Homework 2

Due date:
Mar.17th, 2021
Turn in your homework in class

Rules:

- Please work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism!
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

1. [12%] The circuit is shown in **Fig 1**.
   a) Use superposition theorem to find i', V' and the power absorbed by the dependent source.
   b) Calculate the power absorbed by the independent sources.

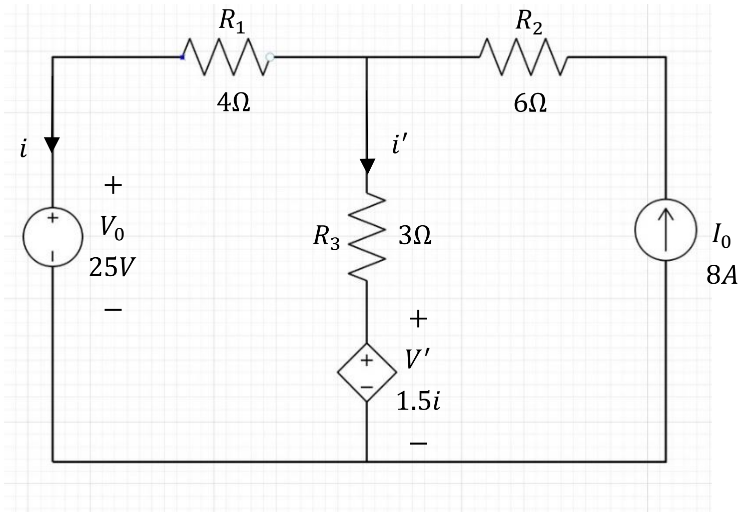

Fig 1.

2. [13%] The circuits are shown in **Fig 2.1** and **Fig 2.2**.
   a) Find $\boldsymbol{i_1}$ and $\boldsymbol{i_2}$ in the circuit shown in **Fig 2.1**.
   b) In **Fig 2.2**, $R_1 = 5\Omega, R_2 = 3\Omega, R_3 = 4\Omega, R_4 = 7\Omega, \mathrm{R}_5 = 8\Omega, R_6 = 9\Omega, U_s = 1V$, Find i in the circuit shown in **Fig 2.2** (Hint: You can use $Y - \Delta$ transformation to simply the circuit.)

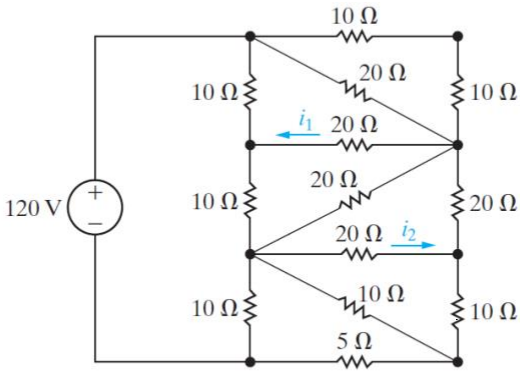

Fig 2.1.

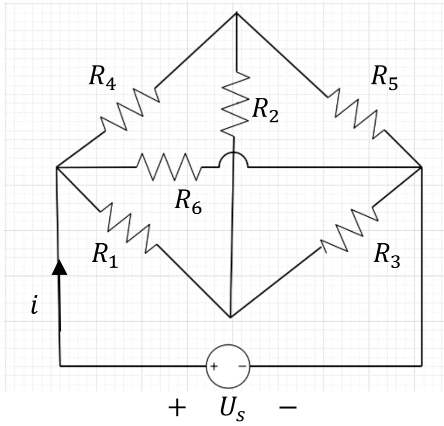

Fig 2.2.

3. [11%] The circuit is shown in **Fig 3**.
    a) Using superposition theorem to find $\boldsymbol{v_0}$
    b) Using source transformation to find $\boldsymbol{v_0}$
    c) Find the Thevenin and Norton equivalent circuit at terminals a and b.

