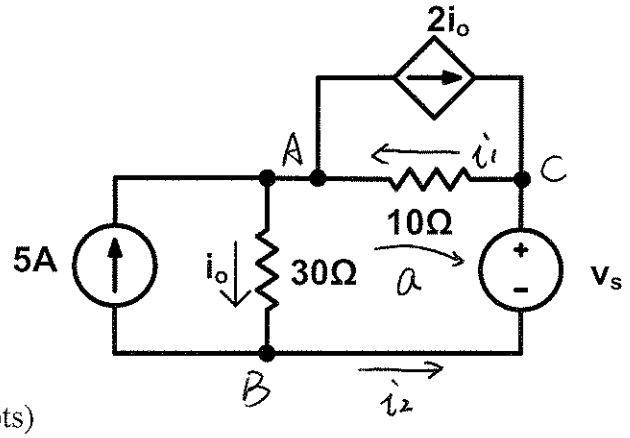
UCLA
Department of Electrical Engineering
EE10 – Spring 2010
Midterm
April 28th, 2010

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		
1. b)	2		
1. c)	2		
1. d)	2		
1. e)	2		
2. a)	4		
2. b)	3		
2. c)	3		
3. a)	7		
3. b)	7		
3. c)	6		
4.	10		
	Total: 50		
		Total	

NAME:
UID:

1. The current $\mathbf{i_o}$ in the circuit is 2A. **[10 pts]**



a) Calculate $\mathbf{v_s}$ (2 pts)

KCL for node A: $i_o + 2i_o - i_1 - 5 = 0$

$\Rightarrow i_1 = i_o + 2i_o - 5 = 2A + 4A - 5A = 1A$

KVL for path a: $-30\Omega \cdot i_o - 10\Omega \cdot i_1 + V_S = 0$

$\Rightarrow V_S = 30\Omega \cdot 2A + 10\Omega \cdot 1A = 70V$

$v_s = 70V$

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

KCL for node B: $5 + i_2 - i_o = 0$

$\Rightarrow i_2 = i_o - 5 = 2A - 5A = -3A$

$P_{VS} = -i_2 \cdot V_S = -(-3A)(70V) = 210W$

Power (absorbed, delivered) = $210W$

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

$$P_{5A} = -5A \cdot V_{AB} = -5A \cdot (30\Omega \cdot 2A) = -300\,W$$

Power (absorbed , (delivered)) = $300\,W$

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

$$P_{2i_0} = 2i_0 \cdot V_{AC} = 4A \cdot (-1A \cdot 10\Omega) = -40\,W$$

Power (absorbed , (delivered)) = $40\,W$

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

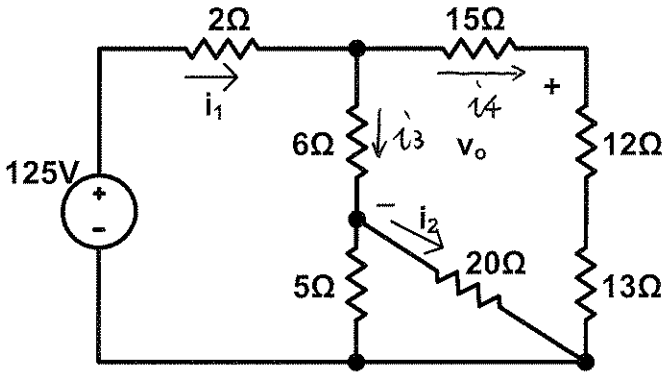
$$P_{30\Omega} = i_0^2 \cdot 30\Omega = (2A)^2 \cdot 30\Omega = 120\,W$$

$$P_{10\Omega} = i_1^2 \cdot 10\Omega = (1A)^2 \cdot 10\Omega = 10\,W$$

$$P_{resistors} = P_{30\Omega} + P_{10\Omega} = 130\,W$$

Total power $= 130\,W$

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



$$i_1 = \frac{125V}{2\Omega + (6\Omega + 5\Omega \| 120\Omega) \| (15\Omega + 12\Omega + 13\Omega)} = \frac{125V}{2\Omega + 10\Omega \| 40\Omega} = 12.5A$$

$$i_3 = \frac{15\Omega + 12\Omega + 13\Omega}{6\Omega + 5\Omega \| 120\Omega + 15\Omega + 12\Omega + 13\Omega} \cdot i_1 = 0.8 \cdot 12.5A = 10A$$

