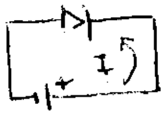
10/3/08

Problemas T.E.: Diodo de Unión

① a) Característica V-I

$$I = I_0\left(e^{\frac{V}{\eta V_T}} - 1\right)$$

$$\frac{qV}{\eta KT} \;-\; V_T$$



Diodo Si $\Rightarrow \eta = 2$

T^a ambiente $= 27°C \Rightarrow T = 273 + 27 = 300° K$

$K = 1'38 \cdot 10^{-23}$

$q = 1'6 \cdot 10^{-19}$ C

$\Rightarrow V_T = 26 mV$

$$I = I_0\left(e^{\frac{V}{52\cdot 10^{-3}}} - 1\right)$$

¿V? / $I = 95\%\, I_0$

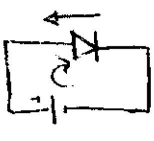
$$-0'95\, I_0 = I_0\, e^{\frac{V}{52\cdot 10^{-3}}} - I_0$$

$$0'05\, I_0 = I_0\, e^{\frac{V}{52\cdot 10^{-3}}}$$

$$\ln(0'05) = \frac{V}{52\cdot 10^{-3}} \ln(e) \Rightarrow \boxed{V = -0'156V}$$

($\ln(e) \to 1$)

b)



DIRECTA

(directa / inversa)

$$\frac{I}{I'} = \frac{I_0\left(e^{\frac{0'1}{26}} - 1\right)}{I_0\left(e^{\frac{-0'1}{26}} - 1\right)} = -6'842$$

$I \neq 0$

$I = -6'842 \cdot I'$

c) (aplicar la fórmula)

$I_0 = 10 nA$ y $\begin{cases} 0'5V \\ 0'6V \\ 0'7V \end{cases}$

$V_T = 26 mV$

$I = I_0 \left(e^{\frac{V}{2V_T}} - 1 \right) \longrightarrow I(V=0'5V) = 1'5 \; 10^{-3} \; A$

$I(V=0'6) = 1'026 \cdot 10^{-3} \; A$

$I(V=0'7) = 7'02 \cdot 10^{-3} \; A$

⑥ a) En sentido directo

$\eta = 2 \;,\; I_{0_{125}} = 0'1 \mu A$

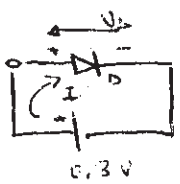
$R_d = \frac{\eta V_T}{I + I_0} = \frac{2 V_T}{I_0 \; e^{V/2V_T}}$

$I_{0_{125}} = 0'1 \mu A \Rightarrow I_{0_{105}} = I_{0_{125}} \; 2^{\frac{105-125}{10}} = I_{0_{125}} \; 2^{-2} =$

$= 0,1 \cdot 10^{-3} \; 2^{-3} = 2'5 \; 10^{-8} \; A$

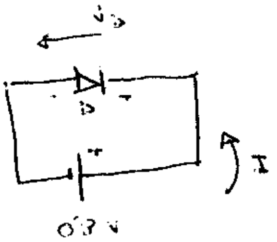
$V_T = \frac{KT}{q} = \frac{K \cdot 378}{q} = \frac{378}{11600}$ $\qquad 105°C \rightarrow 378 °K$

Directo:



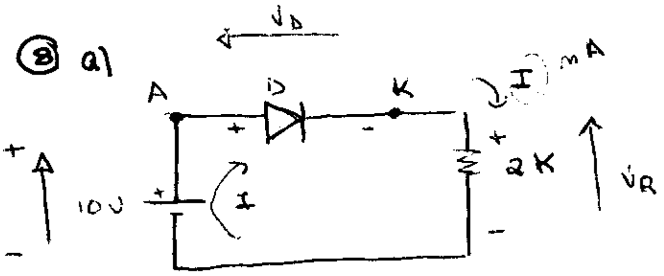
$R_d = \dfrac{2 \; \frac{378}{11600}}{2'5 \cdot 10^{-8} \; e^{\frac{0'3 \cdot 11600}{2 \cdot 378}}} =$

b) Inverso



$$R_d = \frac{2^{\frac{278}{11600}}}{2{,}5\cdot 10^{-8}\, e^{\frac{-0'3\cdot 11600}{2\times 348}}} = 5'387\cdot 10^{11} = 558'76\ \Omega$$

③ a)



$$-10 + V_D + V_R = 0 \qquad V_R = I\,R \quad \Rightarrow$$

$V_D(si) = 0'7\ V$

$V = I\,R$ — V: voltios; I: 10^{-3} mA; R: 10^{3} kΩ

$$\Rightarrow -10 + 0'7\ V + I\cdot 2K = 0 \qquad I = \frac{10 - 0'7}{2} = 4'65\ mA$$

b) $I = 1\ mA$, $V_D = 0'6\ V$

$$I = I_0\left(e^{\frac{V}{\eta V_T}} - 1\right)$$

$$\Rightarrow I_0 = \frac{I}{e^{\frac{V}{\eta V_T}} - 1} = \frac{10^{-3}}{e^{\frac{0'6}{2\cdot 26\cdot 10^{-3}}} - 1} = 9'748\ nA$$

$T = 300\ °K \Rightarrow V_T = 26\ mV$
$\eta = 2\ (si)$

$$I + I_0 = I_0 e^{\frac{V}{2V_T}} \Rightarrow \frac{I + I_0}{I_0} = e^{\frac{V}{2V_T}} \Rightarrow \ln\left(\frac{I + I_0}{I_0}\right) = \frac{V}{2V_T} \ln e^{1}$$

$$\Rightarrow V_D = 2V_T \cdot \ln\left(\frac{I}{I_0} + 1\right)$$ Ojo Calculo la tensión en el diodo.

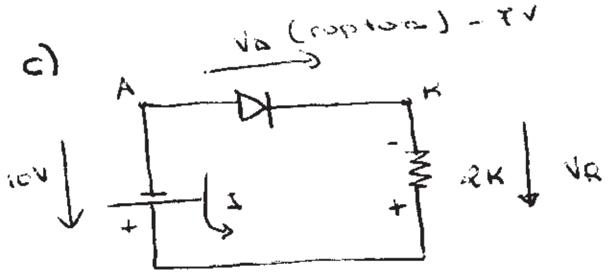
$$V_D^0 = 2 \cdot 26 \cdot 10^{-3} \ln\left(\frac{4'65 \cdot 10^{-3}}{9{,}748 \cdot 10^{-9}} + 1\right) = 0'67992 \text{ V}$$

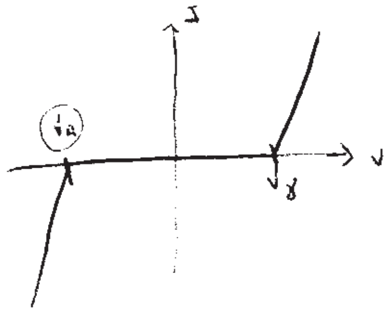
$$I^0 = \frac{10 - V_D^0}{2} = \frac{10 - 0'67992}{2} = 4'66 \text{ mA}$$

$V_D' = 0{,}68005$

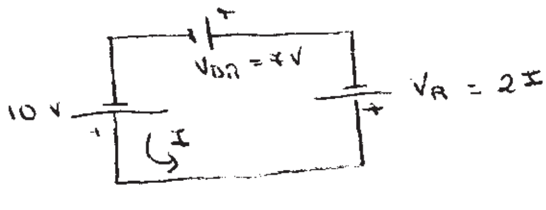
$I' = 4'66$ mA

c)



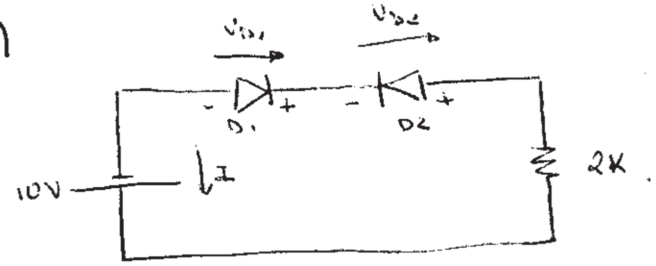


||| circ. equiv

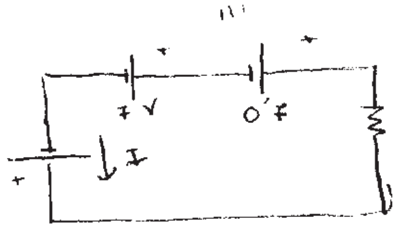


$$+10 - 7 - 2I = 0 \Rightarrow I = \frac{10 - 7}{2} = 1'5 \text{ mA}$$

mirar d)



