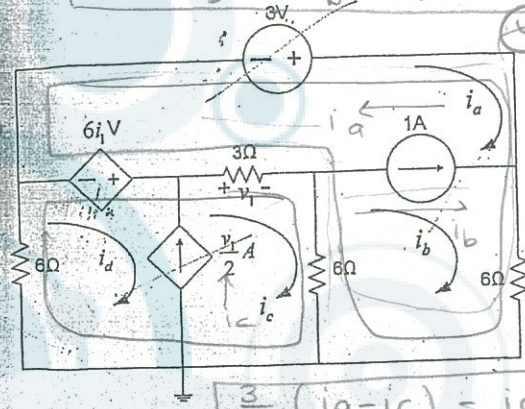
$V_s = 1.999 + 9 \cdot 0.666$

$V_s = 7.999$ Volts

$6i_b + 3(i_c - i_a) + 6(i_c - i_b) + 6i_d = 0$ — (3)

Question 2. (17 Marks) Write the mesh equations in their final form as a function of the labeled mesh currents for the circuit shown below. **(Don't attempt to solve the equations).**

$-3 + 6i_b + 6(i_b - i_c) + 3(i_a - i_c) + -6i_{b=0}$ — (2)



$I = i_a - i_b$ — (4)

$V_1 = 3(i_a - i_c)$

$i_b = -i_1$

$i_d = -i_2$

$\frac{V_1}{2} = i_c - i_d$

$\frac{3}{2}(i_a - i_c) = i_c - i_d$ — (1)

$-6i_1 + (i_c - i_d) + 6(i_d - i_2) = 0$

$3(i_c - i_a) + 6(i_c - i_b) + (i_c - i_d) = 0$

$-3 + 6(i_b - i_1) + 6(i_b - i_c) + 3(i_a - i_c) + 6i_1 = 0$

Mesh (a) & (b)

$-6i_1 + 3 + 6i_b + 6(i_b - i_c) + 3(i_a - i_c) = 0$

$3i_a + 12i_b - 9i_c + 6i_1 = 3$

but $i_1 = -i_b$

$3i_a + 12i_b - 9i_c - 6i_b = 3$

$3i_a + 6i_b - 9i_c = 3$ — (1)

Mesh (c) & (d)

$6i_d - 6i_1 + 3(i_c - i_a) + 6(i_c - i_b) = 0$

$-3i_a - 6i_b + 9i_c + 6i_d + 6i_1 = 0$

$i_1 = -i_b$

$-3i_a - 6i_b + 9i_c + 6i_d + 6i_b = 0$

$-3i_a + 9i_c + 6i_d = 0$ — (2)

at the 1A source

$i_b - i_a = 1$ — (3)

at the dependent current source

$i_c - i_d = \frac{V_1}{2}$

$V_1 = 3(i_c - i_a)$

ok

$i_c - i_d = \frac{3(i_c - i_a)}{2}$

$2i_c - 2i_d = 3i_c - 3i_a$

$-3i_a + i_c + 2i_d = 0$ — (4)

$I = i_a - i_b$ — (3)

$V_1 = 3(i_a - i_c)$

$\frac{V_1}{2} = i_c - i_d$

$\frac{3}{2}(i_a - i_c) = i_c - i_d$ — (1)

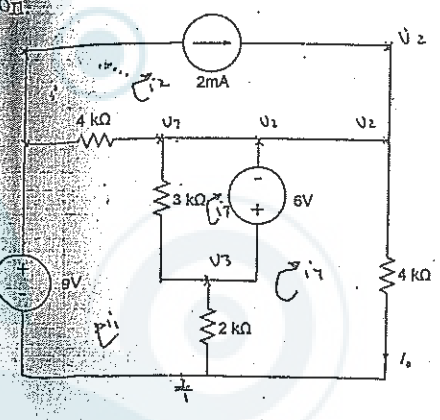
$-6i_1 + (i_c - i_d) + 6(i_d - i_2) = 0$ — (2)

$3(i_c - i_a) + 6(i_c - i_b) + (i_c - i_d) = 0$ — (3)

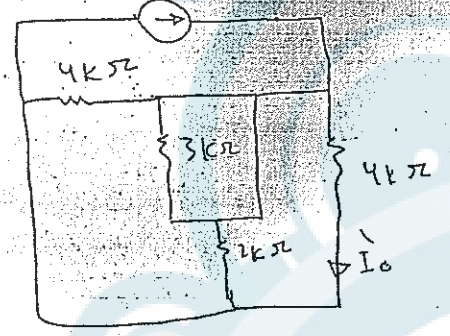
$-3 + 6(i_b - i_1) + 6(i_b - i_c) + 3(i_a - i_c) + 6i_1 = 0$ — (5)

$i_b = -i_1 \; ; \; i_2 = -i_d$ — (6)

Question 3(17 Marks) Find the current I_o using superposition. In the process of your solution use only Ohm's law and current division.



