UCLA
Department of Electrical Engineering
EE10 – Spring 2010
Midterm
April 28th, 2010

1. Exam is closed book. You are allowed **one 8 ½ x 11" double-sided cheat sheets.**
2. Calculators are allowed.
3. Show the intermediate steps leading to your final solution for each problem.
4. **There will be no partial credit for work done correctly using a wrong answer from a previous part of a question. For example, if part a) is wrong and part b) depends on part a), then part b) will be wrong. Therefore, be very careful and double check your work!**
5. You can use both sides of the sheets to answer questions.
6. Write your final answers in the BOX and use correct units for your answers.

Problem	Maximum Score	Your Score	Comments
1. a)	2	2	
1. b)	2	1	
1. c)	2	1	
1. d)	2	1	
1. e)	2	2	
2. a)	4	4	
2. b)	3	3	
2. c)	3	3	
3. a)	7	0	
3. b)	7	6	
3. c)	6	0	
4.	10	10	
	Total: 50		
		Total 33	

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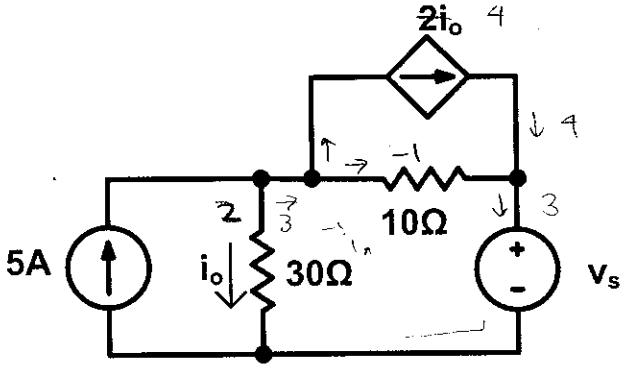
1. The current i_o in the circuit is 2A. **[10 pts]**



a) Calculate v_s (2 pts)

$3A = i_1 + 4$

$i_1 = -1\ A$

$-5 = 4 + I_A$

$I_A = -7$

$I_A = 7$

$-V_S + 1A(10\Omega) + 2A(30\Omega) = 0$

$V_S = 10 + 60 = 70$

2

$v_s = 70V$

b) Calculate the power of the ***independent VOLTAGE*** source and circle if it is ***absorbed*** **OR** ***delivered***. (2 pts)

$P_{V_s} = IV$

$= (3A)(70V)$

$= 210\ W$

1

Power (absorbed , delivered) = 210 W

c) Calculate the power of the ***independent CURRENT*** source and circle if it is ***absorbed*** **OR** ***delivered***. (2 pts)

$P = IV$

$V_S + V_{5A} - 1A \cdot 10\Omega = 0$

$70 + V_{5A} - 10 = 0$

$V_{5A} = -60$

$P = 5 \cdot (-60)$

$= -300\ W$

1

Power (absorbed, delivered) = -300 **W**

d) Calculate the power of the ***CONTROLLED current*** source and circle if it is ***absorbed*** **OR** ***delivered***. (2 pts)

$V_S - 2A(30\Omega) + V_{4A} = 0$

$V_{4A} = 60 - V_S = 60 - 70$

$V_{4A} = -10$

$10 + V_4 = 0$

$V_4 = -10$

$P = IV = 4 \cdot (-10)$

$= -40$

1

Power (absorbed, delivered) = -40 W

e) Calculate the total power dissipated in the ***two resistors***. (2 pts)

