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: [redacted]

Student ID: [redacted]

Student on Left: [redacted]

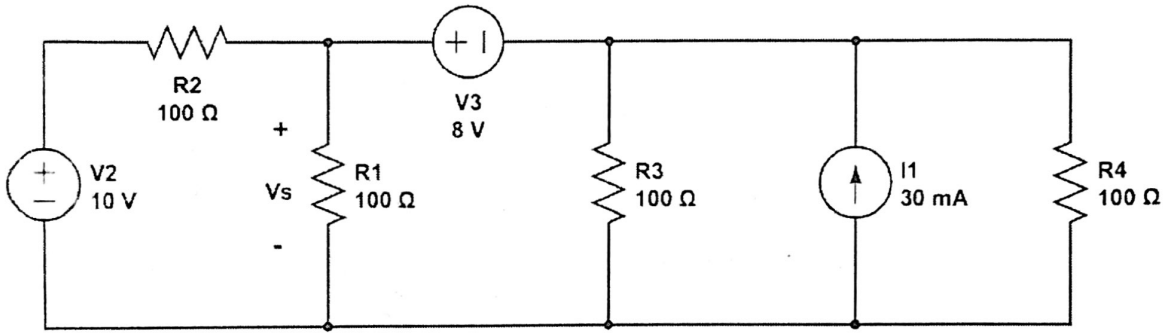
Student on Right: [redacted]

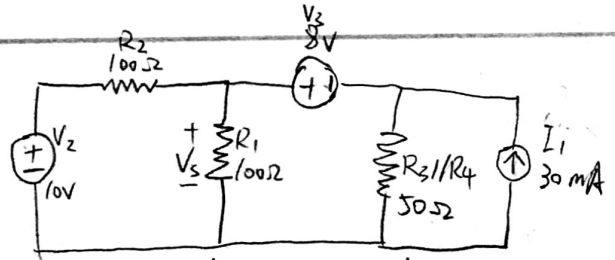
Student in Front: [redacted]

| Problem | Maximum Score | Your Score |
|---|---|---|
| 1 | 6 | 6 |
| 2 | 6 | 5 |
| 3 | 10 | 10 |
| 4 | 8 | 4 |
| Total | 30 | 25 |

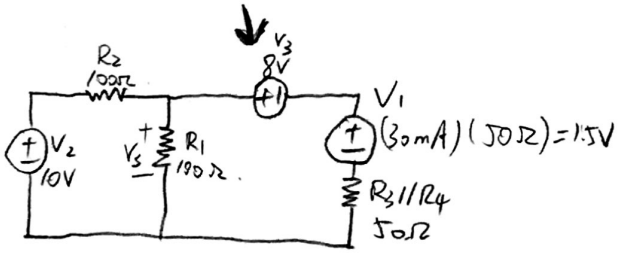
**Q1. (6 points)**

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



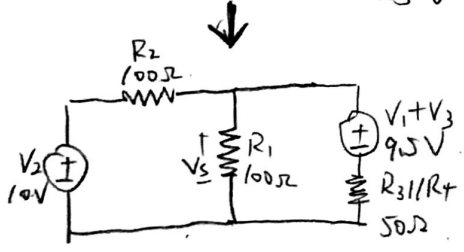




$R_3 // R_4 = \frac{1}{\frac{1}{100}+\frac{1}{100}} = \frac{1}{\frac{1}{50}} = 50\Omega$




$V_1 = I_1(R_3 // R_4) = (30mA)(50\Omega)$

$= 1.5\,V$




$V_1 + V_3 = 9.5\,V$

Assume $V_b = 0$.

write KCL:

