EE10 Midterm 2

Department of Electrical Engineering, UCLA

Fall 2017

Instructor: Prof. Gupta

1. Exam is closed book. Calculator and one double sided cheat-sheet is allowed.
2. Cross out *everything* that you don't want me to see. Points will be deducted for everything wrong!
3. No points will be given without proper explanations
4. Time allotted: 75 minutes

Name: Robert

Student ID: 3C

Student on Left

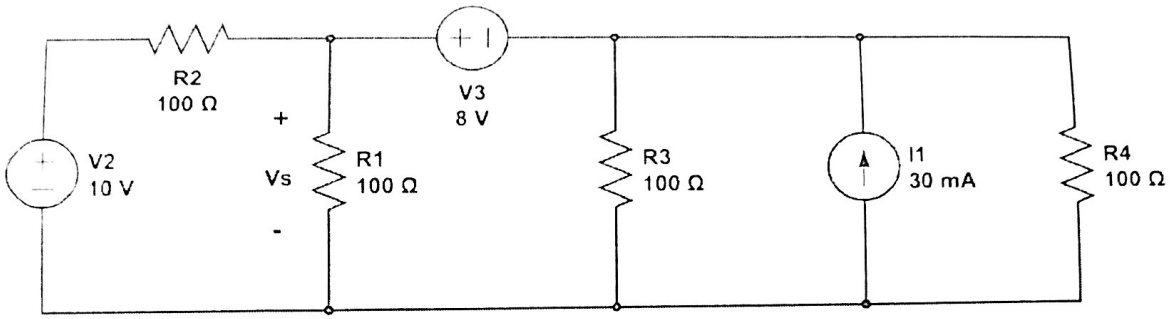
Student on Right: Alex [redacted]ko

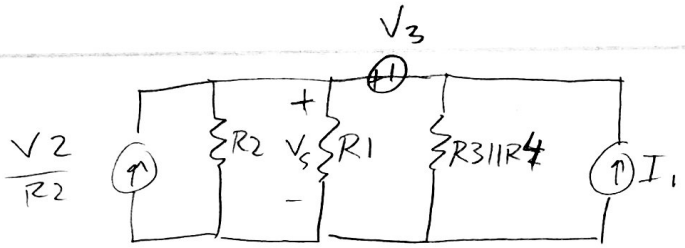
Student in Front: Gezer Domingo

Problem	Maximum Score	Your Score
1	6	6
2	6	6
3	10	10
4	8	8
Total	30	30

Q1. (6 points)

Find Vs by repeating source transformations. Write as few KCL or KVL equations as possible.





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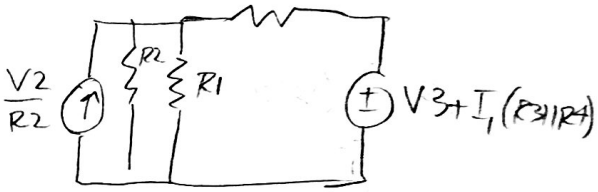
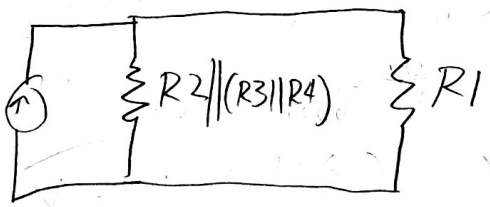


$$\equiv \frac{V2}{R2} + \frac{V3 + I_1(R3 \| R4)}{R3 \| R4}$$



$$V_s = R1\left(\frac{V2}{R2} + \frac{V3 + I_1(R3\|R4)}{R3\|R4}\right)\left(\frac{R2\|(R3\|R4)}{R1 + R2\|(R3\|R4)}\right)$$

