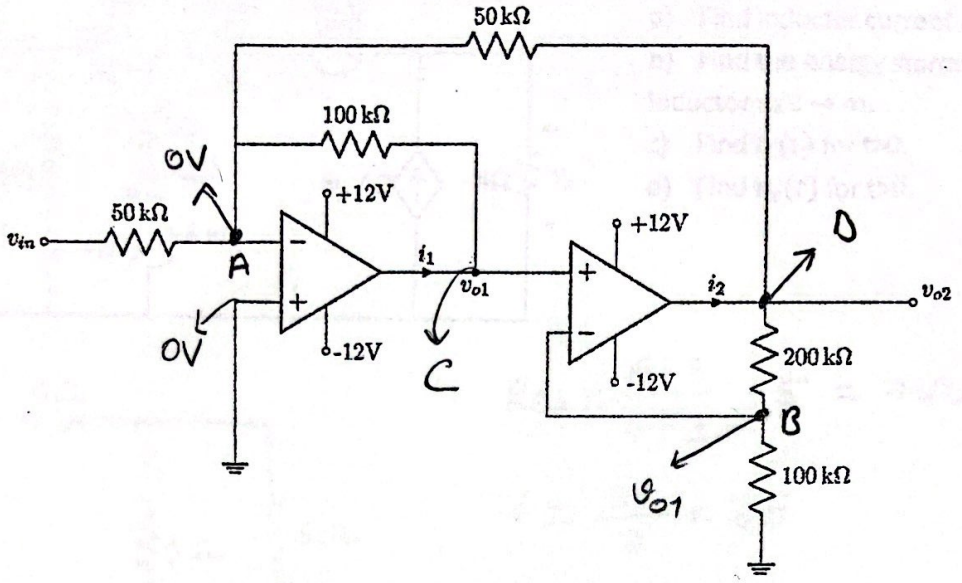
Question 1 (30 pts)

A composite op-amp circuit is formed to obtain better accuracy and more advantageous noise behavior. The figure below shows such a configuration with infinite gain, ideal op-amps.



a) Assume both op-amps are in the linear region, express v_{o2} in terms of v_{in}.
b) Find i_1 and i_2 when $v_{in} = 14\ V$.

a) KCL A: $\frac{-v_{in}}{50k} + \frac{-v_{o1}}{100k} + \frac{-v_{o2}}{50k} = 0 \Rightarrow 2v_{in} + v_{o1} + 2v_{o2} = 0.$

KCL B: $\frac{v_{o1}}{100k} + \frac{v_{o1} - v_{o2}}{200k} = 0 \Rightarrow 3v_{o1} = v_{o2} \Rightarrow v_{o1} = \frac{v_{o2}}{3}$

$\Rightarrow 2v_{in} = -v_{o1} - 2v_{o2} = \frac{-7}{3} v_{o2} \Rightarrow v_{o2} = \frac{-6}{7} v_{in}$

b) KCL C: $\frac{v_{o1}}{100k} - i_1 = 0 \Rightarrow i_1 = \frac{-2}{7} \cdot \frac{14}{100k} = -4 \cdot 10^{-5}\ A.$

KCL D: $\frac{V_{o2}}{50k} - i_2 + \frac{v_{o2} - v_{o1}}{200k} = 0$

$\Rightarrow i_2 = \frac{5v_{o2} - v_{o1}}{200k} = \frac{-4v_{in}}{200k} = -28 \cdot 10^{-5}\ A.$