$$\frac{V_b}{100} + \frac{V_b}{100} + \frac{V_b}{50} - 0.1 - 0.19 = 0$$

$$\frac{V_b}{25} = 0.29$$

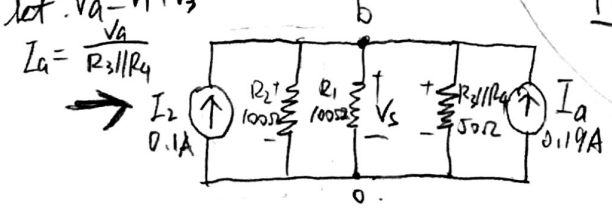
$$V_b = 25 \cdot 0.29 = 7.25\,V$$

since $V_b = V_s$

$$\boxed{V_s = 7.25\,V}$$

let $V_a = V_1 + V_3$

$I_a = \frac{V_a}{R_3 // R_4}$

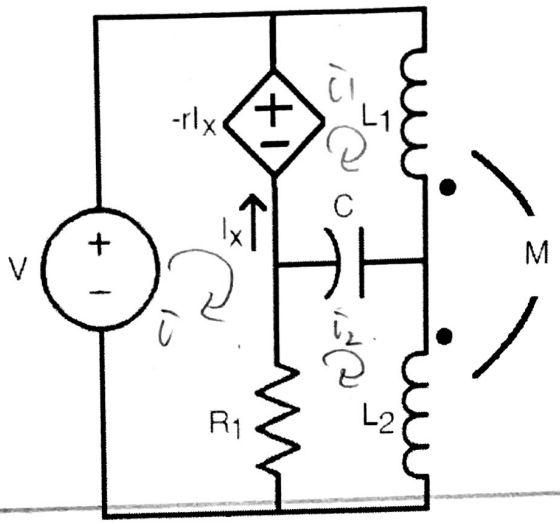



$$I_2 = \frac{10V}{100\Omega} = 0.1A$$

$$I_a = \frac{9.5V}{50\Omega} = 0.19A$$

**Q2. (6 points)**

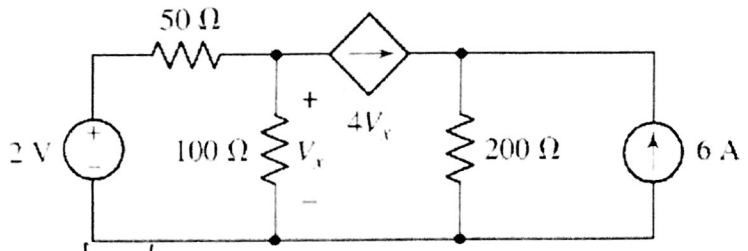
Apply Loop Variable Analysis (Matrix KVL) to the circuit in the figure. The resulting system of equations should be presented in matrix form.



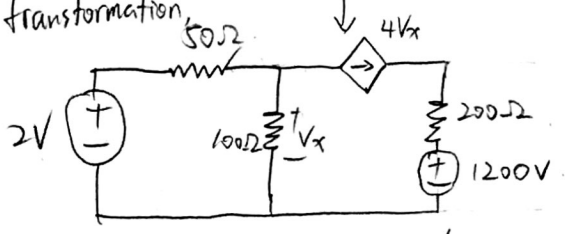

$$\begin{bmatrix} V \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} R_1+r & -r & \frac{1}{C}\int dt \\ -r & r+\frac{1}{C}\int dt + L_1\frac{d}{dt} & \frac{1}{C}\int dt - M\frac{d}{dt} \\ -R_1 & -\frac{1}{C}\int dt - M\frac{d}{dt} & R_1+\frac{1}{C}\int dt + L_2\frac{d}{dt} \end{bmatrix} \begin{bmatrix} i \\ i_1 \\ i_2 \end{bmatrix}$$

**Q3. 10 points**

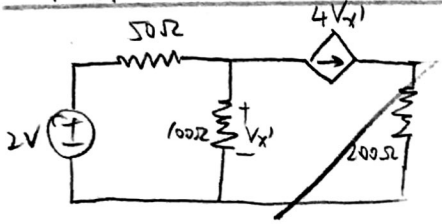
Use superposition to find Vx below.

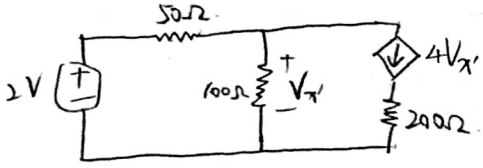


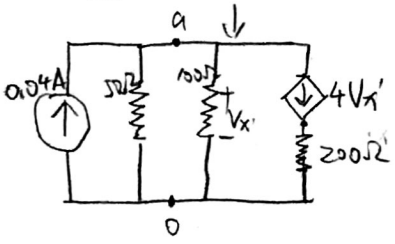

By source transformation




First




Assume $V_o = 0$

write KCL:

