Department of Electrical and Computer Engineering

59+5

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EEN 205 – Electric Circuit

Exam 1 – April 8, 2010

Exam Duration: 60 minutes

Student Name:______________________________

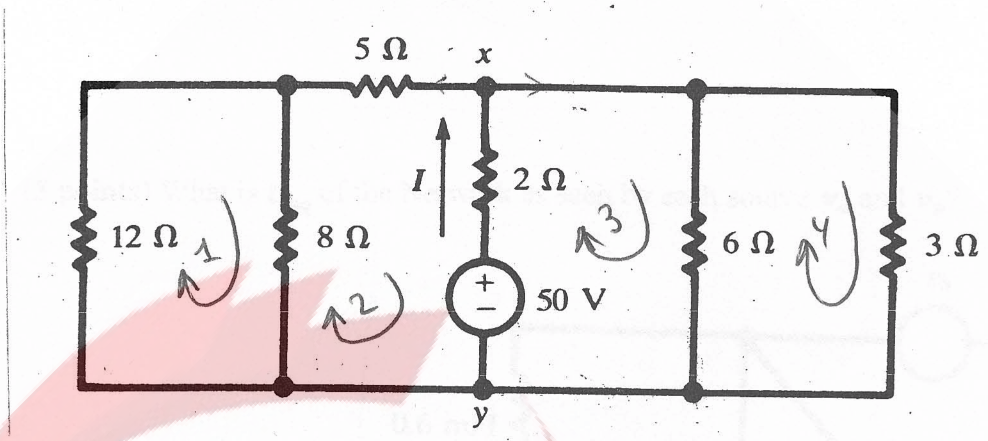
Section:______________________________

Student ID No.:______________________________

Note:

a. You have **7 problems, 8 pages** Exam including the first page.
b. **No** cell phones are allowed in the exam room
c. All questions **should be answered on the space below each question.**
d. All answers are to be **explained in detail.**
e. **Reverse side** of each paper sheet is to **be used for scratch paper.**
f. **Illegible** answers may **not be graded.**
g. **Underline** intermediate answers and **box your final answer**.
h. **Penalty** will be **applied** to any student who **fails to submit** the Exam in full to the instructor within **15 seconds** of the announcement of the **end of the exam.**

1. **(15 points)** Find the Current I Supplied by the 50-V Source.



