Duke University
Edmund T. Pratt, Jr. School of Engineering

ECE 110L.4 Spring 2025
Test I

Michael R. Gustafson II

Name (please print): NetID (please print):

Submitting your work for a grade implies agreement with the following: In keeping with the Community Standard, I have neither provided nor received any assistance on this test. I understand that if it is later determined that I gave or received assistance, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class. I also understand that I am not allowed to communicate with anyone except the instructor about any aspect of this test until the instructor announces that it is allowed. I understand that if it is later determined that I did communicate with another person about the test before the instructor said it was allowed, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class.

Instructions

First - please turn **off** any cell phones or other annoyance-producing devices. Vibrate mode is not enough; your device needs to be in a mode where it will make no sounds during the course of the test, including the vibrate buzz or those acknowledging receipt of a text or voicemail.

Please be sure that your name and NetID are clearly written at the top of every page. Each problem is on the back of a test page; there is space for work for that particular problem on the front of the next page. **Please be sure to put the work and answers for a given problem on the appropriate page.** Draw a box / circle / something around your final answers for each part of each problem. If you absolutely need more space for a particular problem than the extra nearly-blank page allows, put that work on its own piece of paper, clearly write your name, NetID, and the problem number (in either Arabic or Roman numerals) at the **top center** of that page, and submit any such extra pages in problem-order **after** all preprinted pages of the test. Also, on the pages given to work on a problem, write a note that says "see extra page."

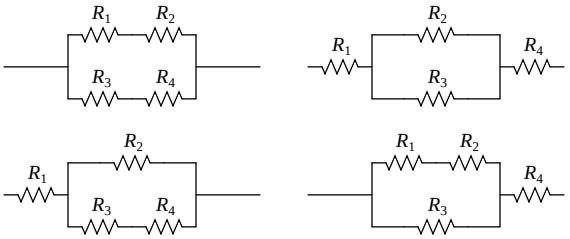
You will *not* be stapling your test but instead will be turning in your test in its original folder to the box at the front of the room. Carefully stack the test pages in order (with any additional pages properly labeled and **after all the original test pages**), put them in the folder you received with the test, and bring the folder to the front of the room.

Note that there may be people taking the test after you, so you are not allowed to talk about the test - even to people outside of this class - until I send along the OK. This includes talking about the specific problem types, how long it took you, how hard you thought it was - really anything. Please maintain the integrity of this test.

You may use the $\|$ symbol for resistances in parallel and do not need to expand that construction unless you are required to determine a numerical answer. Be clear with your use of parentheses, however; simply writing something like

$$R_{\text{eq}} = R_1 + R_2 \parallel R_3 + R_4$$

is too vague since it could refer to any of the four combinations below:



Name (please print):
Community Standard (print NetID):

Problem I: [18 pts.] The Basics

Fill in the 18 blanks in the table below. For the **Equation** column, you can put in any valid equation for the given variable in terms of any other variables in the table (and time), but you are only allowed to use a variation of Ohm's law **once**. You are not allowed to use variables that are not in the table (other than time) for the equations (e.g., $\frac{\rho L}{A}$ would not be accepted for resistance). The equations need to be general and not for a specific circuit element (i.e., R will not show up in your equations either).

Name	Variable	Units	Equation
current			
resistance			
	G		N/R
	w		N/R
		C	N/R
		V	
			$\frac{dw}{dt}$

