EXAMEN 19 ABRIL 2004

CUESTIONES.-

1.- $n_0 = N_c e^{-(E_c-E_F)/KT}$

$p_0 = N_v e^{(E_v-E_F)/KT}$

$$n_i^2 = n_0 p_0 = \left[\sqrt{N_c N_v}\right]^2 e^{\left[-(E_c-E_F)+E_v-E_F\right]/KT} =$$

$$= N_c N_v e^{(E_v-E_c)/KT} = N_c N_v e^{-E_g/KT}$$

$$\boxed{n_i = \sqrt{N_c N_v}\, e^{-E_g/2KT}}$$

2.- $n \simeq N_D^+ \simeq N_D$

$$n = N_c e^{-(E_c-E_F)/KT} \Rightarrow \boxed{E_c - E_F = -KT \ln \frac{n}{N_c}} \Rightarrow \underline{\underline{264\,meV}}$$

3.- - No hay equilibrio térmico.

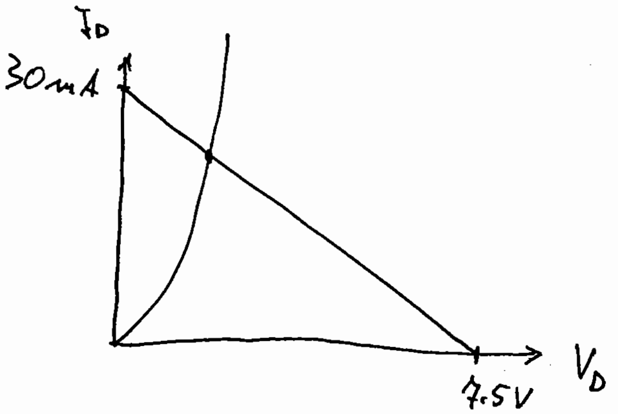
- Hay más e^- que en eq. térmico $\Rightarrow E_{FN} > E_{F_0}$
- " " h " " " " $\Rightarrow E_{FP} < E_{F_0}$

$\Rightarrow E_{FN} \neq E_{FP}$

PROBLEMAS

1.- a) Recta de carga:

$$I_D = I_{R1} - I_{R2} = \frac{V_{DD} - V_D}{R1} - \frac{V_D}{R_2} = \frac{-V_D}{R1\|R2} + \frac{V_{DD}}{R1}$$



- $\frac{V_{DD}}{R1} = \frac{15}{500} = 30mA$
- $I_D = 0 \Rightarrow V_D = \frac{R1\|R2}{R1} V_{DD} = 7.5V$

b) Igualamos ambos I_D:

$$\frac{-V_D}{R1\|R2} + \frac{V_{DD}}{R1} = I_s e^{+V_D/V_T}$$

$$\Downarrow$$

$$V_D = +V_T \ln\left[\frac{1}{I_s}\left[\frac{-V_D}{R1\|R2} + \frac{V_{DD}}{R1}\right]\right] = +25.8m \ln\left[\frac{1}{I_s}\left[\frac{-V_D}{250} + 0.03\right]\right]$$

$$V_D^{(0)} = 0.6V \Rightarrow V_D^{(1)} = 0.62V \Rightarrow \boxed{V_D^{(2)} = 0.62V} \Rightarrow \boxed{I_D = e^{V_D/V_T} \cdot I_s = 27.3mA}$$

c) $$I_D = I_{R1} - I_{R2} = \frac{V_{DD} - V_\gamma}{500} - \frac{V_\gamma}{500} = \frac{14.4}{500} - \frac{0.6}{500} = \frac{13.8}{500} = 27.6mA$$

En una pila no se puede aplicar ley de Ohm ni ninguna relación entre I y V. Por eso aplicamos ley de Kirchoff a los nudos.

2.- $\boxed{V_1 = 0\,V}$

→ Probablemente $\underline{D1\ ON}$

→ D2 depende de V_o. INICIALMENTE supongo OFF

→ $V_o = \cancel{10V}\ V_\gamma + I_D \cdot 10K = V_\gamma + \frac{10-0.6}{20K} \cdot 10K = (0.6 + 4.7)V =$

$I_D = \frac{10-0.6}{20K}$ $\qquad = \boxed{V_o = 5.3V}$

Con esta tensión D2 conduciría, por tanto nos hemos equivocado y:

D1 ON ; D2 ON $\Rightarrow \underline{\underline{V_o}} = 6 - V_\gamma = \underline{\underline{5.4V}}$

$\boxed{V1 = 5V}$ Probablemente D2 OFF, D1 ON

(Observar que no puede ser D1 OFF y D2 ON porque la corriente no tiene por donde ir).

D1 ON D2 OFF $\Rightarrow V_o = \frac{10-5.6}{20K} \cdot 10K + 5.6 = \underline{\underline{7.8V}}$

$\boxed{V1 = 9.5V}$ D2 OFF D1 OFF (Si conduciera $\Rightarrow V_D \geq 9.5 + V_\gamma = 10.1V$

luego: $\Rightarrow V_o = 10V$

V1(V)	D1	D2	V_o(V)
0	ON	ON	5.4
5	ON	OFF	7.8
9.5	OFF	OFF	10

3.- $G = 10^{12} \frac{\text{pares e-h}}{\mu s\, cm^3}$

a) $$\frac{d\delta p}{dt} = G + g_0 - \alpha_r n = G + g_0 - \alpha_r n =$$

$$= G + \alpha_r n_i^2 - \alpha_r (n_0 + \delta n)(p_0 + \delta p) =$$

$$= G + \alpha_r n_0 p_0 - \alpha_r (n_0 p_0 + n_0 \delta p + p_0 \delta n + \cancel{(\delta p)^2}) =$$

Baja inyección

$$\frac{d\delta p}{dt} = G - \alpha_r (n_0 + p_0)\delta p \Rightarrow \boxed{\frac{d\delta p}{dt} = G - \frac{\delta p}{\tau_p}} ; \boxed{\tau_p = \alpha_r^{-1}(n_0 + p_0)^{-1}}$$

$$\simeq \alpha_r^{-1} n_0^{-1}$$

b) EST. ESTAC $\Rightarrow$ $\frac{d\delta p}{dt} = 0 \Rightarrow G = \frac{\delta p}{\tau_p} \Rightarrow \boxed{\delta p = G \cdot \tau_p}$

$$\delta p = \frac{10^{12}}{10^{-6} s\, cm^{-3}} \cdot 2 \mu s = 2 \cdot 10^{12}\ cm^{-3}$$

$$\Rightarrow \quad p = p_0 + \delta p \simeq \delta p = 2 \cdot 10^{12}\ cm^{-3}$$

$$n = n_0 + \delta p \simeq n_0 = 10^{14}\ cm^{-3}$$

c) $$\frac{d\delta p}{dt} = -\frac{\delta p}{\tau_p} \Rightarrow \boxed{\delta p(t) = \delta p(t=0) e^{-t/\tau_p}} \quad (t_0 = 0)$$

$$\delta p(t_2) = \frac{\delta p(t=0)}{2} = \delta p(t=0) e^{-t_2/\tau_p} \Rightarrow 0.5 = e^{-t_2/\tau_p}$$

$$\Rightarrow \boxed{t_2 = -\tau_p \ln 0.5 = 1.39 \mu s}$$