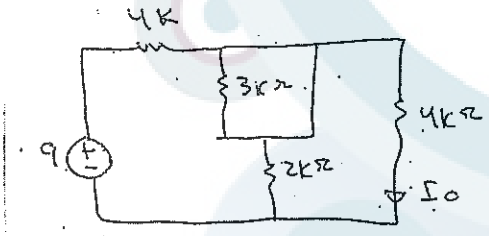
due to 2mA



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

$$I_o = 2\times10^{-3} \frac{\frac{1}{4k}}{\frac{1}{4k}+\frac{1}{2k}+\frac{1}{4k}} = 500\times10^{-6}\ A$$

due to (9V)



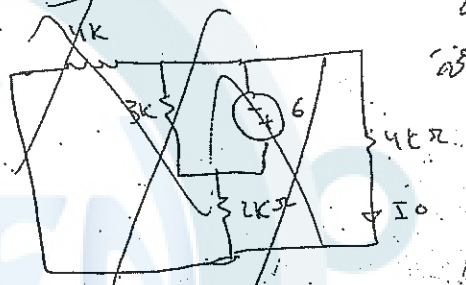
(4kΩ, 2kΩ) parallel

$$R_{eq} = \left(\frac{1}{2k}+\frac{1}{4k}\right)^{-1} = 1.33k\Omega$$

$$I = \frac{9}{4k+1.33k} = 1.6875\times10^{-3}\ A$$

$$I_o'' = 1.6875\times10^{-3} \frac{2k}{} = 562.5\times10^{-6}\ A$$

due to 6 Volts



$$I_o''' = \frac{6}{4k} = 1.5\times10^{-3}$$

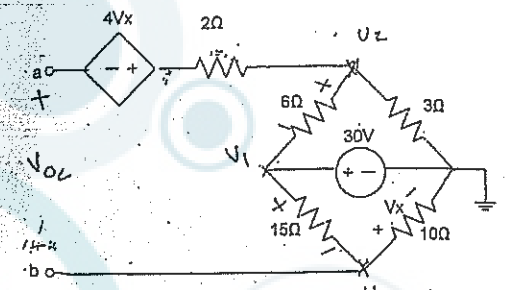
$$I_o''' = 1.5\times10^{-3} \frac{\frac{1}{4k\Omega}}{\frac{1}{4k}+\frac{1}{5k}+\frac{1}{4k}} = -535.71\times10^{-6}$$

$$I_o = I_o' + I_o'' + I_o'''$$

$$500\times10^{-6} + 562.5\times10^{-6} - 535.7\times10^{-6}$$

$$= 437.5\times10^{-6}\ A$$

Question 4. (24 Marks) Use nodal analysis to find the Norton equivalent circuit with respect to terminals *a* and *b* of the circuit shown below.



(14)

at Node (V_1)

$V_1 = 30$ Volts

at Node (2)

$$\frac{V_2}{3} + \frac{V_2 - V_1}{6} = 0$$

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

$$2V_2 + V_2 - V_1 = 0$$

$$3V_2 - V_1 = 0$$

$$3V_2 = 30$$

$V_2 = 10$ Volts

at Node (V_3)

$$\frac{V_3}{15} + \frac{V_3 - V_1}{15} = 0$$

$$15V_3 + V_3 - V_1 = 0$$

$$16V_3 = V_1$$

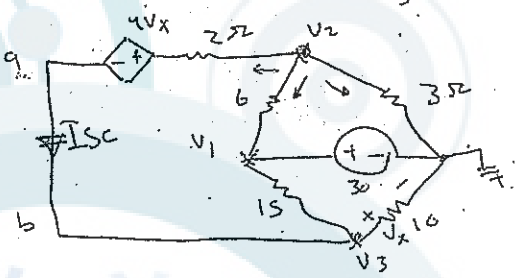
$V_3 = \frac{30}{16} = 1.875$ Volts

KVL [ba V_2 V_1 V_3 b]

$$-V_{oc} - 4V_x + 2(0) + (V_2 - V_1) + (V_1 - V_3) = 0$$

$$V_{oc} = -4 * 12 + 0 + 10 - 12$$

$V_{oc} = -50$ Volts



at Node (V_1)