$P = I^2R$

$= 2^2 \cdot 30$

$= 4 \cdot 30 = 120\ W$

$P = I^2R$

$= (-1)^2 \cdot 10$

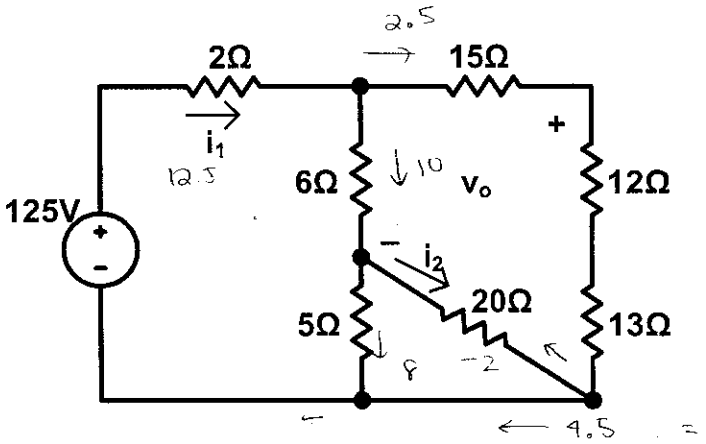
$= 10$

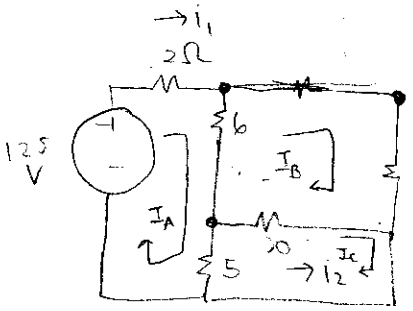
$P_{total} = 130$

2

Total power $= 130$ W

2. Find a) i_1, b) i_2 and c) v_o in the circuit. **[10 pts]**





$I_A = i_1$

$I_2 = I_C - I_B$

$0 = -125 + 2I_A + 6(I_A - I_B) + 5(I_A - I_C)$

$125 = 13I_A - 6I_B - 5I_C$

I_B: $0 = 40I_B + 20(I_B - I_C) + 6(I_B - I_A)$

$0 = 66I_B - 6I_A - 20I_C$

$0 = 6I_A - 66I_B + 20I_C$

I_C: $0 = 20(I_C - I_B) + 5(I_C - I_A)$

$0 = 25I_C - 20I_B - 5I_A$

$625 = -25I_C + 30I_B + 6I_A$

$625 = -50I_B + 60I_A$

$125 = -10I_B + 12I_A$

$I_B = \frac{12I_A - 125}{10}$

$500 = 52I_A - 24I_B - 20I_C$

$500 = 58I_A - 90I_B$

$500 = 58I_A - 9(12I_A - 125)$

$500 = 58I_A - 108I_A + 1125$

$-625 = -50I_A$

$I_A = 12.5$

$I_B = 2.5$

$I_C = 4.5$

$i_1 = 12.5\ A$

$i_2 = 2\ A$

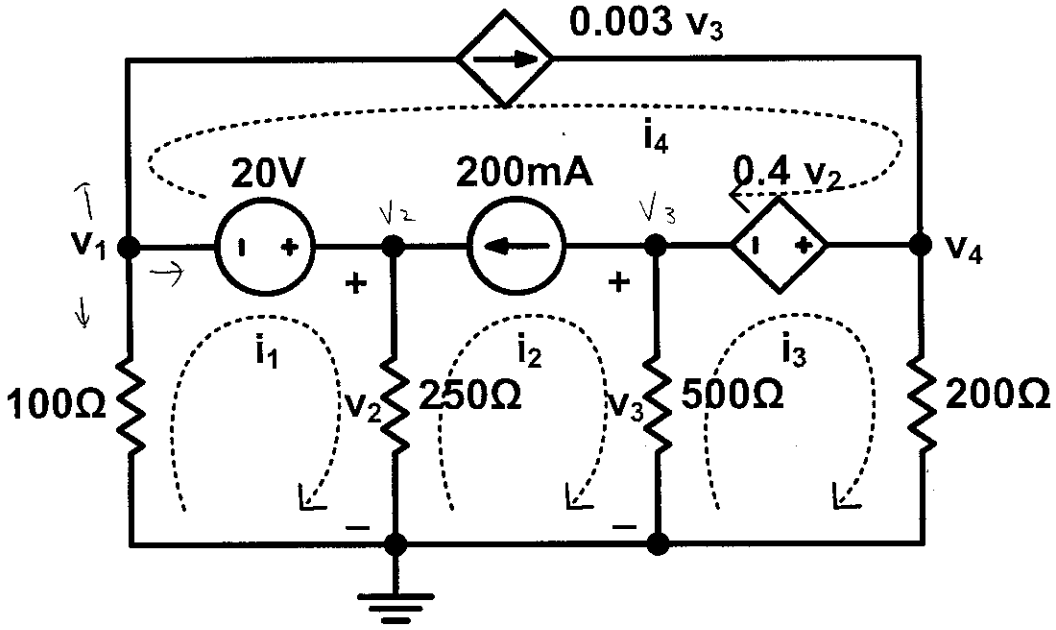
$V_o = 15 \cdot (-1.5) + 6 \cdot 10$

$= -37.5 + 60$

$= 22.5$

a) $i_1 =$ 12.5 A
b) $i_2 =$ 2 A
c) $v_o =$ 22.5 V

3. Node-voltage & mesh-current method **[20 pts]**



a) Make equations to find v_1, v_2 , v_3 and v_4 using the node-voltage method. Use the reference node and the notation in the circuit. (7 pts)

$\frac{V_1}{100} + .003V_3 = 0$ ✗ $V_1 = -0.3$