mesh 1

$-12 i_1 - 8(i_1 - i_2) = 0$ ①

mesh 2

$-8(i_2 - i_1) - 5(i_2) - 2(i_2 - i_3) - 50 = 0$ ②

13

mesh 3

$-2(i_3 - i_2) - 6(i_3 - i_4) + 50 = 0$ ③

mesh 4

$-6(i_4 - i_3) - 3 i_4 = 0$ ④

④ → $-6 i_4 + 6 i_3 - 3 i_4 = 0$

$-9 i_4 = -6 i_3$

$i_4 = \frac{6}{9} i_3 \rightarrow i_4 = 0.666 i_3$

$-20 i_1 + 8 i_2 = 0$

$8 i_1 - 15 i_2 + 2 i_3 = 50$

$2 i_2 - 4.004 i_3 = -50$

$I = i_3 - i_2 = 13.65$

pg. 2

$i_1 = -0.926\,A$

$i_2 = -2.316\,A$

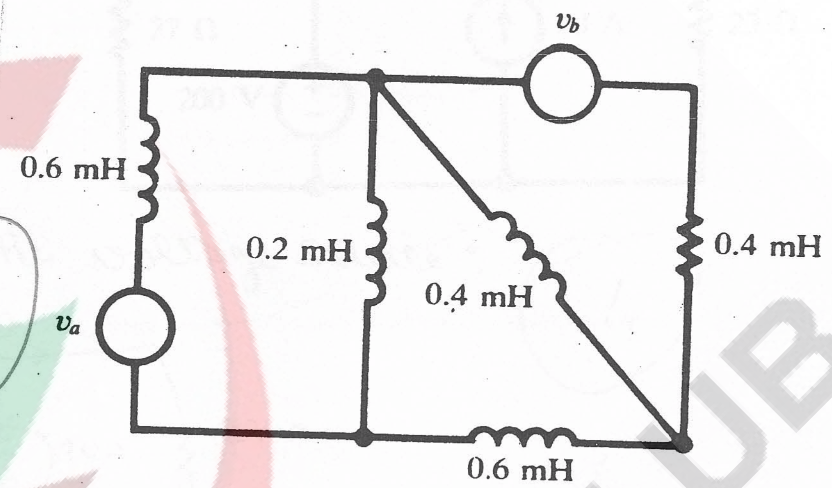
$i_3 = 11.33\,A$

$i_4 = 7.54\,A$

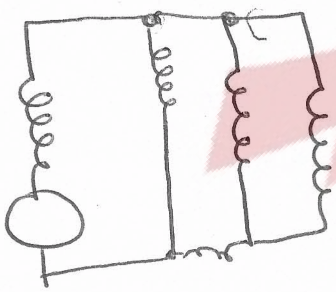
and ~~$I = i_2 + i_3 = -2.316 + 11.33$~~

$I = 9.014\,A$

2. **(5 points)** What is L_{eq} of the Network as seen by each source v_a and v_b?



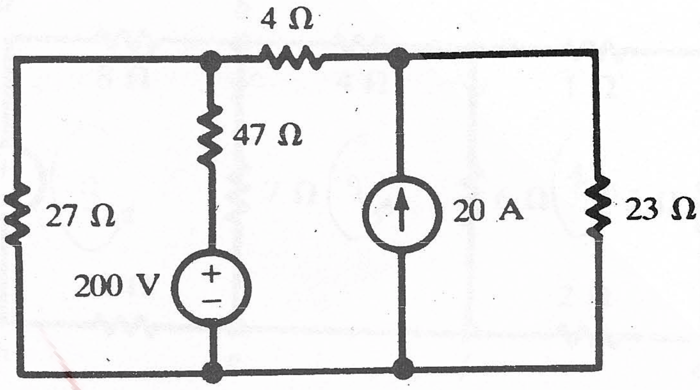
Seen by source v_a



$(0.2 + 0.6) \parallel 0.6 \parallel 0.4 \parallel 0.4$

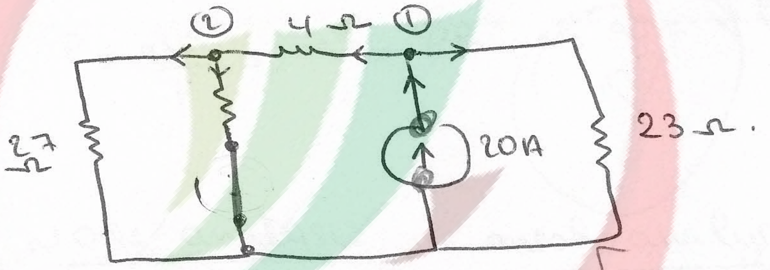
0.12 mH

3. **(15 points)** Compute the Current in the 23Ω resistor by applying the superposition principle. Show all work including equivalent Circuits.



if we remove the voltage source:

4



node analysis: at node 1

$$20 = \frac{v_1}{23} + \frac{v_1 - v_2}{4} \quad (1)$$

at node 2

$$\frac{v_1 - v_2}{4} = \frac{v_2}{47} + \frac{v_2}{27} \quad (2)$$

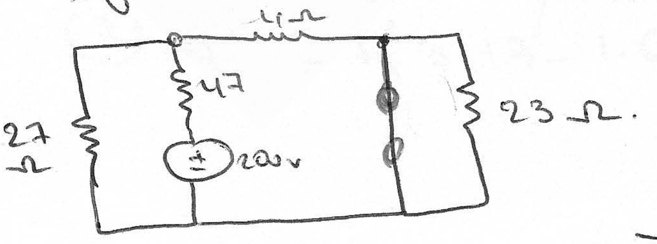
$$\begin{cases} 0.29\, v_1 - 0.25\, v_2 = 20 \\ 0.25\, v_1 - 0.308\, v_2 = 0 \end{cases}$$

