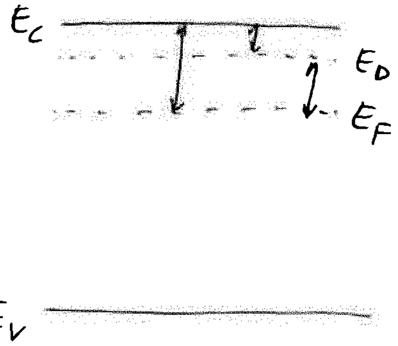
1.- a) $\sigma = q(\mu_n n + \mu_p p) \underset{\uparrow \text{ tipo N}}{\approx} q\mu_n n \approx q\mu_n N_D \Rightarrow N_D = \dfrac{\sigma}{q\mu_n}$

$$\sigma = \frac{1}{\rho} \Rightarrow N_D = \frac{1}{\rho q \mu_n} = \frac{1}{0'11\,\Omega\text{cm} \times 1'6\cdot10^{-19}\text{C} \times 1200\,\frac{\text{cm}^2}{\text{V}\cdot\text{s}}} =$$

$$= 4'73 \cdot \frac{10^{16}}{\text{cm}^3\,\Omega\,\frac{\text{C}}{\text{V}\cdot\text{s}} \to \text{A}} = 4'73\times10^{16}\,\text{cm}^{-3}$$

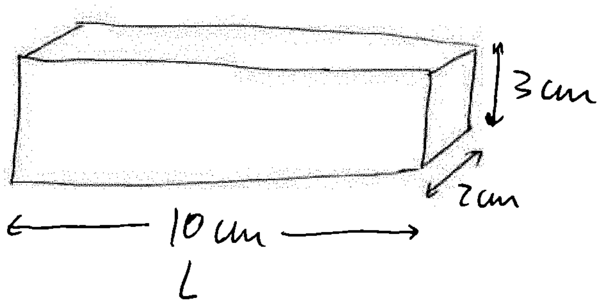
b) $\underset{\underset{N_D}{\wr}}{n_0} = N_c e^{-(E_c-E_F)/KT} \Rightarrow E_c - E_F = KT \ln \dfrac{N_c}{N_D} = 164\,\text{meV}$



$\to f(E_D) = \dfrac{1}{1+e^{(E_D-E_F)/KT}} = 0'012$

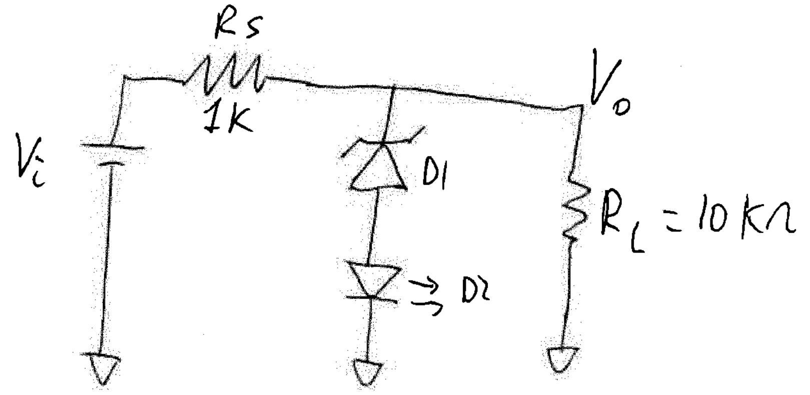
$$E_D - E_F = (E_c - E_F) - (E_c - E_D) = 114\,\text{meV}$$

c)



$$\underline{\underline{R}} = \rho \cdot \frac{L}{A} = 0'11\,\Omega\,\cancel{\text{cm}}\,\frac{10\,\cancel{\text{cm}}}{2\times3\,\cancel{\text{cm}^2}} = 0'18\,\Omega$$

