

MAE140 - Linear Circuits - Winter 19
Midterm, February 7

Instructions

- (i) This exam is open book. You may use whatever written materials you choose, including your class notes and textbook
- (ii) You may use a hand calculator with no communication capabilities
- (iii) You have 75 minutes
- (iv) Do not forget to write your **name** and **student number**
- (v) The exam has 3 questions, for a total of 30 points

Good luck!

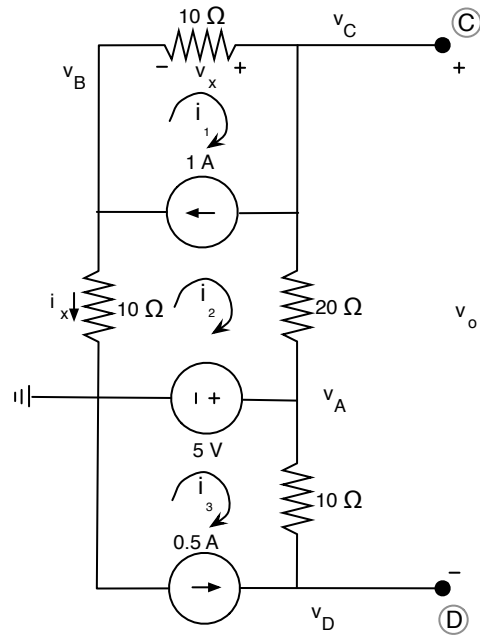


Figure 1: Circuit for all questions.

1. Node voltage analysis

Part I: [5 points] Formulate node-voltage equations for the circuit in Figure 1. Use the node labels provided in the figure. Clearly indicate how you handle the presence of a voltage source (if you have more than one choice to deal with it, use the simplest). The final equations must depend only on unknown node voltages. **Do not modify the circuit or the labels.** No need to solve any equations!

Part II: [3 points] Provide expressions for the mesh currents i_1 , i_2 , and i_3 in terms of the node voltages.

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

2. Mesh current analysis

Part I: [6 points] Formulate mesh-current equations for the circuit in Figure 1. Use the mesh currents shown in the figure and clearly indicate how you handle the presence of the two current sources. The final equations should only depend on the unknown mesh currents. **Do not modify the circuit or the labels** (meaning source transformation or circuit re-drawing are not allowed). No need to solve any equations!

Part II: [2 points] A former student of MAE140 said that, if the value of the bottom right resistor was 5Ω (instead of 10Ω), then (a) the value of the mesh currents would not change and (b) the power delivered by the $0.5A$ current source would be the same. Determine the validity of each assertion, justifying your answer.

Part III: [2 points] If you could modify the circuit instead (meaning circuit re-drawing and source transformations were allowed), how many other methods could you have used to deal with the $1A$ current source?

3. Equivalent circuits

Part I: [4 points] Turn off all the sources in the circuit of Figure 1 and find the equivalent resistance as seen from terminals C and D.

Part II: [2 points] If you solved for the node voltages in Problem 1, you would find that $v_B = 3.75V$, $v_C = -2.5V$, and $v_D = 10V$. Use this information to find the open-circuit voltage v_o .

Part III: [2 points] Use your answers to Parts I and II to determine the Thévenin equivalent of the circuit as seen from terminals C and D.

Part IV: [2 points] If we short-circuit terminals C and D, what would be the value of the short-circuit current?