ECSE 2010
Electric Circuits
Fall 2006 - Millard
Exam 1

Name Solutions Only

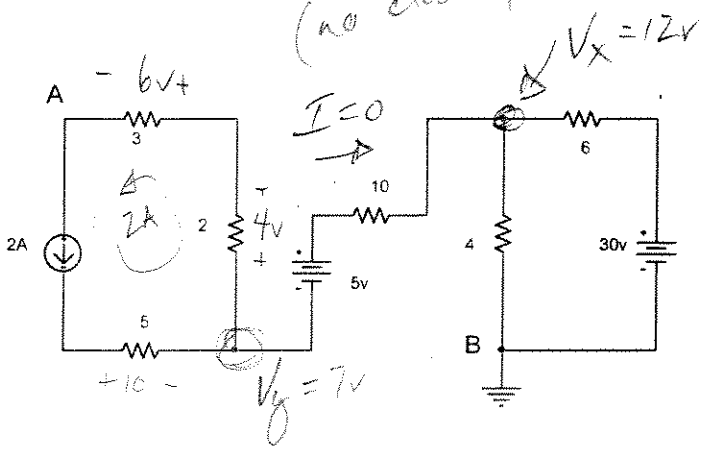
Problem No.	Pts.	Score
1	20pts	x/20
2	20pts	x/20
3	20pts	x/20
4	20pts	x/20
5	20pts	x/20
Total	100pts	x/100

Please Note:

* Please place your answers in the spaces provided.
* You must show your work to receive credit.

Problem 1 (20pts)

a.) Find V_{AB} in the circuit shown. (8pts)



(no closed path!)

$V_x = 12v$

$I = 0$

$V_g = 7v$

$V_B = 0$

$V_x = \frac{4}{4+6} \times 30 = 12v$ → 3pts

$V_g = 12 - 5 = 7v$

$V_A = V_g - 4v - 6v = 7v - 10v$ → 3pts

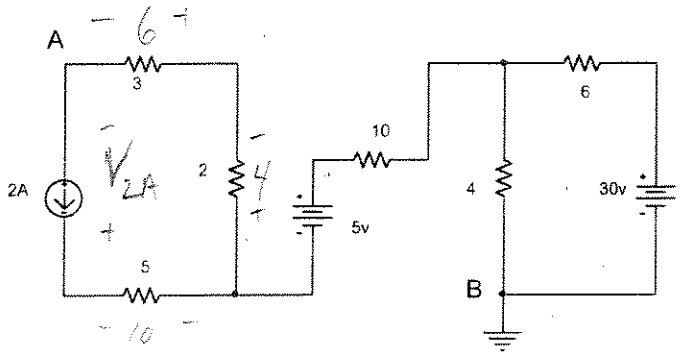
$V_A = -3v$

$V_{AB} = -3 - 0 = -3v$ → 2pts

V_{AB}	$-3v$

Problem 1 (cont)

b.) Find the power supplied/absorbed by the 2A source, 5v source and 4Ω resistor in the circuit shown. (12pts)



① $|P_{2A}| = |V_{2A}| \times |2A|$

$V_{2A} = 20$

$|P_{2A}| = 20 \times 2 = 40w$

$P_{2A} = -40w$ (supply) (3pts)

② $|P_{5v}| = |V_5| \times |I_5|$ ~~$\neq 0$~~

$P_{5v} = 5 \times 0 = 0$ (3pts)

