

EECS 16A Designing Information Devices and Systems I Homework 6

This homework is due Friday, October 14, 2022, at 23:59.

Self-grades are due Monday, October 17, 2021, at 23:59.

Submission Format

Your homework submission should consist of **one** file.

- `hw6.pdf`: A single PDF file that contains all of your answers (any handwritten answers should be scanned) as well as your IPython notebook saved as a PDF.

If you do not attach a PDF “printout” of your IPython notebook, you will not receive credit for problems that involve coding. Make sure that your results and your plots are visible. Assign the IPython printout to the correct problem(s) on Gradescope.

Submit the file to the appropriate assignment on Gradescope.

1. Reading Assignment

For this homework, please review and read Note 11A/B, which introduces the basics of circuit analysis and node voltage analysis. You are always welcome and encouraged to read beyond this as well.

2. It's a Triforce!

Learning Goal: This problem explores passive sign convention and nodal analysis in a slightly more complicated circuit.

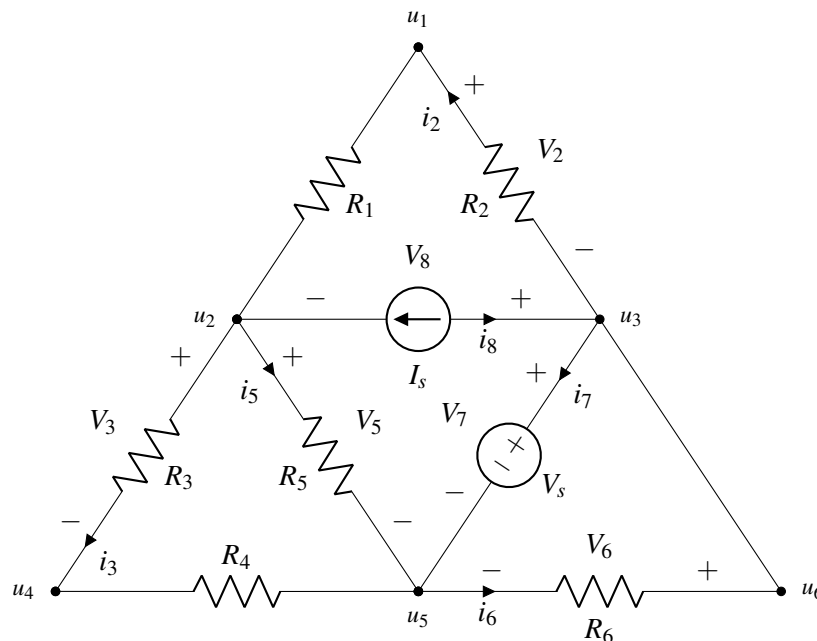
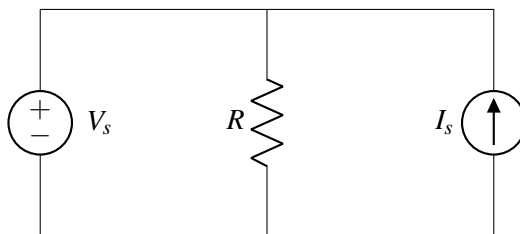


Figure 1: A triangular circuit consisting of a voltage source V_s , current source I_s , and resistors R_1 to R_6 .

- Which elements I_s , V_s , R_2 , R_3 , R_5 , or R_6 in Figure 1 have current-voltage labeling that violates *passive sign convention*? Explain your reasoning.
- In Figure 1, the nodes are labeled with u_1 , u_2 , ... etc. There is a subset of u_i 's in the given circuit that are redundant, i.e. there might be more than one label for the same node. Which node(s)? Justify your answer.
- Redraw the circuit diagram by correctly labeling *all* the element voltages and element currents according to passive sign convention. The component labels that were violating passive sign convention in part (a) should be corrected by *swapping the element voltage polarity*. Also you should now label the elements that have not been labeled yet.
- Write an equation to describe the current-voltage relationship for element R_4 in terms of the relevant i 's, R 's, and node voltages in this circuit.
- Write the KCL equation for node u_2 in terms of the node voltages and other circuit elements.

3. Power Analysis

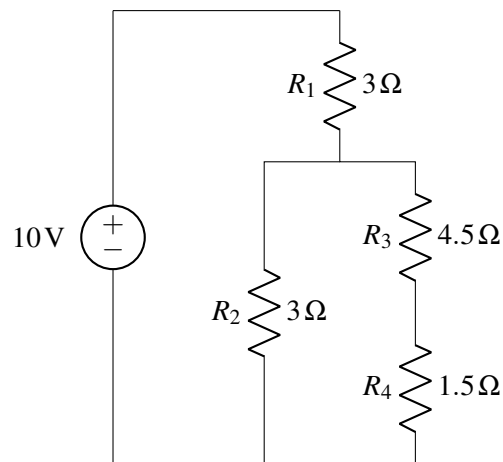
Learning Goal: This problem aims to help you practice calculating power dissipation in different circuit elements. It will also give you insights into how power is conserved in a circuit.



- Find expressions for power dissipated by the voltage source (P_{V_s}), the current source (P_{I_s}), and the resistor (P_R) in the circuit above. Remember to label voltage-current pairs using passive sign convention.
- Use $R = 5 \text{ k}\Omega$, $V_s = 5 \text{ V}$, and $I_s = 10 \text{ mA}$. Calculate the power dissipated by each element. What does a negative value of dissipated power represent? Additionally compute the total power dissipated in all elements.
- Once again, let $R = 5 \text{ k}\Omega$, $V_s = 5 \text{ V}$. What does the value I_s of the current source have to be such that the current source **dissipates** 40 mW? Note that it is possible for a current source to *dissipate* power, i.e. under passive sign convention, $P_{I_s} = +40\text{mW}$. For this value of I_s , compute P_{V_s} and P_R as well.
Hint: If the current source were delivering power, under passive sign convention the computed power would have been $P_{I_s} = -40\text{mW}$, but this is NOT what the question is asking.

4. Mechanical Circuits

Find the voltages across and currents flowing through all of the resistors.



5. Pre-lab Questions

These questions pertain to the pre-lab reading for the *Touch 1* lab. You can find the reading under the *Touch 1* Lab section on the ‘Schedule’ page of the website. We do not expect in-depth answers for the questions. Please limit your answers to a maximum of 2 sentences.

- (a) What are the three terminals of a potentiometer?
- (b) What is the common threshold voltage for an LED?

6. Homework Process and Study Group

Who did you work with on this homework? List names and student ID’s. (In case you met people at homework party or in office hours, you can also just describe the group.) How did you work on this homework? If you worked in your study group, explain what role each student played for the meetings this week.