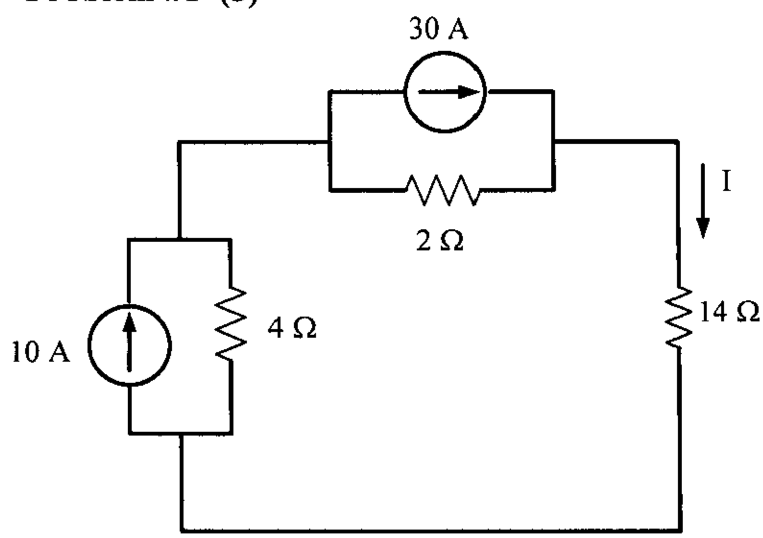
EE 201 Exam II -KEY Solution

Attention:

There are two version for the answer sequence for problems 3,4,5 indicated as version (*) and version (**) which are printed on the cover of the exam

Problem #1 (3)



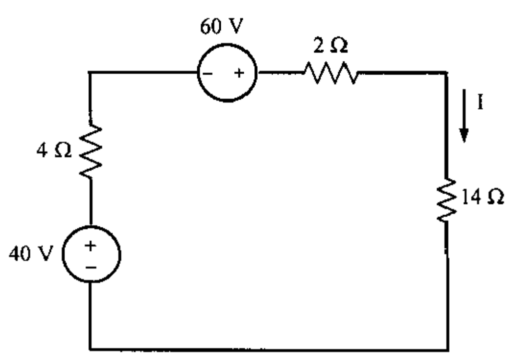
I = 5A	(3)

OR

I = −5A	(1.5)

Find the current I ?

Source Transformation



KVL

$$-40 + 4\,I - 60 + 2\,I + 14\,I = 0 \;\Rightarrow\; 20\,I = 100 \;\Rightarrow\; I = 5\text{ A}$$

For each voltage the following
50% for the correct deactivation
100 % for the correct answer

Problem #2 (6)

V_x'

Ans.	marks
+6	2/2
−6	1/2
else	0/2

V_x''

Ans.	marks
−6	3/3
+6	1.5/3
else	0/3

V_x

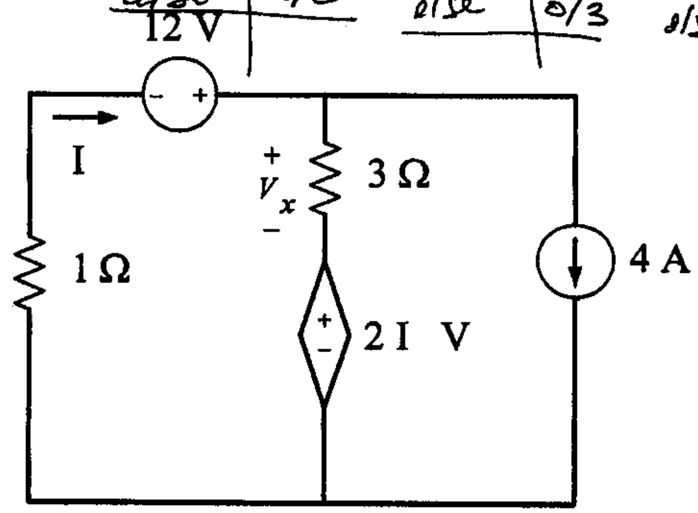
0	1/1
else	0/1

The voltages are :

