MAE40 - Linear Circuits - Fall 25
Midterm #1, October 21

Instructions

(i) You can use a two-sided 1-page handwritten cheatsheet.

(ii) The exam has 2 questions for a total of 20 points and 2 bonus points.

(iii) You have from 2:00pm to 3:20pm to do the exam, but it should require less time for you to complete it.

(iv) You can use a calculator with no communication capabilities.

(v) In your responses, clearly articulate your reasoning, and properly justify the steps.

(vi) **Important:** start each part below on a separate page and write your name & PID at the top of each page.

Good luck!

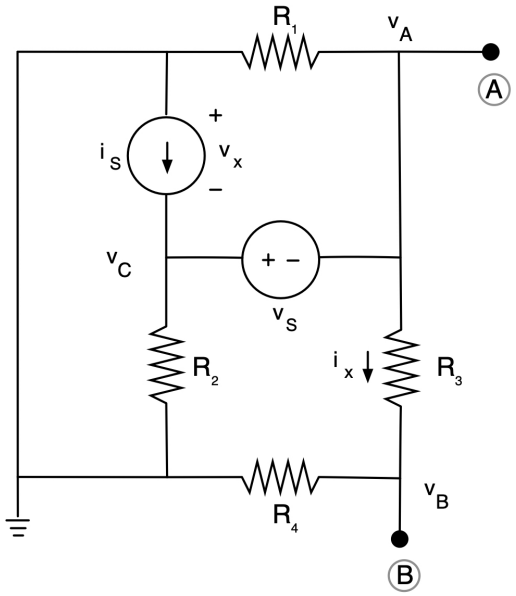

Figure 1: Circuit for all questions.

1. **Circuit analysis**

   Part I: [6 points] Formulate node-voltage equations for the circuit in Figure 1. Use the node labels provided. Clearly indicate the final equations and circuit variable unknowns. Write the final equations **in matrix form** in the unknown node-voltages. **Do not modify the circuit or the labels**. No need to solve any equations!

   Part II: [2 points] Provide expressions for the voltage v_x and the current i_x in terms of node voltages.

   Part III: [2 points] Among the choices for ground other than the one in Figure 1, are there any that are better? Why?

2. **Equivalent circuits**
   For this question, in the circuit in Figure 1, assume $v_S = 10V$, $i_S = 2A$, $R_1 = R_2 = 20\,\Omega$, $R_3 = 10\,\Omega$, and $R_4 = 5\,\Omega$. Do the following:

   Part I: [5 points] Turn off the sources and find the equivalent resistance as seen from terminals Ⓐ and Ⓑ.

   Part II: [3 points] Given your knowledge of Norton/Thévenin equivalence and your answer to Part I, if the short-circuit current when connecting terminals Ⓐ and Ⓑ is $i_{sc} = 1A$ (going downwards), what is the open-circuit voltage v_{oc} as seen from terminals Ⓐ and Ⓑ for the circuit in Figure 1?

   Part III: [2 points] Use your answers to Part I and Part II to find out the power delivered to a $R = 2\,\Omega$ resistor connected to terminals Ⓐ and Ⓑ.

   Part IV: [Extra 2 points] What would happen if the resistor connected in Part III has a power rating of $1\,W$? Could you have prevented this from happening by using a fuse? What is the maximum current rating that the fuse could have?