$V_1 = 30$ Volts — (1)

at Node V_2

$$\frac{V_2 - 4V_x}{2} + \frac{V_2}{3} + \frac{V_2 - V_1}{6} = 0$$

$$3V_2 - 12V_x + 2V_2 + V_2 - V_1 = 0$$

$$6V_2 - 12V_x = V_1$$

$$6V_2 - 12V_3 = 30$$

$V_2 - 2V_3 = 5$ — (2)

at Node (V_3)

$$\frac{V_3}{10} + \frac{V_3 - V_1}{15} = 0$$

$$\frac{V_3}{2} + \frac{V_3 - V_1}{3} = 0$$

$$3V_3 + 2V_3 - 2V_1 = 0$$

$$5V_3 = 60 \Rightarrow V_3 = 12 \text{ Volts}$$

$V_2 - 2V_3 = 5 + 2V_3 = 29$ Volts.

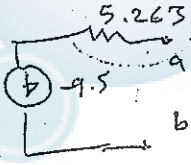
$$I_{sc} = \frac{V_2 - 4V_x}{2}$$

$$I_{sc} = \frac{29 - 4*12}{2}$$

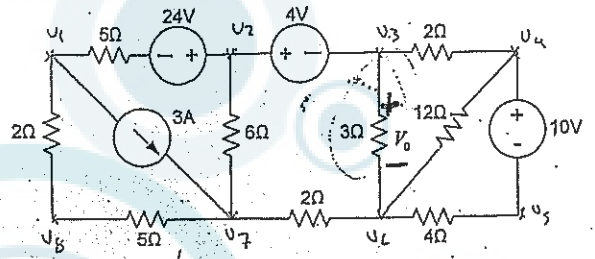
$I_{sc} = -9.5$ A

$R_{Th} = R_{No} = 5.263\,\Omega$

Norton Eqv.



Question 5. (18 Marks) Use source transformation as many times as needed to find V_0



(10.Vo+ts , 4Ω) series

$I_S = \frac{10}{4} = 2.5\ A$

(3A , (2,5)series) ~~series~~ parallel

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

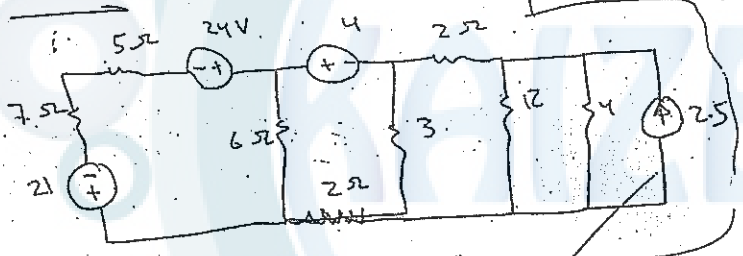
$V = IR = 3*7 = 21$ volts.

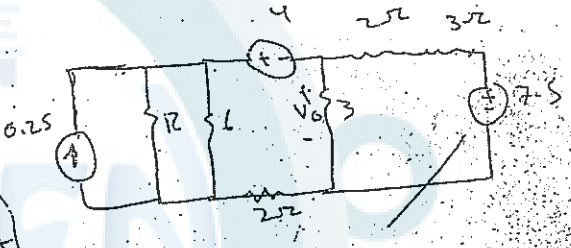
(3V , 12) series

$\therefore I = \frac{3}{12} = 0.25\ A$

(2.5A , 3) parallel

$V = 2.5*3 = 7.5$





(12,6) parallel

$R_{eq} = \left(\frac{1}{12}+\frac{1}{6}\right)^{-1} = 4\Omega$

(2, 3) series

$R_{eq} = 2+3 = 5\Omega$

(7.5Ω, 5Ω) series

$R_{eq} = 7+5 = 12\Omega$

(21V , 24V) series

$V_{eq} = -21+24 = 3$

(0.25A , 4Ω) parallel

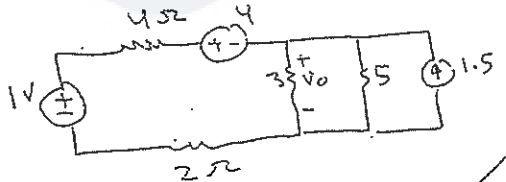
$V = 0.25*4 = 1\ V$

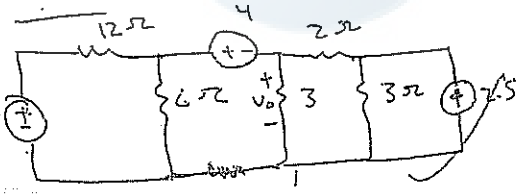
(7.5V , 5Ω)

