Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.200 – Circuits & Electronics
Spring 2024

Quiz #1

13 March 2024

Name: _____

MIT Kerberos Username: _____

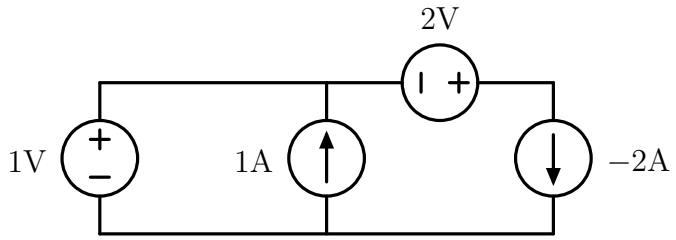
Recitation Time: 11 12 1

- There are 15 pages in this quiz, including this cover page.
- Please put your name and Kerberos ID in the spaces provided above, and circle the time of your recitation.
- Please do not remove any pages from this quiz.
- Do your work for each question within the boundaries of that question, or on the back of the preceding page. *When finished with each part, clearly write your answer for that part into the corresponding answer box or graph.*
- Make sure all work is on pages with QR codes, and **do not write on the QR codes.**
- *All numerical answers require proper units.*
- *In order to guarantee receipt of full credit, all answers should be justified by supporting math and/or explanations.*
- This is a closed-book quiz, but calculators and a single two-sided page of notes are allowed.
- Good luck!

Problem 1: Miscellany – 35%

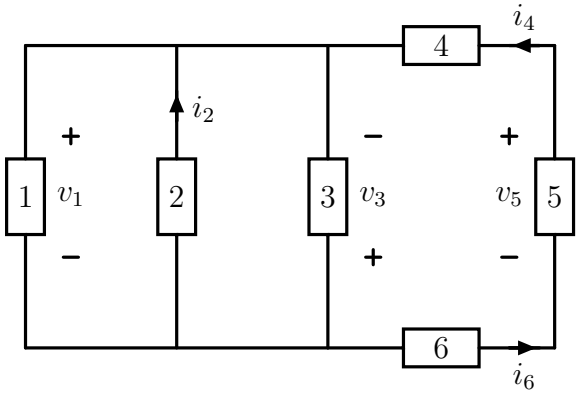
All parts of this problem are independent of the other parts.

(1A) Determine the power sourced (provided) by each of the four sources in the circuit shown below. If a source sinks (receives) power, then consider its sourced power to be negative. *Proper units are required.*



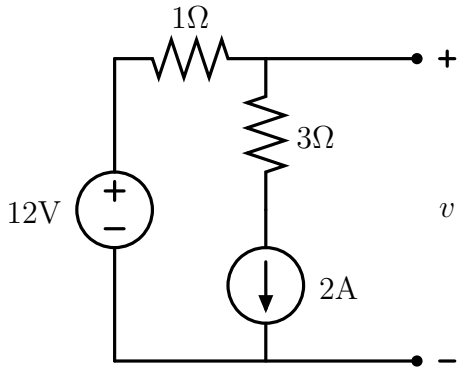
1 V Source:	1 A Source:
2 V Source:	-2 A Source:

(1B) The circuit shown below comprises comprises six branches with partially labeled branch voltages and currents. Add the missing labels to the circuit diagram according to the passive sign convention. A brute-force analysis of the circuit would require the use of six equations obtained from KCL and KVL. Provide six such equations that are necessary and sufficient to carry out a brute-force analysis.