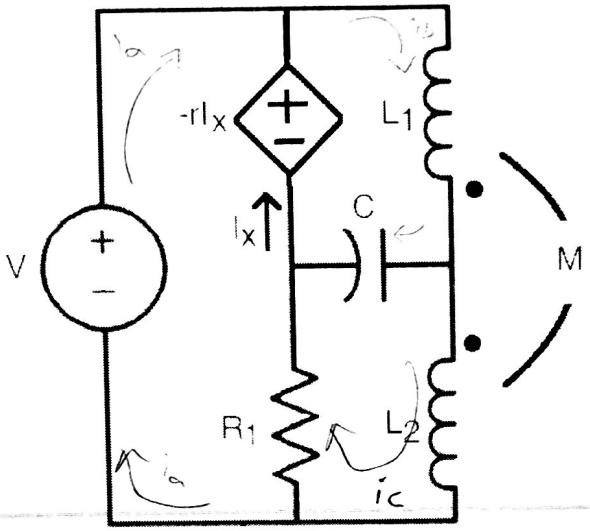
$$V_s = 100\left(\frac{1}{10} + \frac{8 + \frac{3}{100}(50)}{50}\right)\left(\frac{100/3}{400/3}\right)$$

$$V_s = 29\left(\frac{1}{4}\right) = \frac{29}{4}\ V$$

✓

Q2. (6 points)

Apply Loop Variable Analysis (Matrix KVL) to the circuit in the figure. The resulting system of equations should be presented in matrix form.



$I_x = i_b - i_a$

$V = -r(i_b - i_a)$

$-r(i_b - i_a) = L_1 \frac{di_b}{dt}$

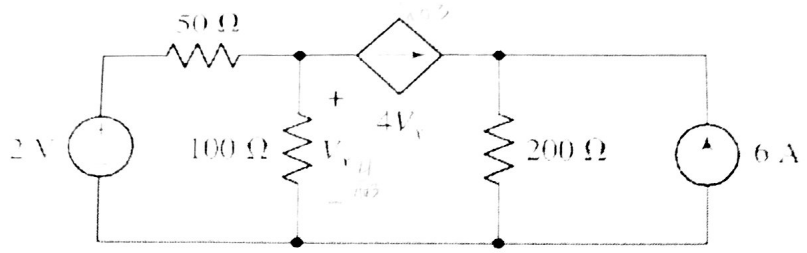
$i_a - i_c$

$$\begin{bmatrix} r+R_1 & -r & -R_1 \\ -r & r+L_1\frac{d}{dt}+\frac{1}{C}\int dt & -M\frac{d}{dt}-\frac{1}{C}\int dt \\ -R_1 & -M\frac{d}{dt}-\frac{1}{C}\int dt & R_1+L_2\frac{d}{dt}+\frac{1}{C}\int dt \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} V \\ 0 \\ 0 \end{bmatrix}$$

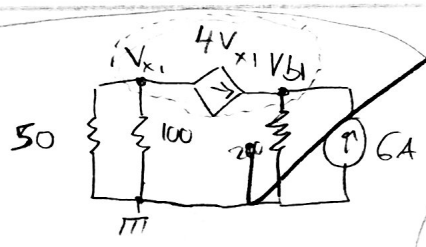
6

Q3. 10 points

Use superposition to find Vx below.



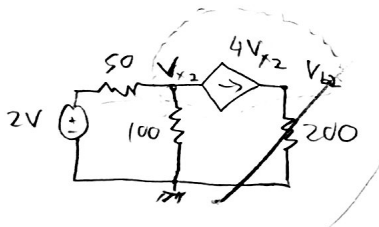
1) 2V shorted



$$V_{x1} = \frac{100}{3}\left(6 - \frac{V_{b1}}{200}\right)$$

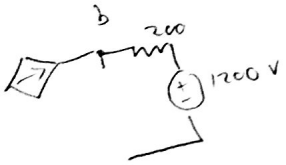
$$\frac{V_{x1}}{50} + \frac{V_{x1}}{100} + \frac{V_{b1}}{200} = 6A$$ ← cutset around dependant source

2) 6A removed



$$\frac{V_{x2} - 2}{50} + \frac{V_{x2}}{100} + \frac{V_{b2}}{200} = 0$$

$$V_{x2} = \frac{100}{3}\left(\frac{1}{25} - \frac{V_{b2}}{200}\right)$$



$$V_{x1} + V_{x2} = V_x = \frac{100}{3}\left(\frac{1}{25} - \frac{V_{b1}}{200} + 6 - \frac{V_{b2}}{200}\right)$$

$$V_x = \frac{100}{3}\left(\frac{151}{25} - \frac{V_b}{200}\right)$$

from here I proceeded to lower left box. Using that answer, I tested it in the above equation

$$V_b = \left(\frac{16}{403} + 6\right)200 = 1207.94 \sim$$

$$\frac{100}{3}\left(\frac{151}{25} - \frac{1207.94}{200}\right) = \frac{4}{403}\ V$$

They concur.

