EE 10 Circuit Analysis I

Fall 2009

Midterm Examination

Closed Book

Name:

Student ID No.:

1) 10 / 10

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4) 9 / 10

TOTAL 39 **/ 40**

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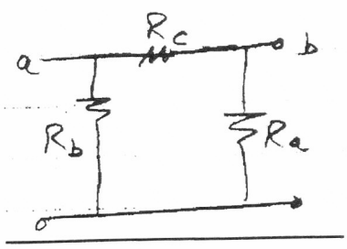
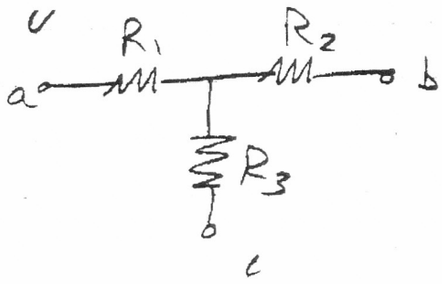




$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

$$R_1 = \frac{R_bR_c}{R_a + R_b + R_c}$$

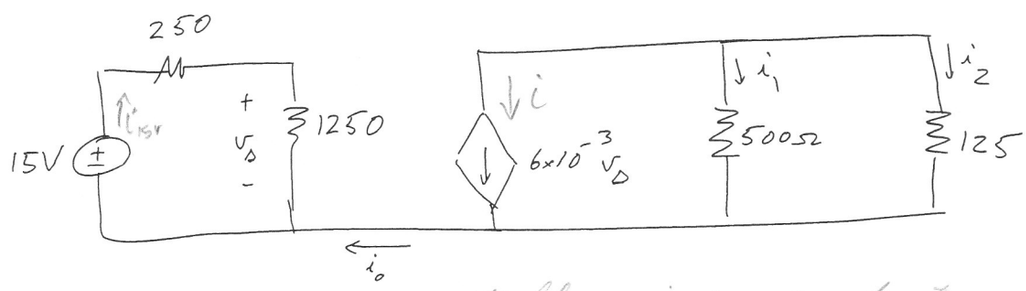
$$R_2 = \frac{R_cR_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_aR_b}{R_a + R_b + R_c}$$

10 pts

Problem 1.

Find the current i_o, i_1, and i_2.



$i_o = 0$ because current cannot flow in one conductor current need to conductors to circulate between the two parts of the circuit

$$i_{15V} = \frac{15}{250+1250} = 0.01\,A.$$

$$V_\Delta = 0.01(1250) = 12.5\,V.$$

$$i = 6\times10^{-3}(12.5) = 0.075\,A.$$

+10

$$i_1 = -\frac{R_{eq}}{500\Omega}\cdot i = -\frac{\frac{500\times125}{500+125}}{500}\cdot 0.075 = -0.015\,A \; i_1$$

$$i_2 = -\frac{R_{eq}}{125}\cdot i = -\frac{\frac{500\times125}{500+125}}{125}\cdot 0.075 = -0.06\,A \; i_2$$

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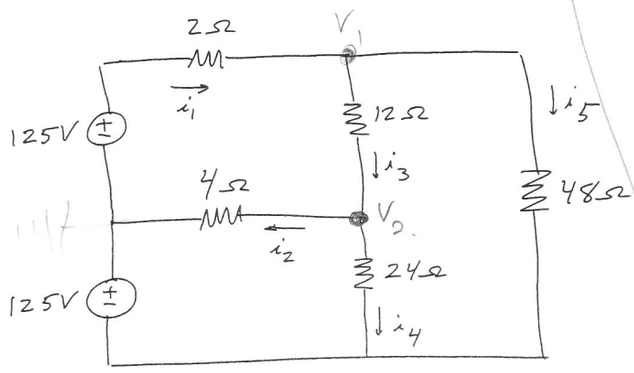
Problem 2.