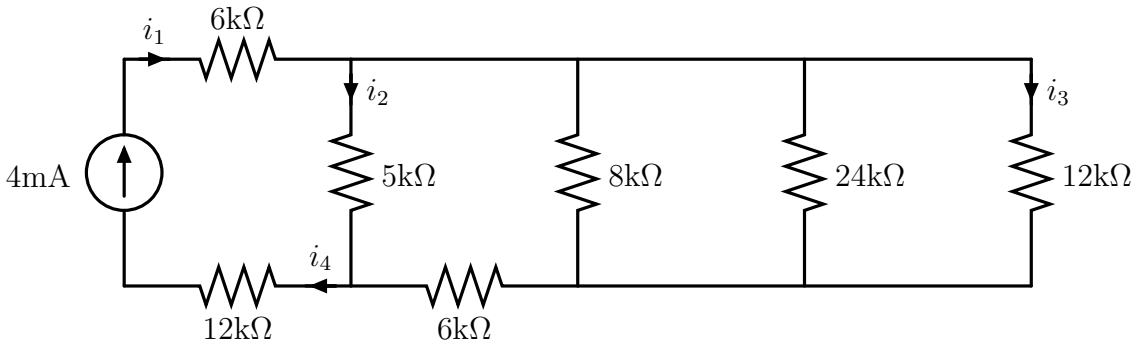
Eqn #1:	Eqn #2:
Eqn #3:	Eqn #4:
Eqn #5:	Eqn #6:

(1C) Determine the voltage v in the circuit shown below. *Proper units are required.* If the voltage cannot be determined, enter "N/A" in the answer box.



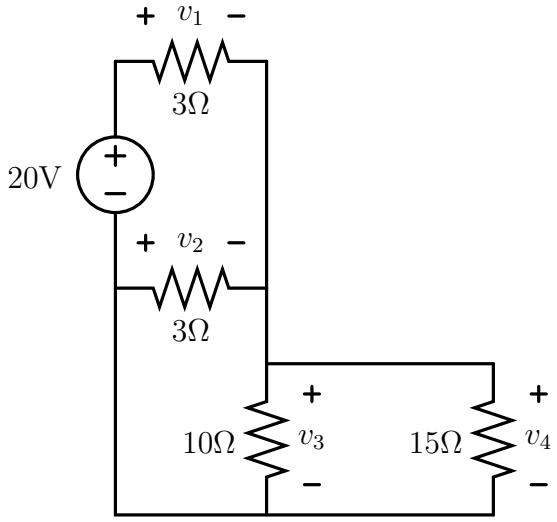
$v =$

(1D) The circuit shown below has four labeled currents. Determine numerical values for all four currents. *Proper units are required.*



$i_1 =$	$i_2 =$
$i_3 =$	$i_4 =$

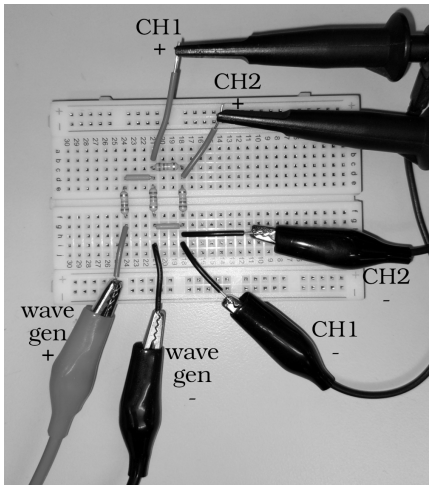
(1E) The circuit shown below has four labeled voltages. Determine numerical values for all four voltages. *Proper units are required.*