③ $P_{4\Omega} = V_4 \times I_4$

$V_4 = \frac{4}{4+6} \times 30 = 12v$

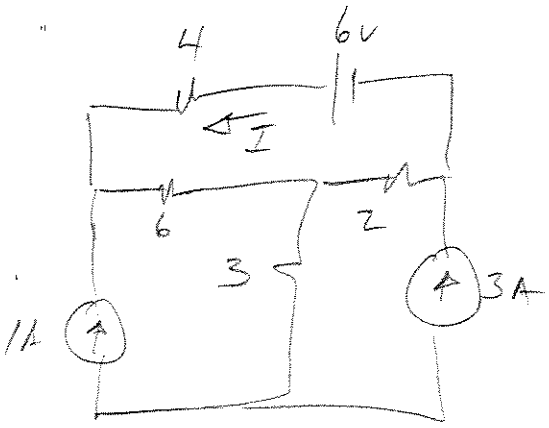
$I_4 = \frac{V_4}{4} = 3A$

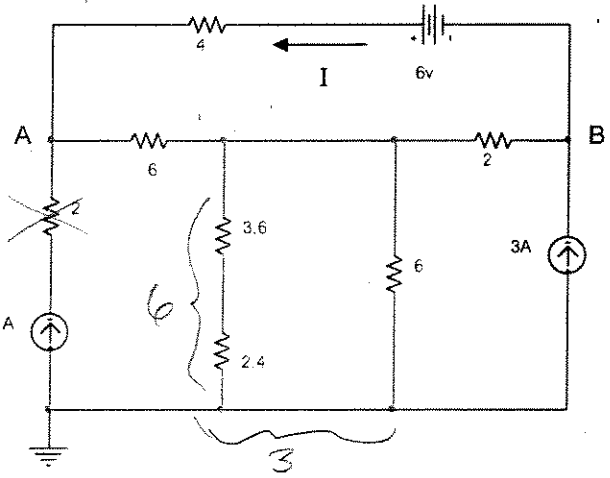
$P_4 = 12 \times 3 = 36w$ (3pts)

P_{2A}	$-40w$
P_{5v}	$0w$
$P_{4\Omega}$	$36w$

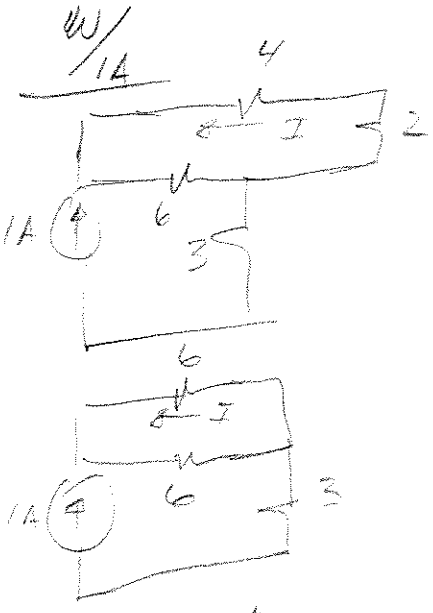
Problem 2 (20pts)

a.) Find I (through the 4Ω resistor) due to each of the sources using superposition for the circuit shown. (15pts)





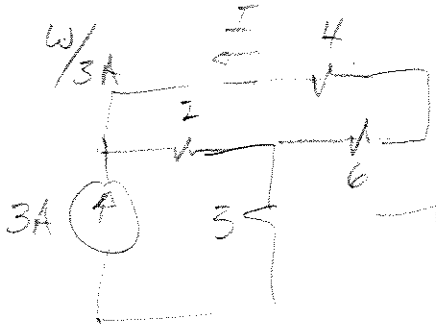
w/ 1A

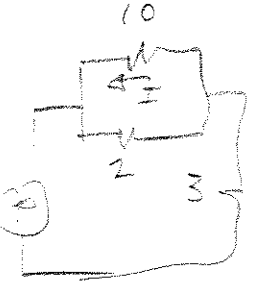


$I = \frac{-1A}{2} = .5A$ (opposite direction)

(5pts)

w/ 3A

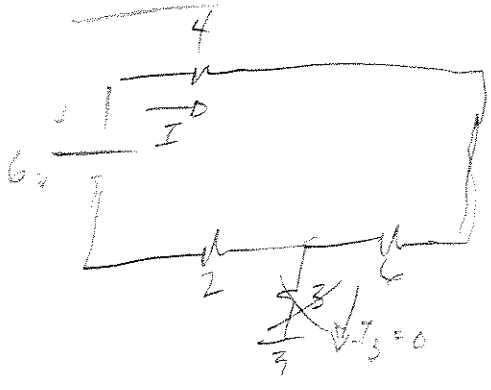




$I = 3A \times \frac{2}{2+10} = \frac{1}{2}A$

(5pts)

w/ 6v:



$I = \frac{6v}{8+4} = \frac{6}{12}$

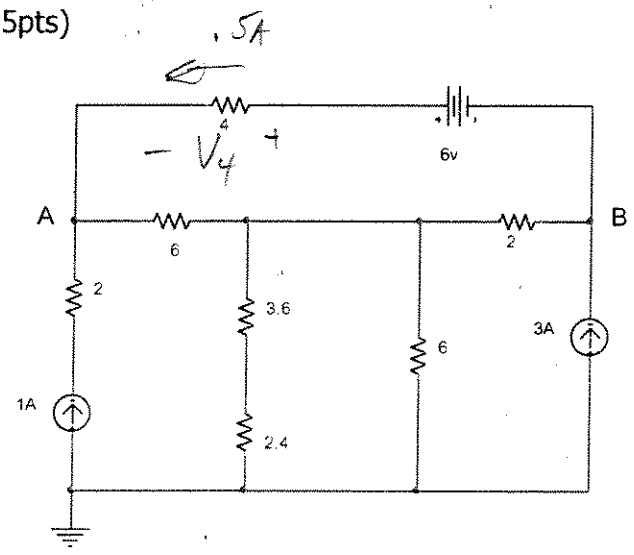
$I = .5A$ (5pts)

$I_{(1A)}$	$-.5A$
$I_{(3A)}$	$+.5A$
$I_{(6v)}$	$+.5A$

$I_{TOT} = .5A$

Problem 2 (cont)

b.) Find V_{AB} in the circuit shown. (5pts)



$V_4 = I_{TOTAL} \times 4$

$V_4 = 4 \times .5 = 2v$

$V_{AB} = V_A - V_B$

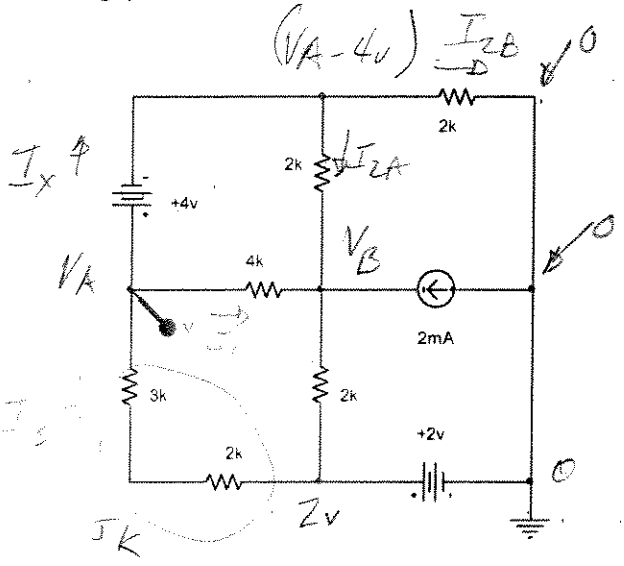
$V_{AB} = 6v - V_4 = 6 - (.5)(4) = 6 - 2 = 4v$

(1 pt)

V_{AB}	4v

Problem 3 (20pts)

Find V (at the probe) for the circuit shown using your choice of either mesh or nodal analysis.



$I_x = I_{2A} + I_{2B}$

$I_x = \frac{(V_A - 4) - V_B}{2k} + \frac{(V_A - 4) - 0}{2k}$

$I_x = \frac{2V_A - 8 - V_B}{2k}$

(a) V_A:

I_1 I_3 I_x

$\frac{V_A - V_B}{4k} + \frac{V_A - 2}{5k} + \frac{2V_A - 8 - V_B}{2k} = 0$

$\times 20k \quad 5V_A - 5V_B + 4V_A - 8 + 20V_A - 80 - 10V_B = 0$

(1) $29V_A - 15V_B = 88$

(a) V_B

$\frac{V_B - V_A}{4K} + \frac{V_B - 2}{2K} + \frac{V_B - (V_A - 4)}{2K} - 2mA = 0$

$\times 4K \quad V_B - V_A + 2V_B - 4 + 2V_B - 2V_A + 8 - 8 = 0$

(2) $-3V_A + 5V_B = 4$

$\times 5 \quad -9V_A + 15V_B = 12$ (3)

$29V_A - 15V_B = 88$ (4)