10 pts

Use the node voltage method to find currents $i_1 - i_5$.



mesh current method to confirm

$-125 + 2I_A + 12(I_A - I_C) + 4(I_A - I_B) = 0$

$-125 + 4(I_B - I_A) + 24(I_B - I_C) = 0$

$48I_C + 24(I_C - I_B) + 12(I_C - I_A) = 0$

$I_A = 12.36$

$I_B = 10.25$

$I_C = 4.643$

$$\frac{V_1 - 125}{2} + \frac{V_1 - V_2}{12} + \frac{V_1 + 125}{48} = 0$$

$$\frac{V_2}{4} + \frac{V_2 - V_1}{12} + \frac{V_2 + 125}{24} = 0$$

$$V_1\left(\frac{1}{2} + \frac{1}{12} + \frac{1}{48}\right) + V_2\left(\frac{-1}{12}\right) - \frac{125}{2} + \frac{125}{48} = 0 \quad (+10)$$

$$V_1\left(\frac{-1}{12}\right) + V_2\left(\frac{1}{4} + \frac{1}{12} + \frac{1}{24}\right) + \frac{125}{24} = 0$$

$$0.6041666\,V_1 - 0.08333\,V_2 = 59.89583$$

$$-0.08333\,V_1 + 0.375\,V_2 = -5.20833$$

$$\Rightarrow V_1 = 100.29\,V$$

$$V_2 = 8.399\,V$$

$$i_1 = -\left(\frac{V_1 - 125}{2}\right) = -\left(\frac{100.29 - 125}{2}\right) = 12.355\,A \quad i_1$$

$$i_2 = \frac{V_2}{4} = \frac{8.399}{4} = 2.01\,A \quad i_2$$

see next page.

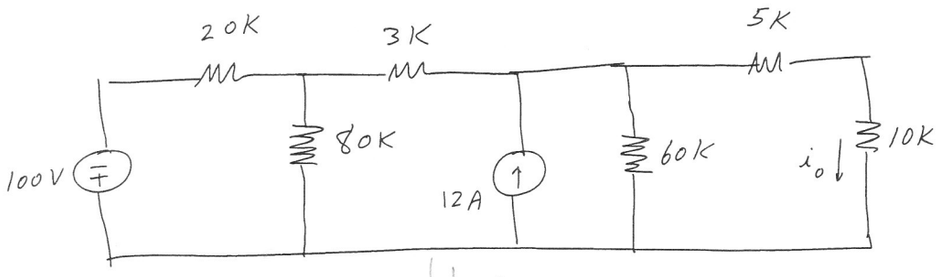
$$i_3 = \frac{V_1 - V_2}{12} = \frac{100.29 - 8.399}{12} = \boxed{7.66\ A}\ i_3$$

$$i_4 = \frac{V_2 + 125}{24} = \frac{8.399 + 125}{24} = \boxed{5.558\ A}\ i_4$$

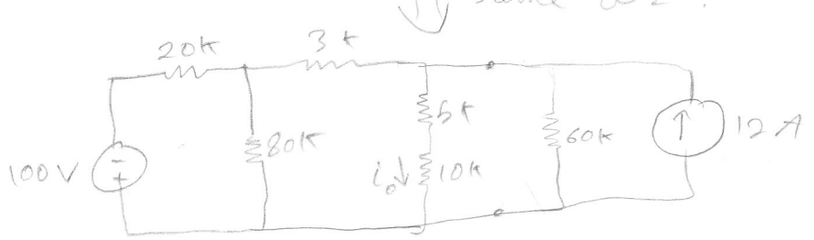
$$i_5 = \frac{V_1 + 125}{48} = \frac{100.29 + 125}{48} = \boxed{4.69\ A}\ i_5$$

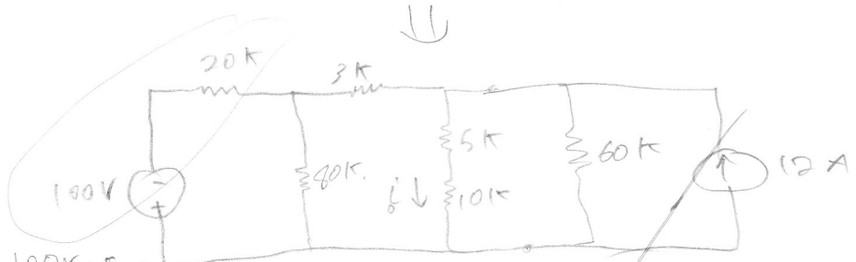
Problem 3.

