LAU
الجامعة اللبنانية الأميركية
Lebanese American University

LAU
School of Engineering

Department of Electrical
and Computer Engineering

ELE 201: Electrical Circuits I
Exam 2 – Spring 2015

Duration: **1 hour 20 minutes**
Start Time: 9:30 am

Date: 7/4/2015
Dr. Dani TANNIR

Name: SOLUTION **ID#:** _____

INSTRUCTIONS:

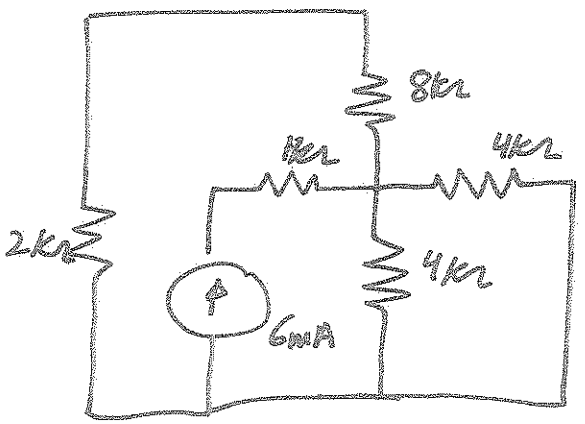
- Answer each of the following questions in the space provided.
- This is a closed-book exam.
- If something is not clear, state your assumptions.
- Programmable calculators are not allowed.
- The number of marks for each question is specified next to it.
- The total number of marks is 50.

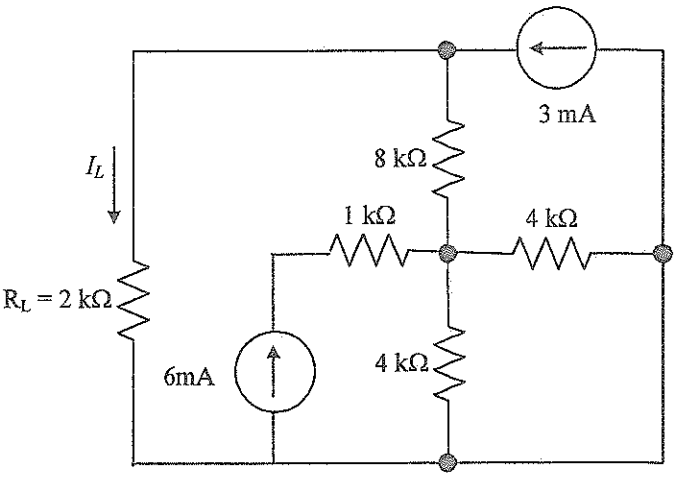
1	2	3	4	Total
/13	/12	/13	/12	50 /50

Question 1 (13 marks)

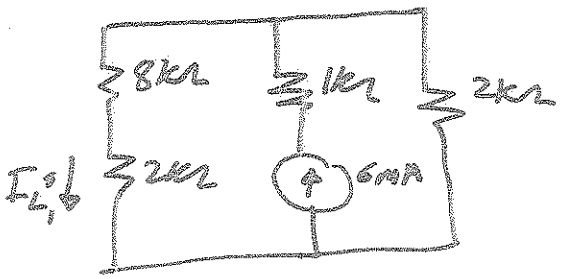
a. Use **superposition** to determine the value of I_L in the 2kΩ load resistance R_L:
b. If R_L is to be replaced with another resistor such that the power transferred to it is maximized, determine the required value of R_L.

