Problem 1 (6 points)
Find $V_o$ and $I_o$ in the circuit shown below. Use the ideal opamp assumptions ($I_+ = 0$, $I_- = 0$, $V_+ = V_-)$.

**Hint:** You should be able to determine $V_o$ numerically before finding $I_o$.

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**Follow these steps in order to determine $V_o$**

1. Since $I_+ = 0$, $2 mA$ flows through the $4 \, k\Omega$ resistor.
   - The voltage across the $4 \, k\Omega$ is $8 \, V$: $V_+ = 8 \, V$

2. Since $V_- = V_+$, $V_- = 8 \, V$ as well.

3. Mark node voltages to the left of $1 \, k\Omega$ and $2 \, k\Omega$ resistors as $2 \, V$ and $-5 \, V$ respectively.

4. **Write a KCL equation at the (-) node of opamp**
   - Using the fact that $I_- = 0$
   - $\sum$ currents out $\Rightarrow \frac{8 \, V - 2 \, V}{4 \, k\Omega} + \frac{8 \, V - (-5 \, V)}{2 \, k\Omega} + \frac{8 \, V - V_o}{5 \, k\Omega} = 0$
   - $6 \, mA$ current in $1 \, k\Omega$
   - $6.5 \, mA$ current in $2 \, k\Omega$
   - $12.5 \, mA + \frac{8 \, V - V_o}{5 \, k\Omega} = 0 \Rightarrow 62.5 \, V + 8 \, V - V_o = 0 \Rightarrow V_o = 70.5 \, V$

Now determine $I_o$

**Write a KCL equation at the $V_o$ node**

- $I_o = I_5 + I_{10}$
  - $I_5 = \frac{70.5 \, V - 8 \, V}{5 \, k\Omega} + \frac{70.5 \, V}{10 \, k\Omega}$
  - $I_o = 12.5 \, mA + 7.05 \, mA$

- $I_o = 19.55 \, mA$

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Problem 2 (4 points)
Find $V_{o1}$ and $V_{o2}$ in the circuit shown below. Use the ideal opamp assumptions ($I_+ = 0$, $I_- = 0$, $V_+ = V_- $).

For opamp #1:
Since $I_+ = 0$, the voltage across the 1kΩ resistor is zero therefore $V_+ = 2V$. And since $V_- = V_+ \Rightarrow V_- = 2V \Rightarrow V_{o1} = 2V$

For opamp #2:
Since $V_+$ is the same node as $V_-$ of opamp #1. $V_+ = 2V$ since $V_- = V_+ \Rightarrow V_- = 2V$

Now write a KCL equation at (-) node of opamp #2 (using the fact that $I_- = 0$)

$$\frac{2V-5V}{2kΩ} + \frac{2V-V_{o2}}{5kΩ} = 0 \Rightarrow -1.5mA + \frac{2V-V_{o2}}{5kΩ} = 0$$

$$\therefore -7.5V + 2V - V_{o2} = 0 \Rightarrow V_{o2} = -5.5V$$

$V_{o1} = \frac{2V}{\text{ }}$  $V_{o2} = \frac{-5.5V}{\text{ }}$