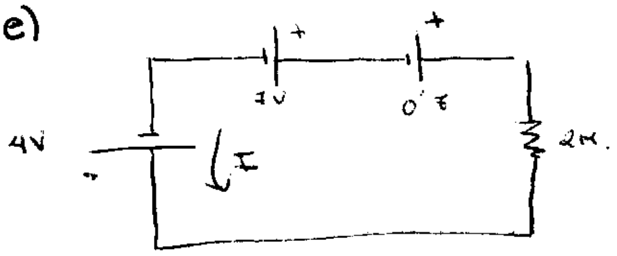
|||



$$-10 + I\,2 + 0'7 + 7 = 0$$

$$\Rightarrow I = \frac{10 - 0'7 - 7}{2} = 1'15 \text{ mA}$$

e)



$$\frac{4-1-0'7}{2} = -I \Rightarrow \text{ERROR}$$

$V < V_R$, $I < 0$ $\Rightarrow$ D_1 OFF

Ojo

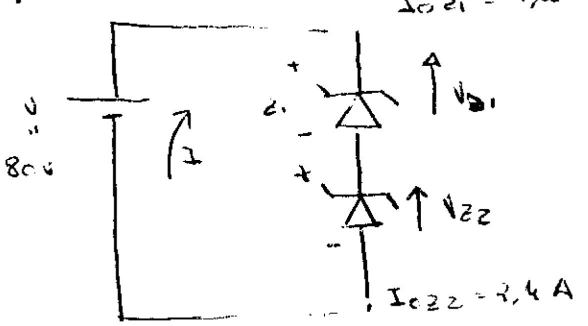
$V_{D_1} \leq V_R = 1\ V$

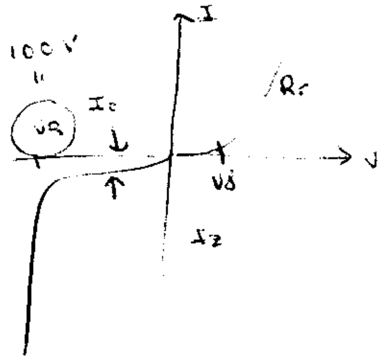
$I = I_0 = 9'843\ nA$.

(10)

a)

$I_{0z_1} = 1\mu A$





Ojo suponiendo uno de ellos en zener tendríamos 100 V a la salida, pero si el otro está en OFF no circula corriente ⇒ los dos están en OFF

$V = 80\ V < V_R = 100\ V \Rightarrow z_1 = z_2 = OFF$

la corriente de saturación es la menor (ya están en serie), es decir $1\mu A$

$I_{0z_1} = 1\mu A$, $I_{0z_2} = 2\mu A$ ⇒ serie ⇒ $I = \min(I_{0z_1}, I_{0z_2}) = 1\mu A$

⇒ es $-V_{z2}$ ya el diodo zener está en inverso

$$-I_{0z_1} = I = I_{0z2}\left(e^{\frac{-V_{z2}}{2 \cdot 26 \cdot 10^{-3}}} - 1\right)$$

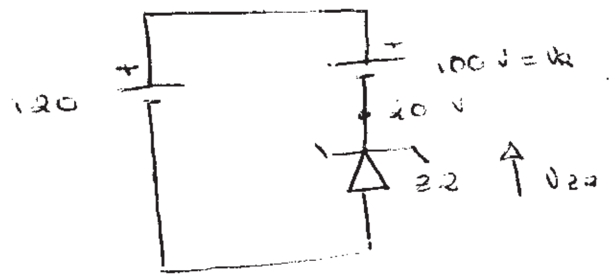
$-I_{0z_1} = -1\mu A$, $I_{0z2} = 2\mu A$

$$\Rightarrow -1 + 2 = 2e^{\frac{-V_{z2}}{52 \cdot 10^{-3}}} \Rightarrow \ln\left(\frac{1}{2}\right) = \frac{-V_{z2}}{52 \cdot 10^{-3}} \Rightarrow -V_{z2} = -0'036 \Rightarrow$$

$\Rightarrow V_{z2} = 0,036\ V$

$V = V_{Z1} + V_{Z2} \Rightarrow V_{Z1} = 80 - 0'056 = 79'864\ V$

Si $V = 120\ V > V_R = 100\ V \Rightarrow$ <u>$Z_1 = ON$</u>

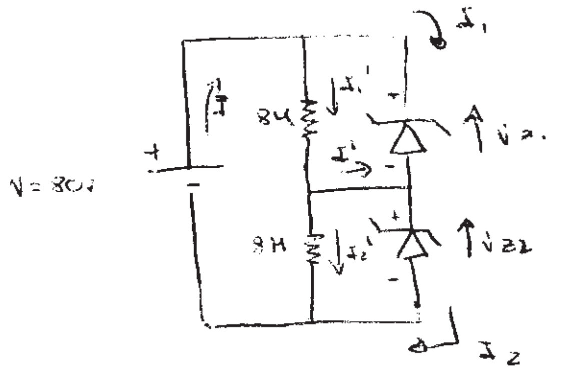


$V_{Z2} = 20\ V < V_R = 100\ V \Rightarrow$ <u>$Z_2 = OFF$</u>

$V_{Z1} = 100\ V$

$V_{Z2} = 20\ V$

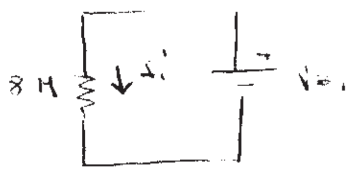
b)



$V = 80\ V \Rightarrow Z_1 = Z_2 = OFF$

$I_1 = I_{0Z1} = 1\ \mu A$

$I_2 = I_{0Z2} = 2\ \mu A$



$-V_{Z1} + I_1' \cdot R = 0 \Rightarrow I_1' = \dfrac{V_{Z1}}{R} = \dfrac{V_{Z1}}{8 \cdot 10^6}$

$I_2' = \dfrac{V_{Z2}}{8 \cdot 10^6}$

$I_1' = I' + I_2' \Rightarrow I' = I_1' - I_2' = \frac{V_{Z1}}{8\cdot 10^6} - \frac{V_{Z2}}{8\cdot 10^6}$

$I_1 + I' = I_2 \Rightarrow I' = I_2 - I_1 = 2 - 1 = 1\mu A$

$10^{-6} = \frac{V_{Z1}}{8\cdot 10^6} - \frac{V_{Z2}}{8\cdot 10^6} \Rightarrow V_{Z1} - V_{Z2} = 8 \Rightarrow \boxed{V_{Z1} = 8 + V_{Z2}}$

$\boxed{-V + V_{Z1} + V_{Z2} = 0}$ $\Rightarrow$

ojo $V_{Z1} = V_{Z2}$ ↑ parece q es así, pero no lo es, hay q tener cuidado con esto (xq parecen circuitos iguales)

$\Rightarrow V = 8 + V_{Z2} + V_{Z2}$

$80 = 8 + V_{Z2} + V_{Z2}$

$72 = 2V_{Z2} \Rightarrow \boxed{V_{Z2} = 36V} < V_R = 100V \Rightarrow \underline{\underline{Z_2 = OFF}}$

$V_{Z1} = 8 + V_{Z2} = 8 + 36 = 44 \Rightarrow \boxed{V_{Z1} = 44V} < V_R = 100V \Rightarrow$

$\Rightarrow \underline{\underline{Z_1 = OFF}}$

Suponemos $Z_1 = Z_2 = OFF$

$V_{Z1} = 8 + V_{Z2}$

$-V + V_{Z1} + V_{Z2} = 0 \quad V_{Z1} + V_{Z2} = V = 120$

$\Rightarrow 120 = 8 + 2V_{Z2}$

$\Rightarrow \boxed{V_{Z2} = 56V} < V_R = 100$;

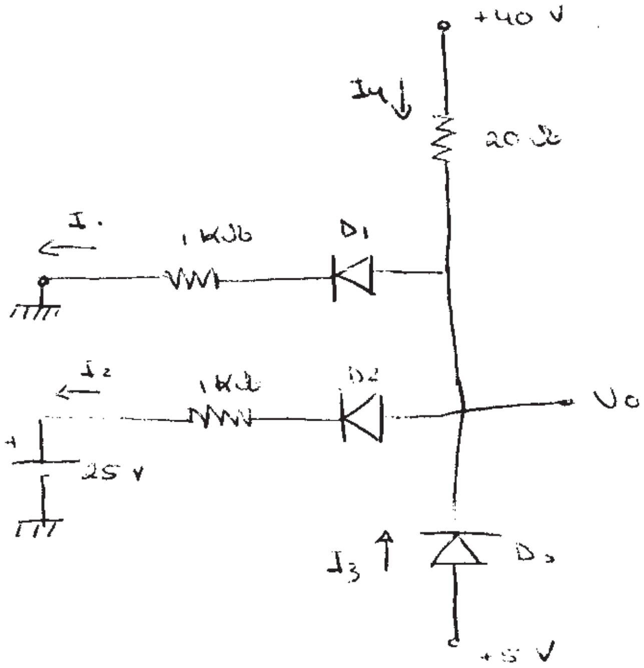
$\Rightarrow \boxed{Z_2 = OFF}$

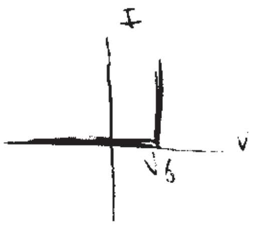
$V_{Z1} = 120 - V_{Z2} = 120 - 56 = 64V$