6mA source





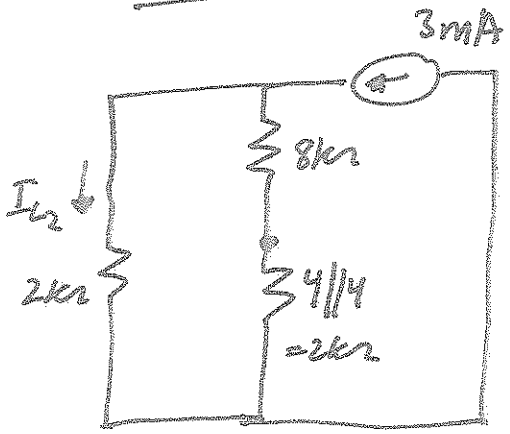
current divider



$$I_{L_1} = \frac{2k}{2k+(8k+2k)}(6m)$$

$$= \frac{2}{12}(6) = 1\,mA$$

3mA source



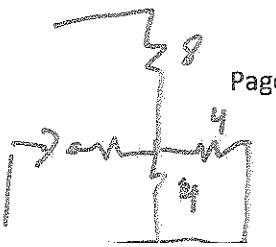
current divider

$$I_{L_2} = \frac{10k}{2k+10k}(3m) = \frac{10}{12}(3)$$

$$= 2.5\,mA$$

$$I_L = I_{L_1} + I_{L_2} = \boxed{3.5\,mA}$$

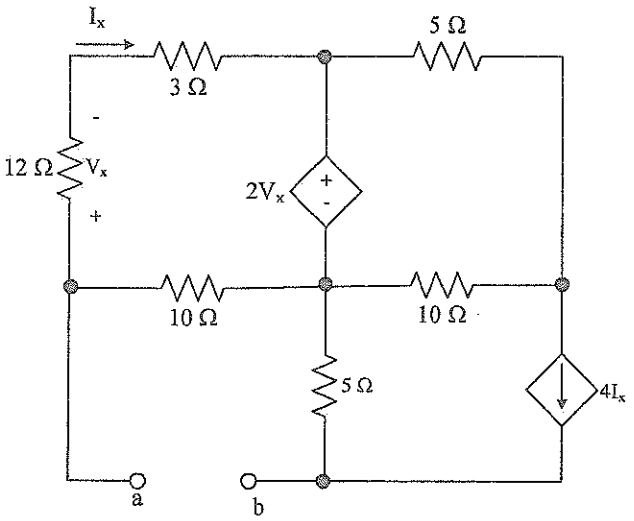
b) $R_L = R_{eq}$



$$= (4||4)+8 = \boxed{10k\Omega}$$

Question 2 (12 marks)

