EEE 31 second semester AY2014-2015 : Removals

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. **Please refer to the circuit drawn on the board**. In the given circuit, the source circuit on the left shall deliver power to the 30 $k\Omega$ on the right.

a. (5 points) Calculate the voltage across terminal a-b (without the 30 $k\Omega$ load).
b. (5 points) Calculate the voltage across terminal a-b when the 30 $k\Omega$ load is connected.
c. (5 points) What ideal Op Amp configuration is needed to eliminate **loading effect** (i.e. difference between your answers in items a and b)?
Draw your new circuit with the ideal Op Amp inserted.
d. (5 points) Calculate the power gain, which is the ratio between the power delivered across the load between item c and item b.
e. (5 points) Where did the **power gain** come from? Explain.

Problem 2. For the circuit Figure 1, solve for I_1 using superposition.

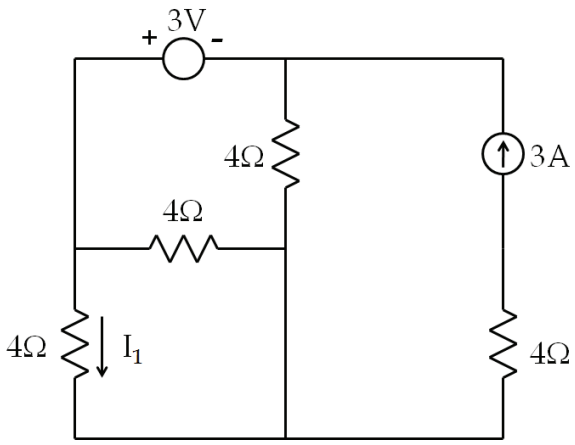

Figure 1:

a. (10 points) $I_{1,1}$ with the 3-V source acting alone.
b. (10 points) $I_{1,2}$ with the 3-A source acting alone.
c. (5 points) Current I_1.

Problem 3. Assume the opamp in Figure 2 is ideal.

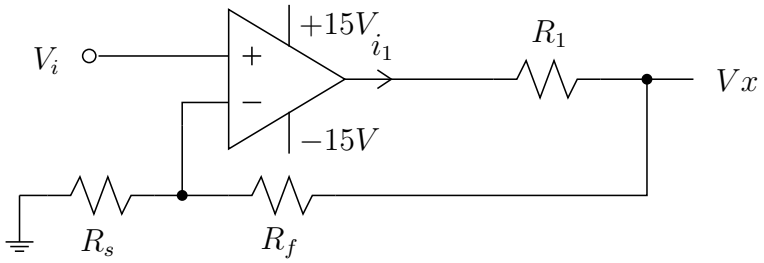

Figure 2:

a. (15 points) Assuming the opamp is operating in the linear region, determine V_x in terms of V_i, R_s and R_f. Show your derivation.
b. (10 points) If $R_s = 10\ k\Omega$, $R_f = 10\ k\Omega$ and $R_1 = 4\ k\Omega$, what is the range of values for V_i to avoid saturation?

Problem 4. Given the circuit in Figure 3,

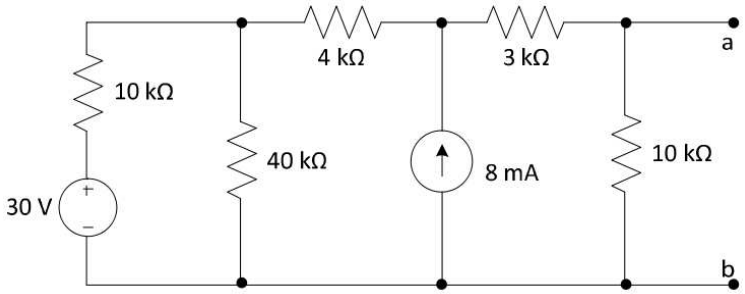

Figure 3:

a. (20 points) Obtain the Thevenin equivalent circuit of Figure 3 using successive source transformation. Show your complete solution.
b. (5 points) By deactivating the independent source, compute the equivalent resistance as seen from the terminals a-b.