

EECS 16A Designing Information Devices and Systems I

Spring 2023 Homework 6

This homework is due Friday, March 3rd, 2023, at 23:59.

Self-grades are due Friday, March 10th, 2023, 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).

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.

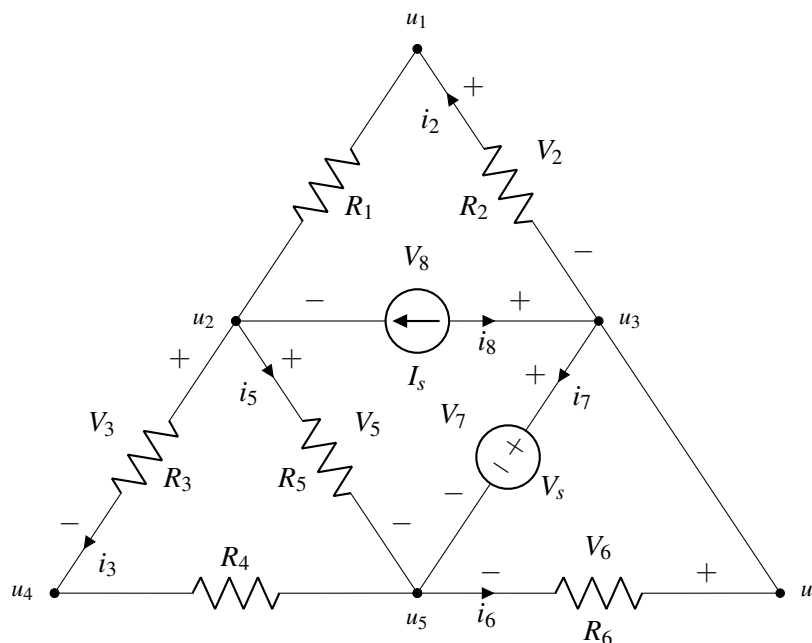


Figure 1: A triangular circuit consisting of a voltage source V_s , current source I_s , and resistors R_1 to R_6 .

- (a) 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.

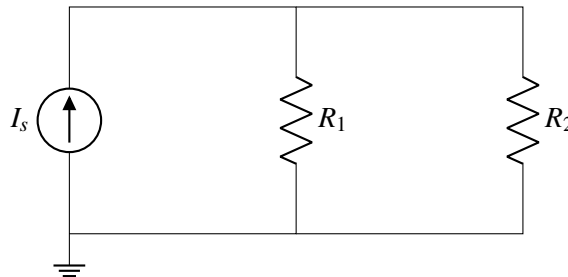
- (b) In Figure 1, the nodes are labeled with u_1, u_2, \dots etc. There is a subset of u_i 's in the given circuit that are redundant, i.e. there might be more than one label for the same node. Which node(s) do not have a unique label? Justify your answer.
- (c) Redraw the circuit diagram by correctly 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*. Additionally, label the elements that have not been labeled yet.
- (d) 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. Your final expression should include u_4, u_5 , and i_4 .
- (e) Write the KCL equation for node u_2 in terms of the node voltages and other circuit elements.

3. Circuit Analysis

Learning Goal: This problem will help you practice circuit analysis using the node voltage analysis (NVA) method.

Using the steps outlined in lecture or in Note 11, analyze the following circuits to calculate the currents through each element and the voltages at each node. Use the ground node labelled for you. You may use a numerical tool such as IPython to solve the final system of linear equations.

- (a) $I_s = 3 \text{ mA}, R_1 = 2 \text{ k}\Omega, R_2 = 4 \text{ k}\Omega$



4. 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) How can you make a voltage divider using a potentiometer?
- (c) What is the threshold voltage of the red LED we use in the lab?

5. 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.