1) $\frac{V_{x1}}{50} + \frac{V_{x1}}{100} + 4V_{x1} = 0 \quad V_{x1} = 0$

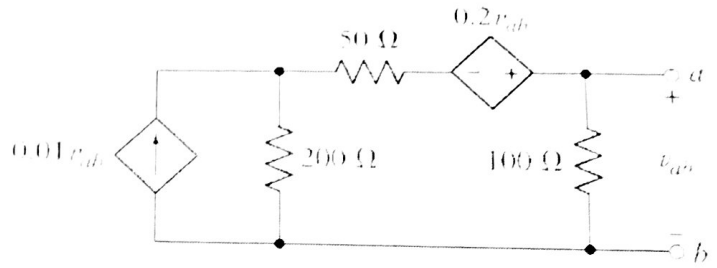
2) $\frac{V_{x2} - 2}{50} + \frac{V_{x2}}{100} + 4V_{x2} = 0$

$$V_{x2} = \frac{1}{25}\left(\frac{100}{403}\right) = \frac{4}{403}\ V$$

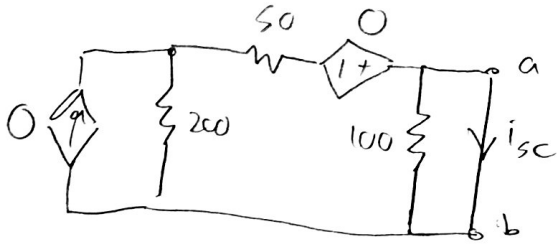
$$V_x = \frac{4}{403}\ V$$

Q4. 8 points

Find the Thevenin Equivalent between *a* and *b*.



i_{sc}:



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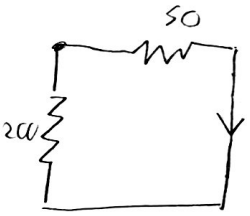
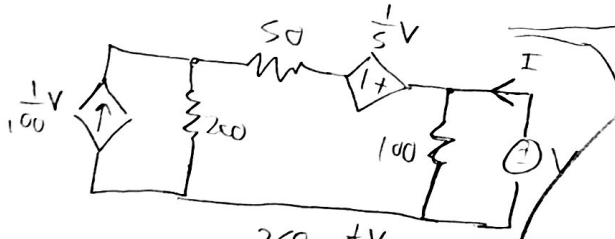


$i_{sc} = 0$

$i_{sc} = \frac{V_{Th}}{R_{Th}}$ $\quad V_{Th} = 0\,V$

R_{Th}:



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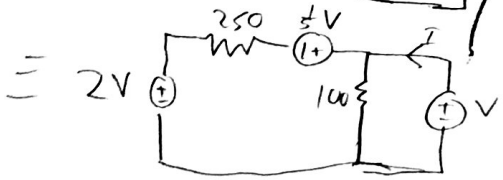
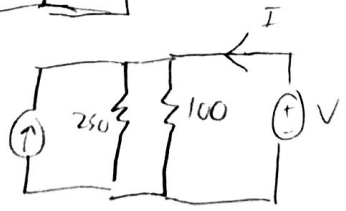
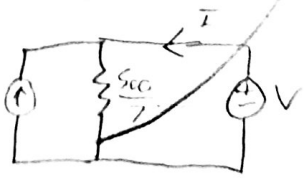


$\frac{2.2V}{250}$



$\equiv \frac{2.2V}{250}$



$V = \frac{500}{7}\left(I + \frac{2.2V}{250}\right)$

$V = \frac{500}{7}I + \frac{22}{35}V$ $\quad V = \frac{2500}{13}I$ $\quad R_{TH} = \frac{2500}{13}\Omega$