10 pts Find i_o using a series of source transformations. Be sure to redraw the circuit at each stage.

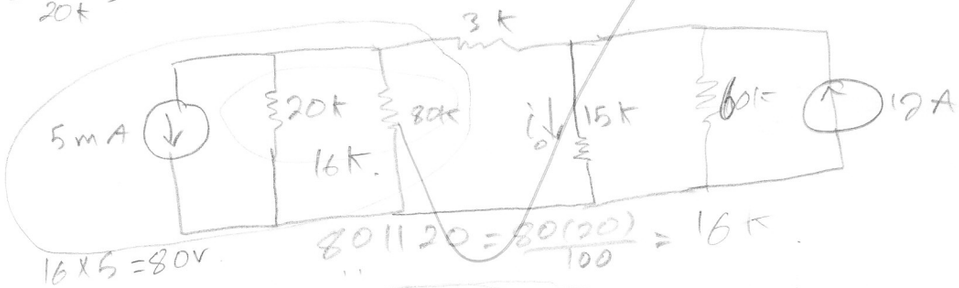


Same as.



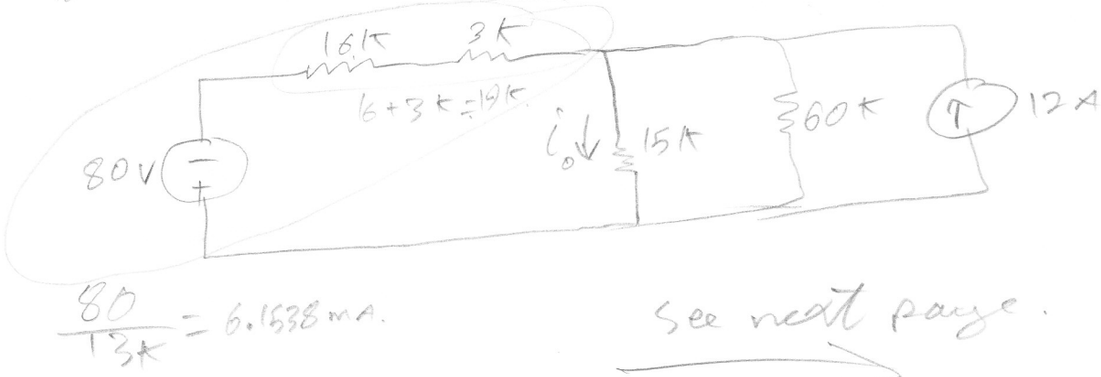


$\frac{100V}{20k} = 5mA$



$16 \times 5 = 80V$

$80 \| 20 = \frac{80(20)}{100} = 16k$



$\frac{80}{13k} = 6.1538mA.$

See next page.

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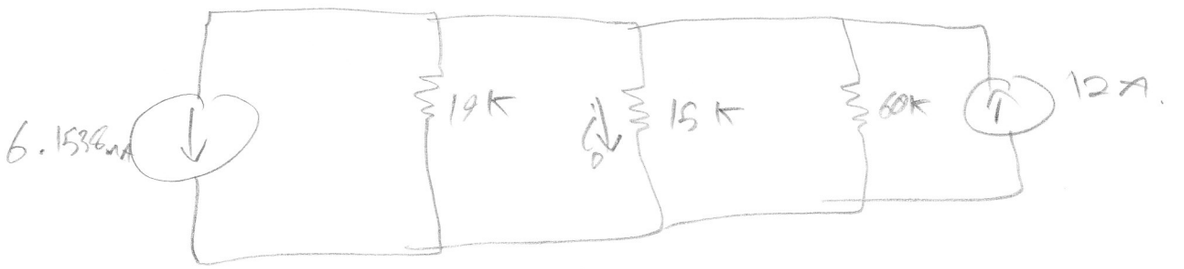
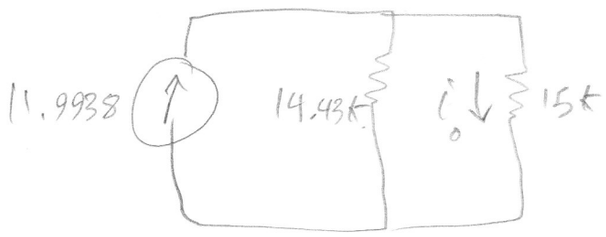