$I = \frac{7.5}{5} = 1.5\ A$

(4,12) parallel

$R_{eq} = \left(\frac{1}{12}+\frac{1}{4}\right)^{-1} = 3\Omega$





(2Ω, 4Ω) series $\Rightarrow R_{eq} = 6\Omega$

(4V, 1V) series $\Rightarrow V_4 = -1+4 = 3V$

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* ارجو مراجعة السؤال

11/30

10+1/30

Electrical Circuits
EE 221
Mid Exam

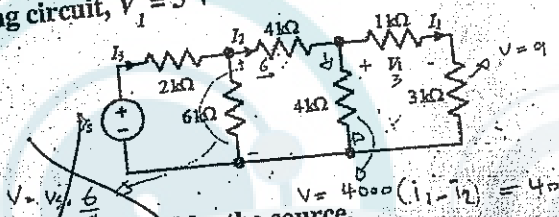
Time:90 mints

Reg .No: 00 57345

Name(Arabic): منذر علي حسن كوبه

3 + Q1 = 1
Q2 - 2
Q3 - 1
Q4 - 3
Q5 - 3

Q1) In the following circuit, $V_1 = 3$ V



$V = V_3 \cdot \frac{6}{8}$

$V = 4000(i_1 - i_2) = 4000(i_2 - 3\cdot10^{-3})$

a) **Find *Vs***

b) **Determine the power supplied by the source.**

$I_1 = \frac{3}{10^3} = 3\cdot10^{-3}$

KVL loop 3 $\Rightarrow 4000(i_1 - i_2) + 3 = 0$ // $12 - 4000 i_2 + 12 = 0$ // $-24 = -4000 i_2$ // $i_2 = 6_1$

KVL loop 2: $\frac{-6V_s}{8} + 4000(6\cdot10^{-3}) + 4000(6\cdot10^{-3} - 3\cdot10^{-3}) = 0$

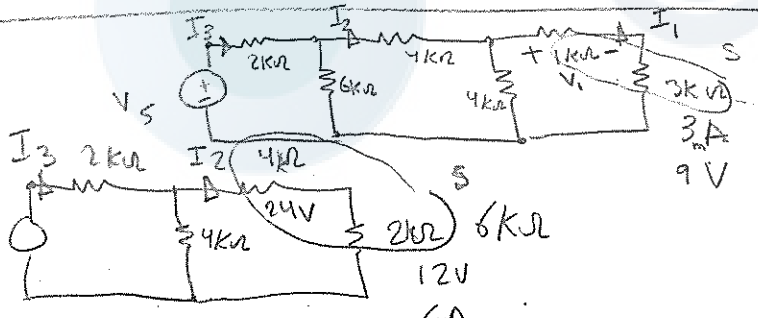
$\frac{-6V_s}{8} + 24 + 24 - 12 = 0$

$\frac{-6V_s}{8} + 48 = 12 \Rightarrow \frac{-6V_s}{8} = -36 \Rightarrow -6V_s = -288$ // $V_s = 48$ V

b) Power $P = IV$

$i_1 = 48 \times \frac{2000}{8000} \times \frac{1}{2000} = 6\cdot10^{-3}$

$P = 288$ W



$V_1 = 3$V

$V_s = ?$

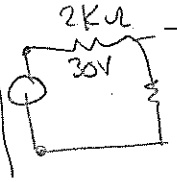
$I = 3_m$A

4kΩ
12V

$I_2 = 6$m A

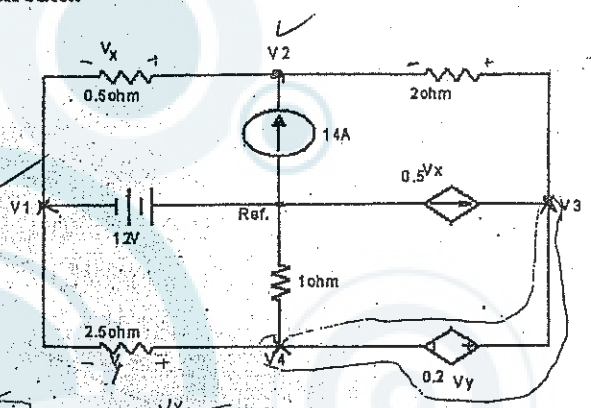
$V_s = 66$V

$P = 990$mW



$I_1 = 15$mA

Q2. Using nodal analysis technique to Determine the values of the unknowns node to reference voltage in the following circuit..