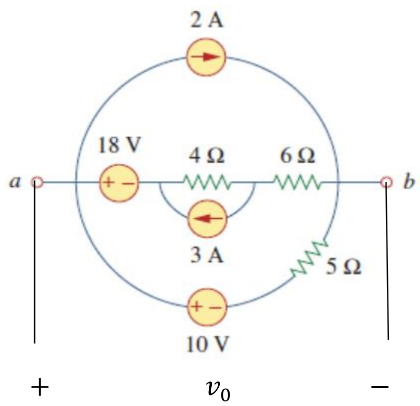

Fig 3.

4. [10%] The circuit is shown in **Fig 4.**
   a) Use source transformation to find v_0 in the circuit in **Fig 4**.
   b) Find the power extracted from the 430V source.
   c) Find the power extracted from the 1A current source.
   d) Verify that the total power delivered equals the total power dissipated.

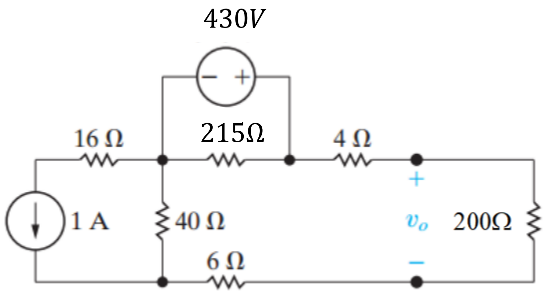

Fig 4.

5. [10%] The circuit is shown is **Fig 5.**
   a) Find the Norton equivalent circuit at terminals a, b.
   b) If we replace the dependent source in the red frame (the voltage of the dependent source is $250i_x$) with an independent source $V_1 = 5V$. We connect a load resistance R_L between terminal a and b. Find R_L for maximum power deliverable to R_L.
   c) Under b) condition, determine the maximum power on R_L.

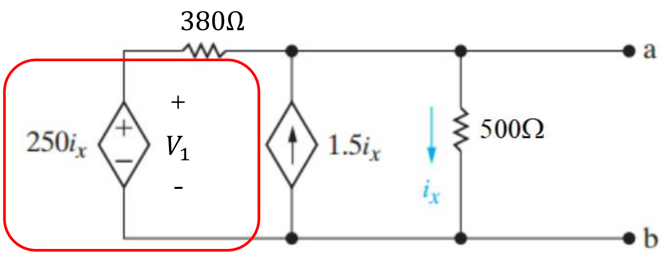

Fig 5.

6. [6%] For the circuit in Fig. 6, find ***k*** from the given voltage transfer function of $V_o/V_s = -3.1875$. Assume that all Op Amps are ideal and work in their linear regions.

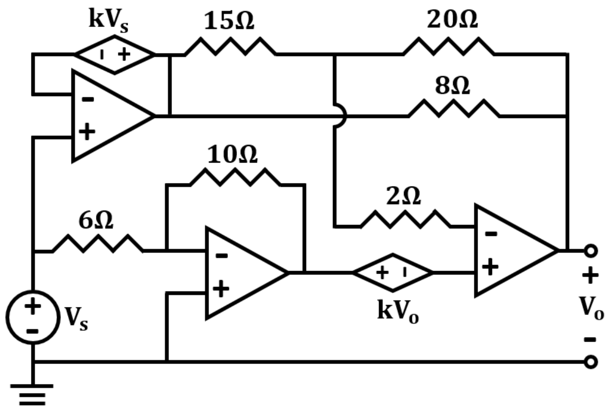

Fig 6.

7. [6%] Consider the circuit in the following Fig. 7 that v_A = 0.7V and v_B = 1.2V. Find the output voltage $\boldsymbol{v_o}$ assuming that all Op Amps are ideal and work in their linear regions.

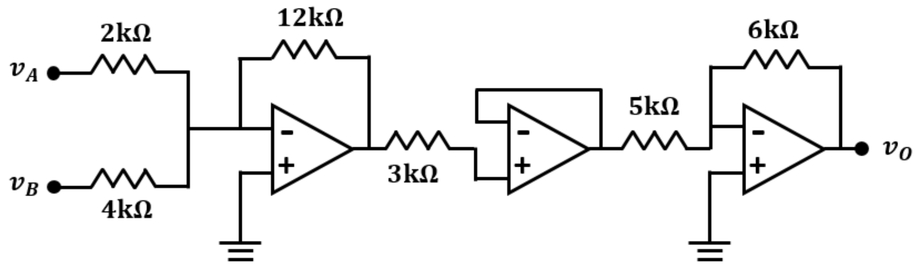

Fig 7.