$\boxed{V_{Z1} = 64V} < V_R = 100V \Rightarrow \boxed{Z_1 = OFF}$

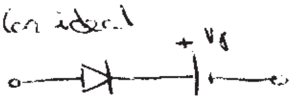
(15) $R_j = 0$ $V_\gamma = 0'6\ V$ $R_r = \infty$

0'7 V

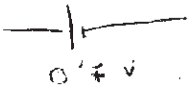


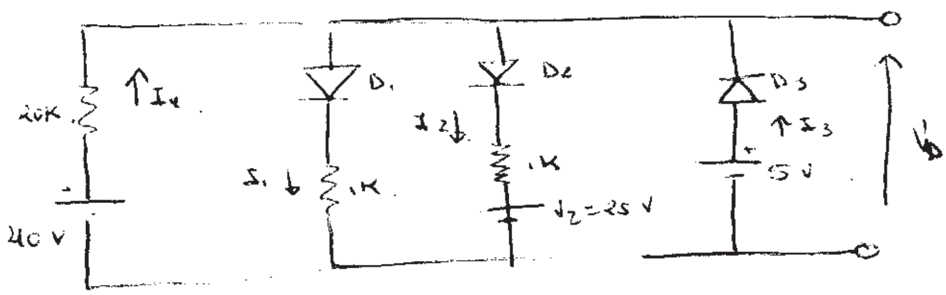


Con ideal



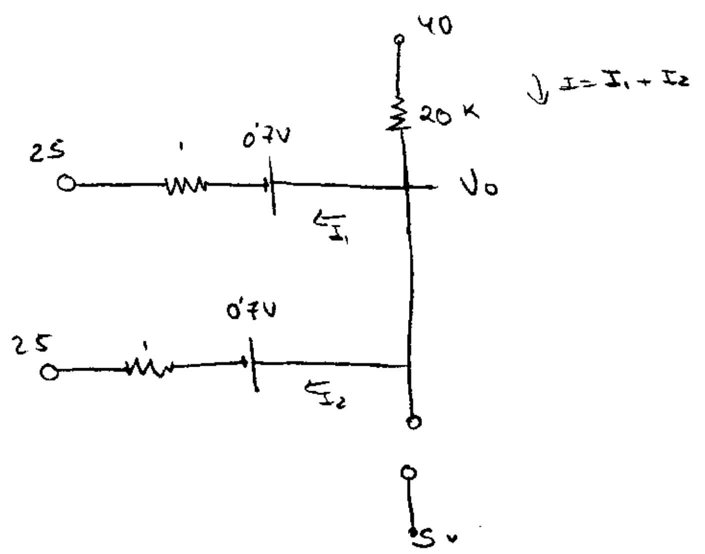
Directo





Caso A. D1 = D2 = D3 = OFF => VD = 40 V => D1 = D2 = ON

Suponemos D1 ON, D2 ON $\Rightarrow V_o > 25 \Rightarrow$ D3 OFF



$$\left. \begin{array}{l} 40 = 20(I_1 + I_2) + 0'7 + 1 \cdot I_1 + 25 \\ 40 = 20(I_1 + I_2) + 0'7 + 1 \cdot I_2 + 25 \end{array} \right\}$$

$$\left. \begin{array}{l} 40 - 25 - 0'7 = 21 I_1 + 20 I_2 \\ 40 - 25 - 0'7 = 21 I_2 + 20 I_1 \end{array} \right\}$$

$$\left. \begin{array}{l} 14'3 = 21 I_1 + 20 I_2 \\ 14'3 = 21 I_2 + 20 I_1 \end{array} \right\}$$

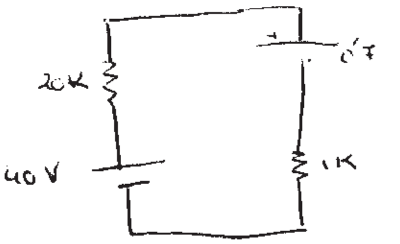
$$I_1 = \frac{14'3 - 20 I_2}{21} \rightarrow 14'3 = 21 I_2 + 20\left(\frac{14'3 - 20 I_2}{21}\right) \Rightarrow 14'3 \cdot 21 = 21 \cdot 21 I_2 + 20(14'3 - 20 I_2)$$

$$14'3 \cdot 21 - 20 \cdot 14'3 = 21^2 I_2 - 20^2 I_2 \Rightarrow \boxed{I_2 = \frac{14'3}{21^2 - 20^2} = 0'35 \text{ mA}}$$

$$\boxed{I_1 = 0'35 \text{ mA}}$$

$V_o = 40 - 20(I_1 + I_2) = 40 - 20 \cdot 0'7 = \underline{26 V}$ (respeta D1, D2 ON).

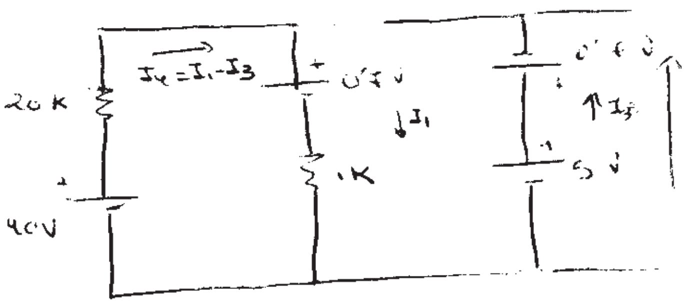
Caso 2 D3 = OFF ⇒ $I_3 = 0$ D1 = ON , D2 = OFF



$I_1 = I_4 \Rightarrow 40 = I \cdot 20 + 0'7 + I \Rightarrow I_1 = I_4 = 1'87$

$V_0 = 40 - 20\,I = 2,57$ V ⇒ D3 = ON .

Caso 3 D1 = D3 = ON y D2 = OFF



$V_0 = 4'3$ V

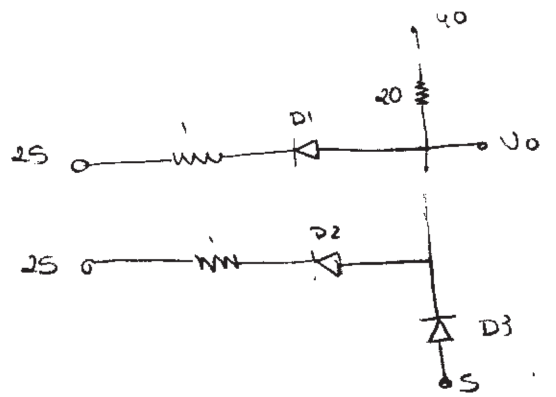
$I_2 = 0$

$4'3 = 0'7 + I_1 \cdot 1 \rightarrow I_1 = 3'6$ mA

$40 = 20\,(I_1 - I_3) + 4'3$

$$I_3 = \frac{40 - 4'3 - 20\,I_1}{20} = \frac{35'7 - 20 \cdot 3'6}{20} = 1'815 \text{ mA}$$

b) $V_1 = V_2 = 25$ V



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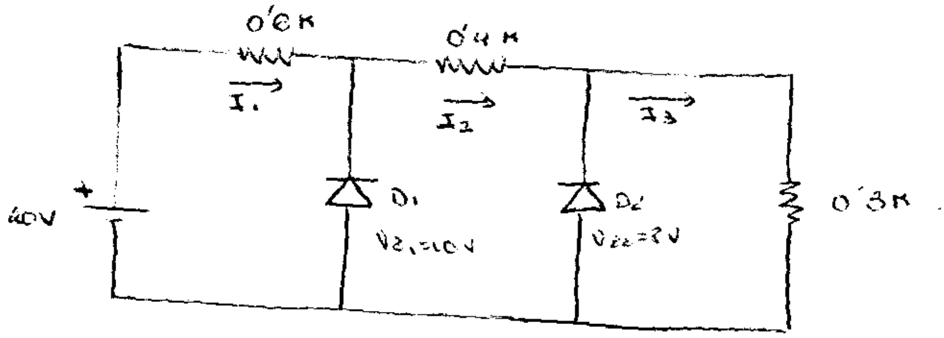
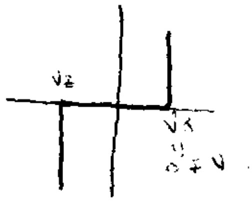
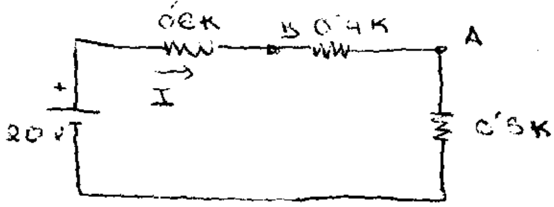
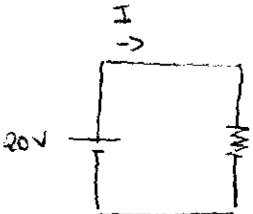


Modelo D1, D2



Caso 1 : D1 y D2 = OFF





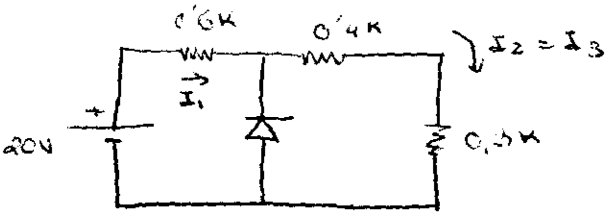
$I = \frac{20V}{1,3} = 15,385$ mA

$R = 0,6K + 0,4K + 0,3K = 1,3K$.