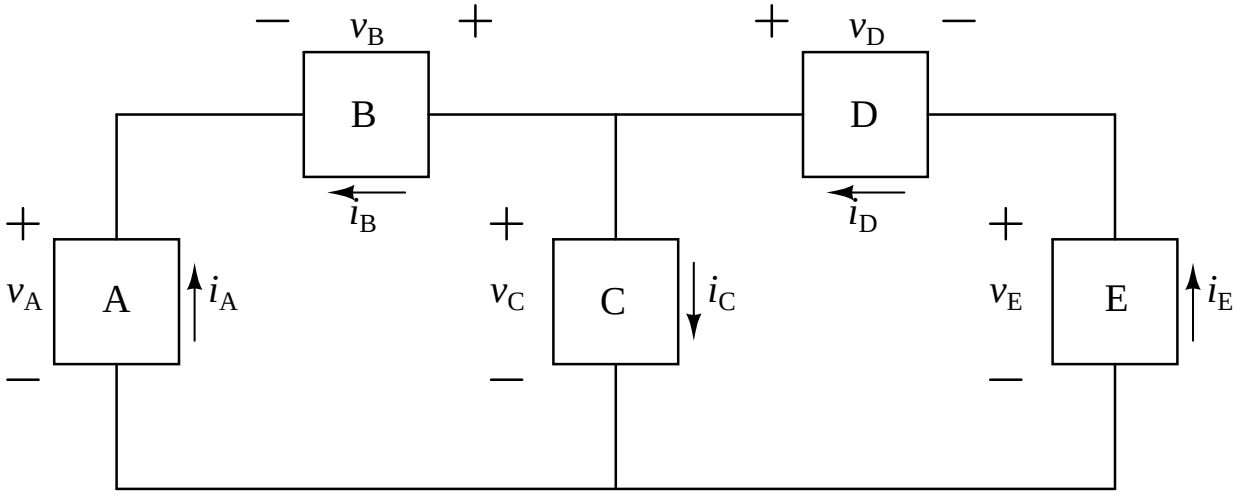
Name (please print):
Community Standard (print NetID):

Extra work for Problem I

Name (please print):
Community Standard (print NetID):

Problem II: [14 pts.] Conservation Laws

Given the block diagram below and the labeled quantities, fill out the table's missing entries for sign convention (**A** or **P**), voltage measurement, current measurement, and power absorbed. Put any work below the table or on the following page.



Element	Conv.	Voltage v, V	Current i, A	Power Absorbed p_{abs}, W
A				12
B			2	
C		10		
D		8		
E				6

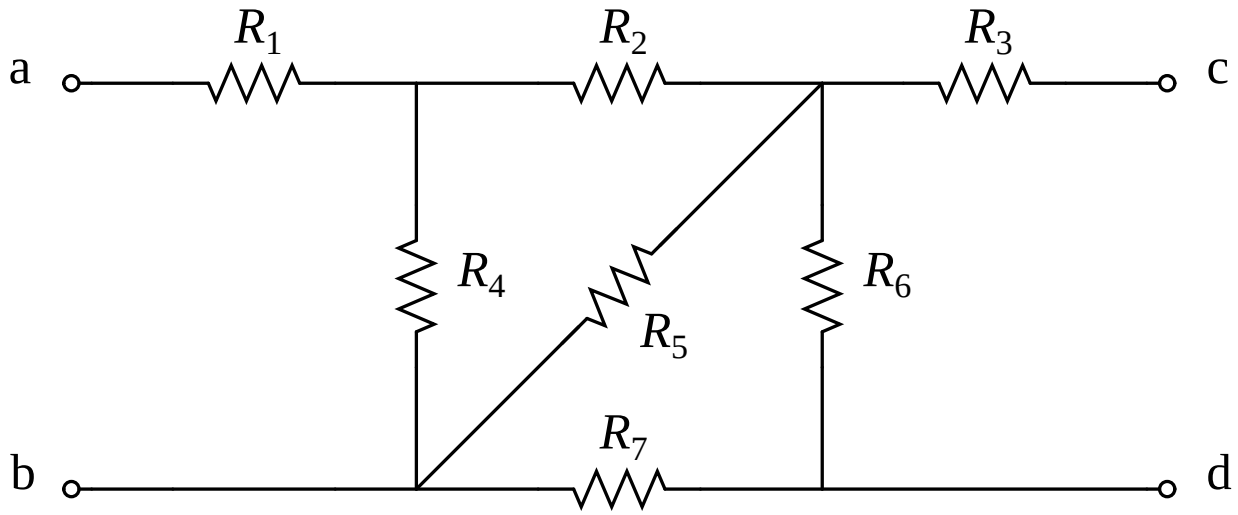
Name (please print):
Community Standard (print NetID):

Extra work for Problem II

Name (please print):
Community Standard (print NetID):

Problem III: [14 pts.] Equivalent Resistance

For the following network:



1. Find the equivalent resistance as seen from terminals a and b, R_{ab}.
2. Find the equivalent resistance as seen from terminals b and c, R_{bc}.
3. Find the equivalent resistance as seen from terminals c and d, R_{cd}.
4. Of the three remaining possible equivalent resistances (R_{ac}, R_{ad}, R_{bd}), which one(s) would require a Δ-Y conversion to find? You are not required to actually find any of them.