(2) $V_x'|_{12V} = 6V$

(3) $V_x''|_{4A} = -6V$

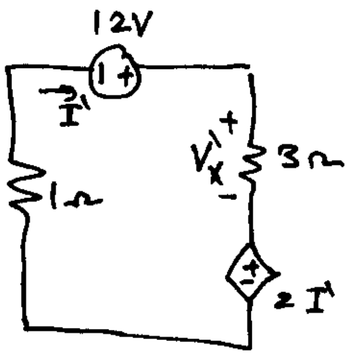
(1) $V_x = 0V$



Using the <u>principle of superposition</u> find all voltage components of V_X and find the total V_X and put all the values on the box

First, turn the current source off:

(2 pts)



Apply KVL:

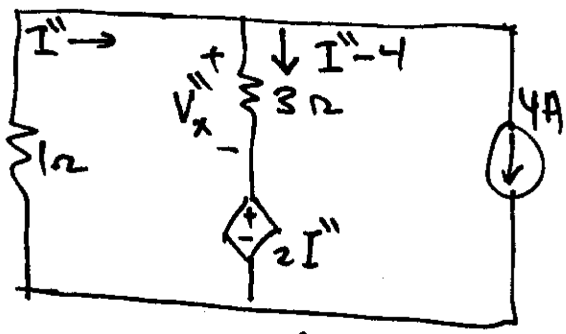
$+1 * I' - 12 + 3 I' + 2 I' = 0$

$\therefore I' = 2A$

$V_x' = 3I' = 3*2 = 6V$

Then, turn the independent voltage source off:

(3 pts)



Apply KVL on the left loop:

$I'' + 3(I'' - 4) + 2I'' = 0$

$6I'' = 12$

$I'' = 2A$

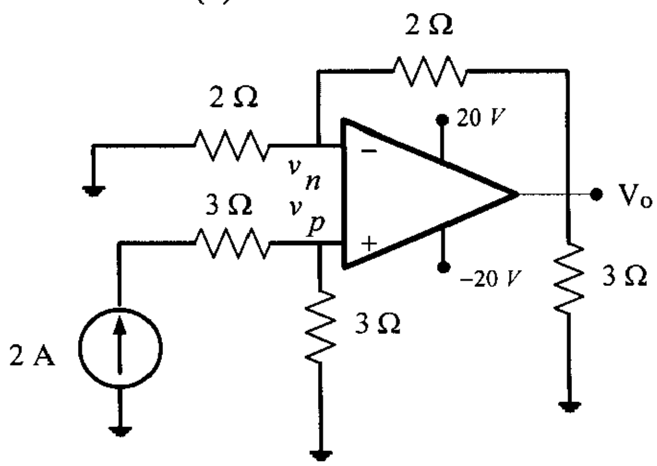
$V_x'' = 3(I'' - 4) = 3(2-4) = -6V$

(1 pt) $\longrightarrow V_x = V_x' + V_x'' = 6 + (-6) = 0V$

Summation is 1 point but with right polarity

VERSION (*)

Problem #3 (4)



For the ideal Op Amp circuit shown above find the voltage V_o ?

Version (*)

(a)	6
(b)	–6
(c)	20
(d)	–20
(e)	12 → (4)
(f)	–12 → (2)
(g)	8

oR

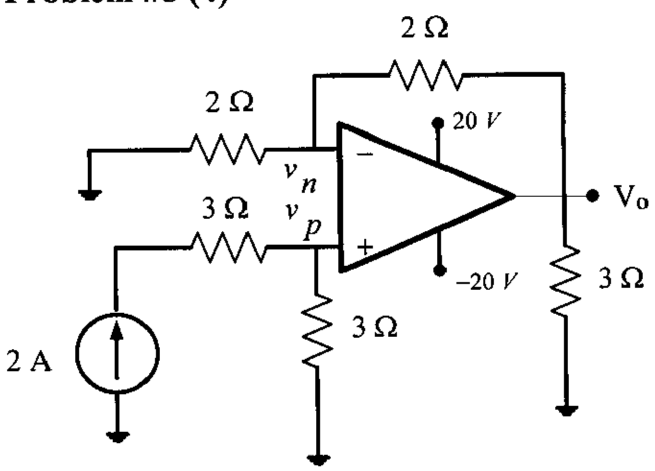
$$v_p = 3(2) = 6\text{ V} = v_n$$

KCL at (–) terminal

$$\frac{v_n - 0}{2} + \frac{v_n - v_o}{2} = 0 \Rightarrow v_o = 2\,v_n = 2(6) = 12\text{ V}$$

