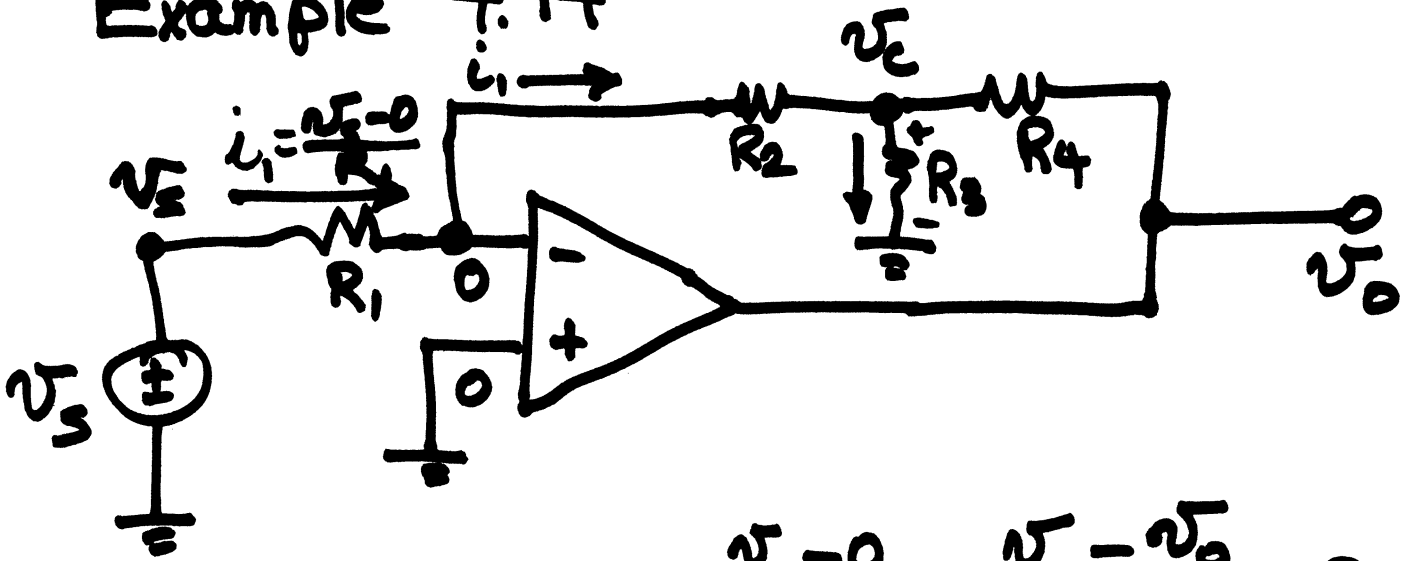# Example 4.14

$$@c \quad \sum_{in}^{+} i = 0 \qquad +i_1 - \frac{v_e - 0}{R_3} - \frac{v_e - v_o}{R_4} = 0$$

$$\frac{v_s}{R_1} - \frac{v_e}{R_c} - \frac{v_e}{R_4} + \frac{v_o}{R_4} = 0 \quad (1)$$
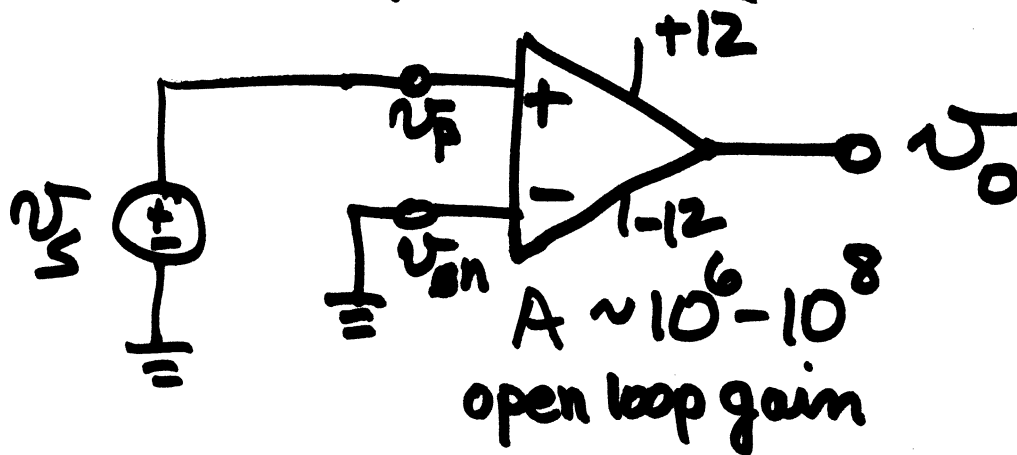
$$+ \frac{v_s - 0}{R_1} - \frac{0 - v_e}{R_2} = 0 \quad (2)$$

$$\frac{v_o}{v_s}$$

$$\frac{v_s}{R_1} + \frac{v_e}{R_2} = 0 \qquad a \quad v_e = -\frac{v_s R_2}{R_1}$$

$$\frac{v_s}{R_1} - \left(\frac{1}{R_c} + \frac{1}{R_4}\right)\left(-\frac{v_s R_2}{R_1}\right) + \frac{v_o}{R_4} = 0$$

