ECSE 2010
Electric Circuits
Exam 1
Spring 2007

Name Solutions

Section (please circle one)

MR	MR
10-12	2-4
Millard	Abouzeid

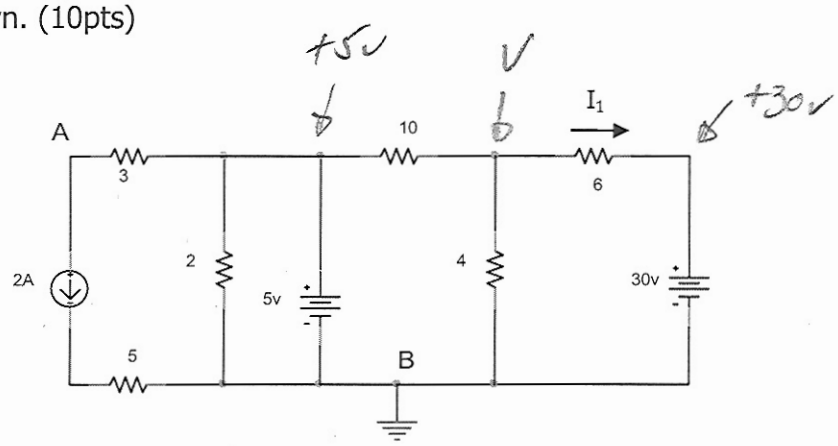
Problem No.	Pts.	Score
1	20pts	X/20
2	20pts	X/20
3	20pts	X/20
4	20pts	X/20
5	20pts	X/20
Total	100pts	X/100

Please Note:

* Place all your answers in the spaces provided.
* You MUST show your work to receive any credit.

Problem 1 (20pts)

a.) Find I_1 in the circuit shown. (10pts)



KCL @ V:

$$\frac{V-5}{10} + \frac{V}{4} + \frac{V-30}{6} = 0 \quad (5pts)$$

$$I_1 = \frac{V-30}{6} \quad (5pts)$$

X60

$$6V - 30 + 15V + 10V - 300 = 0 \; ; \quad 2.4V - 12 + 6V + 4V - 120 = 0$$

$$31V = 330 \qquad 12.4V = 132$$

$$V = \frac{330}{31} = 10.65 \qquad V = \frac{132}{12.4} \cong 10.65$$

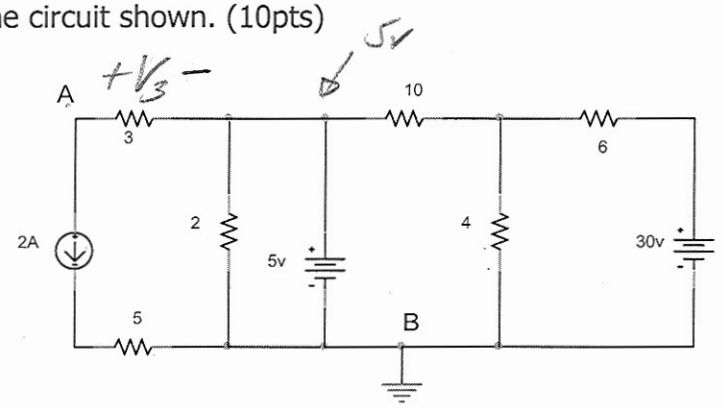
$$I_1 = \frac{\frac{330}{31} - 30}{6} = -3.225A$$

$$\cong -3.23$$

I_1	$-3.23A$

Problem 1 (cont)

b.) Find the voltage V_{AB} in the circuit shown. (10pts)



