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

Instructions

(i) You can use 2 two-sided 1-page handwritten cheatsheets.

(ii) The exam has 2 questions for a total of 20 points and 2 bonus points.

(iii) You have from 2:00pm to 3:20pm 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 and write your name & PID at the top of each page.

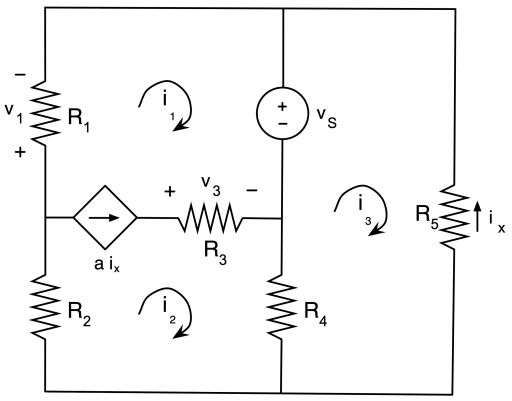

Figure 1: Circuit for Question 1.

Good luck!

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

   Part I: [6 points] Formulate mesh-current equations for the circuit in Figure 1. Use the mesh labels provided and notice the presence of the dependent source. Clearly indicate the final equations and circuit variable unknowns. Write the final equations **in matrix form** in the unknown mesh currents. **Do not modify the circuit or the labels**. No need to solve any equations!

   Part II: [2 points] Provide expressions for the voltages v_1 and v_3 in terms of the mesh currents.

   Part III: [2 points] How would changing the value of the resistor R_3 affect the mesh currents? Why?

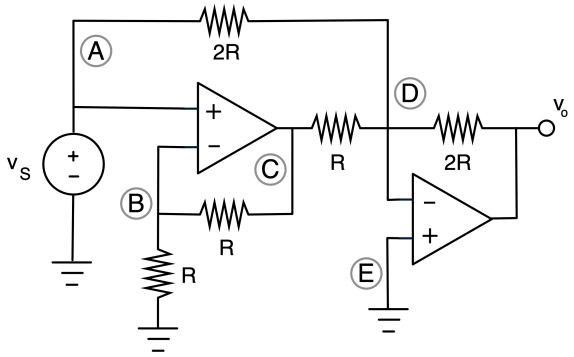

Figure 2: Circuit for Question 2.

2. **OpAmp circuit analysis and design**

   Part I: [6 points] Use node-voltage analysis to determine the output voltage v_o in the circuit in Figure 2.

   Part II: [2 points] With $R = 100\,\Omega$ and $v_{CC} = \pm 12\,V$ for both op-amps, an engineer connected a load resistor $R_L = 10\,\Omega$ between the output node and ground. With a voltage source of $v_S = 3V$, what was the power consumed by the load resistor? Can you explain why?

   Part III: [2 points] Design your own circuit, using only 1 OpAmp and resistors with value R, that generates the same output voltage as the circuit in Figure 2.

   Part IV: [+ Extra 2 points] Design your own circuit, using only 1 OpAmp and resistors with value $2R$, that generates the same output voltage as the circuit in Figure 2.