$V_A = I\, 0,3 = 4,61\,V < V_{Z2} = 8\,V \Rightarrow D2 = OFF$

$V_B = I\,(0'3 + 0'4) = 10,769\,V > V_{Z1} = 10V \Rightarrow D1$ en Zener.

Caso 2 D1 = ZENER , D2 = OFF



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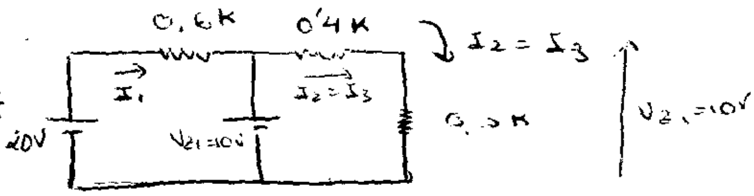

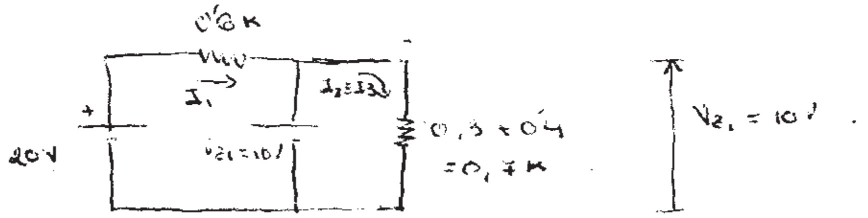

$V_{Z1} = 10V = I_2 \cdot (0,3+0,4) \Rightarrow I_2 = I_3 = \frac{10}{0,7} = 14,286\ mA$

$-20 + 0,6\ I_1 + 10 = 0 \Rightarrow I_1 = 16,667\ mA$

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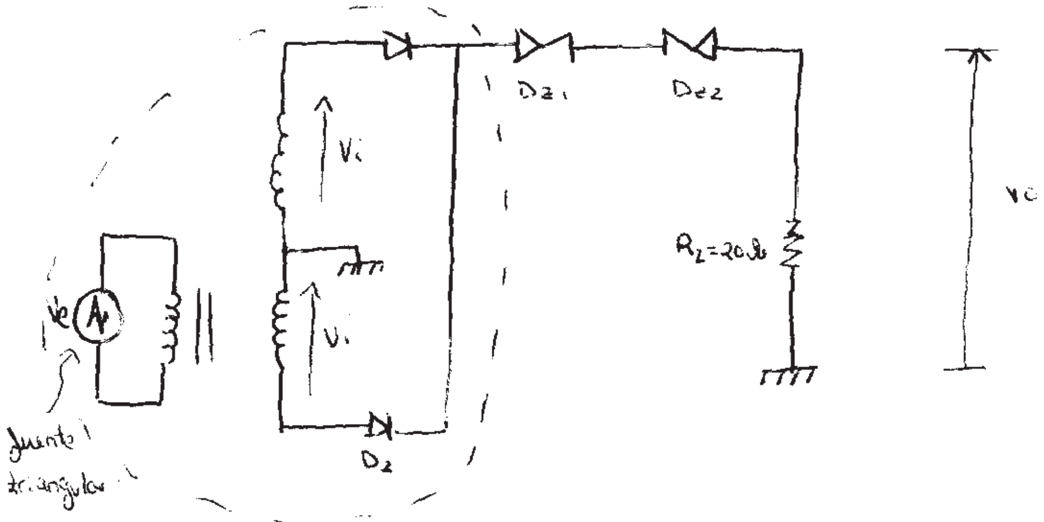
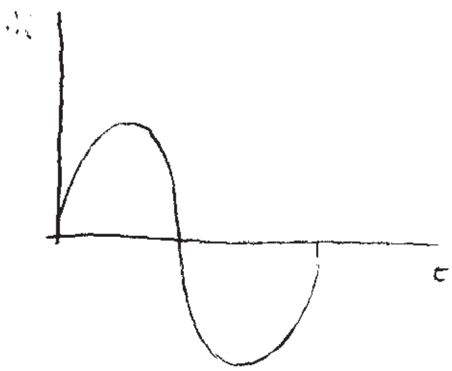
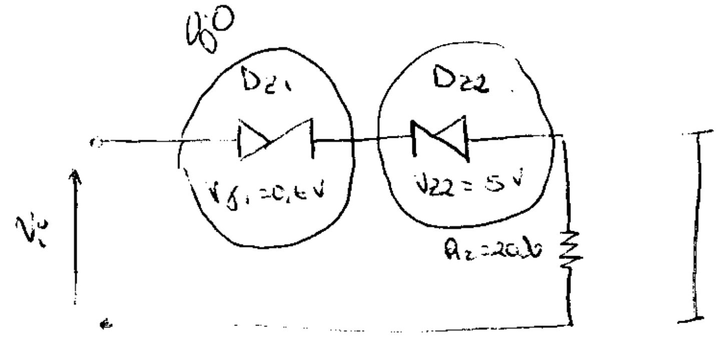
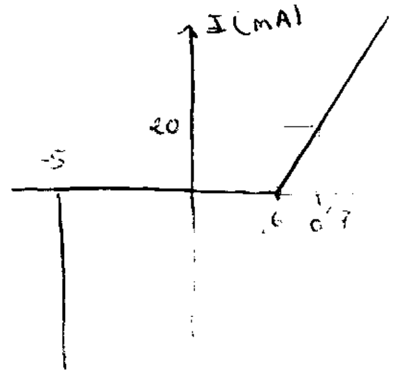


para el apartado (a) podemos considerar la fuente como una señal sinusoidal ⊚







$\underline{Rj} = \frac{\Delta V}{\Delta I} = \frac{0'7 - 0'6}{20} = 5\Omega$

V (Volt)

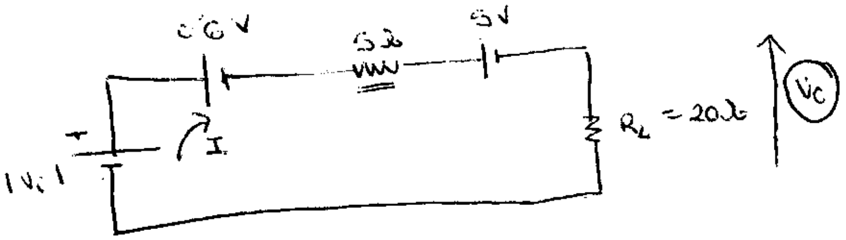
Mientras V_i no supere $V_{\gamma 1} + V_{z2}$ los diodos van a estar en OFF y V_o va a ser cero

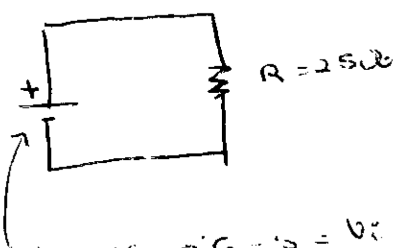
Si $|V_i| < V_{\gamma 1} + V_{z2} = 5,6\ V \Rightarrow$

$0 < V_i < 0,6\ V \Rightarrow D_{z1} = OFF \Rightarrow V_o = 0\ V$

$0,6 \leq V_i < 5,6\ V \Rightarrow D_{z1} = ON,\ D_{z2} = OFF \Rightarrow V_o = 0\ V$

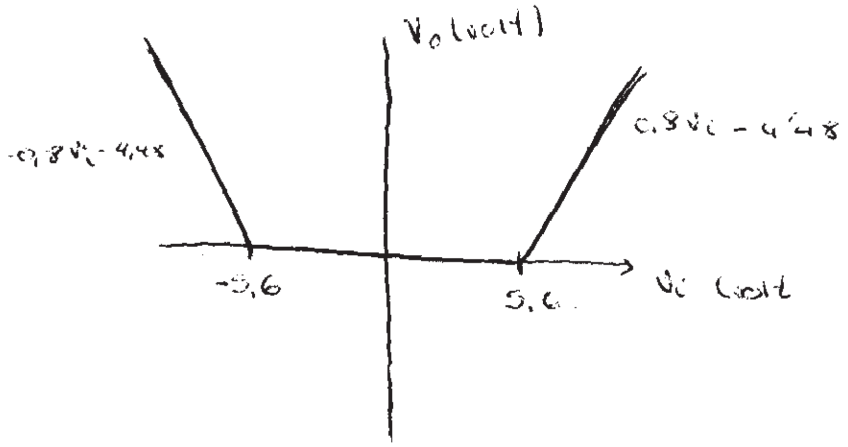
Si $|V_i| \geq 5,6\ V \Rightarrow D_{z1} = ON,\ D_{z2} = ZENER$