2.-



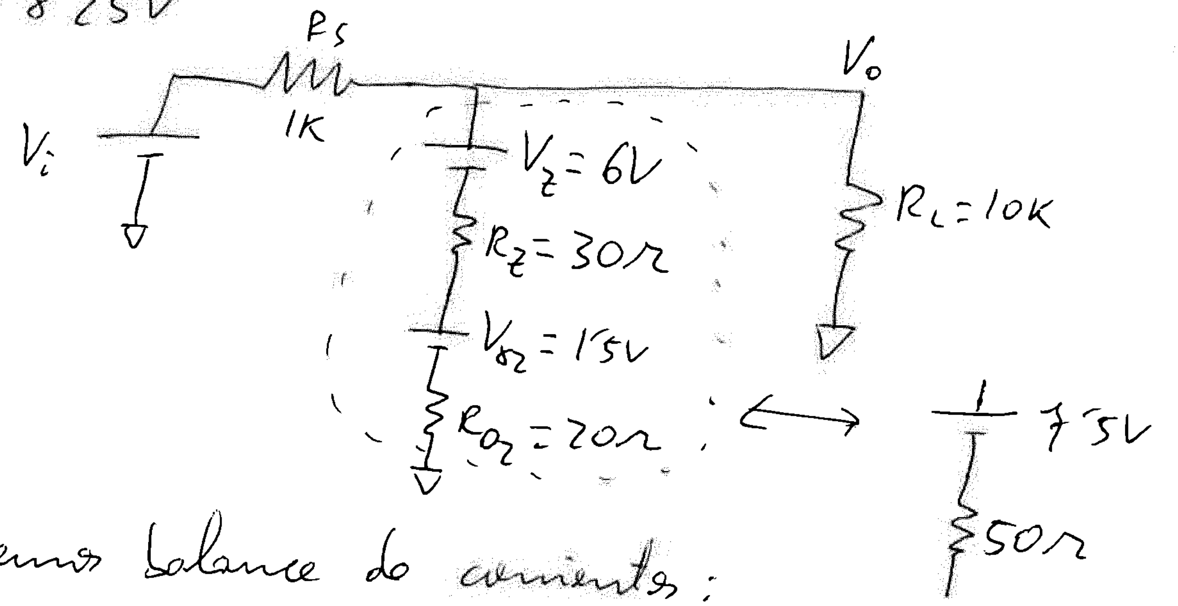
a) V_i 20V ⇒ D1, D2 OFF ⇒ $V_0 = \frac{R_L}{R_S+R_L} \cdot V_i = \boxed{0'909\, V_i = V_0}$

La rama de los diodos comienza a conducir (con el Zéner en inversa) a partir de que $V_0 \geq V_{\gamma 2} + V_Z = 7'5V$

Esto sucede para una $V_i = \frac{V_0}{0'909} = 8'25V$

Desde esa tensión:

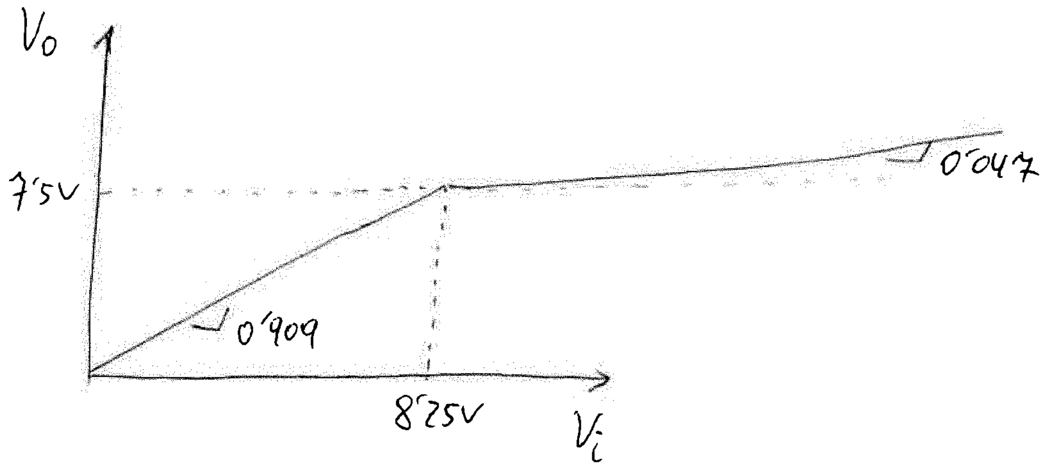
$V_i \geq 8'25V$



Hacemos balance de corrientes:

$$\frac{V_i - V_o}{R_S} = \frac{V_o - (V_Z + V_{\gamma 2})}{R_Z + R_{D2}} + \frac{V_o}{R_L}$$

$$\frac{V_i}{1k\Omega} = V_o\left(\frac{1}{1k\Omega} + \frac{1}{50\Omega} + \frac{1}{10k\Omega}\right) - \frac{7'5V}{50\Omega} \Rightarrow \boxed{V_o = 0'047\, V_i + 7'109V}$$



b) $I_{DZ} = 5mA \Rightarrow \dfrac{V_o - (V_Z + V_{\gamma Z})}{R_Z + R_{DZ}} = 5mA \Rightarrow$