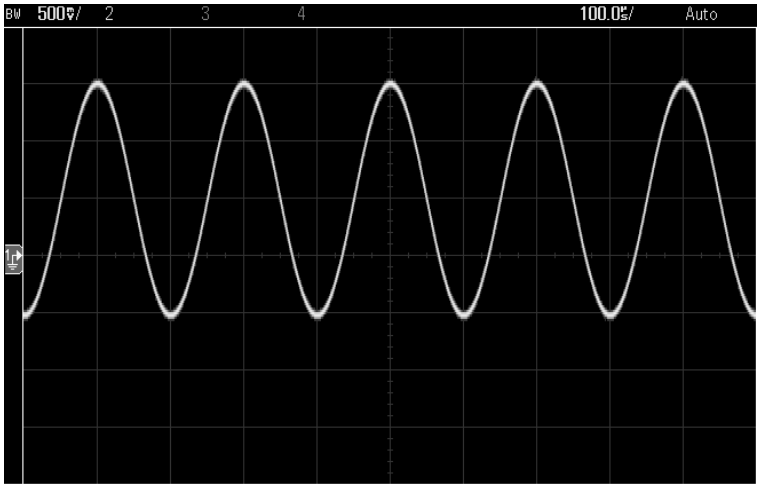


$v_1 =$	$v_2 =$
$v_3 =$	$v_4 =$

Problem 2: Measurements – 15%

The top figure below shows a photograph of a circuit built on a protoboard. The resistance of each of the four resistors in the circuit is 22 kΩ. The oscilloscope image shows the voltage measured on Channel 1.

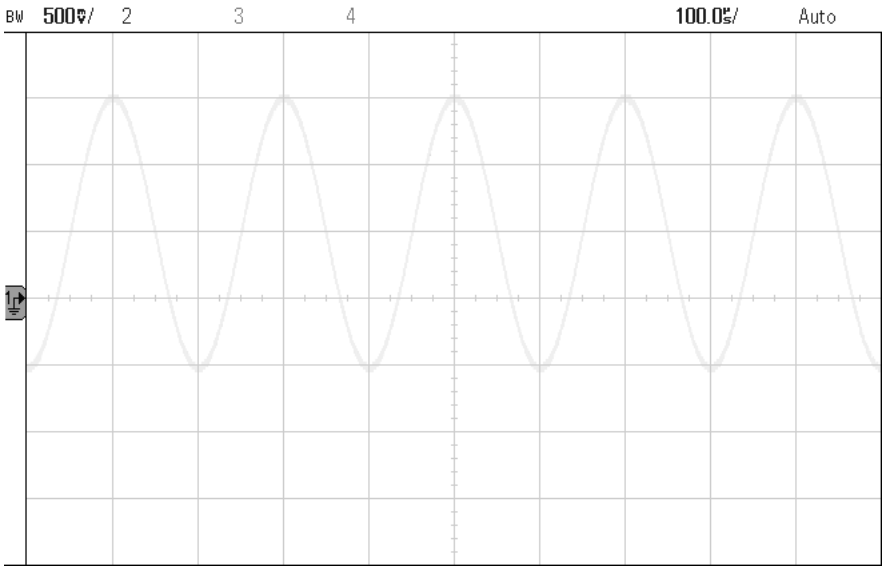




Given this measurement, determine the amplitude and frequency of the sine wave produced by the signal generator. *Proper units are required.*

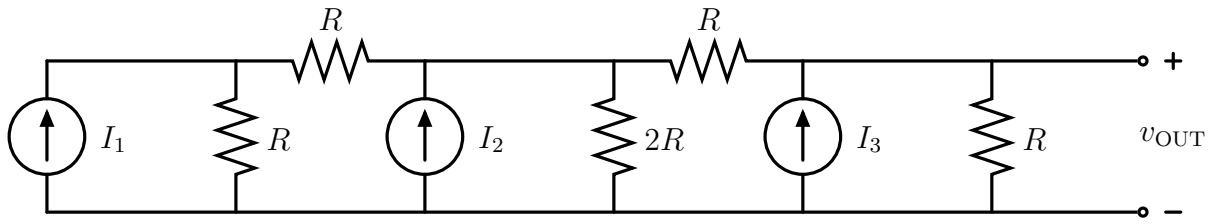
Amplitude:	Frequency:

In addition, on the axes given below, sketch the waveform measured by Channel 2. The voltage from Channel 1 has been reproduced in light grey for reference.



Problem 3: Multiple Sources – 14%

This problem concerns the circuit shown below, comprising three current sources and five resistors. The circuit has one port labeled with the voltage v_{OUT}.



(3A) Determine v_{OUT} in terms of I_1, I_2, I_3 and R.

