

**MAE40 - Linear Circuits - Winter 24**  
**Midterm #1, February 6**

**Instructions**

- (i) The exam is open book. You may use your class notes and textbook.
- (ii) The exam has 2 questions for a total of 20 points and 2 bonus points.
- (iii) You have from 9:30am to 10:50am 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.

Good luck!

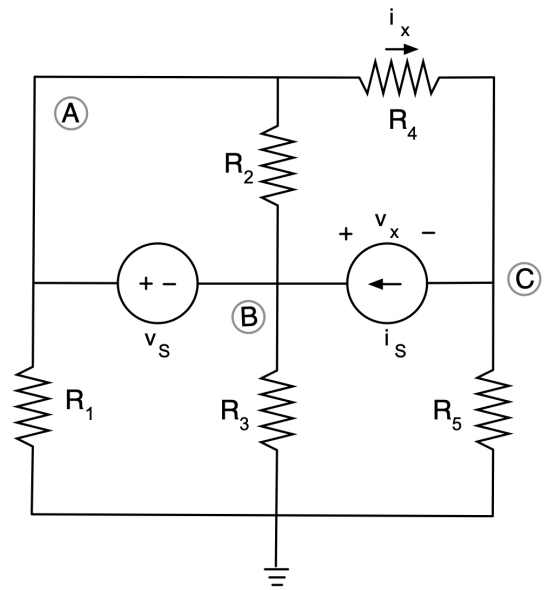


Figure 1: Circuit for question 1.

**1. Circuit analysis**

**Part I:** [6 points] Formulate node-voltage equations for the circuit in Figure 1. Use the node labels provided in the figure. 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] How would changing the value of the resistor  $R_2$  affect the value of  $v_x$  and  $i_x$ ? Why?

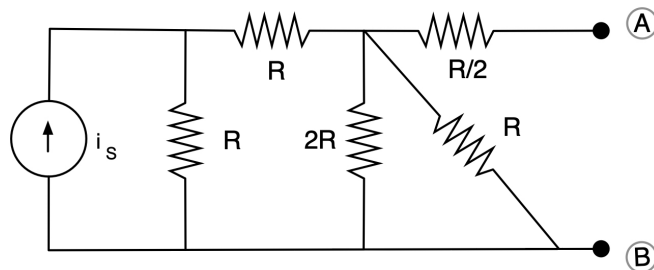


Figure 2: Circuit for question 2.

**2. Equivalent circuits**

For the circuit in Figure 2, do the following:

**Part I:** [4 points] Turn off the source and find the equivalent resistance as seen from terminals A and B.

**Part II:** [4 points] Compute the open-circuit voltage as seen from terminals A and B using association of resistors, equivalent sources, and voltage/current division.

**Part III:** [2 points] What are the Thévenin equivalent and the Norton equivalent of the circuit as seen from terminals A and B?

**Part IV:** [Extra 2 points] Let  $i_s = 4\text{ A}$  and  $R = 100\ \Omega$ . If we connect a fuse rated at  $500\text{ mA}$  and a  $200\ \Omega$  resistor in series to terminals A and B, will the fuse blow? How about if we connect the same fuse but with a  $50\ \Omega$  resistor instead?