$60 \parallel 19 = \frac{60 \times 19}{79} = 14.43\,K$



+10

$$i_o = \frac{R_{eq}}{15K} \cdot (11.9938)$$

$$= \frac{14.43}{14.43+15} \cdot (11.9938) = 5.88\ A$$

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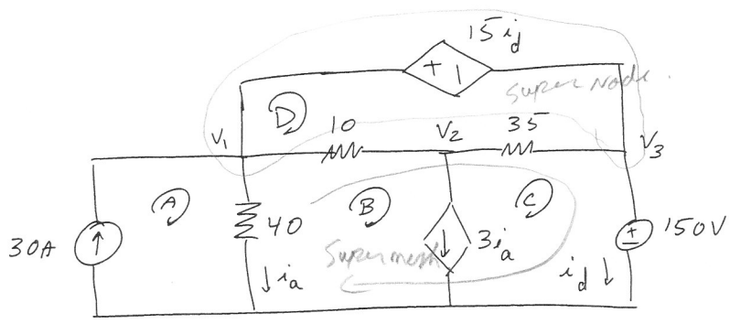
Problem 4.

10 pts

5 pts (a) For the circuit shown below, write but do not solve, the Mesh current equations in terms of I_A, I_B, I_C, and I_D. You should have 4 equations in all.

5 pts (b) For the circuit shown below, write, but do not solve, the Node voltage equations in terms of V_1, V_2, and V_3. You should have 3 equations in terms of V_1, V_2, V_3.



(a).

$I_A = 30\,A$.

Super mesh. $40(I_B - I_A) + 10(I_B - I_D) + 35(I_C - I_D) + 150 = 0$.

$10(I_D - I_B) + 15 i_d + 35(I_D - I_B) = 0$. ①

$3 i_a = I_B - I_C$ ②

$i_a = 40(I_A - I_B)$ ③ ?

$i_d = I_C$ ④.

Substitute ④ into ① and ③ into ②.

$10(I_D - I_B) + 15 I_C + 35(I_D - I_B) = 0$.

$120(I_A - I_B) = I_B - I_C$ ×

Final mesh eqn:

$I_\alpha = 30$ ✓

$-40 I_A + 50 I_B + 35 I_C - 45 I_D = -150$ ✓

$-45 I_B + 15 I_C + 45 I_D = 0$ ✓

$120 I_A - 121 I_B + I_C = 0$ ✗ (+4)

(b) From the Super Node: $-30 + \frac{V_1}{40} + \frac{V_1 - V_2}{10} + \frac{V_3 - V_2}{35} + i_d = 0$ (1)

$\frac{V_2 - V_1}{10} + \frac{V_2 - V_3}{35} + 3 i_a = 0$ (4)

$V_1 - V_3 = 15 i_d \Rightarrow i_d = \frac{V_1 - V_3}{15}$ ✓ (2)

(2) into (1).

$\frac{V_1}{40} + \frac{V_1 - V_2}{10} + \frac{V_3 - V_2}{35} + \frac{V_1 - V_3}{15} = 30$

$i_a = \frac{V_1}{40}$ ✓ (3)

(3) into (4).

$\frac{V_2 - V_1}{10} + \frac{V_2 - V_3}{35} + 3\frac{V_1}{40} = 0$

Also $V_3 = 150\,V$

see next page.

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Node voltage eqns:

$$V_1\left(\frac{1}{40}+\frac{1}{10}+\frac{1}{15}\right)+V_2\left(\frac{-1}{10}-\frac{1}{35}\right)+V_3\left(\frac{1}{35}-\frac{1}{15}\right)=30$$

$$V_1\left(-\frac{1}{10}+\frac{3}{40}\right)+V_2\left(\frac{1}{10}+\frac{1}{35}\right)+V_3\left(\frac{-1}{35}\right)=0$$

$$V_3 = 150$$

+5