VERSION (* *)

Problem #3 (4)



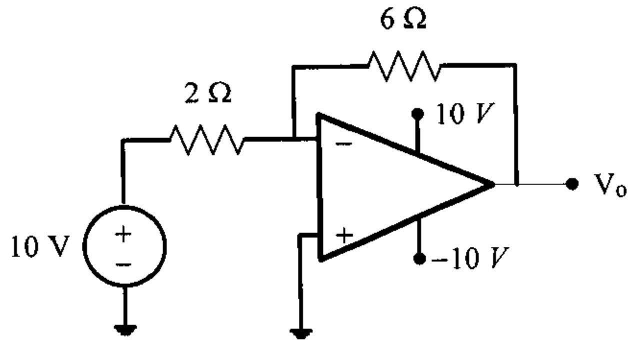
For the ideal Op Amp circuit shown above find the voltage V_o and circle the correct answer ?

(a)	8
(b)	12 → (4)
(c)	−12 → (2)
(d)	−20
(e)	20
(f)	−6
(g)	6

OR

VERSION (*)

Problem #4 (3)



For the ideal Op Amp circuit shown above find the voltage V_O ?

(a)	**−10**
(b)	**+10**
(c)	**−30**
(d)	**+30**
(e)	**18**
(f)	**−18**
(g)	**20**

→ (3)

$v_p = 0 = v_n$

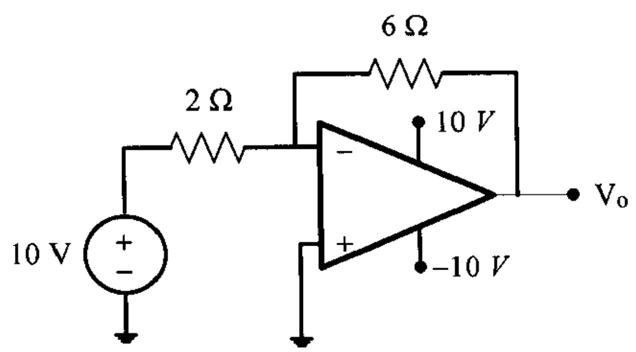
KCL at (−) terminal

$$\frac{0-10}{2} + \frac{0-v_o}{6} = 0 \Rightarrow v_o = -30$$

$\Rightarrow v_o = -10$ (Saturation) (a)

VERSION (* *)

Problem #4 (3)



For the ideal Op Amp circuit shown above find the voltage V_O and circle the correct answer ?

(a)	–30
(b)	+30
(c)	7.5
(d)	–7.5
(e)	–10 → ③
(f)	10
(g)	2.5

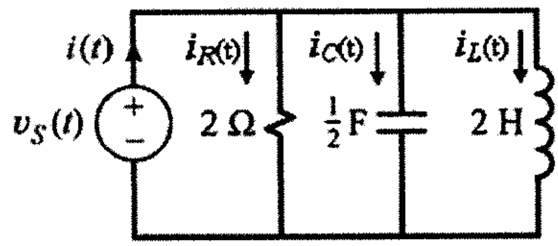
Version (*)

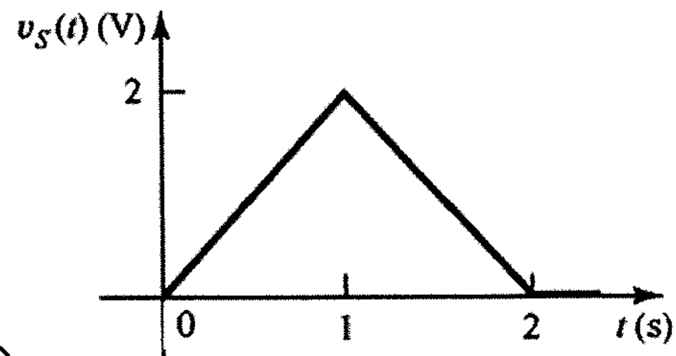
Problem #5 (5)

