EEE 31 second semester AY2014-2015 : Second Exam

General Instruction: READ and FOLLOW the INSTRUCTIONS!!
Deduction will be given if you do not follow the instructions. Use only black and/or blue ballpen. Write your name, student number, section and teacher at the upper right hand corner of every page of your answer sheet. Answer each problem on a separate sheet. Do not use the reverse side of your answer sheet for your solutions. Anything written at the back will be considered scratch. Answer each problem completely. No calculators are allowed for this exam. Answers in fractional form must be in simplest form. All mobile devices must be turned off.

Problem 1.

a. (15 points) Determine the value of I_x in Figure 1 by using source transformation techniques
b. (10 points) If R_L is to be connected to terminals a and b of Figure 1, what value of R_L will ensure it absorbs maximum possible amount of power?

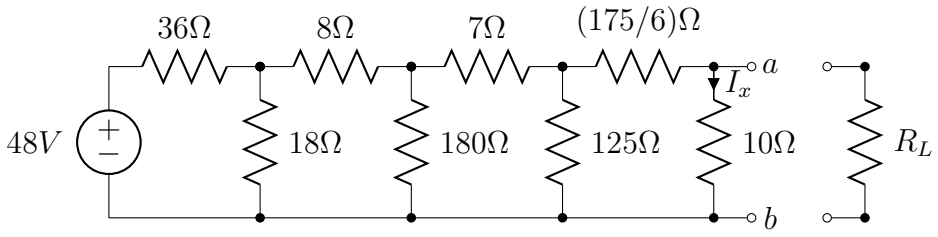

Figure 1:

c. (15 points) In Figure 2, determine the Thevenin resistance (R_{TH}) as seen from terminals a and b.
d. (15 points) In Figure 2, determine the short circuit current (I_{SC}) across terminals a and b.
e. (5 points) Draw the Thevenin equivalent circuit of Figure 2 as seen from terminals a and b.

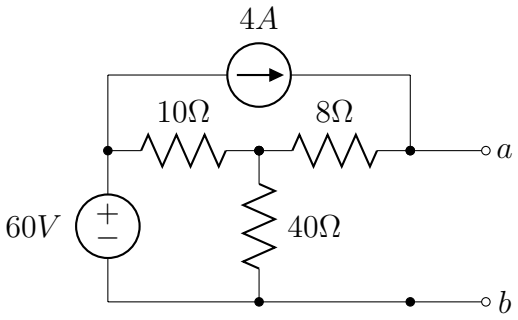

Figure 2:

Problem 2.

The output current of operational amplifiers are limited. Take for example a simple non-inverting amplifier with an output voltage of 2 V. Even though the output voltage is well within saturation, some operational amplifiers may not be able to deliver the required current if the load resistance is low enough (e.g., 100 Ω). To increase the output current that can be delivered to the load, the following circuit can be used.

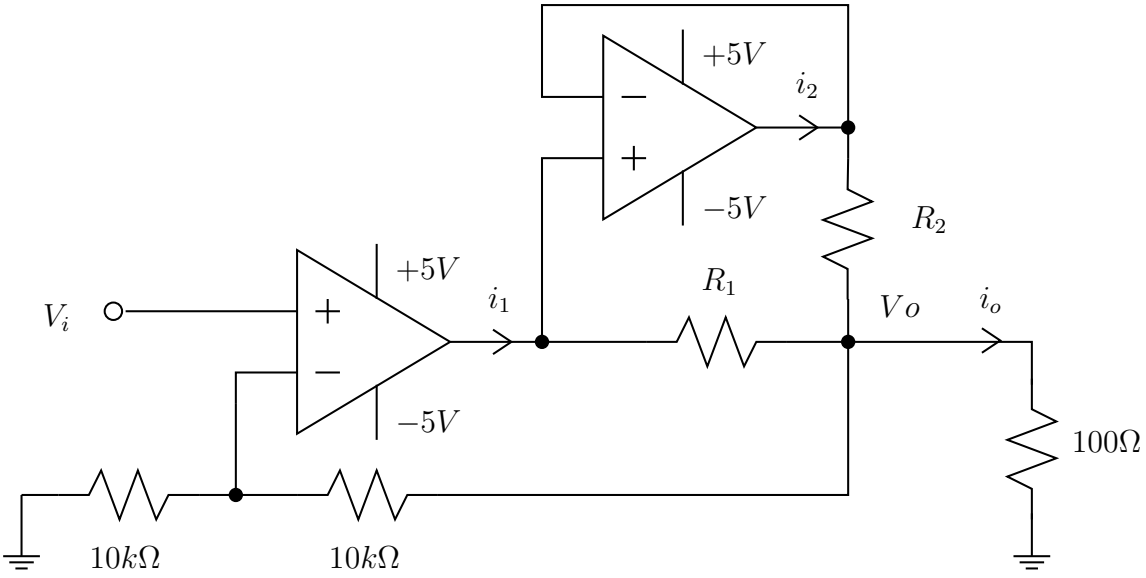

Figure 3:

Assume the opamps in Figure 3 are ideal.

a. (10 points) Determine V_o in terms of V_i. Show your derivation.
b. (10 points) Given $V_i = 1\ V$, compute the current I_o.
c. (10 points) With $V_i = 1\ V$, $R_1 = 10\ \Omega$ and $R_2 = 10\ \Omega$, compute currents i_1 and i_2. Express in mA to two decimal places.
d. (5 points) With $V_i = 1\ V$, $R_1 = 100\ \Omega$ and $R_2 = 200\ \Omega$, compute currents i_1 and i_2. Express in mA to one decimal place.
e. (5 points) With $V_i = 1\ V$, $R_1 = 400\ \Omega$ and $R_2 = 200\ \Omega$, compute currents i_1 and i_2. Express in mA to one decimal place.
f. (10 points) Assuming the operational amplifiers are not saturated, what is the ratio of the current i_1 and current i_2 (i.e., i_1/i_2) in terms of R_1 and R_2. Show your derivation.
g. (10 points) Assuming the operational amplifiers are not saturated, what is the ratio of the current i_1 and total current $i_1 + i_2$, i.e., the ratio $i_1/(i_1 + i_2)$, in terms of R_1 and R_2. Show your derivation.