$\frac{V_2}{250} - 0.002A = 0$ ✗ $V_2 = 0.5$ V

$-.002A + \frac{V_3}{500} = 0$ $V_3 = -2.5$ V

$-0.003V_3 + \frac{V_4}{200} = 0$

$-.003(-2.5) + \frac{V_4}{200} = 0$

$V_4 = -1.5$ V

$i_1 = 0.00003$

EQN1:	$V_1/100 + 0.003V_3 = 0$ ✗
EQN2:	$V_2/250 - 0.2A = 0$ ✗
EQN3:	$-0.2A + V_3/500 = 0$ ✗
EQN4:	$-0.003V_3 + V_4/200 = 0$

$0.200 = i_4 - i_2$

$i_2 = i_4 - 0.2$

b) Make equations to find i_1, i_2, i_3 and i_4 using the mesh-current method. Use the notation in the circuit. (7 pts)

$V_2 = (i_1 - i_2)250$

i_1: $100i_1 - 20 + 250(i_1 - i_2) = 0$

i_2: $250(i_2 - i_1) + 500(i_2 - i_3) = 0$

i_3: $500(i_3 - i_2) - 0.4V_2 + 200i_3$

$500i_3 - 500i_2 - 100(i_1 - i_2) + 200i_3 = 0$

$700i_3 - 400i_2 - 100i_1 = 0$ $\quad 7i_3 - 4i_2 - i_1 = 0$

$750i_2 - 250i_1 - 500i_3 = 0$ $\quad -2i_3 + 3i_2 - i_1 = 0$

$V_3 = 500(i_2 - i_3)$

$20 = 350i_1 - 250i_2$ $\quad 14i_3 - 8i_2 - 2i_1 = 0$

$-14i_3 - 21i_2 + 7i_1 = 0$

$2 = 35i_1 - 25i_2$ $\quad -29i_2 + 5i_1 = 0$

$i_4 = 0.003V_3$

$2 = 35(29/5)i_2 - 25i_2$ $\quad i_1 = 29/5\, i_2$

$i_2 = 2/178 = 0.01126$

EQN1:	$100i_1 - 20 + 250(i_1 - i_2) = 0$ ✓
EQN2:	$250(i_2 - i_1) + 500(i_2 - i_3) = 0$ ✗
EQN3:	$500(i_3 - i_2) - 0.4(i_1 - i_2)250 + 200i_3 = 0$ ✓
EQN4:	$i_4 = 0.003[500(i_2 - i_3)]$ ✓

c) Find power absorbed by 20V source by solving equations from a) or b). (6 pts)