For the circuit shown, circle the correct answer

(1) $i_R(0.5)$ equals

(a)	0.5A → ①
(b)	0.125A
(c)	0.25 A
(d)	1.75A
(e)	1A
(f)	−1A
(g)	−0.5A
(h)	none of the above





(2) $i_C(0.5)$ equals

(a)	0.5A
(b)	0.125A
(c)	0.25 A
(d)	1.75A
(e)	1A → ②
(f)	−1A
(g)	−0.5A
(h)	none of the above

$$i_R(t) = \frac{V_s(t)}{2} \Rightarrow i_R(0.5) = 0.5\text{A}$$

$$i_c(t) = \frac{1}{2}\frac{dV_s(t)}{dt} = 1 \quad 0<t<1$$

$$\Rightarrow i_c(0.5) = 1\text{ A}$$

(3) $i_L(0.5)$ equals

(a)	0.5A
(b)	0.125A → ②
(c)	0.25 A
(d)	1.75A
(e)	1A
(f)	−1A
(g)	−0.5A
(h)	none of the above

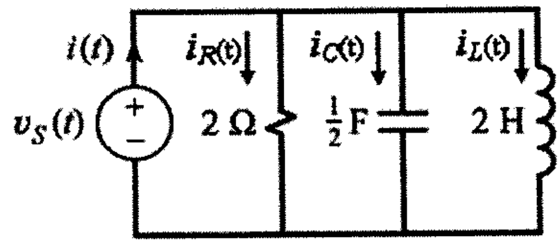
$$i_L(t) = \frac{1}{2}\int_{-\infty}^{t} V_s(\tau)d\tau = \frac{t^2}{2} \quad 0\le t\le 1$$

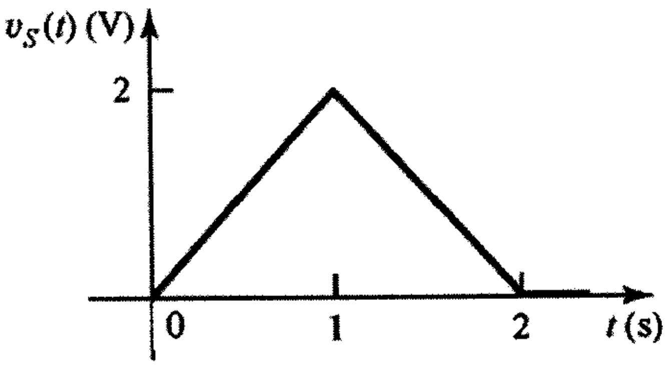
$$\Rightarrow i_L(0.5) = 0.125\text{ A}$$

Version (**)

Problem #5 (5)

For the circuit shown, circle the correct answer





(1) $i_C(0.5)$ equals

(a)	0.5A
(b)	0.125
(c)	0.25 A
(d)	1.75A
(e)	1A
(f)	−1A
(g)	−0.5A
(h)	none of the above

→ (2)

(2) $i_L(0.5)$ equals

(a)	0.5A
(b)	0.125
(c)	0.25 A
(d)	1.75A
(e)	1A
(f)	−1A
(g)	−0.5A
(h)	none of the above

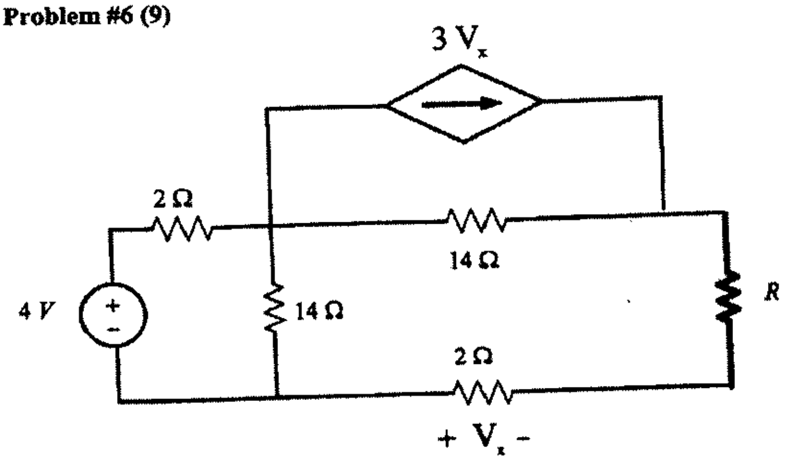
→ (2)