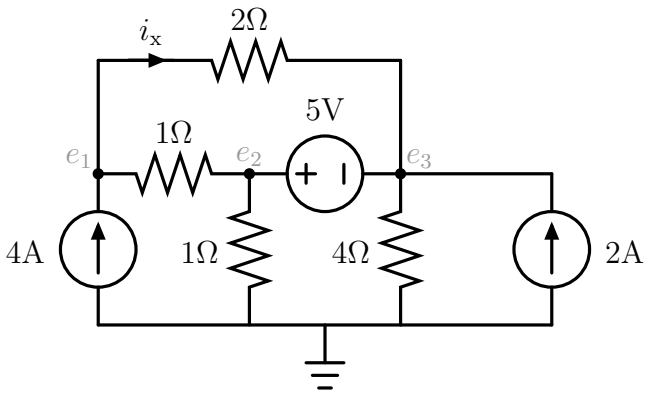
$v_{\mathrm{OUT}} =$

(3B) Draw and clearly label the Thévenin and Norton equivalents for the original circuit when viewed from the port labeled v_{OUT}.

Thévenin:
Norton:

Problem 4: Node Analysis – 20%

Consider the network shown below. The objective of this problem is to use nodal analysis to determine the current i_x flowing through the 2Ω resistor. To do so, follow the steps outlined below. *To receive partial credit, please clearly explain your approach including the equations you are using for part (4A).*



(4A) Write two node equations that can be solved for the unknown node voltages e_1 and e_2. *Proper units are required.*

Equation 1:
Equation 2:

(4B) Determine the values of e_1, e_2 and e_3. *Proper units are required.*

e_1:
e_2:
e_3:

(4C) Determine the current i_x flowing through the 2Ω resistor. *Proper units are required.*

If you were unable to determine numerical values for e_1, e_2 and e_3, then provide symbolic expressions for partial credit.

i_x:

(4D) Determine the power dissipated in the 2Ω resistor. *Proper units are required.*

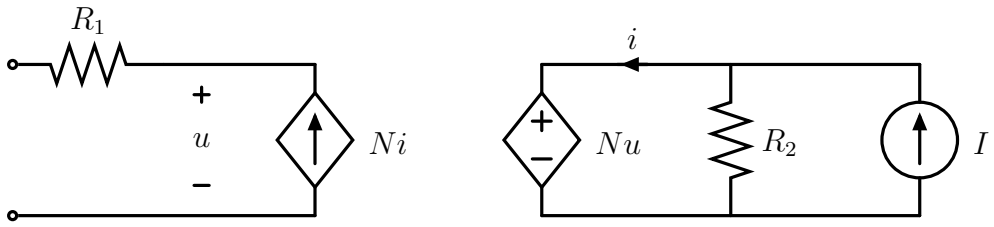
If you were unable to determine numerical values for e_1, e_2 and e_3, then provide symbolic expressions for partial credit.

Power:

Problem 5: Dependent Sources – 16%

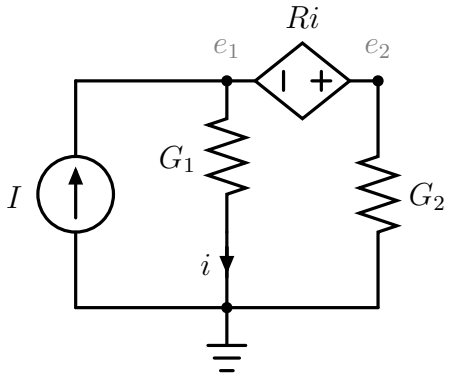
With one exception, all parts of this problem are independent of the other parts. The one exception is that Parts (C) and (D) consider the same circuit.

(5A) Determine the Thévenin equivalent, as viewed from the open port, of the circuit shown below. Make sure to clearly label the open port in the Thévenin equivalent.



Thévenin:

(5B) Determine the two unknown node voltages e_1 and e_2 in the circuit shown below. Note that the two resistors in the circuit are labeled with their *conductances* as opposed to their resistances.



$e_1 =$
$e_2 =$