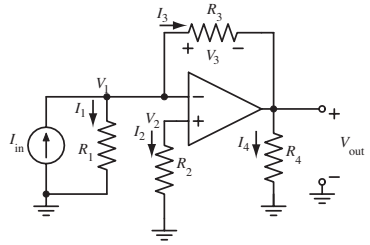
Solution of ECE 300 Test 5 S09

1. In the circuit below, find the numerical values of these voltages and currents. (The operational amplifier is ideal.) Check all answers to ensure that Ohm's Law, KCL and KVL are satisfied everywhere

I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is zero by Ohm's Law because I_2 is zero.
V_1 is zero because the two op-amp inputs must be at the same voltage.
I_1 is zero by Ohm's Law because V_1 is zero.
I_3 is 10 mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is zero.
V_3 is 50 V by Ohm's Law.
V_{out} is -50 V by KVL.
I_4 is $-50\text{V}/4\text{k}\Omega = -12.5\text{mA}$ by Ohm's Law.

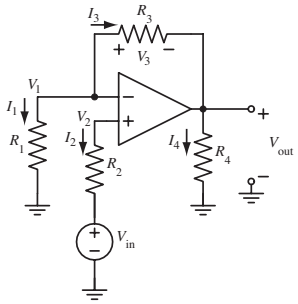
$I_{in} = 10\text{mA}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$



2. In the circuit below, find the numerical values of these voltages and currents. (The operational amplifier is ideal.) Check all answers to ensure that Ohm's Law, KCL and KVL are satisfied everywhere

I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is 4V by Ohm's Law and KVL because I_2 is zero.
V_1 is 4V because the two op-amp inputs must be at the same voltage.
I_1 is $4\text{V}/3\text{k}\Omega = 1.333\text{mA}$ by Ohm's Law because V_1 is 4V.
I_3 is -1.333mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is 1.333mA.
V_3 is $-1.333\text{mA} \times 5\text{k}\Omega = -6.667\text{V}$ by Ohm's Law.
V_{out} is $4\text{V} - (-6.667\text{V}) = 10.667\text{V}$ by KVL.
I_4 is $10.667\text{V}/4\text{k}\Omega = 2.667\text{mA}$ by Ohm's Law.

$V_{in} = 4\text{V}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$



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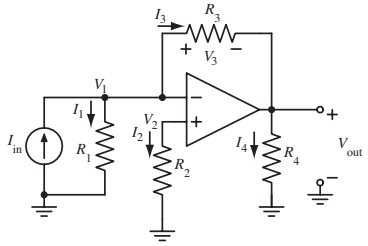
I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is zero by Ohm's Law because I_2 is zero.
V_1 is zero because the two op-amp inputs must be at the same voltage.
I_1 is zero by Ohm's Law because V_1 is zero.
I_3 is 5 mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is zero.
V_3 is 25 V by Ohm's Law.
V_{out} is -25 V by KVL.
I_4 is $-25\text{V}/4\text{k}\Omega = -6.25\text{mA}$ by Ohm's Law.

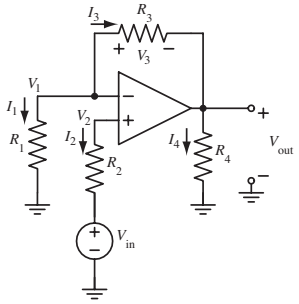
$I_{in} = 5\text{mA}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$



2. In the circuit below, find the numerical values of these voltages and currents. (The operational amplifier is ideal.) Check all answers to ensure that Ohm's Law, KCL and KVL are satisfied everywhere

I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is 6V by Ohm's Law and KVL because I_2 is zero.
V_1 is 6V because the two op-amp inputs must be at the same voltage.
I_1 is $6\text{V}/3\text{k}\Omega = 2\text{mA}$ by Ohm's Law because V_1 is 6V.
I_3 is -2mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is 2mA.
V_3 is $-2\text{mA} \times 5\text{k}\Omega = -10\text{V}$ by Ohm's Law.
V_{out} is $6\text{V} - (-10\text{V}) = 16\text{V}$ by KVL.
I_4 is $16\text{V}/4\text{k}\Omega = 4\text{mA}$ by Ohm's Law.

$V_{in} = 6\text{V}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$



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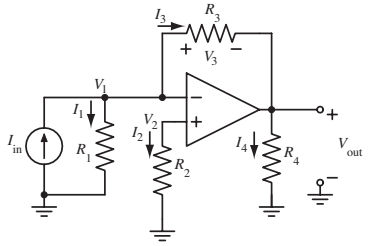
1. In the circuit below, find the numerical values of these voltages and currents. (The operational amplifier is ideal.) Check all answers to ensure that Ohm's Law, KCL and KVL are satisfied everywhere

I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is zero by Ohm's Law because I_2 is zero.
V_1 is zero because the two op-amp inputs must be at the same voltage.
I_1 is zero by Ohm's Law because V_1 is zero.
I_3 is 3 mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is zero.
V_3 is 15 V by Ohm's Law.
V_{out} is -15 V by KVL.
I_4 is $-15\text{V}/4\text{k}\Omega = -3.75\text{mA}$ by Ohm's Law.

$I_{in} = 3\text{mA}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$



2. In the circuit below, find the numerical values of these voltages and currents. (The operational amplifier is ideal.) Check all answers to ensure that Ohm's Law, KCL and KVL are satisfied everywhere

I_2 is zero because no current can flow into an input terminal of an op-amp.
V_2 is 8V by Ohm's Law and KVL because I_2 is zero.
V_1 is 8V because the two op-amp inputs must be at the same voltage.
I_1 is $8\text{V}/3\text{k}\Omega = 2.667\text{mA}$ by Ohm's Law because V_1 is 8V.
I_3 is -2.667mA by KCL because no current can flow into an input terminal of an op-amp and I_1 is 2.667mA.
V_3 is $-2.667\text{mA} \times 5\text{k}\Omega = -13.333\text{V}$ by Ohm's Law.
V_{out} is $8\text{V} - (-13.333\text{V}) = 21.333\text{V}$ by KVL.
I_4 is $21.333\text{V}/4\text{k}\Omega = 5.333\text{mA}$ by Ohm's Law.

$V_{in} = 8\text{V}$, $R_1 = 3\text{k}\Omega$, $R_2 = 1\text{k}\Omega$
$R_3 = 5\text{k}\Omega$, $R_4 = 4\text{k}\Omega$