(3) $i_R(0.5)$ equals

(a)	0.5A
(b)	0.125
(c)	0.25 A
(d)	1.75A
(e)	1A
(f)	−1A
(g)	−0.5A
(h)	none of the above

→ (1)

Problem #6 (9)



Find the maximum power absorbed by the load resistance *R*

<u>Solution of Problem 6</u>

The solution is in 3 parts:

Part1: finding Vth

In this part we have three options:

a) **1 mark** If starts in the right direction by (Removing the load resistor) and (Calculating the open-voltage Voc between the terminals) as shown in figure 1, Look at **Figure 1**.

b) **2 marks**: if followed part (a) and found that Vth = 3.5 V.

c) **Zero**: if he did not start in the right direction

Part2: finding Rth

In this part we have three options:

a) **2.5 marks**: if starts in the right directions by one of the following options

   i. **Figure 2a**: Finding the Short circuit current isc then Rth = Voc/Ish.

   ii. **Figure 2b**: By deactivating the independent voltage source (4V) by short circuit then applying a test voltage source and calculate Iex, then Rth = Vex/Iex.

   iii. **Figure 2c**: By deactivating the independent voltage source (4V) by short circuit then applying a test current source and calculate Vex, then Rth = Vex/Iex.

   iv. **Figure 2d**: Some students might use source transformation.

b) **5 marks**: if he followed part (a) and found that Rth = 101.75 Ω.

c) **Zero**: if he did not start in the right direction.

Part3: finding maximum power

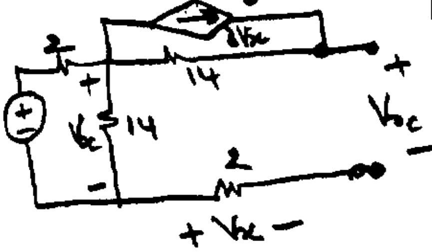
There are two options:

a) **2 marks**: if he wrote $P_{\max} = \dfrac{V_{th}^2}{4R_{th}} = \dfrac{(3.5)^2}{4(101.75)} = 30.1 \text{ mW}$

b) **Zero**: if he made a mistake in the maximum power expression.

For max power transfer $R = R_{TH}$ $\quad R_{TH} = \frac{V_{oc}}{I_{sc}}$ (1)

Voc

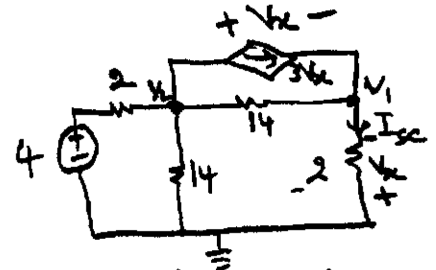


$\underline{V_x = 0}$ (0.5) $\Rightarrow \underline{V_{oc} = V_{14}}$ (0.5) $= \frac{14}{14+2} 4 = 3.5V$ (1)

$\boxed{V_{oc} = 3.5\,V}$

Figure 1: finding Voc

Isc



$\frac{V_2-4}{2} + \frac{V_2}{14} + \frac{V_2-V_1}{14} + 3(-V_1) = 0$ (1)

$\frac{V_1}{2} + \frac{V_1-V_2}{14} + 3V_1 = 0$ (1)

$7V_2 - 28 + V_2 + V_2 - V_1 - 42V_1 = 0$

$-43V_1 + 9V_2 = 28$ (1) (1) [3]

$7V_1 + V_1 - V_2 + 42V_1 = 0$

$50V_1 - V_2 = 0 \quad V_2 = 50V_1$ (2)

same pattern if mesh analysis is used here

(2) in (1) $\Rightarrow -43V_1 + 9(50V_1) = 28 \Rightarrow 407V_1 = 28$

$V_1 = 0.0688$

$\therefore I_{sc} = \frac{V_1}{2} = 0.0344$ $\boxed{I_{sc} = 34.4\,mA}$ (0.5)