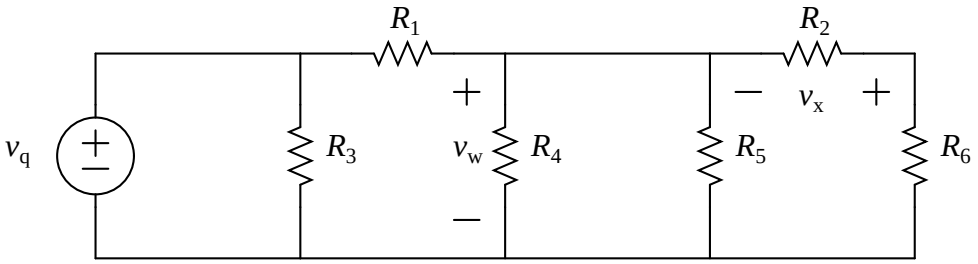
Name (please print):
Community Standard (print NetID):

Extra work for Problem III

Name (please print):
Community Standard (print NetID):

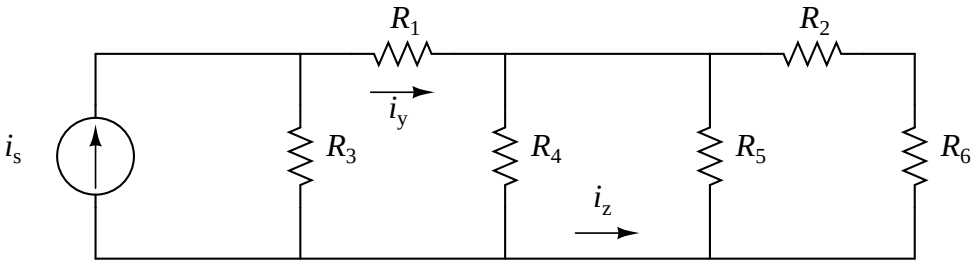
Problem IV: [14 pts.] Division

1. For the following circuit:



clearly show voltage division to obtain expressions for v_w and v_x in terms of the resistors and v_q.

2. For the following circuit:



clearly show current division to obtain expressions for i_y and i_z in terms of the resistors and i_s.

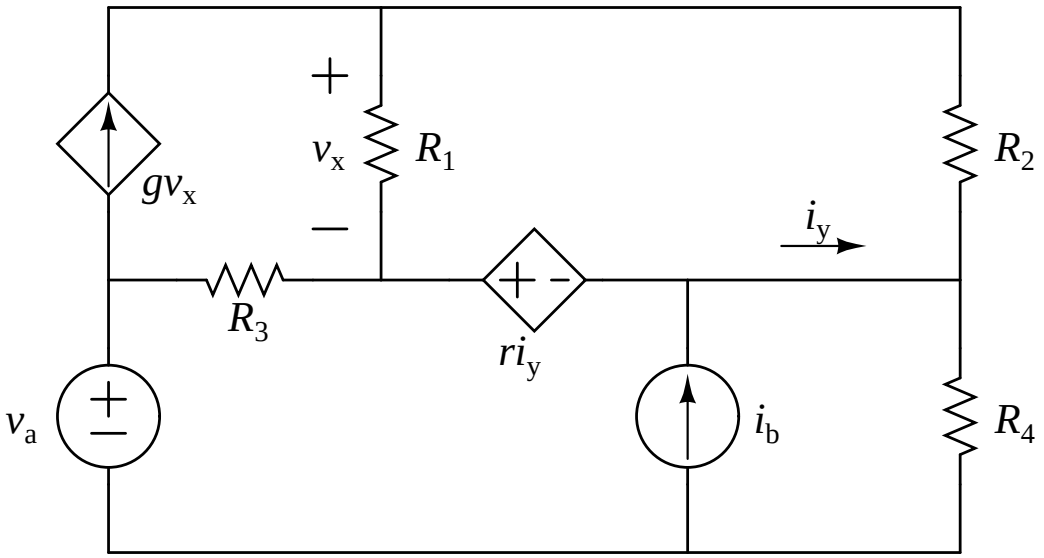
Name (please print):
Community Standard (print NetID):