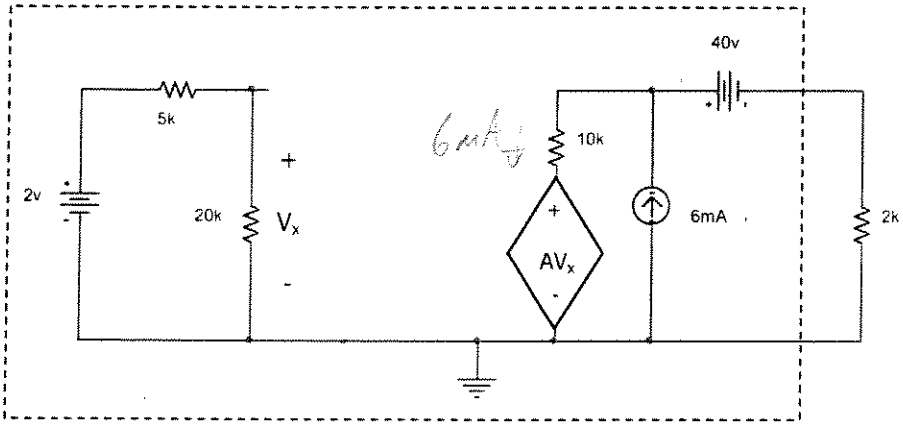
$20V_A + 0V_B = 100$

Thus: $V_A = 5$

V	5v

Problem 4 (20pts)

Given the following circuit:



a.) Find V_{TH}, the open circuit (without the 2K) output voltage of the circuit in the dashed line, if **A=100**. (8pts)

V_{TH}:

$V_x = \frac{20k}{25k} \times 2v = \frac{8}{5}v$

$AV_x = 100 \times \frac{8}{5} = 160$

$V_{oc} = AV_x + (6mA)10k - 40v$

$V_{oc} = V_{TH} = 160 + 60 - 40$

$V_{TH} = 180$

R_{TH}:

$I_{sc} = 6mA + I_{2k} = 6mA + \frac{40 - 0}{2k}$

$I_{sc} = 6mA + \frac{40}{2k} = 26mA$

V_{TH}	180v

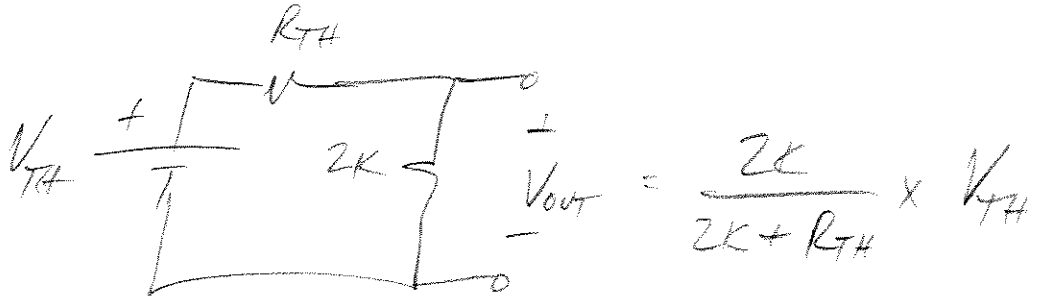
Problem 4 (cont)

b.) Find the equivalent resistance (R_{TH}) that a multimeter would read across the two wires that exit the dashed line (to the right of the 2K resistor; but not including the 2K resistor) if **A=100**. (8pts)

$$R_{TH} = \frac{V_{TH}}{I_{SC}} = \frac{180V}{18mA} = 10K$$

R_{TH}	10K

c.) Find V_{out} across the 2k resistor at the output of above circuit if **A=100**. (4pts)