$v_1 = 229.67\,V$

$v_2 = 186.42\,V$

$v_1 = 23 \times i \Rightarrow$ $i_1 = \frac{229.67}{23} = 9.98\,A$

If we remove the current source:

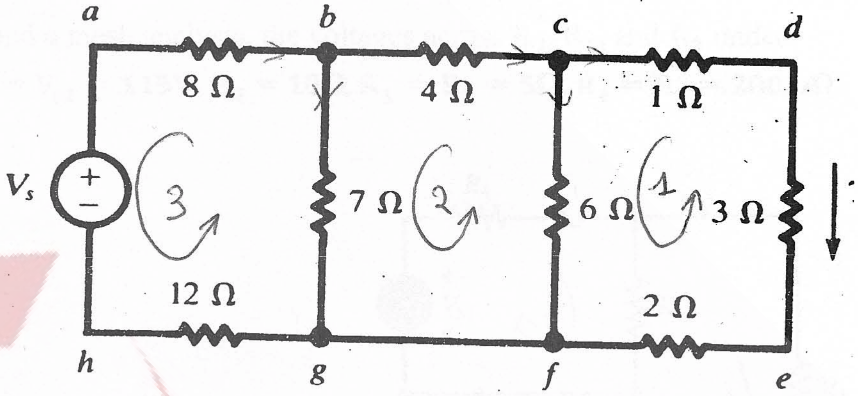


$i_2 = 0$

$\Rightarrow i = i_1 + i_2 = 9.98 + 0 \Rightarrow i = 9.98\,A$

4. **Find the Source voltage V_s that result in power of $P = 3W$ in the 3Ω resistor**

(15 points)



$R = 3\Omega \rightarrow P = 3W$

$P = \frac{v^2}{R} \Rightarrow v^2 = PR \Rightarrow v = \sqrt{PR} \Rightarrow v_{3\Omega} = \sqrt{3\times 3} = 3V$

$i_{3\Omega} = \sqrt{\frac{P}{R}} = \sqrt{\frac{3}{3}} = 1A.$

8

~~Node analysis~~

~~node b~~

~~$\frac{V_s - V_b}{8}$~~

mesh analysis

① $-3i_1 - 1i_1 - 6(i_1 - i_2) - 2i_1 = 0$

② $-6(i_2 - i_1) - 4i_2 - 7(i_2 - i_3) = 0$

③ $-7(i_3 - i_2) - 8(i_3) - V_s - 12i_3 = 0$

① $\rightarrow -3 - 1 - 6 + 6i_2 - 2 = 0$

$6i_2 = 10 \rightarrow i_2 = 1.66A$

② $\rightarrow -6(1.66 - 1) - 4(1.66) - 7(1.66) + 7i_3 = 0$

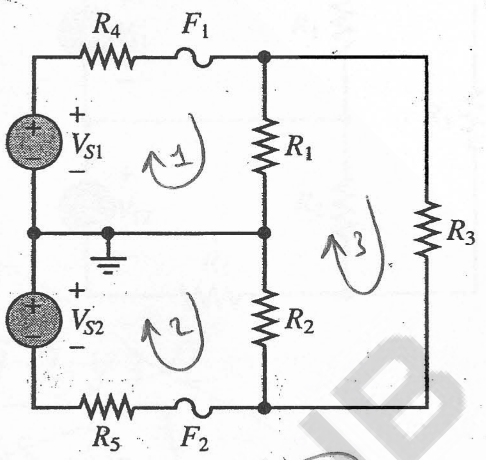
$7i_3 = 22.22 \rightarrow i_3 = 3.17A$

94. V=14

③ $\rightarrow -7(3.17 - 1.66) - (8\times 3.17) - V_s - (12\times 3.17) = 0$

~~$V_s = 7$~~ $V_s = -73.97V$

5. **(20 points)** Under normal condition the fuses F1 and F2 in the circuit below are modeled as a short circuit. However, if excess current flows through a fuse, its element melt and the fuse blows.
Determine, using KVL and a mesh analysis, the voltages across R_1, R_2, and R_3 under normal conditions. $V_{s1} = V_{s2} = 115V$, $R_3 = 10\Omega, R_1 = R_2 = 5\Omega, R_4 = R_5 = 200m\Omega$