$\therefore R_{th} = \frac{3.5}{0.0344} = \underline{101.75\,\Omega}$ $\quad \underline{R = 101.75\Omega}$

Figure 2a: finding Rth using Isc and previous Voc

For max power transfer $R = R_{TH}$ (1) $R_{TH} = \frac{V_T}{I_T}$ (1) $V_{oc} = 35V$ (2)

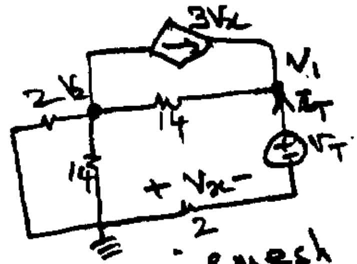
$3V_x = 6 i_T$

$V_x = 2 i_T$

$i_T = \frac{V_T - V_1}{2}$

$V_T - V_1 = 2 i_T$

$V_T - 2 i_T = V_1$



Same of mesh Analysis is used here

$\frac{V_2}{2} + \frac{V_2}{14} + \frac{V_2 - V_1}{14} + 6 i_T = 0$ (1)

$\frac{V_1 - V_2}{14} - 6 i_T - i_T = 0$ (1)

$7V_2 + V_2 + V_2 - V_1 + 84 i_T = 0$

$9V_2 - V_1 = -84 i_T$

$V_1 - V_2 = 7 \times 14\, i_T$

$8V_2 = 14 i_T$

4

$V_2 = V_1 - 98 i_T$ (1.5)

$8(V_1 - 98 i_T) = 14 i_T$

$8(V_T - 2 i_T - 98 i_T) = 14 i_T$

$8V_T - 800 i_T = 14 i_T$

$8V_T = 814 i_T$

$\frac{V_T}{i_T} = \frac{814}{8} = 101.75\,\Omega$ (0.5)