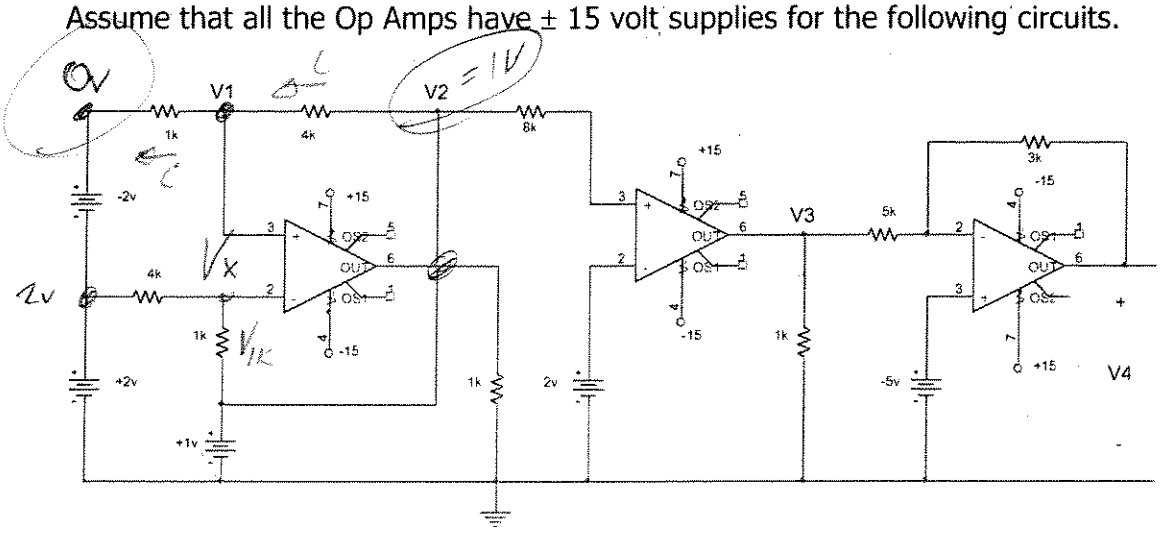


$$V_{out} = \frac{2}{12} \times 180 = 30V$$

V_{out}	30V

Problem 5 (20pts)

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



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

$V_x = V_{1K} + 1v$

$V_{1K} = \frac{1K}{1K+4K}(2v - 1v) = \frac{1}{5}v$

$V_x = 1.2v$

$\frac{V_1 - 0}{1K} = \frac{V_2 - V_1}{4K}$ (no I into the op amp)

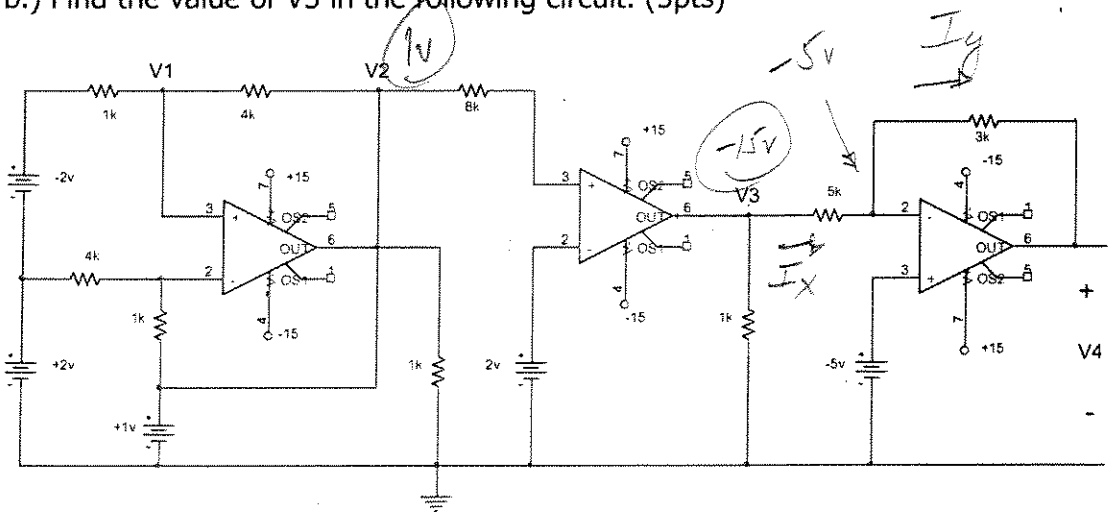
$V_1 = \frac{V_2}{5} = \frac{1}{5} = .2v$

Thus: $V_1 \neq V_x$!

V1	.2v
V2	1v

Problem 5 (cont)

b.) Find the value of V3 in the following circuit. (5pts)



$$V_3 = V_D \times \infty = (1-2) \times (+\infty) = -\infty \rightarrow -15v$$

V3	$-15v$

c.) Find V4 in the above circuit. (5pts)