$V_1 = -12$

@ 1: $-14 + \frac{V_2}{.5} - \frac{V_3}{2} + \frac{V_2}{.5} + \frac{+12}{.5} = 0$

$10 = 2.5V_2 - .5V_3$

@ per node:

$-.5V_x + \frac{V_3}{20} - \frac{V_2}{20} + \frac{V_4}{2.5} + \frac{V_1}{2.5} = 0$

$-.5V_x + .5V_4 + .05V_3 - .05V_2 - .4V_1 = 0$

$V_3 - V_4 = 2V_y$ //

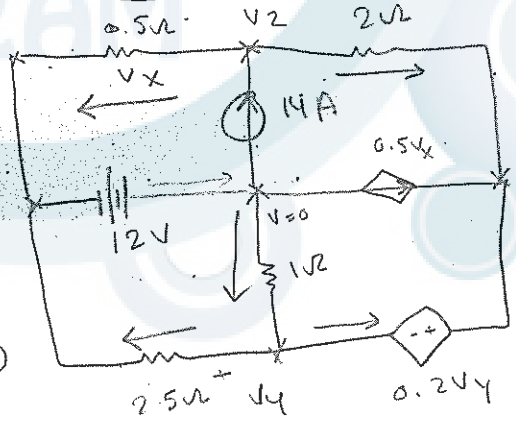
$\frac{V_2}{2.5} - \frac{V_1}{2.5} = V_y$

$\frac{V_2}{.5} - \frac{12}{.5} = V_x$

$V_x = \frac{V_2 - 12}{.5}$

$-.5\left(\frac{V_2 - 12}{.5}\right) + .5V_4 + .05V_3 - .05V_2 - .4V_1 = 0$

missing equation



$V_1 = 12V$ — (1)

$14 = \frac{V_2 - V_1}{0.5} + \frac{V_2 - V_3}{2}$ — (2)

$\frac{V_2 - V_3}{2} + 0.5(V_2 - V_1) + 0.2(V_4 - V_1) = 0$ — (3)

$-V_4 = 0.2(V_4 - V_1) + \frac{V_4 - V_1}{2.5}$ — (4)

$V_x = V_2 - V_1$

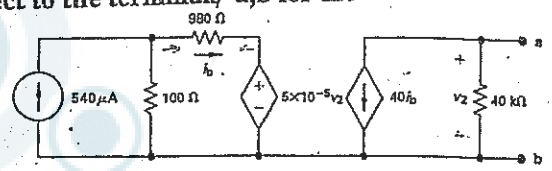
$V_y = V_4 - V_1$

$V_1 = 12V$, $V_2 = 20.3V$

$V_3 = 25.7V$, $V_4 = 4.5V$

$V = 5\times10^{-5} v_2 \times \frac{980}{1080}$

Q3 Determine the Thevenin equivalent with respect to the terminals a,b for the circuit shown.



$i_b = \frac{540\times10^{-6}\times100}{1080} - \frac{5\times10^{-5}v_2}{1080}$

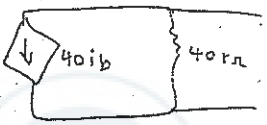
$i_b = .05 - 4.629\times10^{-8} v_2$

$i_2 = 40\times10^{+3} \times 40 i_b$

$i_2 = 40\times10^{-3} \cdot 40(.05 - 4.629\times10^{-8} v_2)$

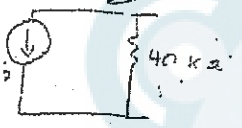
$i_2 = 40\times10^{3}\,(2 - 1.851\times10^{-6} v_2)$