$$\Rightarrow V_o = 5mA \cdot 50\Omega + 7'5V = 7'75V$$

Esa tensión V_o la obtenemos para V_{i_lim} tal que

$$7'75V = 0'047\, V_{i\_lim} + 7'109V \Rightarrow \boxed{V_{i\_lim} = 13'638V}$$

El led se enciende para

$$\boxed{V_i \geq 13'638V}$$

3.-

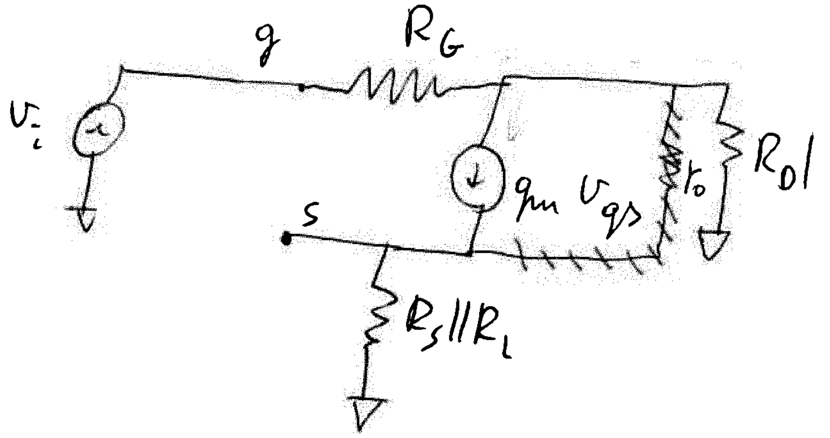
a) $V_D = 6V \Rightarrow \underline{\underline{R_D}} = \dfrac{10V - 6V}{0'8mA} = \underline{\underline{5k\Omega}}$

$$I_{DS} = 0'8mA = \frac{\beta_n}{2}(V_{GS} - V_T)^2 \Rightarrow \boxed{V_{GS} = 4'82V}$$

Como $V_{DS} = V_{GS}$ y $V_D = 6V \Rightarrow \boxed{V_S = 1'18V}$

$$\underline{\underline{R_S}} = \frac{\cancel{I_{DS}}\ V_S}{I_{DS}} = \frac{1'18V}{0'8mA} = \underline{\underline{1'475k\Omega}}$$

b)



$r_o \rightarrow \infty$

$$v_s = g_m v_{gs}(R_S \| R_L) = g_m (R_S \| R_L) \cdot (v_i - v_s)$$

$$\left(1 + \frac{1}{g_m \cdot (R_S \| R_L)}\right)(v_s) = v_i \Rightarrow \frac{v_o}{v_i} = \frac{g_m (R_S \| R_L)}{1 + g_m R_S \| R_L}$$

$v_s = v_o$

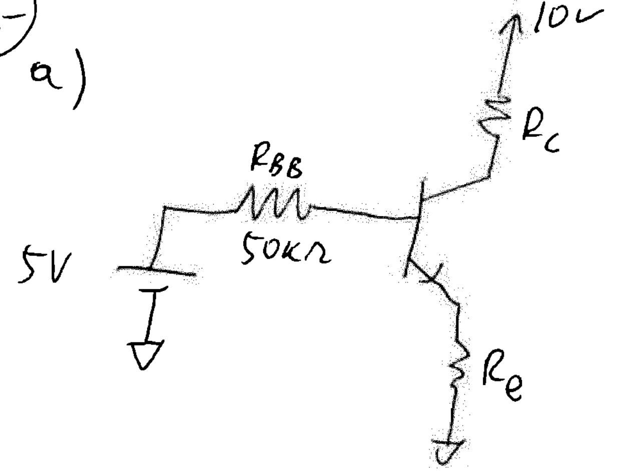
$$g_m = \beta_n (V_{GS} - V_T) = 5'64 \cdot 10^{-4}\ \mho$$

$$R_S \| R_L = 1'14k\Omega$$

$$\Rightarrow \boxed{\frac{v_o}{v_i} = 0'39}$$

4.-

a)



$$5V = I_B \cdot R_{BB} + V_{BE} + I_E \cdot R_E = I_B \cdot R_{BB} + V_{BE} + I_B(\beta_F + 1) \cdot R_E \Rightarrow$$

$$\Rightarrow \underline{R_E} = \frac{5V - 0'7V - 5\mu A \cdot 50k\Omega}{5\mu A \cdot 201} = \underline{4'03k\Omega}$$

$$V_E = I_E \cdot R_E = (\beta_F + 1) I_B \cdot R_E = 4'05V \Rightarrow V_C = 7'05V$$

$$\underline{R_C} = \frac{10V - 7'05V}{I_C} = \underline{2'95k\Omega}$$

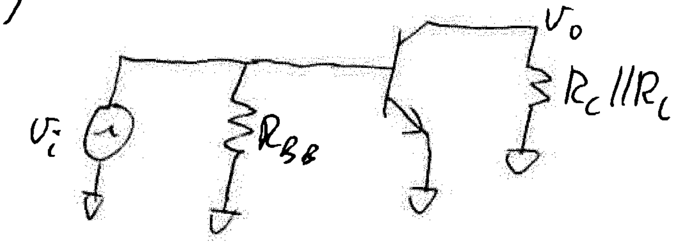
$\hookrightarrow 200 \cdot 5\mu A = 1mA$

b) Mientras activa, I_C, I_B, I_E, V_E cte.

límite $V_C = V_E + 0'2V = 4'25V$

$$\underline{R_{C\_MAX}} = \frac{10V - 4'25V}{1mA} = \underline{5'75k\Omega}$$

c)



$$\boxed{\frac{v_o}{v_i} = -g_m R_C \| R_L = -88'4}$$

$$g_m = \frac{I_C}{V_T} = 0'039 \mho$$

$$R_C \| R_L = 2'28k$$