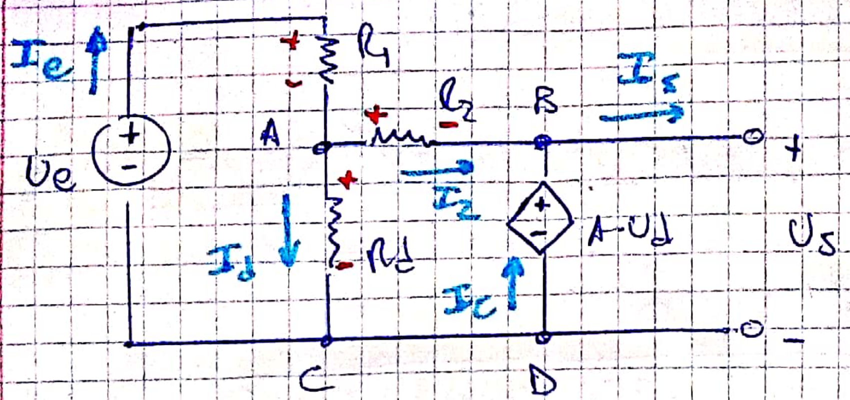
Problema n°08



$U_d = I_d \cdot R_d$ Por 1° ley Kirchoff: $\left\{ I_e = I_d + I_2 \right.$

Por 2° ley de Kirchoff: $U_e - I_e \cdot R_1 - U_d = 0$. (I)

$-I_2 \cdot R_2 - A \cdot U_d + U_d = 0$ (II)

$U_s - A \cdot U_d = 0$. (III)

$\cancel{\therefore U_s = A \cdot U_d \Rightarrow U_d = I_2 \cdot R_2}$

(I): $U_e - (I_d + I_2) R_1 - I_d \cdot R_d = 0$.

(II): $-I_2 \cdot R_2 - A \cdot I_d \cdot R_d + I_d \cdot R_d = 0$.

$\therefore$ (I): $U_e = I_d \cdot (R_1 + R_d) + I_2 \cdot R_1$

(II): $0 = I_d \cdot (A \cdot R_d - R_d) + I_2 \cdot R_2$

$$\begin{array}{cc} I_d & I_2 \end{array}$$
$$\left(\begin{array}{cc|c} R_1 + R_d & R_1 & U_e \\ R_d\,(A-1) & R_2 & 0 \end{array}\right) \xrightarrow[F_2 - F_1 \cdot \frac{R_d (A-1)}{R_1 + R_d}]{} \left(\begin{array}{cc|c} R_1 + R_d & R_1 & U_e \\ 0 & R_2 - \frac{R_1 R_d (A-1)}{R_1 + R_d} & -\frac{U_e R_d (A-1)}{R_1 + R_d} \end{array}\right)$$

$$\therefore I_2 = -\frac{U_e \cdot R_d\,(A-1)}{\cancel{(R_1 + R_d)}} \cdot \frac{\cancel{(R_1 + R_d)}}{R_2 (R_1 + R_d) - R_1 R_d (A-1)}$$

$$I_2 = \frac{U_e \cdot R_d\,(A-1)}{R_1 \cdot R_d\,(A-1) - R_2\,(R_1 + R_d)}$$

$$I_d = \frac{U_e - I_2 \cdot R_1}{R_1 + R_d} = \frac{U_e}{R_1 + R_d} - \frac{U_e \cdot R_d\,(A-1) \cdot R_1}{[R_1 R_d (A-1) - R_2 (R_1 + R_d)]\,(R_1 + R_d)}$$

$$U_s = A \cdot R_d \cdot U_e \frac{[R_1 \cancel{R_d (A-1)} - R_2 \cancel{(R_1 + R_d)}] - R_1 \cancel{R_d (A-1)}]}{[R_1 R_d (A-1) - R_2 (R_1 + R_d)]\,\cancel{(R_1 + R_d)}}$$

$$U_S = \boxed{\frac{-A \cdot R_d \cdot U_e \cdot R_2}{R_1 R_d (A-1) - R_2 (R_1+R_d)}}$$

b) $$U_S = \frac{-100000 \cdot 20 \cdot 10^6 \, \Omega \cdot 1 \cdot \cancel{10^{-3}} \, V \cdot 47 \cdot \cancel{10^3} \, \Omega}{1 \cdot 10^3 \, \Omega \cdot 20 \cdot 10^6 \, \Omega \, (100000-1) - 47 \cdot 10^3 \, \Omega \cdot (10^3 \, \Omega + 20 \cdot 10^6 \, \Omega)}$$

$$U_S = \frac{-94 \cdot 10^{12} \, V \cdot \cancel{\Omega^2}}{1999980 \cdot 10^9 \, \cancel{\Omega^2} - 940047 \cdot 10^6 \, \cancel{\Omega^2}}$$

$$U_S = -47{,}02 \cdot 10^{-3} \, V = \boxed{-47{,}02 \, mV}$$

c) $$I_e = I_d + I_2 = \frac{U_e - I_2 \cdot R_1}{R_1 + R_d} + I_2$$

$$I_e = \frac{U_e}{R_1+R_d} + I_2 \frac{(\cancel{R_1} + R_d - \cancel{R_1})}{R_1+R_d} = \frac{U_e + I_2 \cdot R_d}{R_1+R_d}$$

$$I_e = \frac{U_e}{R_1+R_d} + \frac{U_e \cdot R_d^2 (A-1)}{[R_1 R_d (A-1) - R_2 (R_1+R_d)](R_1+R_d)}$$

$$I_e = \frac{U_e}{R_1+R_d} \left[\frac{R_1 R_d (A-1) - R_2 (R_1+R_d) + R_d^2 (A-1)}{R_1 R_d (A-1) - R_2 (R_1+R_d)} \right]$$

$$I_e = \frac{U_e}{R_1+R_d} \left\{ \frac{R_d (A-1) \, [R_1 + R_d] - R_2 (R_1+R_d)}{R_1 R_d (A-1) - R_2 (R_1+R_d)} \right\}$$

$$I_e = \frac{1 \cdot 10^{-3} \, V}{20001 \cdot 10^3 \, \Omega} \left\{ \frac{40002 \cdot 10^{10} \cdot 99999 - 940.047 \cdot 10^6}{2 \cdot 10^{10} \cdot 99999 - 940047 \cdot 10^6} \right\}$$

$$\boxed{I_e \cong +1 \, \mu A}$$ ✓ (hacia arriba)

Con el resultado b: $U_S = A \cdot U_d = A \cdot I_d \cdot R_d$

$$I_d = \frac{U_S}{A \cdot R_d} = -2{,}35 \cdot 10^{-14} \, A \quad (S.S.I)$$

$$I_d = \frac{U_e - I_2 \cdot R_1}{R_1+R_d} \Rightarrow I_2 = U_e - I_d (R_1 + R_d)$$

$$I_2 = 1{,}0004 \cdot 10^{-3} \, A \quad (S.S.e)$$

$$I_e = I_d + I_2 \cong +1 \, \mu A$$