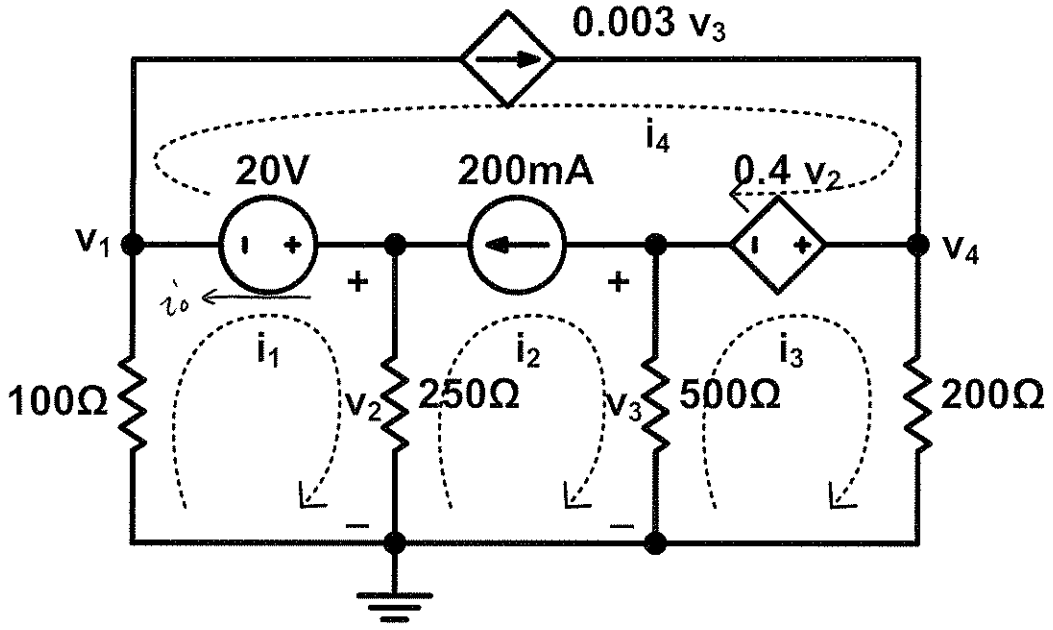
$$i_2 = \frac{5\Omega}{5\Omega + 20\Omega} \cdot i_3 = 0.2 \cdot 10A = 2A$$

$$i_4 = i_1 - i_3 = 12.5A - 10A = 2.5A$$

$$V_o = 6\Omega \cdot i_3 - 15\Omega \cdot i_4 = 6\Omega \cdot 10A - 15\Omega \cdot 2.5A = 22.5V$$

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

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)

$$\frac{V_1}{100} + \frac{V_2}{250} + 0.003V_3 - 0.2 = 0$$

$$V_1 + 20 = V_2$$

$$\frac{V_4}{200} + \frac{V_3}{500} - 0.003V_3 + 0.2 = 0$$

$$V_3 + 0.4V_2 = V_4$$

EQN1:	$0.01V_1 + 0.004V_2 + 0.003V_3 = 0.2$
EQN2:	$V_1 - V_2 = -20$
EQN3:	$-0.001V_3 + 0.005V_4 = -0.2$
EQN4:	$0.4V_2 + V_3 - V_4 = 0$

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)