$V_B = 0v$

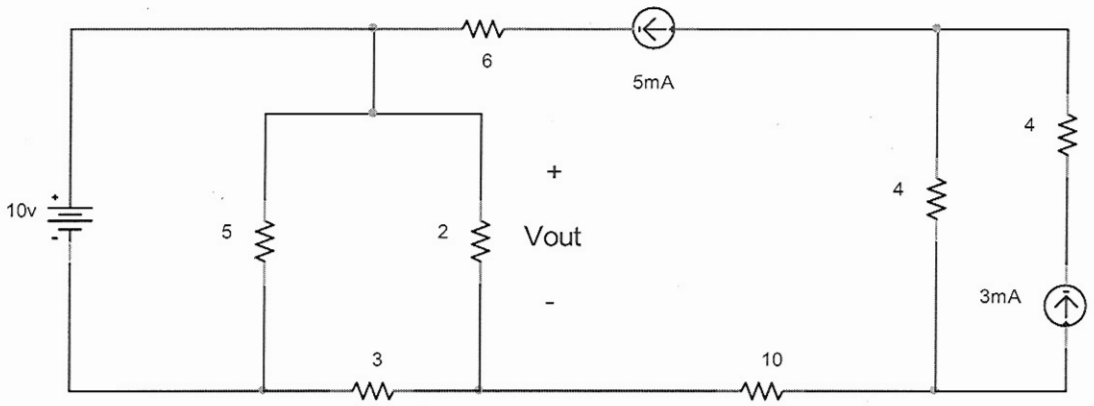
$V_3 = -2A \times 3 = -6v$

$V_A = 5v + (-6v) = -1v$

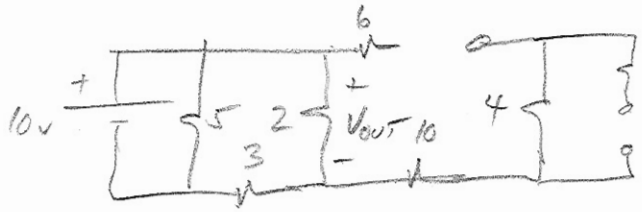
V_{AB}	$-1v$

Problem 2 (20pts)

a.) Find the voltage Vout across the 2 ohm resistor due to each of the sources using superposition for the circuit shown. (15pts)

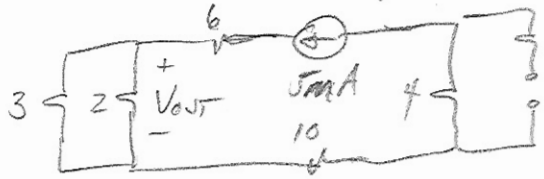


V(10v) 5mA → open, 3mA → open



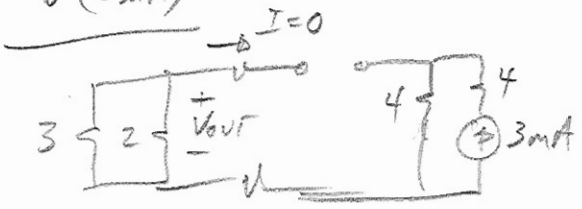
$V_{OUT} = 10 \times \frac{2K}{5K} = 4v$

V(5mA) 10v → short, 3mA → open



$V_{OUT} = I_2 \times 2 = \left(5mA \frac{3K}{5K}\right) \times 2K = 6v$

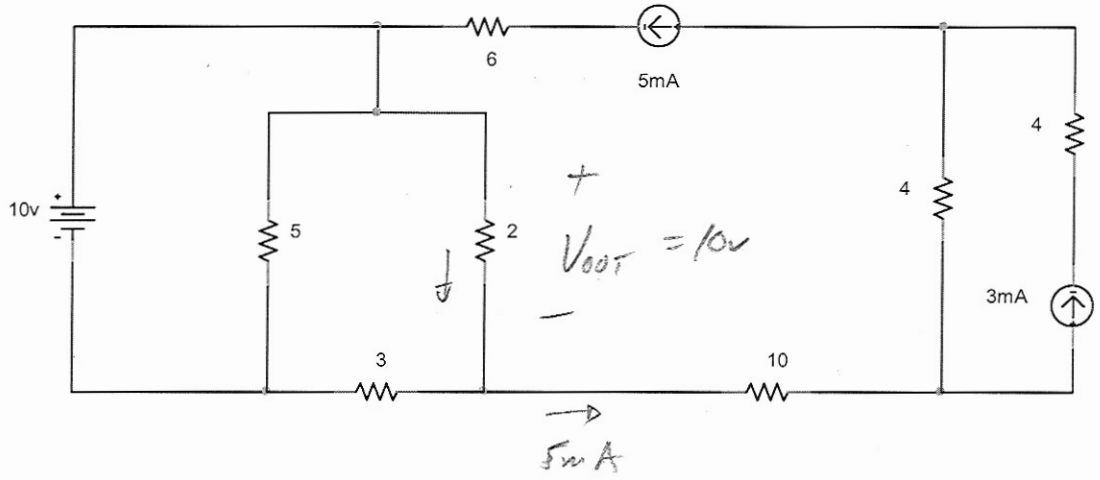
V(3mA)