$$I_x = I_y$$

$$I_x = \frac{-15 - (-5v)}{5K} \quad ; \quad I_y = \frac{-5v - V_4}{3K}$$

$$5 + 3K\left(\frac{-10}{5K}\right) = -V_4$$

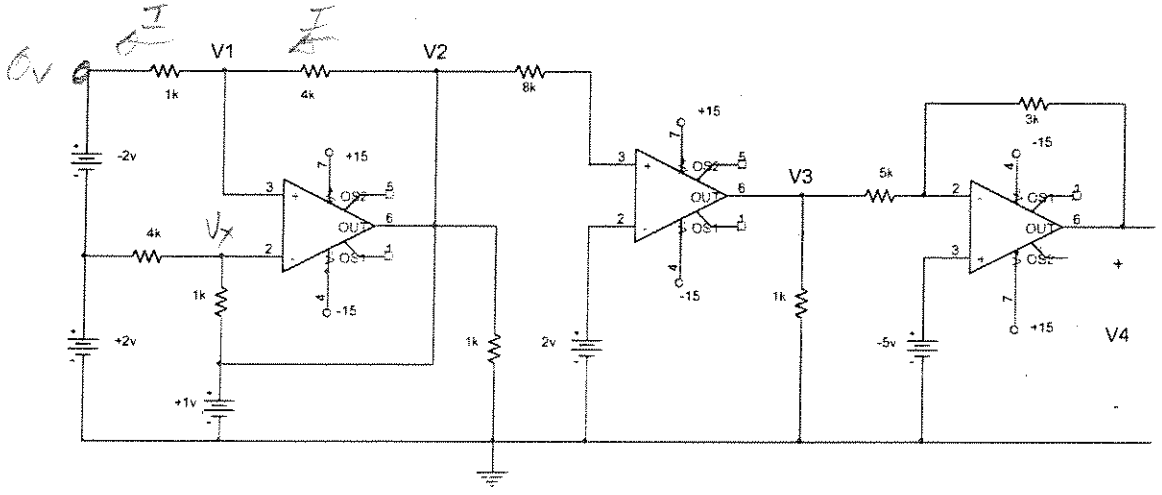
$$V_4 = 6 - 5 = 1v$$

V4	$1v$

WRONG but OK

Problem 5 (20pts)

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



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

Assuming neg fdbk: (which is why holding $V_x = 0$ V)

$$V_1 = V_x$$

$$V_x = \left[(2-1) \times \frac{1k}{1k+4k}\right] + 1v = 1.2v$$

so...

V_1 should $= 1.2v$

If so:

$$\frac{V_1 - 0}{1K} = \frac{V_2 - V_1}{4K}$$

$$4V_1 + V_1 = V_2$$

$V_2 = 6v$ but is connected to the 1v source.

If $V_2 = 6v$:

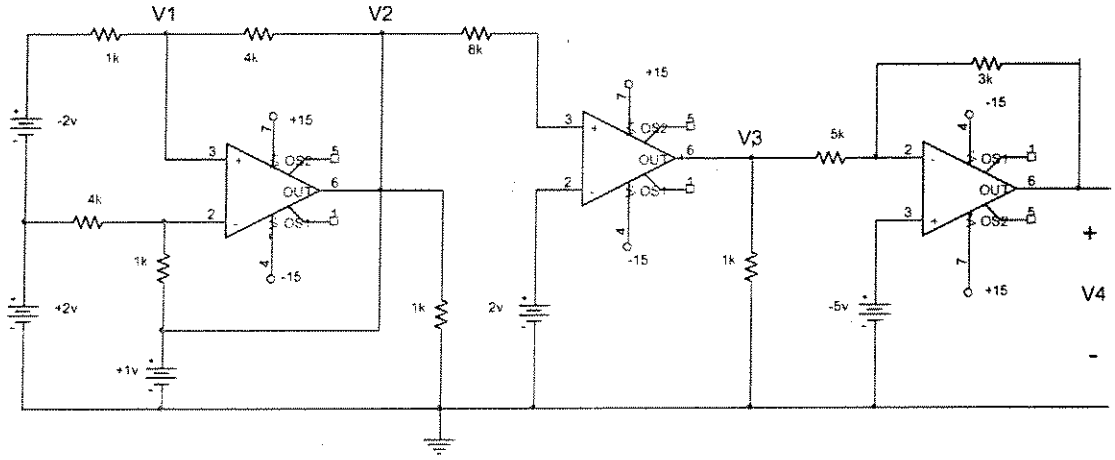
V1	1.2
V2	6v

WRONG but OK

WRONG BUT OK

Problem 5 (cont)

b.) Find the value of V3 in the following circuit. (5pts)



$V_3 = (V_2 - 2v) \times$ ~~$\frac{4k}{4k}$~~ (no fdbk)

$V_3 = +15v$

V3	+15

WRONG BUT OK

c.) Find V4 in the above circuit. (5pts)

$$\frac{V_3 - (-5v)}{9k} = \frac{(-5 - V_4)}{3k}$$

$12 = -5 - V_4$

$V_4 = -5 - 12 = -17$ → −15

V4	−15v

WRONG BUT OK