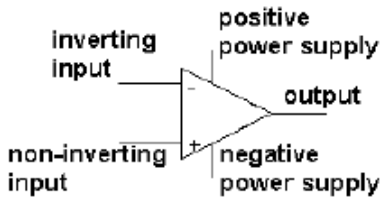
ECE203 DC Circuits
Homework Set 19 – Solutions

HW19.1

Problem 5.1 *(answers in back of chapter)*

[a] The five terminals of the op amp are identified as follows:



[b] The input resistance of an ideal op amp is infinite, which constrains the value of the input currents to 0. Thus, $i_n = 0$ A.

[c] The open-loop voltage gain of an ideal op amp is infinite, which constrains the difference between the voltage at the two input terminals to 0. Thus, $(v_p - v_n) = 0$.

[d] Write a node voltage equation at v_n:

$$\frac{v_n + 3}{5000} + \frac{v_n - v_o}{15{,}000} = 0$$

But $v_p = 0$ and $v_n = v_p = 0$. Thus,

$$\frac{3}{5000} - \frac{v_o}{15{,}000} = 0 \quad \text{so} \quad v_o = 9 \text{ V}$$

HW19.2

Problem 5.2 *(answers in back of chapter)*

$$v_o = -(0.5 \times 10^{-3})(10{,}000) = -5 \text{ V}$$

$$\therefore \quad i_o = \frac{v_o}{5000} = \frac{-5}{5000} = -1 \text{ mA}$$

HW19.3

Problem 5.5 (Pay attention to polarity of v_m.)

$$\frac{v_\text{b} - v_\text{a}}{20{,}000} + \frac{v_\text{b} - v_o}{100{,}000} = 0, \qquad \text{therefore} \quad v_o = 6v_\text{b} - 5v_\text{a}$$

[a] $v_\text{a} = 4$ V, $v_\text{b} = 0$ V, $v_o = -15$ V (sat)

[b] $v_\text{a} = 2$ V, $v_\text{b} = 0$ V, $v_o = -10$ V

[c] $v_\text{a} = 2$ V, $v_\text{b} = 1$ V, $v_o = -4$ V

[d] $v_\text{a} = 1$ V, $v_\text{b} = 2$ V, $v_o = 7$ V

[e] $v_\text{a} = 1.5$ V, $v_\text{b} = 4$ V, $v_o = 15$ V (sat)

[f] If $v_\text{b} = 1.6$ V, $v_o = 9.6 - 5v_\text{a} = \pm 15$

$$\therefore \quad -1.08 \text{ V} \le v_\text{a} \le 4.92 \text{ V}$$