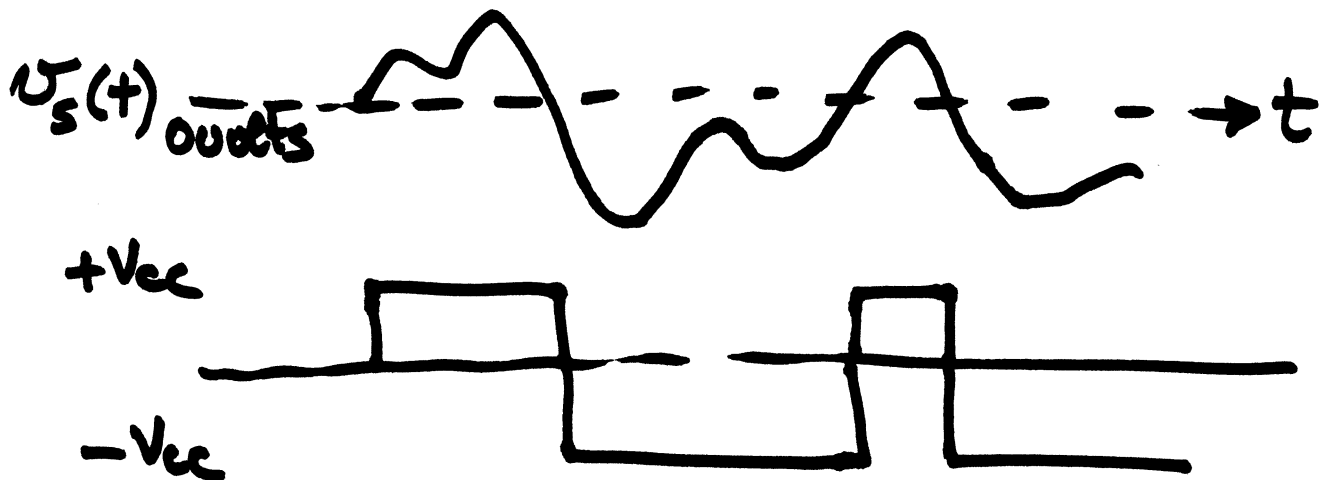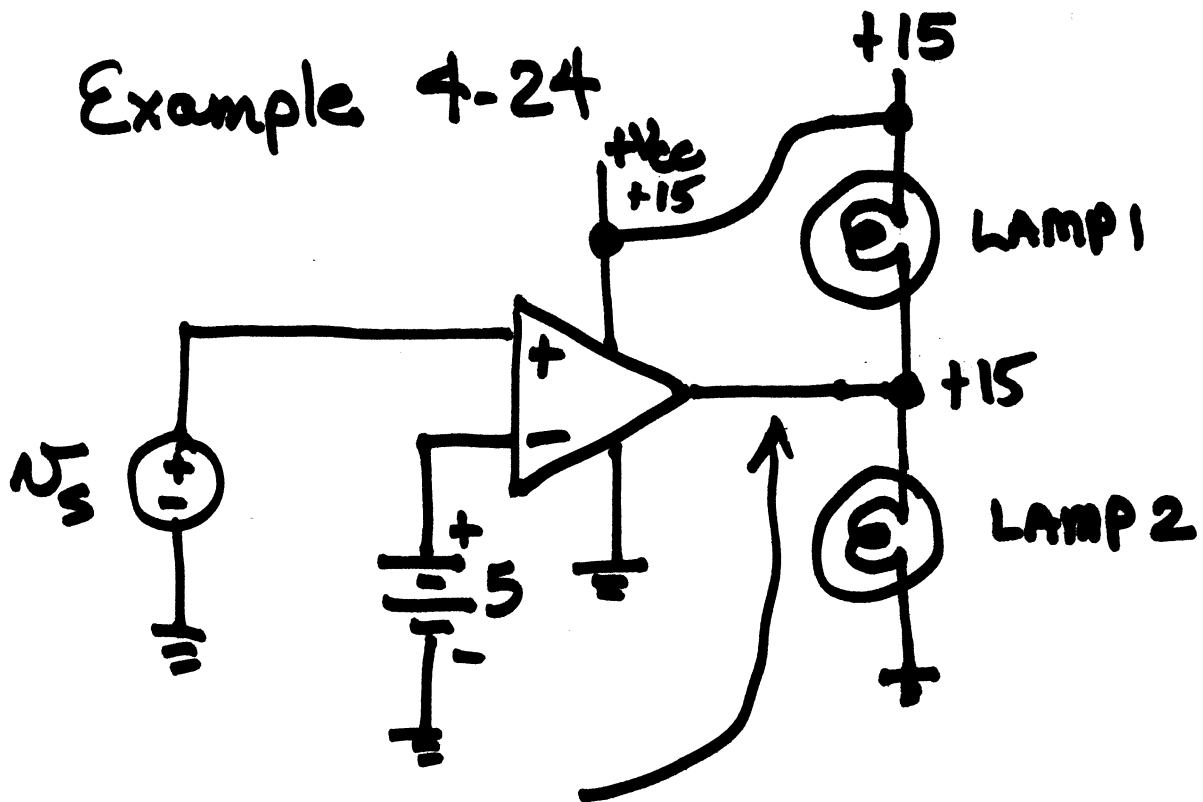$$v_o = - \frac{R_c R_3 + R_2 R_4 + R_3 R_4}{R_1 R_3} \, v_s$$

GAIN

4.7 The Comparator

$+12$

V_P

-12

V_{on}

V_0

$A \sim 10^6 - 10^8$

open loop gain

converting analog signals to digital

two values
ON/OFF

$V_P > V_N \qquad V_0 \rightarrow +$ saturation

$V_P < V_N \qquad V_0 \rightarrow -$ saturation

$V_S(t)_{\text{volts}}$ ⟶ t

$+V_{cc}$

$-V_{cc}$

Example 4-24

$$A(\upsilon_P - \upsilon_N)$$
$$=$$
$$+5$$
$$(\upsilon_P - 5)$$

if $\upsilon_S > 5 \longrightarrow \upsilon_o \rightarrow +15$ LAMP2 LAMP1
                                                  ON   OFF

$\upsilon_S < 5 \longrightarrow \upsilon_o \rightarrow$ LAMP2 LAMP1
                                          0   OFF   ON