V_{out} (10v)	4v
V_{out} (3mA)	6v
V_{out} (5mA)	0v

Problem 2 (cont)

b.) Find the power delivered to the 5, 6, and the 3 ohm resistors. (5pts)



$$P_5 = \frac{V^2}{R} = \frac{(10)^2}{5K} = 20mW$$

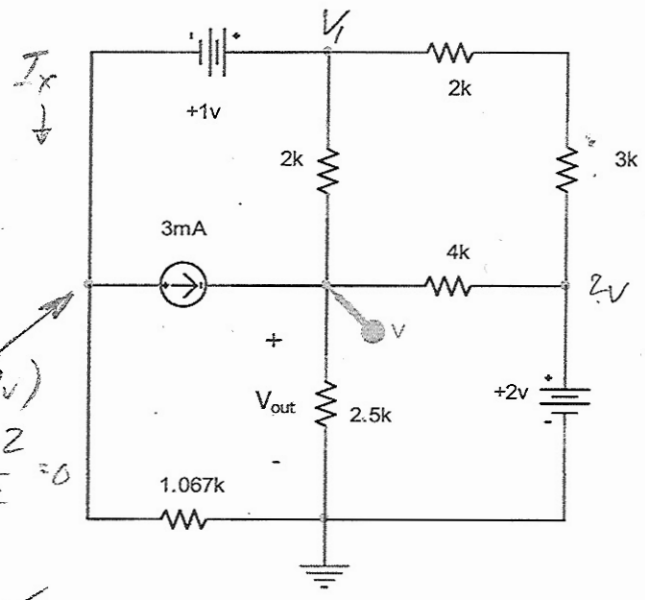
$$P_6 = I^2R = (5mA)^2 6K = 150mW$$

$$P_3 = VI = 0I = 0$$

$P_{5\text{-ohm}}$	20 mW
$P_{6\text{-ohm}}$	150 mW
$P_{3\text{-ohm}}$	0

Problem 3 (20pts)

Find V_{out} for the circuit shown (where the probe is located with respect to ground) using your choice of either mesh or nodal analysis. Please show all your work.



@ V_1:

$$I_x + \left(\frac{V_1 - V_0}{2K}\right) + \left(\frac{V_1 - 2}{5K}\right) = 0$$

$$3mA + \frac{(V_1 - 1v)}{1.067K} + \frac{V_1 - V_0}{2K} + \frac{V_1 - 2}{5K} = 0 \qquad (V_1 - 1v)$$

$$15 + 4.69(V_1 - 1) + 2.5(V_1 - V_0) + V_1 - 2 = 0$$

$$I_x = 3mA + \frac{(V_1 - 1v)}{1.067K}$$

$$V_1(4.69 + 2.5 + 1) + V_0(-2.5) = (-15 + 4.69 + 2)$$

@ V_0:

$$8.19V_1 - 2.5V_0 = -8.31$$

$$-3mA + \frac{V_0}{2.5K} + \frac{V_0 - 2}{4K} + \frac{V_0 - V_1}{2K} = 0$$

$$-12 + 1.6V_0 + V_0 - 2 + 2V_0 - 2V_1 = 0$$

2 equations
2 unknowns

$$-2V_1 + 4.6V_0 = 14$$

$$-1.086 + 2.5V_0 = 7.6$$

$$7.104V_1 = -.71$$

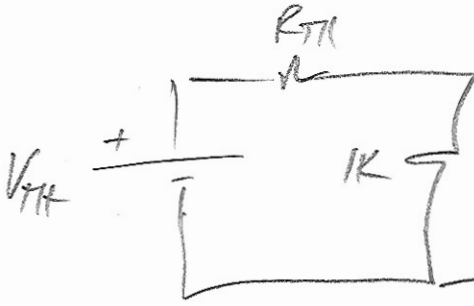
$$V_1 \approx -.1$$

$$V_{out} = \frac{(14 + .2)}{4.6} = 3.08 \approx 3v$$

V_{out}	3v

Problem 4 (cont)

b.) Find Vout across the 1k resistor if V1 = 10v and V2 = 20v. (5pts)



$$V_{OUT} = \frac{1K}{1K + R_{TH}} V_{TH} = \frac{1K}{2.67K}\left(\frac{2V_1 + V_2}{3}\right)$$

$$= \frac{1K}{2.67K}\left(\frac{20+20}{3}\right)$$

$$\cong 5V$$

V_{out}	$5V$

c.) Determine the power supplied by the 10v source. (5pts)

