MAE140 - Linear Circuits - Winter 17
Midterm, February 9

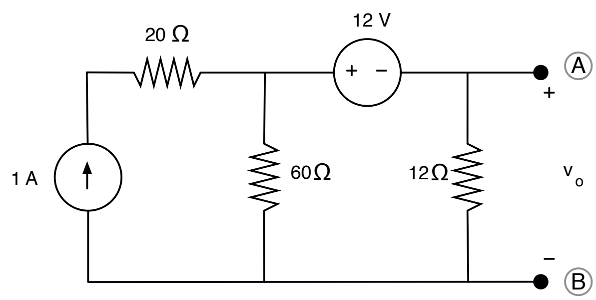
Instructions

(i) This exam is open book. You may use whatever written materials you choose, including your class notes and textbook. You may use a hand calculator with no communication capabilities

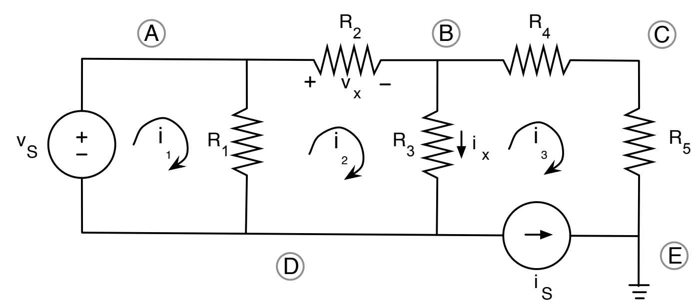
(ii) You have 75 minutes

(iii) Do not forget to write your **name** and **student number**

Good luck!



(a) Question 1



(b) Questions 2&3

Figure 1: Circuits for all questions.

1. **Equivalent circuits**

   Part I: [2 points] Turn off all the sources in the circuit of Figure 1(a) and find the equivalent resistance as seen from terminals (A) and (B).

   Part II: [4 points] Find the voltage v_0 using only superposition, source transformations, voltage division, and current division.

   Part III: [1 point] What is the Thévenin equivalent of the circuit as seen from terminals (A) and (B)?

   Part IV: [1 point] Find the power absorbed by a $30\,\Omega$ resistor that is connected to terminals (A) and (B).

2. **Node voltage analysis**

   Part I: [5 points] Formulate node-voltage equations for the circuit in Figure 1(b). Use the node labels (A) through (E) provided in the figure and clearly indicate how you handle the presence of a voltage source. The final equations must depend only on unknown node voltages and the resistor values R_1 through R_5. **Do not modify the circuit or the labels**. No need to solve any equations!

   Part II: [1 point] Provide expressions for the voltage v_x and the current i_x in terms of node voltages.

   Part III: [1 bonus point] If it was up to us, would you have chosen ground differently? Justify your answer.

3. **Mesh current analysis**

   Part I: [5 points] Formulate mesh-current equations for the circuit in Figure 1(b). Use the mesh currents shown in the figure and clearly indicate how you handle the presence of the current source. The final equations should only depend on the unknown mesh currents and the resistor values R_1 through R_5. **Do not modify the circuit or the labels**. No need to solve any equations!

   Part II: [1 point] Provide expressions for the voltage v_x and the current i_x in terms of mesh currents.

   Part III: [1 bonus point] Would changing the value of the resistors R_4 and R_5 have any effect on the mesh currents? Is this consistent with what we know about source transformations?