Determine the Norton Equivalent Circuit at Terminals a-b

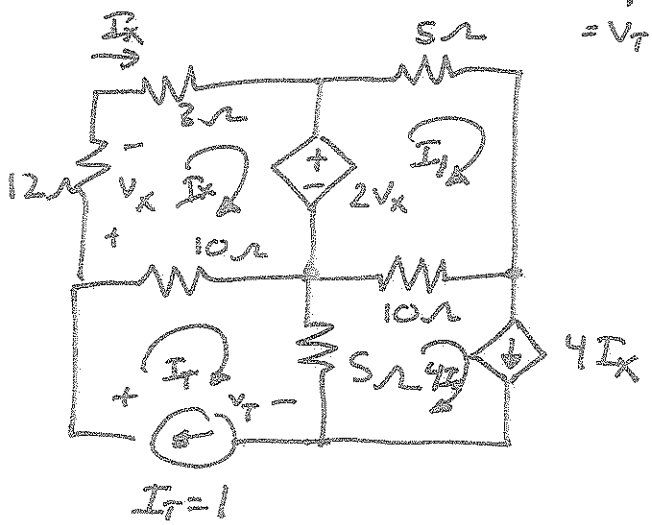


No independent sources

$I_N = I_{SC} = 0$

$R_{th} = \frac{V_T}{I_T}$

Take $I_T = 1 \Rightarrow R_{th} = \frac{V_T}{1} = V_T$



$I_T = 1 \qquad V_x = 12I_x$

$15I_x + 2V_x + 10(I_x - I_T) = 0$

$15I_x + 24I_x + 10I_x - 10 = 0$

$49I_x = 10$

$I_x = \frac{10}{49}$

$V_T = 10(I_T - I_x) + 5(I_T - 4I_x)$

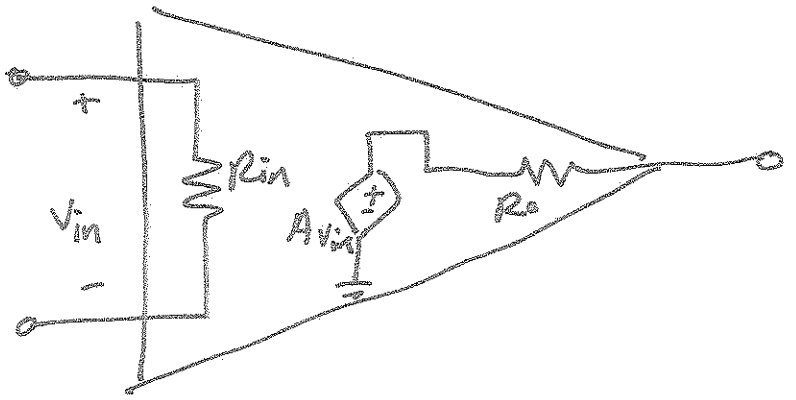
$= 15I_T - 30I_x$

$= 15 - \frac{300}{49} = 8.88\ V$

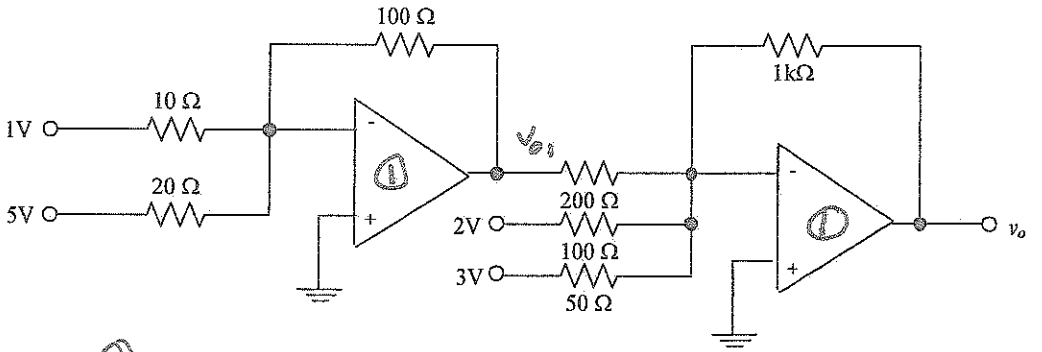
$\Rightarrow R_{th} = 8.88\ \Omega$

Question 3 (13 marks)

a. Draw and label the linear equivalent circuit of an operational amplifier



b. Assuming an ideal op-amp, determine the value of v_o in the following circuit



① $V_+ = V_- = 0V$

$$-\frac{1}{10} - \frac{5}{20} - \frac{V_{o1}}{100} = 0 \quad \Rightarrow V_{o1} = -\frac{100}{10} - \frac{500}{20}$$

$$= -10 - 25$$

$$= -35V$$

② $V_+ = V_- = 0V$

$$-\frac{V_{o1}}{200} - \frac{2}{100} - \frac{3}{50} - \frac{V_o}{1k} = 0$$

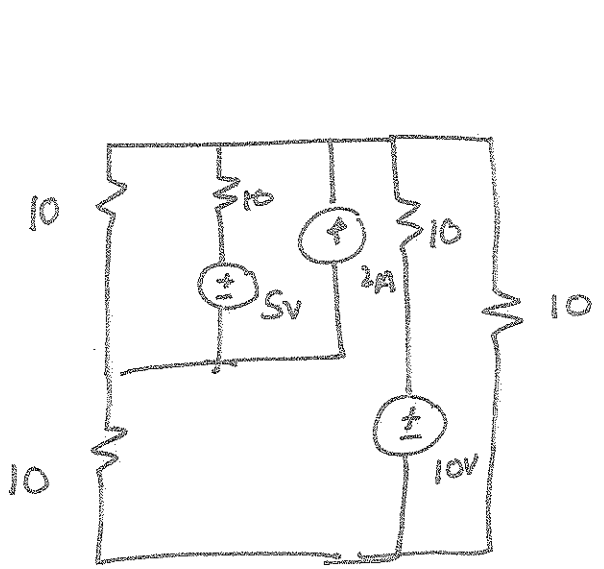
$$V_o = -\frac{1000}{200}(-35) - \frac{(2)(1000)}{100}$$