~~KVL~~

mesh analysis

$V_{s1} - R_4 i_1 - R_1(i_1 - i_3) = 0$

(1) $115 - 0.2\, i_1 - 5(i_1 - i_3) = 0$

$V_{s2} - R_2(i_2 - i_3) - R_5 i_2 = 0$

(2) $115 - 5(i_2 - i_3) - 0.2\, i_2 = 0$

$-R_1(i_3 - i_1) - R_2(i_3 - i_2) - R_3 i_3 = 0$

(3) $-5(i_3 - i_1) - 5(i_3 - i_2) - 10\, i_3 = 0$

$-5.2 i_1 + 5 i_3 = -115$

$-5.2 i_2 + 5 i_3 = -115$

$5 i_1 + 5 i_2 - 10 i_3 = 0$

12

$i_1 = 42.59 A$; $i_2 = 42.59 A$; $i_3 = 21.29 A$

find the accurate current on R_1 $(i_1 - i_3)$

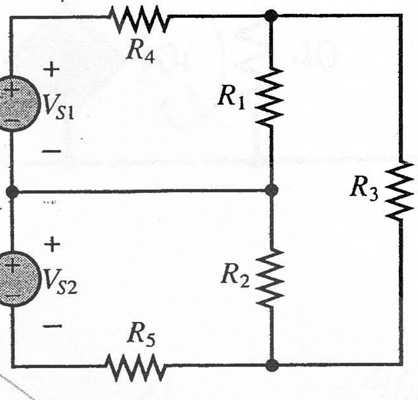
$v_1 = R_1 i_1 = 42.59 \times 5 \Rightarrow v_1 = 212.95 V$

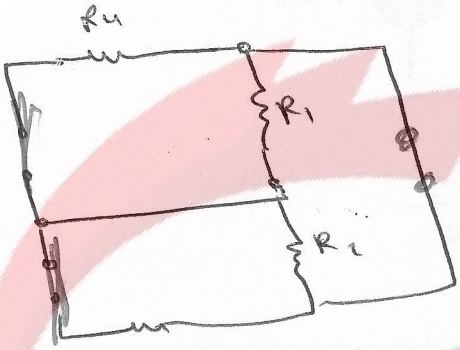
$v_2 = R_2 i_2 = 5 \times 42.59 \Rightarrow v_2 = 212.95 V$

$v_3 = R_3 i_3 = 10 \times 21.29 \Rightarrow v_3 = 212.9 V$

similarly for V_{R_2} $(i_2 - i_3)$

6. (**20 points**) Find the Thevenin equivalent circuit resistance seen by $\mathbf{R_3}$ in the circuit below. Compute the Thevenin voltage and the Norton Current when $\mathbf{R_3}$ is the load.
$V_{s1} = V_{s2} = 450V, R_3 = 10\Omega, R_1 = 7\Omega, R_2 = 5\Omega, R_4 = R_5 = 1\Omega$





Req = (R4 // R1) + (R2 // R5) = 1.2083 Ω
= 0.875 + 5 = 5.875 Ω (crossed out)

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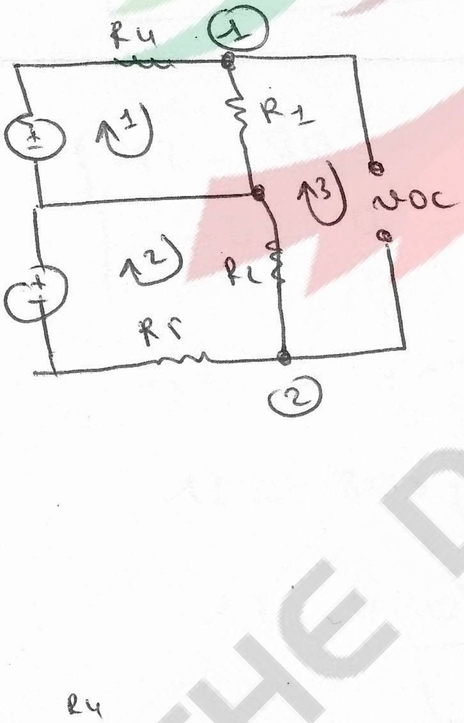


