

**MAE40 - Linear Circuits - Winter 22**  
**Midterm #1, January 31**

**Instructions**

- (i) Prior to the exam, you must have completed the Academic Integrity Pledge at <https://academicintegrity.ucsd.edu/forms/form-pledge.html>
- (ii) The exam is open book. You may use your class notes and textbook.
- (iii) Collaboration is not permitted. Your answers must be the result only of your own work.
- (iv) The exam has 2 questions for a total of 20 points and 1 bonus point.
- (v) You have from 11:00am to 11:50am to do the exam. Allow sufficient time to post your answers in Canvas (submission closes at 12:00pm).
- (vi) If there is any clarification needed for a statement, post your question in the "Discussions" tab of the class Canvas webpage ("Clarifications on question statements of midterm1")

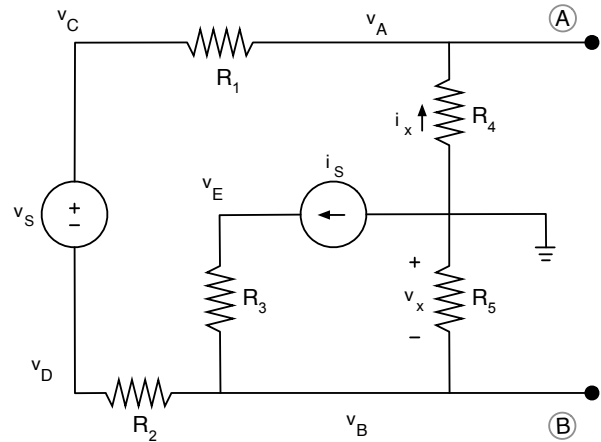


Figure 1: Circuit for all questions.

Good luck!

**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. The final equations in matrix form must depend only on unknown node-voltages. **Do not modify the circuit or the labels** (no source transformation allowed). 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] If we were allowed to modify the circuit, what other method would you have used to formulate node-voltage equations for the circuit in Figure 1?

**2. Linearity and Equivalent circuits**

- Part I:** [3 points] Turn off all the sources in the circuit of Figure 1 and find the equivalent resistance as seen from terminals  $\textcircled{A}$  and  $\textcircled{B}$ .
- Part II:** [3 points] Turn off the voltage source and compute the open-circuit voltage as seen from terminals  $\textcircled{A}$  and  $\textcircled{B}$  using association of resistors, equivalent sources, and voltage division.
- Part III:** [2 points] Turn off the current source and compute the open-circuit voltage as seen from terminals  $\textcircled{A}$  and  $\textcircled{B}$  using association of resistors and voltage division.
- Part IV:** [2 points] Use superposition and your answers to Parts I-III to determine the Thévenin equivalent of the circuit as seen from terminals  $\textcircled{A}$  and  $\textcircled{B}$ .
- Part V:** [Extra 1 point] How would your answer to Part IV be different if the resistor  $R_3$  was not present (i.e., substitute it by a short circuit)?