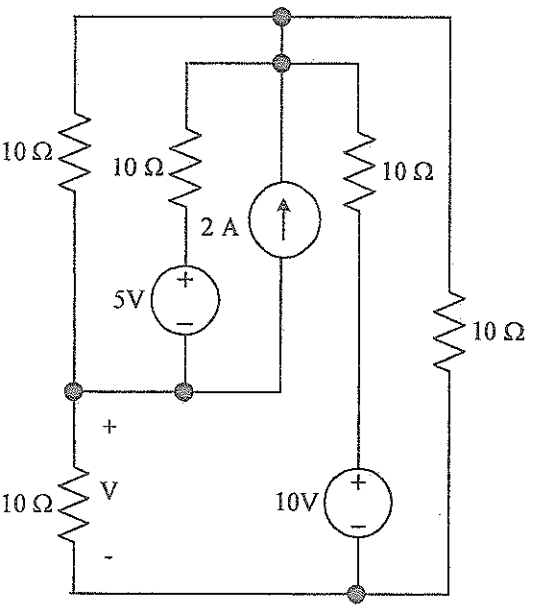
$$\frac{(3)(1000)}{50} = +175 - 20$$

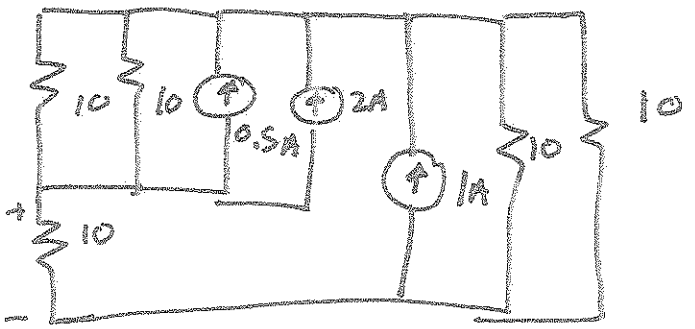
$$= \frac{-60}{195V}$$

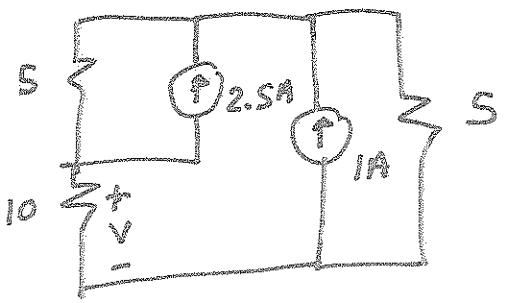
Question 4 (12 marks)

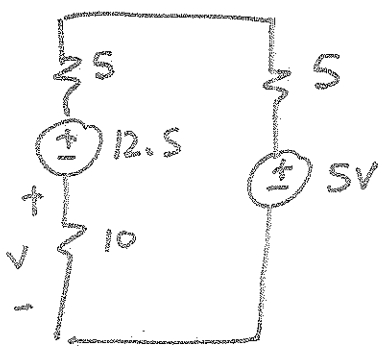
Use source transformation to first simplify the following circuit to one that contains a single source, and then determine the value of the voltage V from the simplified circuit.

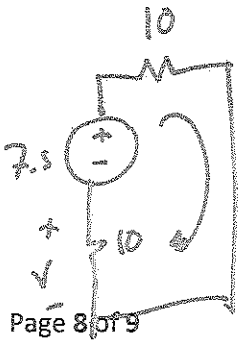












$$I = \frac{7.5}{20} = 0.375$$

$$V = (-10)(0.375)$$

$$= \boxed{-3.75\text{V}}$$