$i_2 = 80{,}000$



$i_b = .05 - 3.2032\times10^{-7}$

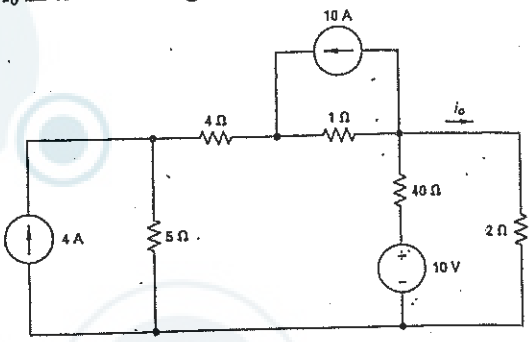
$i_b = .49$

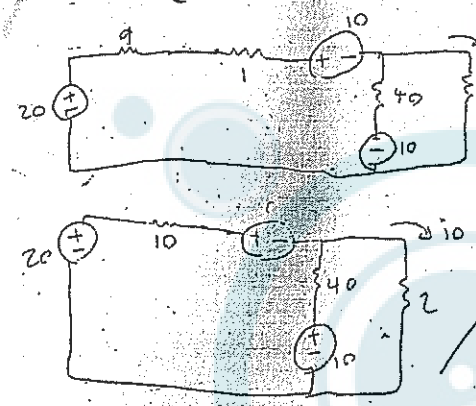


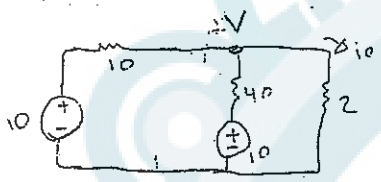
79974.88

(3)

Q4- Use a series of source transformations to find i_0 in the following circuit.







$V_{10\Omega} = 10 * \frac{10}{50} = 2$

KVL: $-10 + 2 + 2i_o = 0 \Rightarrow -8 + 2i_o = 0 \Rightarrow 8 = 2i_o \Rightarrow i_o = 4A$

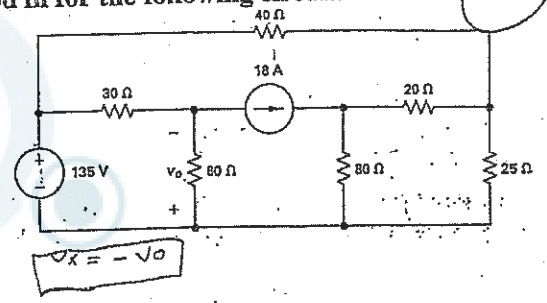
KCL: $\frac{V}{10} - \frac{10}{10} + \frac{V}{40} - \frac{10}{40} + \frac{V}{2} = 0$

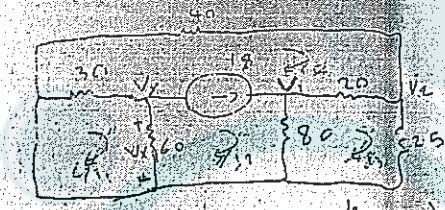
$.1V - 1 + .025V - .25 + .5V = 0$

$1.525V - 1.25 = 0 \Rightarrow 1.525V = 1.25 \Rightarrow V = .8196\ V$

$i_o = \frac{V}{2} = .409\ A$

Q5- Find the voltage V_0 using superposition method in for the following circuit. (3)



① 

$18 = -i_1 + i_2$

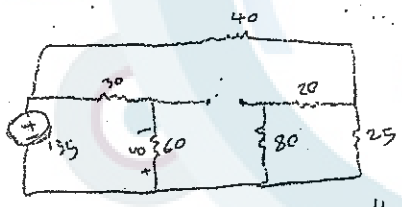
Nodal:

$\frac{V_x}{30} + \frac{V_x}{60} + \frac{V_x}{40} - \frac{V_2}{40} + \frac{V_x}{30} = 0$ // $.075\,V_x - .025\,V_2 + .033\,V_x = 0$

$\frac{V_2}{20} - \frac{V_1}{20} + \frac{V_2}{40} - \frac{V_x}{40} + \frac{V_2}{25} = 0$ // $.115\,V_2 - .05\,V_1 - .025\,V_x = 0$

$\frac{V_1}{20} - \frac{V_2}{20} + \frac{V_1}{80} = 18$ // $.0625\,V_1 - .05\,V_2 = 18$

$.1083\,V_x - .025\,V_2 = 0$

② 

KVL : $-135 + 30i + 60i = 0$ // $90i = 135$, $i = 1.5$ // $V_o'' = 90V$ //

$V_o = V_o' + V_o''$

$= V_o' + 90$