**Problem 4.9** The supply voltage of the op amp in the circuit of Fig. P4.9 is 16 V. If $R_L = 3 \, \text{k}\Omega$, assign a resistance value to $R_f$ so that the circuit would deliver 75 mW of power to $R_L$.

![Figure P4.9: Circuit for Problem 4.9.](image)

**Solution:** Per Table 4-2, this is a noninverting amplifier circuit for which

$$u_o = G u_i = \left( \frac{R_1 + R_2}{R_2} \right) u_i.$$  

In this case,

$$R_1 = R_f$$
$$R_2 = 4 \, \text{k}\Omega$$
$$u_i = 3 \, \text{V}.$$  

Hence,

$$u_o = \left( \frac{R_f + 4k}{4k} \right) \times 3 = (0.75R_f + 3) \, \text{V}, \text{ with } R_f \text{ in k}\Omega.$$  

$$R_L = \frac{u_o^2}{P_L} = \frac{u_o^2}{75 \times 10^{-3}} = 75 \times 10^{-3} \, \text{W},$$

or $u_o = 15 \, \text{V}$, which is less than $V_{cc} = 16 \, \text{V}$. Solving for $R_f$:

$$15 = 0.75R_f + 3,$$

which gives

$$R_f = 16 \, \text{k}\Omega.$$
Problem 4.15  Determine the gain $G = v_L / v_s$ for the circuit in Fig. P4.15.

![Circuit diagram for Problem 4.15](image)

**Figure P4.15:** Circuit for Problems 4.15 and 4.16.

Solution: The basic op-amp circuit is that of a noninverting amplifier. We first convert the input from $v_s$ to $v'_s$.

Since $i_p = 0$,

$$v'_s = v_s \cdot \frac{20k}{(5+20)k} = 0.8v_s$$

$$v_0 = \frac{(70+10)k}{10k} \cdot v'_s = 8v'_s = 8 \times 0.8v_s = 6.4v_s$$

Voltage division at the output side gives

$$v_L = \frac{v_0 R_L}{R_L + 4k}$$

$$G = \frac{v_L}{v_s}$$