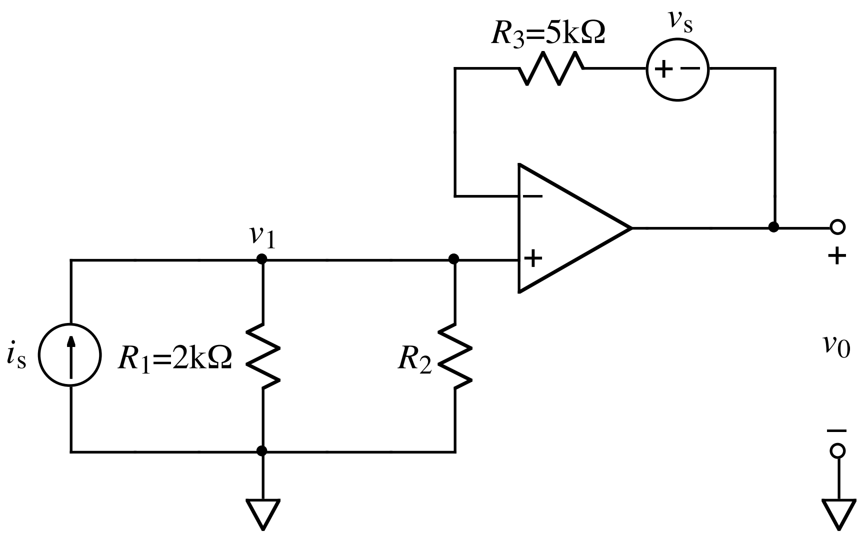
HOMEWORK #17 solution

Ex:



Rail voltage = ±9 V

a) The above circuit operates in linear mode. Derive a symbolic expression for v_o. The expression must contain not more than the parameters i_s, v_s, R_1, R_2, and R_3.

b) If $v_s = 0$ V, find the value of R_2 that will yield an output voltage of $v_o = 1$ V when $i_s = 1$ mA.

c) Using the value of R_2 from part (a), find the value of v_s that will yield $v_o = 1$ V when $i_s = 0$ A.

d) Using the value of R_2 from part (a), calculate the input resistance, $R_{in} = v_1/i_s$, seen by the i_s source.

sol'n: a) First, we find the voltage, v_1, at the + input of the op-amp.

$$v_1 = i_s \cdot R_1 \| R_2$$

Second, we assume the voltage, v_n, at the − input of the op-amp = v_1

$$v_n = i_s \cdot R_1 \| R_2$$

Third, we find the value of v_o that yields the above value of v_n.

Since no current flows into the op-amp inputs, no current flows in R_3, and R_3 has no voltage drop.

$$\therefore \quad v_o = v_n - v_s$$

or $$v_o = i_s \cdot R_1 \| R_2 - v_s$$

b) Given $v_s = 0V$ and $i_s = 1mA$ we are to find the value of R_2 that yields $v_o = 1V$.

Using the expression in (a) for v_o we have

$$1V = 1mA \cdot 2k\Omega \| R_2 - 0V$$

or $$2k\Omega \| R_2 = 1k\Omega$$

or $$R_2 = 2k\Omega$$

c) We have $1V = \overset{0V}{\cancel{0A \cdot 2k\Omega \| 2k\Omega}} - v_s$

or $$v_s = -1V$$

d) From part (a), we have the following:

$$v_1 = i_s \cdot R_1 \| R_2$$

$$R_{in} \cong \frac{v_1}{i_s} = R_1 \| R_2 = 1k\Omega$$