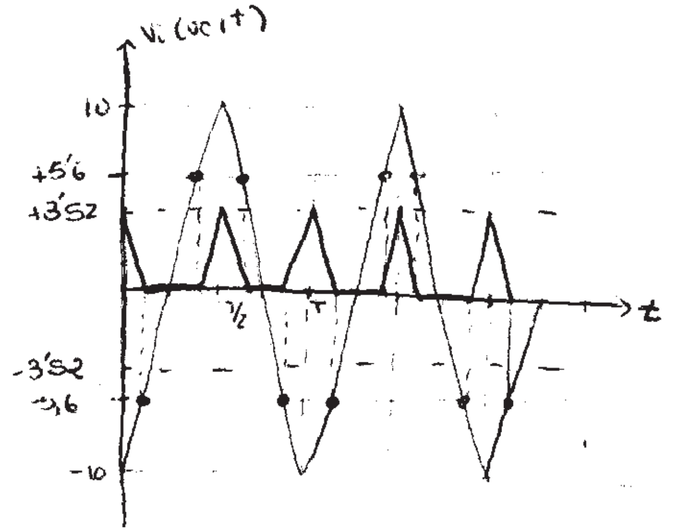


$V = V_i - 0'6 - 5 = V_i - 5,6 \qquad I = \frac{V}{R} = \frac{V_i - 5,6}{25}$

$V_o = I\, R_L = \frac{|V_i| - 5,6}{25} \cdot 20 = 0,8\, |V_i| - 4,48$



b)

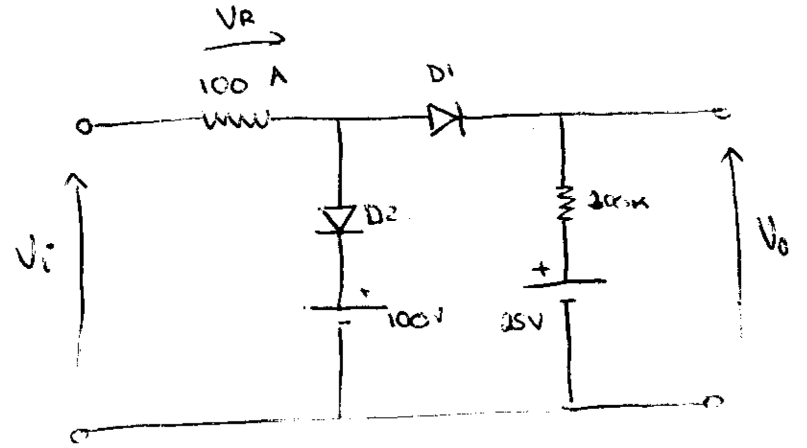


• salida = cero entre -5,6 y 5,6

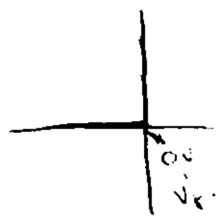
$|Vi|_{max} = 10 V$

$\Rightarrow V_{o_{max}} = 0,8 \cdot 10 - 4,48 = 3'52 V$

③



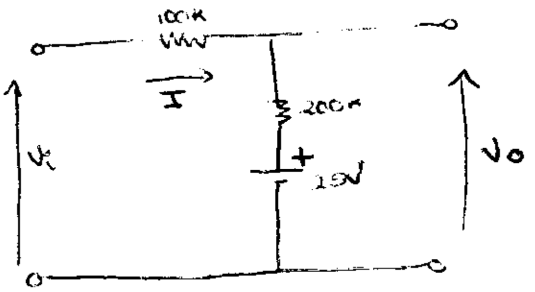
Diodo Ideal



Caso 1: D1 = D2 = OFF

$V_R > V_i > 25\,V$ => D1 = ON D2 = OFF

Caso 2 D1 = ON D2 = OFF



$$I = \frac{V_i - 25}{100 + 200} = \frac{V_i - 25}{300} \text{ in A}$$

$$-V_i + 100 I + V_o = 0 \Rightarrow V_o = V_i - 100 I$$

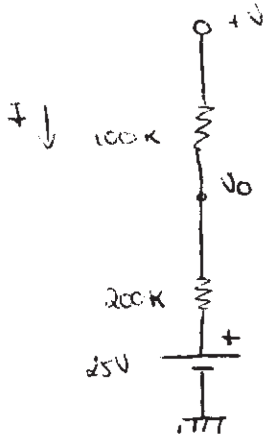
$$V_o = V_i - 100 \frac{V_i - 25}{300} = \frac{2}{3} V_i + \frac{25}{3}$$

Si $V_i = 100\,V$ => D2 = ON

$$\Rightarrow V_o = 100 = \frac{2}{3} V_R + \frac{25}{3} \Rightarrow V_R = 137{,}5\,V$$

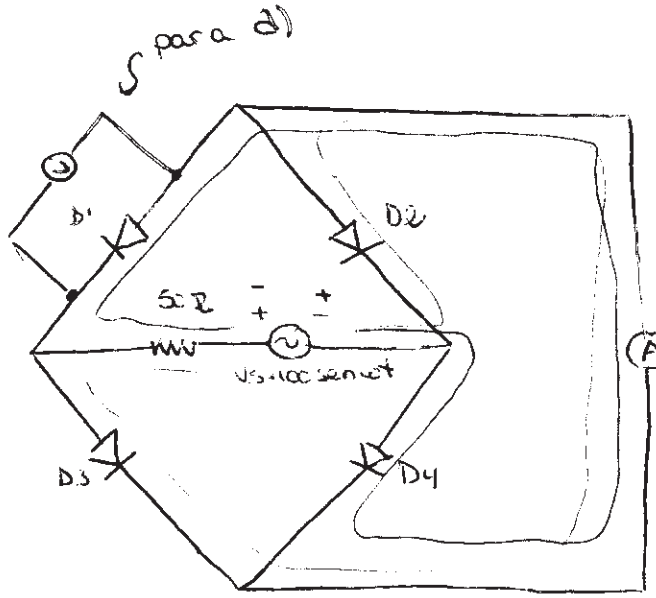
Si $25\,V < V_i < 137{,}5\,V$ => $V_o = \frac{2}{3} V_i + \frac{25}{3}$

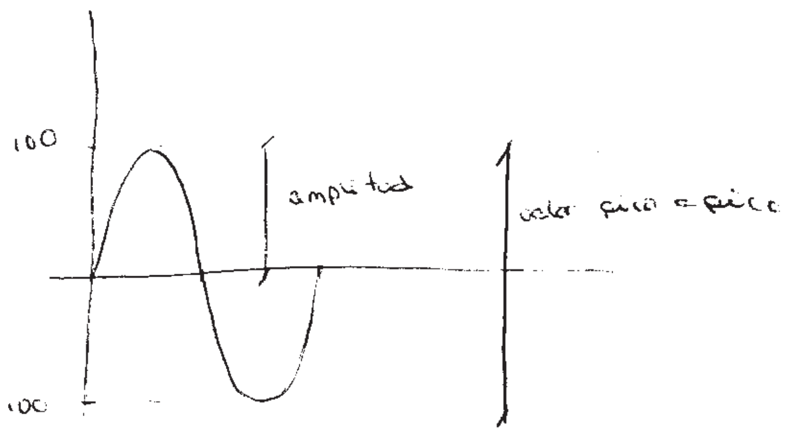
Si $V_i > 137{,}5\,V$ => $V_o = 100\,V$



$$V_o = 25 + \frac{V_i - 25}{300} \cdot 200$$

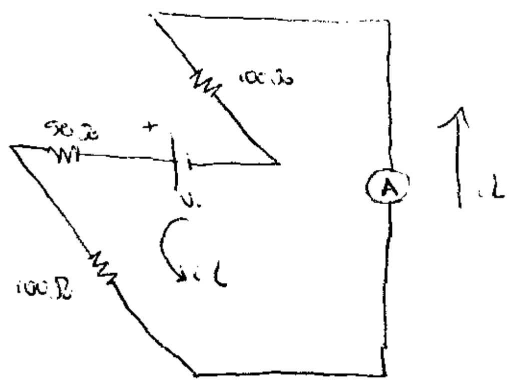
(10)





$$V_{ef} = \frac{\text{amplitud}}{\sqrt{2}} = \frac{\text{Valor pico a pico}}{2\sqrt{2}}.$$