$100 i_1 - 20 + 250(i_1 - i_2) = 0$ ①

$i_2 - i_4 = -0.2$ ②

$500(i_3 - i_2) - 0.4 V_2 + 200 i_3 = 0$ ③

$i_4 = 0.003 V_3$ ④

$V_2 = 250(i_1 - i_2)$ substitute ③

$V_3 = 500(i_2 - i_3)$ substitute ④

EQN1:	$350 i_1 - 250 i_2 = 20$
EQN2:	$i_2 - i_4 = -0.2$
EQN3:	$-100 i_1 - 400 i_2 + 700 i_3 = 0$
EQN4:	$1.5 i_2 - 1.5 i_3 - i_4 = 0$

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

Solving equations from (a)

$V_1 = 24V$ $V_2 = 44V$ $V_3 = -72V$ $V_4 = -54.4V$

$i_0 + \frac{V_2}{250} - 0.2 = 0 \Rightarrow i_0 = 0.2 - \frac{V_2}{250} = 24mA$

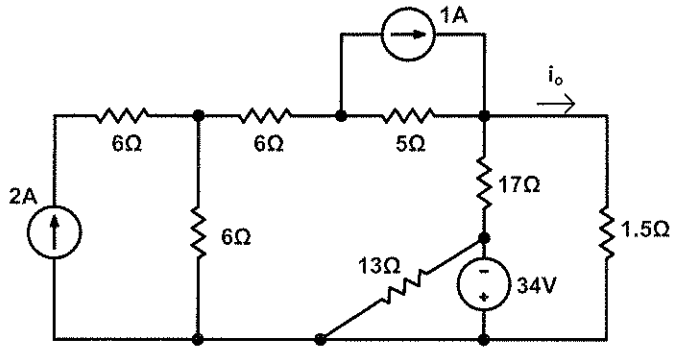
$P_{20V} = (20V)(24mA) = 480mW$

Solving equations from (b). $i_1 = -0.24A$ $i_2 = -0.416A$ $i_3 = -0.272A$ $i_4 = -0.216$

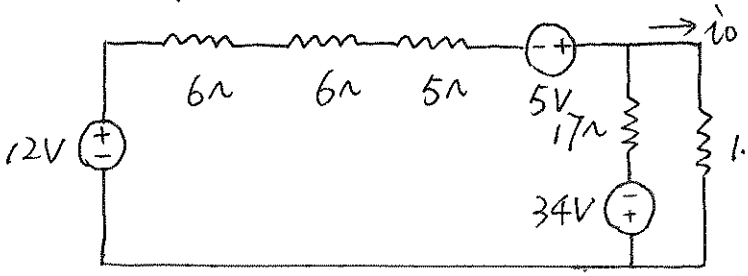
Power absorbed = 480 mW

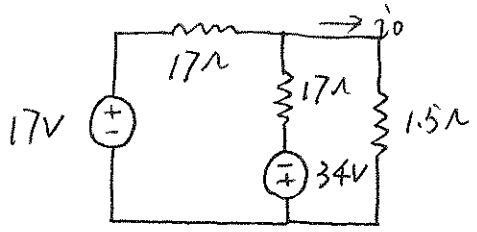
4. Source transformation **[10 pts]**

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

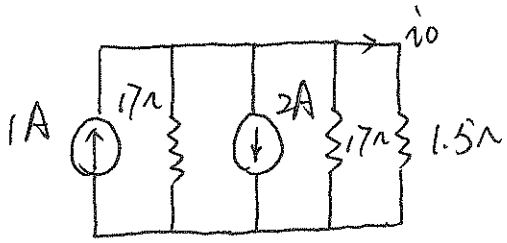


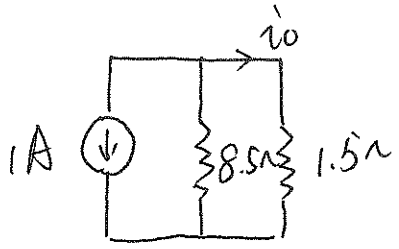
Remove 6Ω and 13Ω resistors first. then apply a source transformation to each current source yields





Apply source transformation on voltage sources





$$i_o = -\frac{8.5}{8.5+1.5} \cdot 1A = -0.85A$$

$$\boxed{i_o = -0.85A}$$