$$\frac{V_x - 10}{1K} + \frac{V_x - 20}{2K} + \frac{V_x - 5}{1K} = 0$$

$$2V_x - 20 + V_x - 20 + 2V_x - 10 = 0$$

$$5V_x = 50$$

$$V_x = 10$$

$$I_{10v} = \frac{V_1 - V_x}{1K} = \frac{10-10}{1K}$$

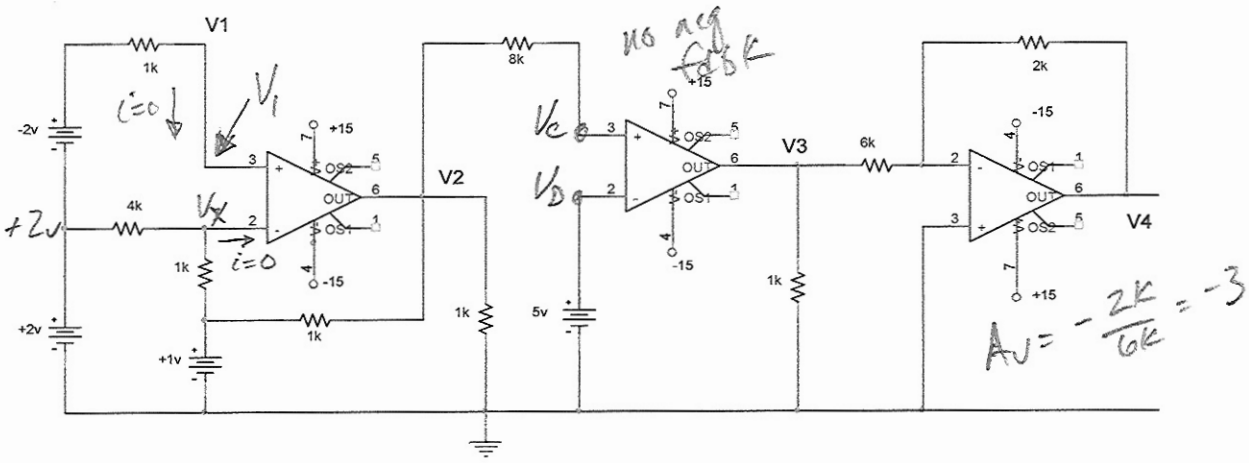
$$I_{10v} = \frac{0}{1K} = 0\,!$$

P_{10v}	0_W

$$P = VI = 10 \times 0 = 0_W.$$

Problem 5 (20pts)

Assume that all the Op Amps have ± 15 volt supplies for the following circuits.



a.) Find V1 and V2 in the above circuit. (10pts)

$V_1 = +2v + (-2v) = 0v$

$V_x = 1v + (2-1)\frac{1K}{1K+4K} = 1.2v$

$V_x \neq V_1$ (not in linear mode)

Thus $V_2 \rightarrow \pm V_{cc} = \pm 15v$

* Credit should be given for any reasonable response.

* most likely:

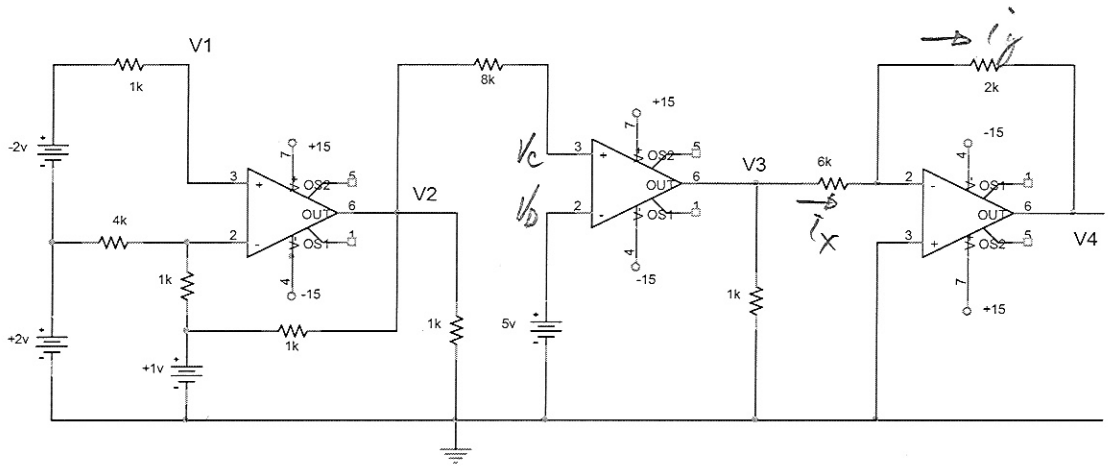
$V_2 = (V_x - V_1) \times (+\infty) \rightarrow +15v$

(1-2 = 0, 10^{12})

V1	0
V2	±15v

Problem 5 (cont)

b.) Find V3 and V4 in the circuit (the same circuit as part a). (10pts)



If $V_2 = -15v$

$V_c = V_+ = \pm 15v$

$V_D = V_- = 5v$

$V_{DIFF} = V_+ - V_- = +10/-20$

$V_{DIFF} \times (+\infty) \rightarrow \pm\infty \rightarrow \pm 15v$

$i_x = i_y \; ; \quad \frac{V_3}{6K} = \frac{-V_4}{2K}$

$V_4 = -\frac{2}{6} V_3 = -\frac{1}{3} V_3$

$V_4 = \frac{+1}{3}(\pm 15) = \pm 5v$

V3	$\pm 15v$
V4	$\pm 5v$