8. [10%] The circuit in the Fig. 8 is some kind of a differential amplifier. $V_{CC} = 4\text{V}$. Assume that the Op Amp is ideal.
   a) Derive an expression for the output voltage v_o in terms of v_1, v_2, R_1, R_2, R_3 and R_4.
   b) If we connect a load resistor R_L between the output (node v_0) and the ground, would the result of the previous expression change for v_o? Why?
   c) Let $v_2 = 2v_1$, $R_1 = 3\text{k}\Omega$, $R_2 = 15\text{k}\Omega$, and $R_3 = 6\text{k}\Omega$. Find R_4 so that $v_o = 0$.
   d) Let $v_1 = 3\text{V}$ and $v_2 = 1\text{V}$. Using the values given in **c)** part including the computed value for R_4, find v_o.

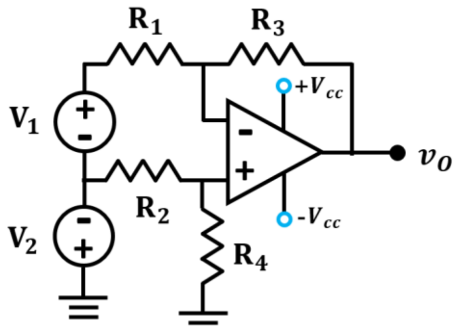

Fig 8.

9. [12%] For the circuit of the Figure below, if we want to have a maximum power of **60mW** transfer into the resistor load $\boldsymbol{R_o}$, what resistance values should $\boldsymbol{R_L}$ and $\boldsymbol{R_o}$ be? Assume that the Op Amp is ideal.

   (Hint: you can first calculate the Thevenin equivalent circuit at terminal v_0 and the ground (neglecting R_o). Afterwards, use maximum power transfer theory to find proper R_L and R_o.)

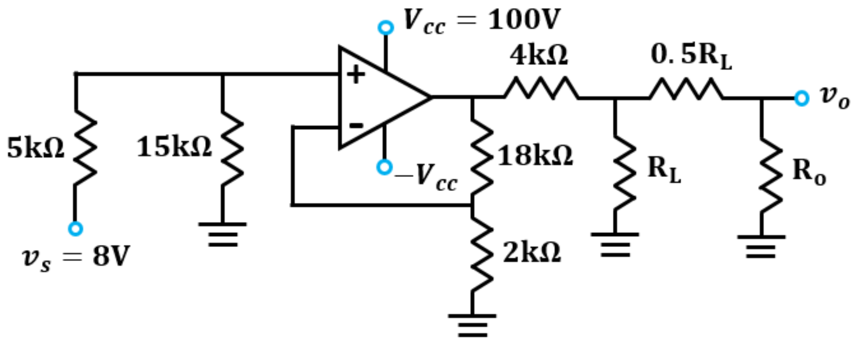

Fig 9.

10. [10%] In the circuit of Figure below, a bridge circuit (circuit on the left part of the terminal (a, b)) is connected at the input side of an inverting Op Amp circuit. Assume that the Op Amp is ideal and work in the linear region.
   a) Obtain the Thevenin equivalent at terminal (a, b) for the left side circuit in terms of v_s, R_1, R_2, R_3 and R_4.
   b) Use the result in (a) and R_f to obtain an expression for $G = v_o/v_s$.
   c) Evaluate G for $R_1 = R_4 = 100\Omega$, $R_2 = R_3 = 101\Omega$, and $R_f = 100k\Omega$.

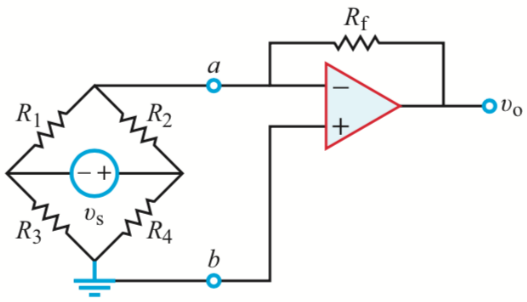

Fig 10.