D3 = D2 = ON   D1 = D4 = OFF



$iL\,(100 + 50 + 100) - V_i = 0$

La corriente es máxima cuando $V_i = 100\,V$

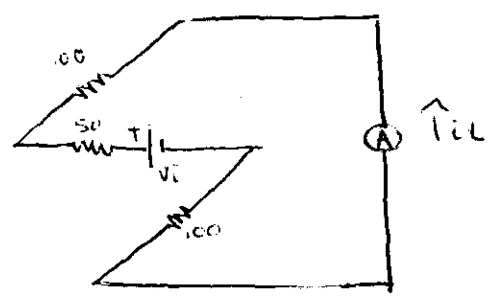
$$iL_{max} = \frac{V_{i\,max}}{100 + 50 + 100} = \frac{100}{250} \Rightarrow iL_{MAX} = 0{,}4\,A$$

$$I_L = \frac{V_i}{250}$$

Si D2 = D3 = OFF   D1 = D4 = ON

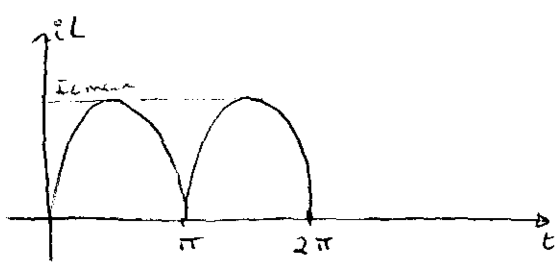
$$\Rightarrow I_L = -\frac{V_i}{250}$$

$I_{LMAX} = 0{,}4\,A$ $V_i = -100\,V$



$iL\,(100 + 50 + 100) + V_i = 0$

$$\boxed{I_L = \frac{|V_i|}{250}}$$



b)

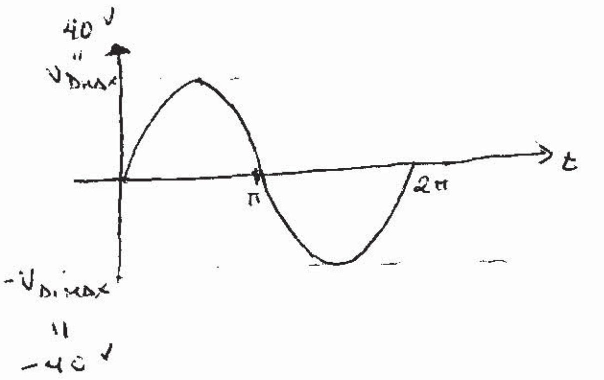
$x = \omega t$

$V_S = 100 \cdot \text{sen}\, \alpha$

$$\boxed{I_{dc}} = 2 \cdot \frac{1}{2\pi} \int_0^{\pi} I_{MAX} \cdot \text{sen}\, \alpha \cdot dx = \frac{1}{\pi} \int_0^{\pi} 0{,}4 \cdot \text{sen}\, x \, dx = \frac{0{,}4}{\pi} \left[-\cos \alpha \right]_0^{\pi}$$

$$= \frac{0{,}4}{\pi} \left[-(-1) + 1 \right] = \frac{0'8}{\pi} = \boxed{\frac{2 \cdot I_{MAX}}{\pi}} = 254{,}7 \text{ mA}$$

c)



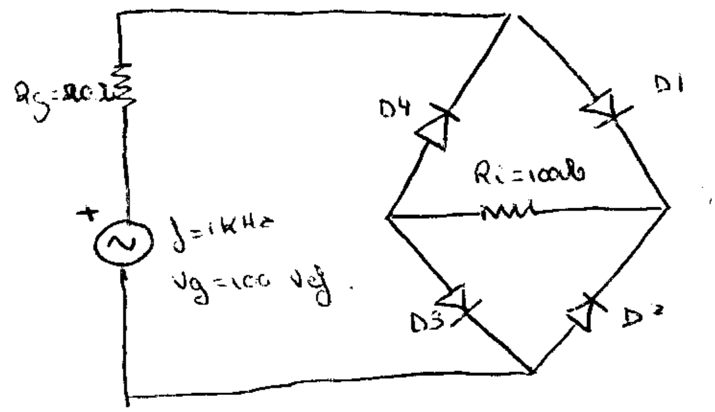
$$V_{D,max} = R_{D} \cdot I_{max}$$
$$= 100 \cdot 0{,}4$$
$$= 40 \text{ V}$$

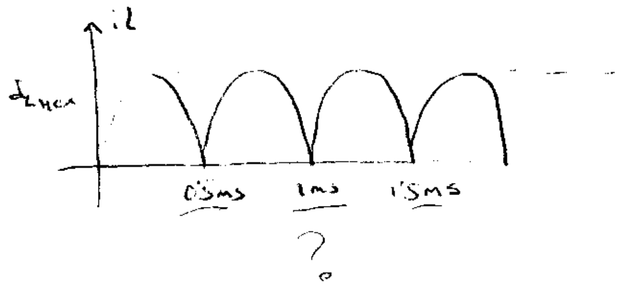
d)

$$V_{ef} = \sqrt{\frac{1}{T} \int x^2(t)\, dt} = \sqrt{\frac{1}{2\pi} \int_0^{2\pi} 40^2 \, \text{sen}^2 \alpha \, d\alpha} = \frac{A}{\sqrt{2}} =$$

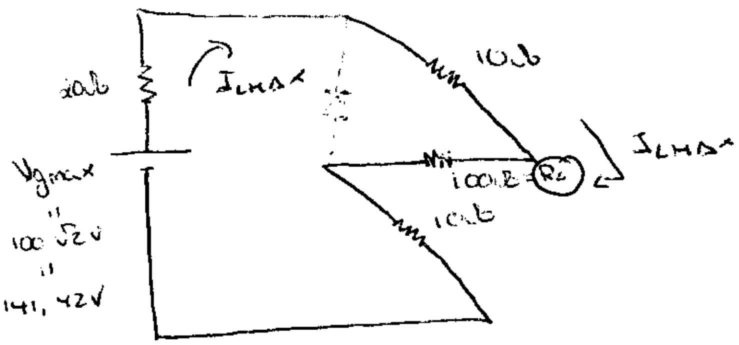
$$= \frac{40}{\sqrt{2}} = 28'284 \text{ V}_{ef}$$

FEB 92





D1 = D3 = ON



a) $V_g = 100$ Vef $\Rightarrow V_{ef} = \frac{V_{max}}{\sqrt{2}} \Rightarrow V_{max} = 100\sqrt{2} = 141,42$ V

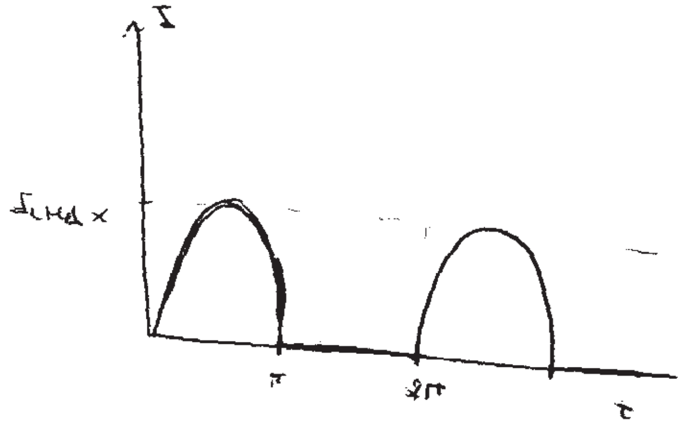
$$I_{LMAX} = \frac{141,42}{100+10+10+20} = \frac{141,42}{140} = 1,01 \text{ A}$$

b) $$V_{LMAX} = I_{LMAX} \cdot R_L = 100 \cdot \frac{141,42}{140} = 101,015 \text{ V}$$

$$V_{dc} = \frac{2 V_{LMAX}}{\pi} = \frac{2 \cdot 101,015}{\pi} = 64,3 \text{ V}$$

$$V_{ef} = \frac{V_{LMAX}}{\sqrt{2}} = \frac{101,015}{\sqrt{2}} = 71,428 \text{ Vef}$$

c) I en cada diodo:



$$\boxed{P = R_f \cdot I_{ef}^2}$$

$$\boxed{I_{ef} = \frac{I_{LMAX}}{2}}$$

$$I_{ef} = \sqrt{\frac{1}{2\pi}\int_0^{\pi} I_{LMAX}^2 \, sen^2\alpha \, d\alpha} = \frac{I_{LMAX}}{2} = \frac{141,42}{280} = 0,505\,A$$

