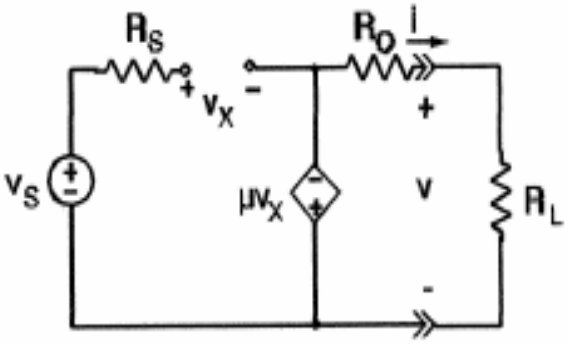
Homework Solutions 7

4-12 The input loop contains an open circuit, hence $i_S = 0$. A KVL equation around the input loop is

$$-v_S + v_X - \mu \cdot v_X = 0$$



Solving for v_x yields $v_X = \dfrac{v_S}{1-\mu}$

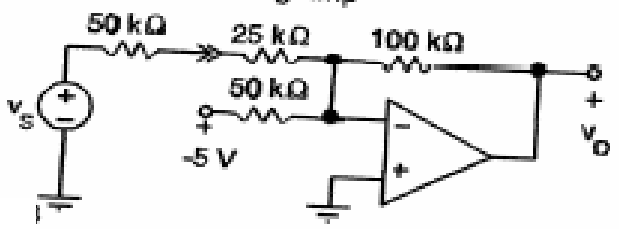
The open-ckt voltage is

$$v_T = -\mu \cdot v_X = \frac{-\mu}{1-\mu} \cdot v_S$$

The short-ckt current is $i_N = \dfrac{-\mu \cdot v_X}{R_O}$

The Thevenin resistance is $R_T = \dfrac{v_T}{i_N} = R_O$

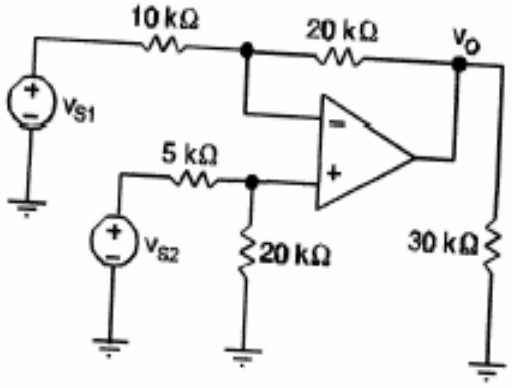
4-22 Ckt is in summing amp



$$v_O = \frac{-100 \cdot 10^3}{50 \cdot 10^3 + 25 \cdot 10^3} \cdot + \frac{-100 \cdot 10^3}{50 \cdot 10^3} \cdot \quad \textbf{(-5)}$$

$$v_O = 10 - \frac{4}{3} \cdot v_S$$

4-24



(a) $v_O = K_1 \cdot v_{S1} + K_2 \cdot v_{S2}$

$$K_1 = \frac{R_2}{R_1} = -2$$

$$K_2 = \frac{R_1 + R_2}{R_1} \cdot \frac{R_4}{R_3 + R_4} = \frac{12}{5}$$

$$v_O = -2 \cdot v_{S1} + 2.4 \cdot v_{S2}$$

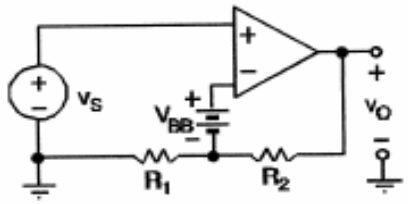
(b) $V_{CC} := 15 \quad v_{S2} := 10$

$$-V_{CC} < -2 \cdot v_{S1} + 2.4 \cdot v_{S2} < V_{CC}$$

$$\frac{-V_{CC} + 2.4 \cdot v_{S2}}{2} < v_{S1} < \frac{V_{CC} + 2.4 \cdot v_{S1}}{2}$$

$$4.5 < v_{S1} < 19.5$$

4-26



(a) $v_P = v_S \quad v_N = \left(\frac{R_1}{R_1 + R_2}\right) \cdot v_O + V_{BB}$

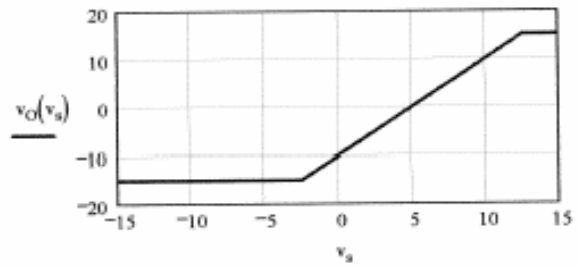
$$v_P = v_N \quad \longrightarrow \quad v_S = \left(\frac{R_1}{R_1 + R_2}\right) \cdot v_O + V_{BB}$$

$$v_O = \frac{R_1 + R_2}{R_1} \cdot (v_s - V_{BB}) = K \cdot (v_s - V_{BB})$$

$$K = \frac{R_1 + R_2}{R_1}$$

(b) $V_{BB} := 5 \quad V_{CC} := 15 \quad R_1 = R_2 \quad K := 2 \quad v_s := -15, -14.9 .. 15$

$$v_O(v_s) := \begin{cases} (-V_{CC}) & \text{if } v_s < \frac{-V_{CC}}{K} + V_{BB} \\ K \cdot (v_s - V_{BB}) & \text{if } \frac{-V_{CC}}{K} + V_{BB} \le v_s \le \frac{V_{CC}}{K} + V_{BB} \\ V_{CC} & \text{if } \frac{V_{CC}}{K} + V_{BB} < v_s \end{cases}$$



$v_O(12.5) = 15$

$v_O(5) = 0$

$v_O(0) = -10$

$v_O(-2.5) = -15$