Extra work for Problem IV

Name (please print):
Community Standard (print NetID):

Problem V: [20 pts.] Node Voltage Method

Given the following circuit:



and assuming that constants g and r, the values for the passive elements (R_1 through R_4), and the values for the independent sources (v_a and i_b) are known,

(1) *Clearly* demonstrate the use of the Node Voltage Method in labeling unknowns for the circuit and in determining a complete set of linearly independent equations that could be used to solve for these unknowns. List the set of unknowns you believe your equations will find. Clearly label the circuit above and then put the list of unknowns and the equations in the box below:

Name (please print):
Community Standard (print NetID):

Extra work for Problem V

(2) Assuming you are able to solve for those unknowns, write expressions for the following. Put your expressions and any work done in the box below the expression.

- $p_{\text{abs},R_3} =$

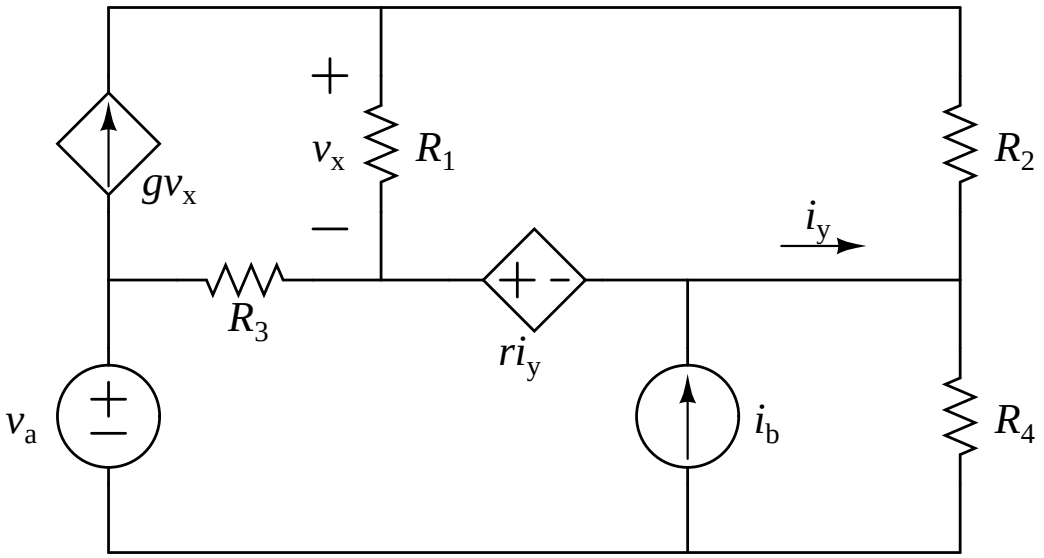
- $p_{\text{del,CCVS}} =$

- $p_{\text{del,VCCS}} =$

Name (please print):
Community Standard (print NetID):

Problem VI: [20 pts.] Mesh or Branch Current Method

Given the following circuit:



and assuming that constants g and r, the values for the passive elements (R_1 through R_4), and the values for the independent sources (v_a and i_b) are known,

(1) *Clearly* demonstrate the use of either the Mesh Current Method or the Branch Current Method in labeling unknowns for the circuit and in determining a complete set of linearly independent equations that could be used to solve for these unknowns. List the set of unknowns you believe your equations will find. Clearly label the circuit above and then put the list of unknowns and the equations in the box below:

Name (please print):
Community Standard (print NetID):

Extra work for Problem VI

(2) Assuming you are able to solve for those unknowns, write expressions for the following. Put your expressions and any work done in the box below the expression.

- $p_{\text{abs},R_3} =$

- $p_{\text{del,CCVS}} =$

- $p_{\text{del,VCCS}} =$