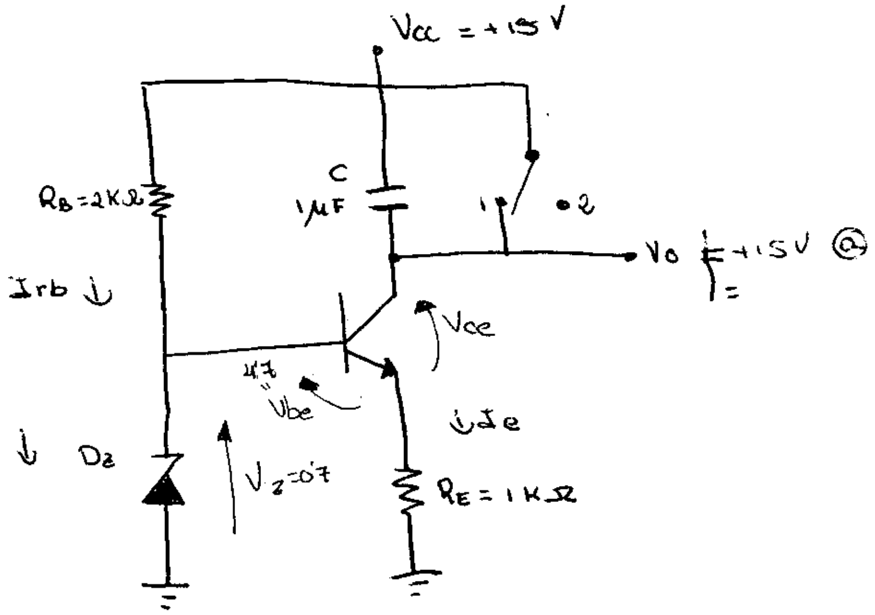
$$\Rightarrow P = R_f \cdot I_{ef}^2 = 10\,(0,505)^2 = 2'55\,W$$

$$\boxed{V_{INV}} = I_{LMAX} \cdot (10 + 100) = \frac{141,42}{140} \cdot 110 = 111,1\,V.$$

29/4/08

TRANSISTOR BIPOLAR

FEB 96



Dz: $V_Z = 4'7\,V$, $I_{Z\,min} = 1\,mA$, $R_Z = 0\,\Omega$

BJT: $V_\gamma = 0'5\,V$, $V_{BE} = V_{BEsat} = 0'7\,V$, $V_{CEsat} = 0\,V$, $\beta = 200$

a) S en 1

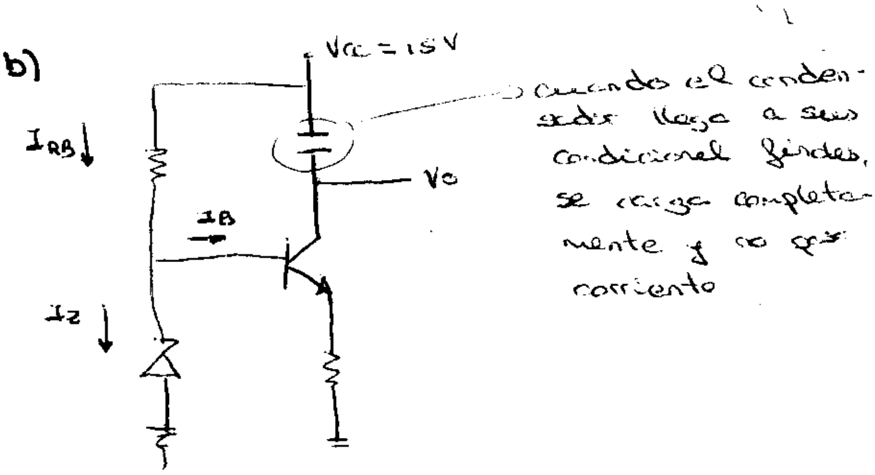
con el paso del tiempo el condensador se carga del todo ⇒ desaparece es como si no estuviera.

- Con Dz en Zéner

$$I_{RB} = \frac{15 - 4'7}{2} = 5,15\,mA$$

- $V_e = V_z - V_{be} = 4'7 - 0'7 = 4\,V$
- $I_e = \frac{V_e}{R_e} = 4\,mA \approx I_c$ ← debido a β es muy grande ($\beta = 200$)
- $V_{ce} = V_{cc} - V_e = 15 - 4 = 11\,V$
- Pto funcionamiento: (4 mA, 11V)

b)



cuando el condensador llega a sus condiciones finales, se carga completamente y no pasa corriente

- BJT saturado con $I_c = 0$ (por condensador)
  → $V_{ce\,sat} = 0\,V$
- $I_e = I_b = \frac{4'7 - 0'7}{1} = 4\,mA$
- $I_z = 5,15 - 4 = 1'15\,mA > I_{Z\,min}$
- $V_o = V_e + V_{cesat} = 4\,V$
  (4 + 0)

c)

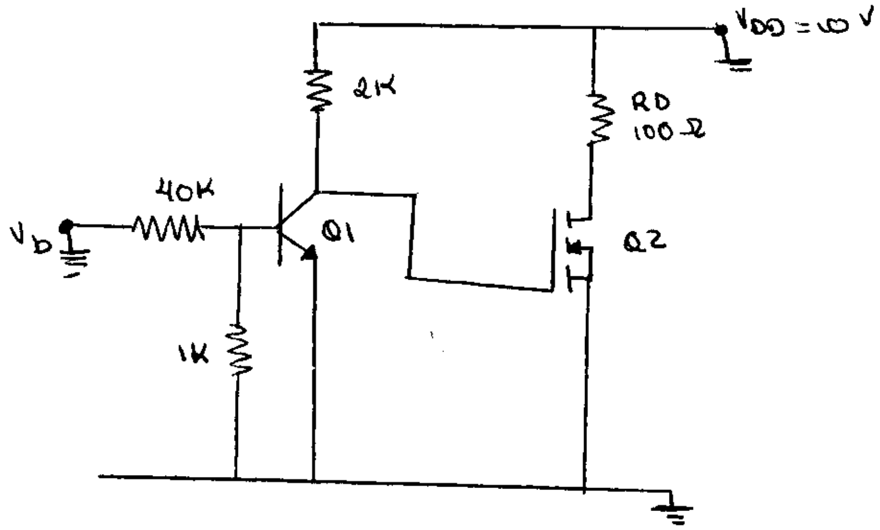
$$V_o\big|_{t=1ms} = V_{cc} - \frac{I_c \cdot t}{C} = 15 - \frac{4 \cdot 10^{-3} \cdot 10^{-3}}{10^{-6}} = 11V \quad (*)$$

$V_o\big|_{t=10ms} = 4\ V$ con el BJT saturado

(*) el condensador todavía se está cargando ⇒ todavía pasa corriente a traves de el

TRANSISTORES UNIPOLARES

Junio 94



BJT: $\beta = 50$, $V_{BE} = 0'7\ V$, $V_\gamma = 0'5\ V$, $V_{BESAT} = 0'8\ V$, $V_{CE\,SAT} = 0'2\ V$

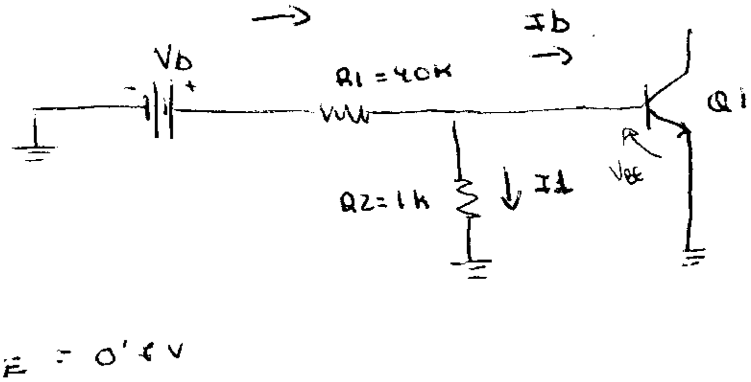
MOSFET: $K = 0'5\ mA/V$, $V_T = 3\ V$

a) Valor de V_B para el cual comienza a conducir Q2

$V_{BE} = 0'7\ V < V_{BESAT} = 0'8\ V \Rightarrow$ está en activa

- Q2 comienza ON $\Rightarrow V_{GS} = V_T = 3\ V = V_{CE}$
- Entonces : $I_C = \frac{10-3}{2} = 3'5\ mA$

$$I_B = \frac{I_C}{\beta} = \frac{3'5}{50} = 0'07\ mA$$



$V_{BE} = 0'7\ V$

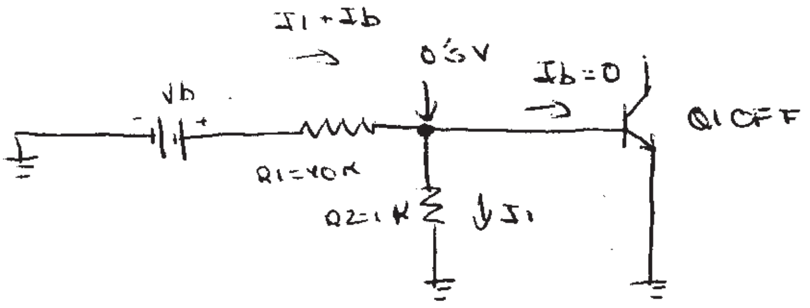
$I_1 = \frac{0'7}{1} = 0'7\ mA$

$I_1 + I_B = 0'7 + 0'07 = 0'77\ mA$

$V_b = 0'7 \cdot 1 + 0'77 \cdot 40 = 31'5\ V$

b) Valor de VB para el cual I_D es máximo

- I_D será máximo cuando Q1 esté en OFF
- Si Q1 en OFF ⇒ $V_{BE} = V_\gamma = 0'5\ V$



