MAE40 - Linear Circuits - Winter 22
Midterm #2, February 25

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 midterm2")

Good luck!

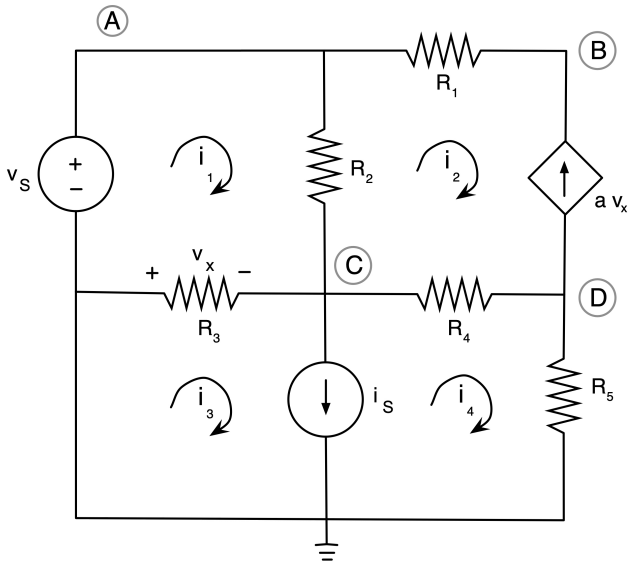

Figure 1: Circuit for Question 1.

1. **Mesh current analysis with dependent sources**

   Part I: [6 points] Formulate mesh-current equations for the circuit in Figure 1 (use the labels provided). Clearly indicate the final equations and variable unknowns. Make sure your final answer has the same number of independent equations as unknown variables (notice the presence of the dependent source). **Do not modify the circuit or the labels**. No need to solve any equations!

   Part II: [4 points] Provide expressions of node voltages v_A, v_B, v_C, v_D in terms of known quantities and the mesh currents i_1, i_2, i_3, i_4.

   Part III: [Extra 1 point] If the resistor R_1 was replaced by a short circuit, will this affect any of the values of the mesh currents? Why?

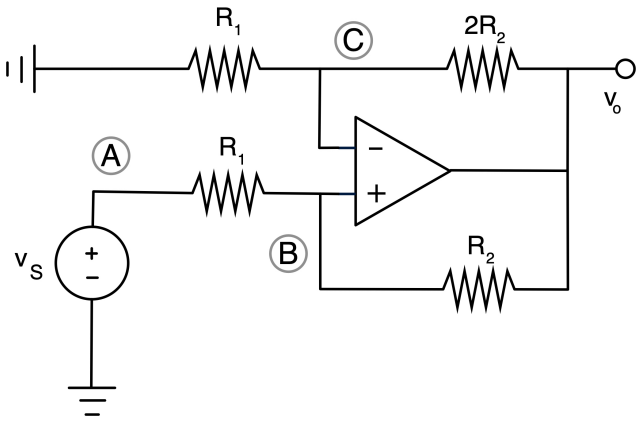

Figure 2: Circuit for Question 2.

2. **OpAmp circuit analysis and design**

   Part I: [5 points] Use node-voltage analysis to determine which one of the following expressions of the output voltage in the circuit in Figure 2 is correct;

$$v_o = -\frac{R_1 + 2R_2}{R_1}\frac{R_2}{R_1}v_S \qquad v_o = \frac{R_1 + 2R_2}{R_1}v_S \qquad v_o = -\frac{R_1 + 2R_2}{R_1}v_S$$

   Part II: [2 points] What are the limits of the input voltage v_S for linear operation of the circuit in Figure 2 if $R_1 = 100\Omega$, $R_2 = 50\Omega$, and the op-amp is connected to an external power supply with $+v_{CC} = 20V$ and $-v_{CC} = -10V$?

   Part III: [3 points] Design your own circuit, using only basic op-amp building blocks and as many resistors with values R_1 and R_2 as you need, that generates the same output voltage as the circuit in Figure 2.