or chose $V_T = 1V$ or put current source $i_T = 1A$ and find V_1

$R_{TH} = \frac{V_1}{1}$

Figure 2b: finding Rth using external voltage source

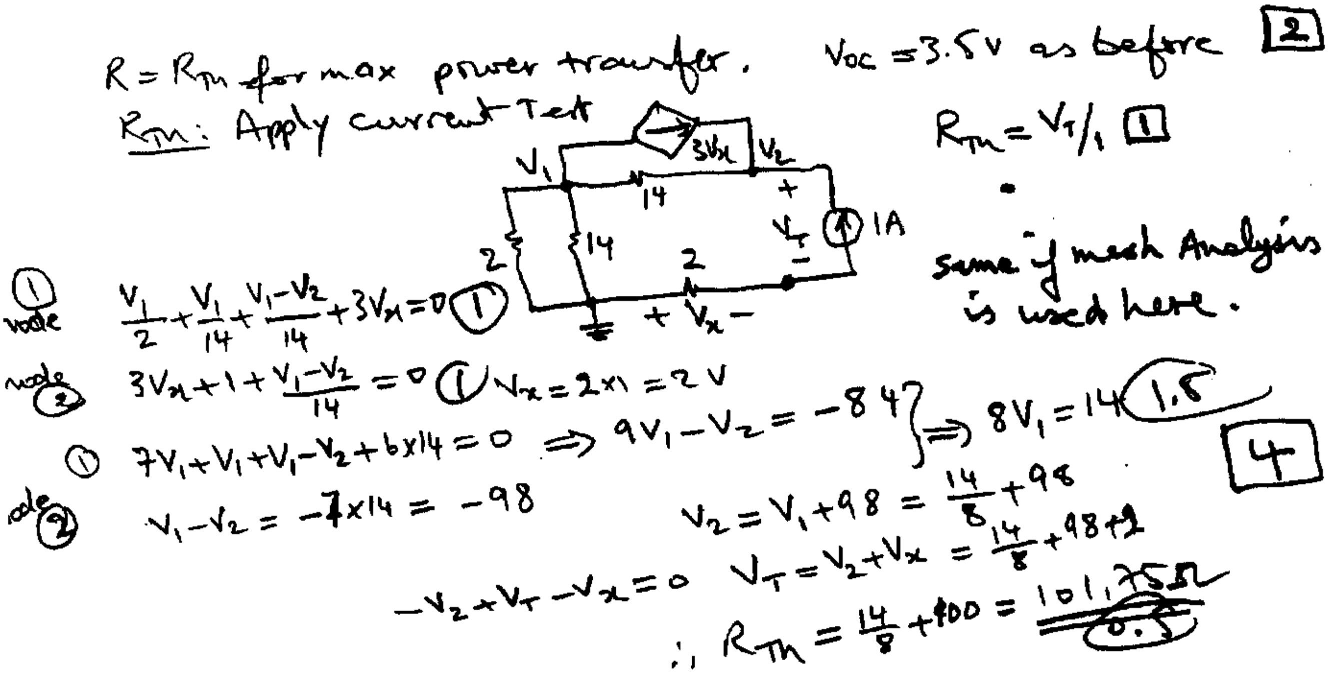


Figure 2c: finding Rth using external current source

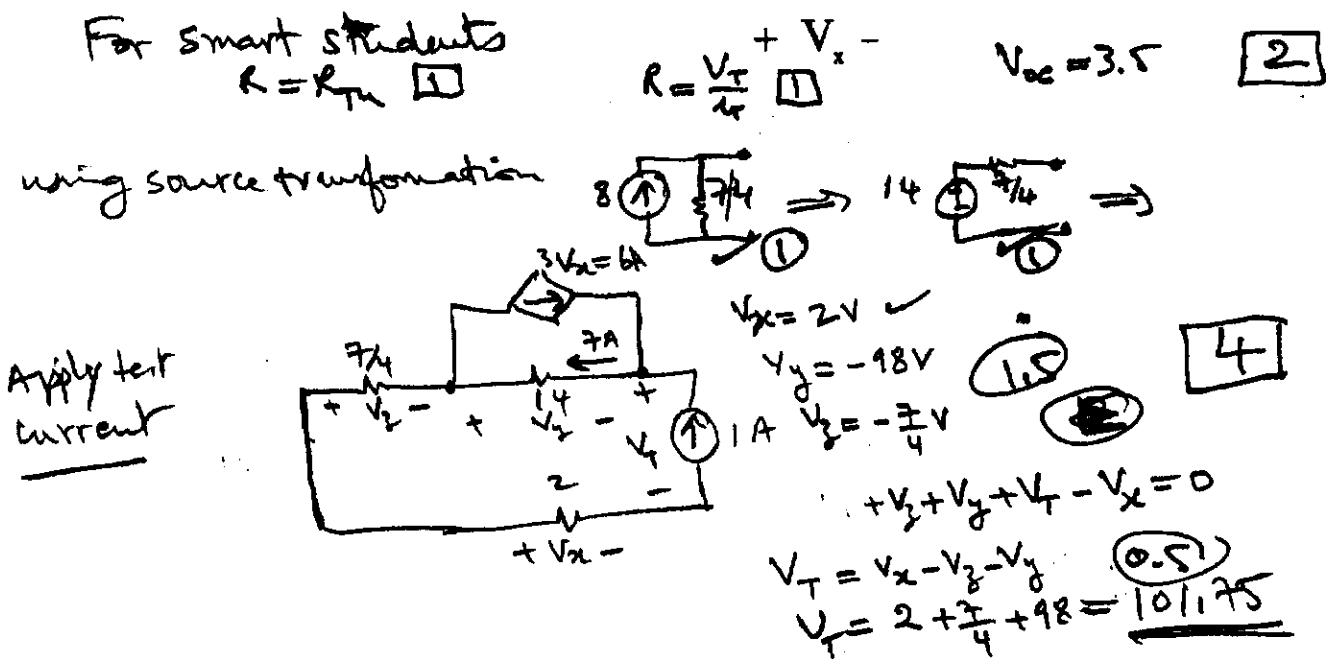


Figure 2d: finding Rth using source transformation