$$\frac{V_a}{50} + \frac{V_a}{100} - 0.04 + 4V_{x'} = 0$$

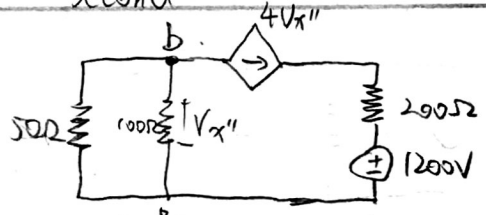
since $V_a = V_{x'}$

$$\frac{V_{x'}}{50} + \frac{V_{x'}}{100} + 4V_{x'} = 0.04$$

$$\frac{3V_{x'}}{100} + \frac{400}{100}V_{x'} = 0.04$$

$$V_{x'} = \frac{4}{403}\ V$$

Second




write KCL for b

$$\frac{V_b}{50} + \frac{V_b}{100} + 4V_{x''} = 0$$

since $V_b = V_{x''}$

$$\frac{V_{x''}}{50} + \frac{V_{x''}}{100} + 4V_{x''} = 0$$

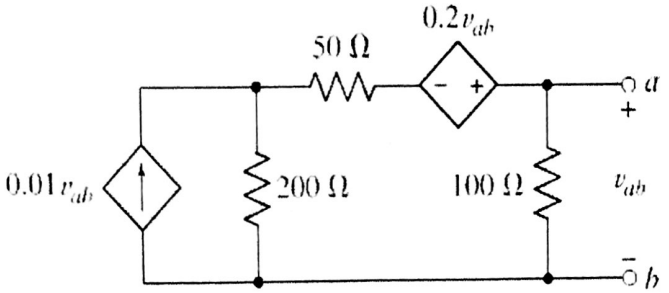
$$\frac{3V_{x''}}{100} + \frac{400}{100}V_{x''} = 0$$

$$V_{x''} = 0\ V$$

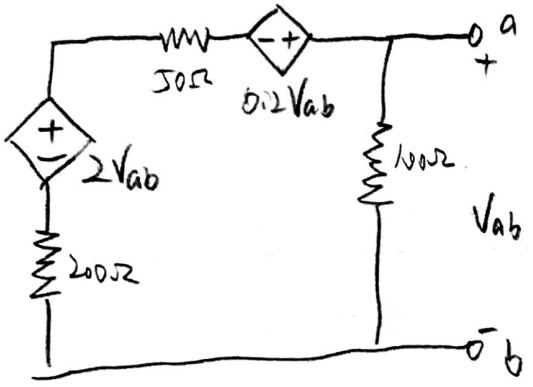
$$V_x = V_{x'} + V_{x''} = \frac{4}{403} + 0 = \frac{4}{403}\ V$$

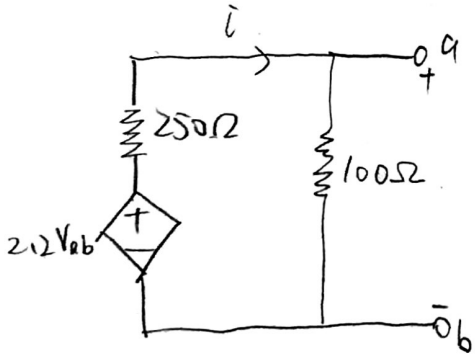
**Q4. 8 points**

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




By source transformation,




$2.2V_{ab} - i \cdot 250 - i \cdot 100 = 0$

$i = \frac{2.2V_{ab}}{350}$

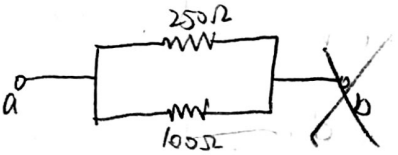
$V_{ab} = \frac{2.2V_{ab}}{250+100} \cdot 100$

$V_{ab} = \frac{22}{35} V_{ab}$

$V_{ab} = 0 \cdot V = V_T$

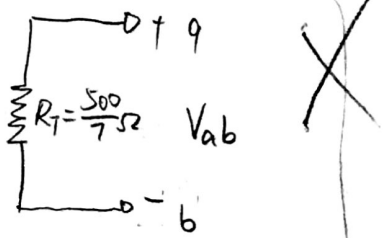
Zero out the dependent sources because they are supplying 0 volts.

we have




$R_T = \frac{1}{\frac{1}{100}+\frac{1}{250}} = \frac{500}{7}\Omega$

then the Thevenin Equivalent circuit is




$V_T = 0\ V$

$R_T = \frac{500}{7}\Omega$