# EE 211 Circuit and Signals I, Fall 2012
Exam 1 September 21, 2012
Solution

Rules: This is a closed-book exam. You may use only your brain, a calculator and pen/paper. Each numbered question counts equally toward your grade.

Grading policy: Only boxed answers count. If you have boxed the correct answer and show enough relevant math you get 10. If only one of them you get 5. Otherwise you get 0. Always include the unit on every answer and reduce to simple form!

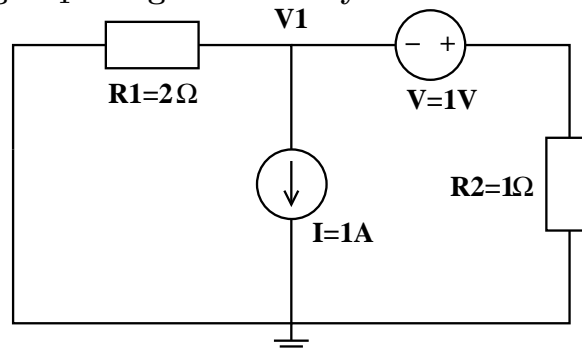### Node analysis

1. Compute current I using nodal analysis.
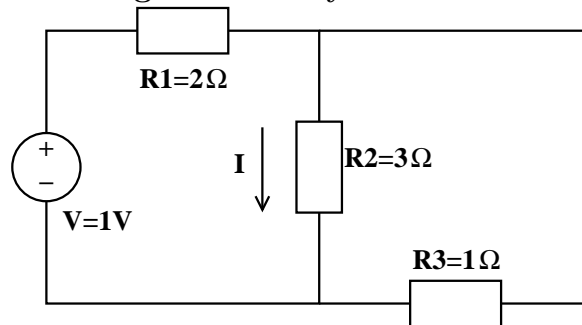
$$\frac{IR_2 - V}{R_1} + \frac{IR_2}{R_3} + I = 0$$

$$I\left(\frac{R_2}{R_1} + \frac{R_2}{R_3} + 1\right) = \frac{V}{R_1}$$

$$I = \frac{1}{11}\,\text{A}$$

2. Compute voltage V_1 using nodal analysis.

$$\frac{V_1}{R_1} + I + \frac{V_2}{R_2} = 0$$
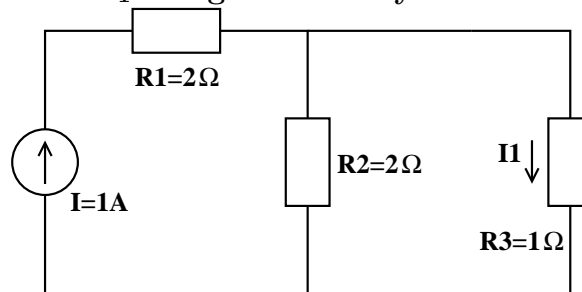
$$V_2 - V_1 = V$$

$$\frac{V_1}{R_1} + I + \frac{V}{R_2} + \frac{V_1}{R_2} = 0$$

$$V_1 \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = -I - \frac{V}{R_2}$$

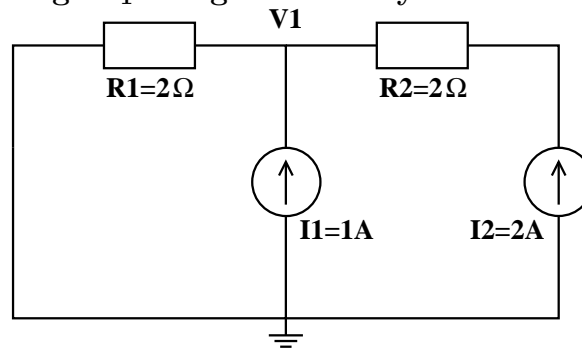$$V_1 = -\frac{4}{3} \text{ V}$$

Mesh analysis

3. Compute the current I_1 using mesh analysis.

$$(I_1 - I) R_2 + I_1 R_3 = 0$$

$$I_1 = \frac{I R_2}{R_2 + R_3} = \frac{2}{2+1} = \frac{2}{3} \text{ A}$$

4. Compute the voltage V_1 using mesh analysis.

Clockwise mesh currents I_A (left) and I_B (right).
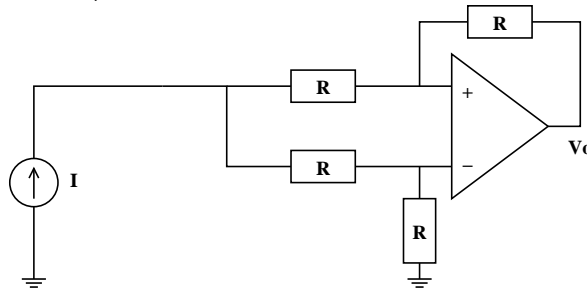
$$I_B = -I_2 = -2 \text{ A}$$

$$I_B - I_A = I_1$$

$$I_A = I_B - I_1 = 1 + 2 = 3\,\text{A}$$

$$V_1 = R_1 I_A = 2 \times 3 = 6\,\text{V}$$

Operational amplifiers

5. Compute the gain V_O/I for this circuit
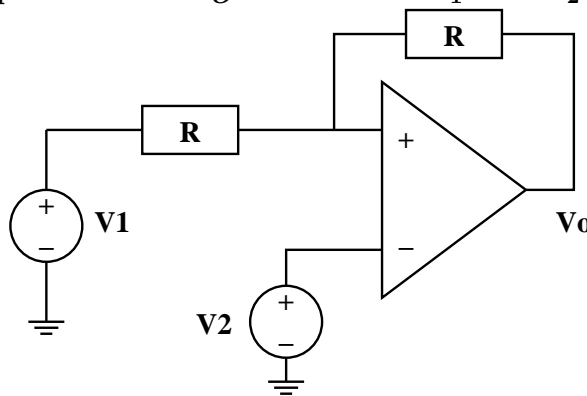

$$V_+ = \frac{V_I}{2} \qquad I_- = I_+ = \frac{I}{2}$$

$$V_+ = V_- = \frac{IR}{2}$$

$$V_O = V_- - \frac{I}{2}R = \frac{IR}{2} - \frac{IR}{2} = 0$$

$$\frac{V_O}{I} = 0$$

6. Compute an expression for V_O in terms of V_1 and V_2

$$I = \frac{V_1 - V_2}{R}$$

$$V_O = V_2 - IR = V_2 - \frac{V_1 - V_2}{R}R = 2V_2 - V_1$$