~~mesh analysis~~

at node 1

$\frac{450 - v_1}{1} = \frac{v_1}{7}$

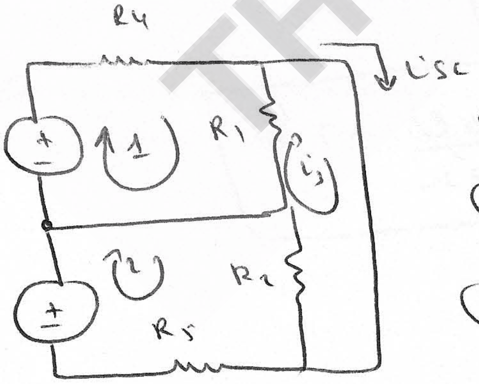
$450 = 1.14\, v_1$

$v_1 = 393.75V$

~~at node 2~~

voc = 393.75 V

V_2? $V_{oc} = V_1 - V_2$



mesh analysis

(1) 450 − 1 i1 − 7(i1 − isc) = 0

(2) 450 − 5(i2 − isc) − 1 i2 = 0

(3) −7(isc − i1) − 5(isc − i2) = 0

−8i1 + 7isc = −450
−6i2 + 5isc = −450
7i1 + 5i2 − 12isc = 0

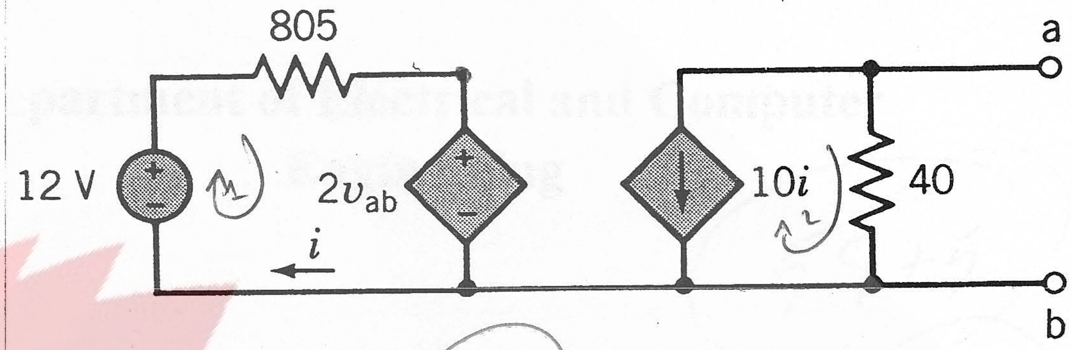
next page continue →

$i_1 = 450\ A$

$i_2 = 450\ A$

~~$i_3 =$~~ $i_{sc} = 450A$

7. **(10 points)** Find the Norton equivalent Circuit.



$R_T = \frac{V_{oc}}{i_{sc}}$

(7)

$i = \frac{12}{805} = 0.014\,A$

$I_{sc} = 10 \times 0.014 = -0.14\,A$

$V_{oc} = -960\,V$

$R_t = \frac{V_{oc}}{i_{sc}} = 6.442\,k\Omega$

$12 - 805i + 2v_{ab} = 0$

$-40 \times 10i = v_{ab} \rightarrow -i = \frac{v_{ab}}{400}$

~~$-(12 - 805i - 2(\ldots i)) = 0$~~

$12 - 805\left(\frac{v_{ab}}{400}\right) - 2v_{ab} = 0$

$12 - 4.015v_{ab} = 0$

$v_{ab} = 2.99\,V$

~~$R_T = \frac{v_{ab}}{i_{sc}} = \frac{2.29}{0.14} = 21.36\,\Omega$~~