MAE40 - Linear Circuits - Winter 25
Midterm #1, February 4

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, use only one side, and write your name & PID at the top of each page.

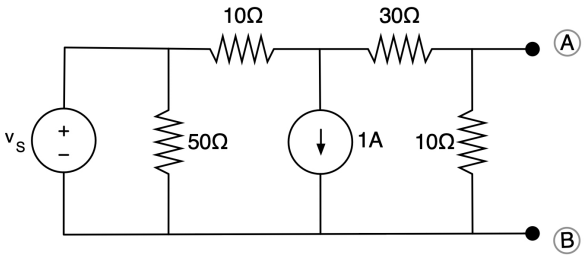

Figure 1: Circuit for question 1.

Good luck!

1. **Equivalent circuits**
   For the circuit in Figure 1, do the following:

   Part I: [3 points] Turn off the sources and find the equivalent resistance as seen from terminals Ⓐ and Ⓑ.

   Part II: [3 points] Express the open-circuit voltage as seen from terminals Ⓐ and Ⓑ as a function of the value v_S of the voltage source.

   Part III: [4 points] To determine the value of v_S, an engineer connected a $R = 16\,\Omega$ resistor to terminals Ⓐ and Ⓑ and measured the power supplied to R as $\frac{1}{9}\,W$. They then used this information and the fact that $v_S \neq 0$ to find out the value of v_S. What is it?

   Part IV: [Extra 2 points] Instead, when the engineer connected a fuse rated at $50\,mA$ and a $R = 16\,\Omega$ resistor in series to terminals Ⓐ and Ⓑ, they measured the power supplied to R as $0\,W$. Why?

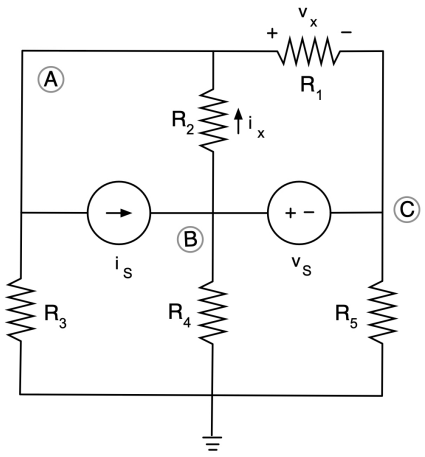

Figure 2: Circuit for question 2.

2. **Circuit analysis**

   Part I: [6 points] Formulate node-voltage equations for the circuit in Figure 2. 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 bottom node, are there any that are better? Why?