$i_4 = 1.5i_2 - 1.5i_3$

$0.2 = i_4 - i_2$

$i_4 = 1.5(i_4 - 0.2) - 1.5i_3$

$1.5i_3 + 0.3 = 0.5i_4$

$i_4 = 3i_3 + 0.6$

i_1: $20 = 350i_1 - 250i_2$ $\quad 2 = 35i_1 - 25i_2$

i_3: $700i_3 - 400i_2 - 100i_1 = 0$

$-i_1 + 4i_2 + 7i_3 = 0$

$i_1 - 3i_2 + 2i_3 = 0$

$-7i_2 + 9i_3 = 0$

i_2: $750i_2 - 250i_1 - 500i_3 = 0$

$i_1 - 3i_2 + 2i_3 = 0$

$i_1 = \frac{2 + 25i_2}{35}$ $\quad i_3 = \frac{7}{9}i_2$

$\frac{2 + 25i_2}{35} - 3i_2 + \frac{14}{9}i_2 = 0$

$18 + 225i_2 - 945i_2 + 490i_2 = 0$

$18 = -1660i_2$

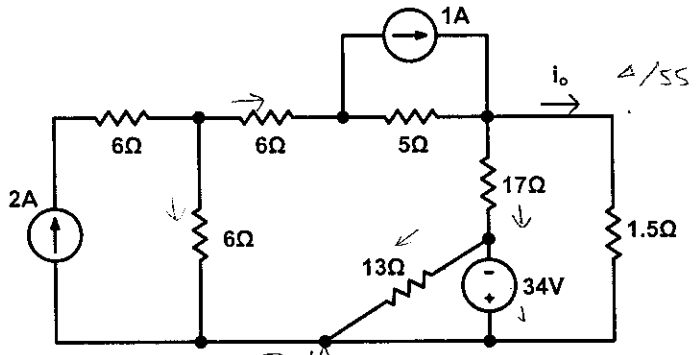
$i_2 = -0.0108$

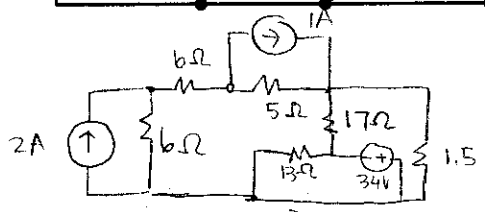
$i_1 = 0.0494$

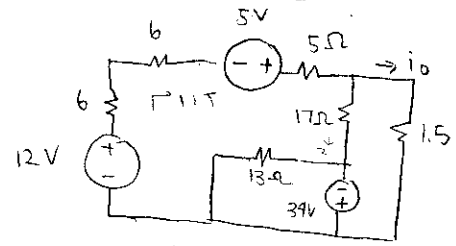
Power absorbed $= 0.988$ W

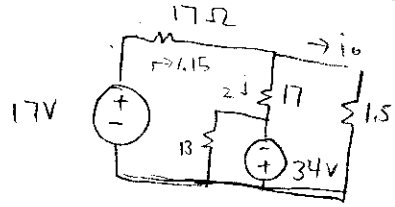
4. Source transformation **[10 pts]**

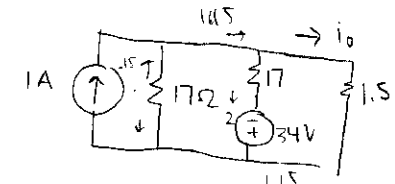
Use a series of source transformation to find the current $\mathbf{i_o}$ in the circuit.

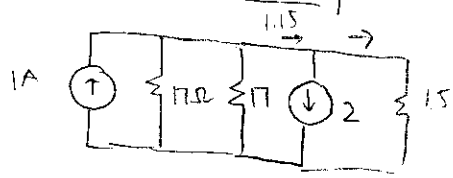


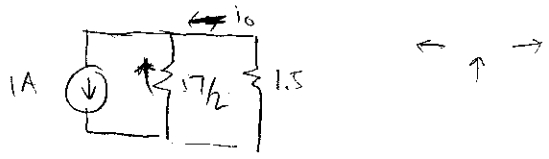












$17 \| 17$

$\frac{1}{R_{eq}} = \frac{1}{17} + \frac{1}{17_{eq}} = \frac{2}{17}$

$R_{eq} = 17/2$

$i_o = -\left(\frac{17/2}{17/2 + 17/2}\right) = -\left(\frac{17/2}{10}\right) = -(0.85)$

$i_o = -0.85$ A