$V_b = 0'5 \cdot \frac{40+1}{1} = 20'5\ V$ (por Thevenin)

$= I_1 \cdot R_{eq} = \frac{V_\gamma}{R_2} \cdot (R_1 + R_2)$

c) Valores de V_{DS} en ambos casos

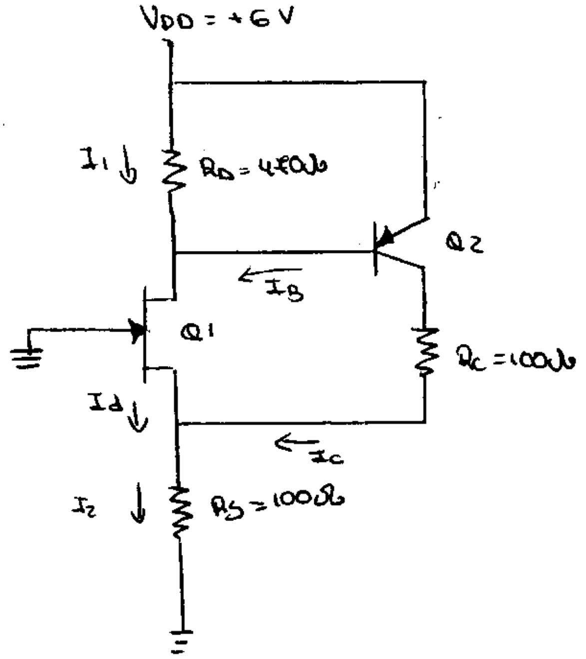
a) $V_{DS}\Big|_{I_D=0} = V_{DD} = 10\ V$ ✓ $Q_2 = OFF \Rightarrow V_{DS} = V_{DD} = 10V$.

b) $I_D = K(V_{GS} - V_T)^2 = 0'5 \cdot (10-3)^2 = 24'5\ mA$

$V_{DS} = \underbrace{10}_{V} - \underbrace{\underbrace{24,5}_{mA} \cdot \underbrace{0'1}_{K\Omega}}_{V} = 7'55\ V > V_{GS} - V_T = 10 - 3 = 7V \Rightarrow$ SAT

FEB 94 no, solo como teoría

Obtener los puntos de trabajo para los transistores BJT y JFET del circuito de la figura



$I_{DSS} = 4mA$

$V_P = +2V$

$\beta = 100$

$V_{BE} = -0'7V$

$I_D = I_{DSS}\left(1 - \left|\frac{V_{GS}}{V_P}\right|^2\right)$

$I_B \ll I_1$

$$I_1 = \frac{V_{EB}}{470} = 1'49\ mA \Big|_{I_b \ll I_1} = I_D$$

$$V_{GS} = V_P\left[1 - \sqrt{\frac{I_D}{I_{DSS}}}\right] = +2\left[1 - \sqrt{\frac{1,49}{4}}\right] = -0'78\ V$$ (tiene q ser negativo (<0))

$$I_2 = -\frac{V_{GS}}{100} = 7'8\ mA = I_D + I_C$$

$$I_C = I_2 - I_D = 7'8 - 1'49 = 6'31\ mA$$

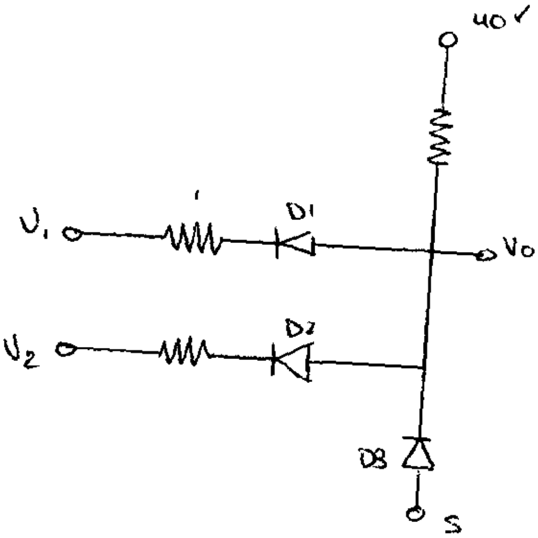
$$V_{EC} = 6 - 6'31 \cdot 0'1 + V_{GS} = 4'59\ V = -V_{CE} \Rightarrow V_{CE} = -4'59\ V$$

$$V_{DS} = (6 - 0'7) + V_{GS} = 4'52\ V$$

$$V_{DS} > V_{GS} - V_P = -0'78 + 2$$

13/4/07

15.



$R_f = 0$

$V_\gamma = 0'6\ V$

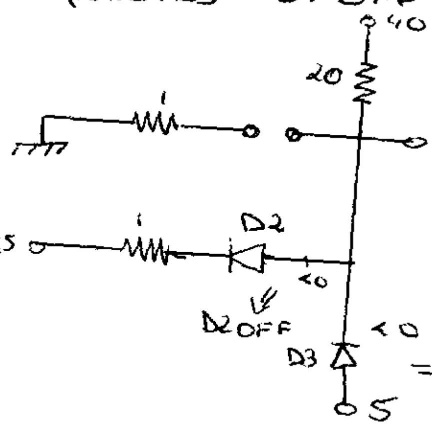
$R_r = \infty$

$V_{cond} = 0'7\ V$

a) $V_1 = 0$, $V_2 = 25\ V$

D1	D2	D3	
OFF	OFF	OFF	
OFF	OFF	ON	(*)
OFF	ON	OFF	
OFF	ON	ON	
ON	OFF	OFF	
ON	OFF	ON	(OK)
ON	ON	OFF	
ON	ON	ON	

Suponemos D1 OFF

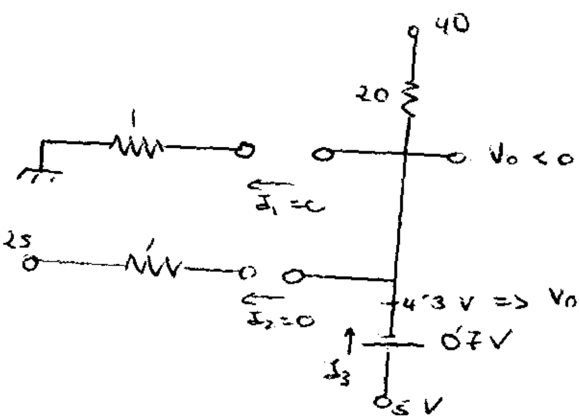


$\Rightarrow V_0 < 0$

$\Leftrightarrow$

$\Rightarrow$ D3 ON

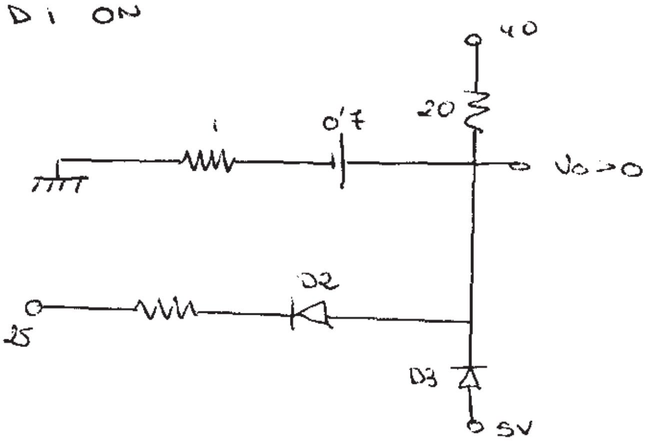
$\Leftrightarrow$



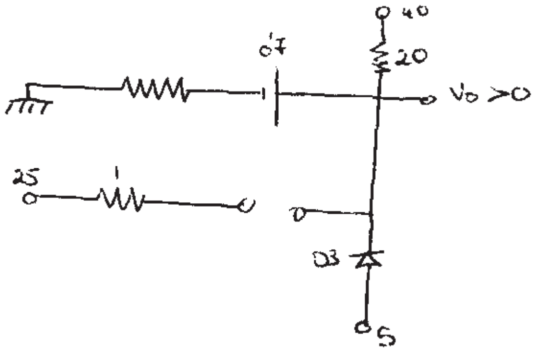
4'3 V $\Rightarrow V_0 = 4'3\ V$ (contradice $V_0 < 0 \Leftarrow$ D1 OFF

D1 OFF no puede ser)

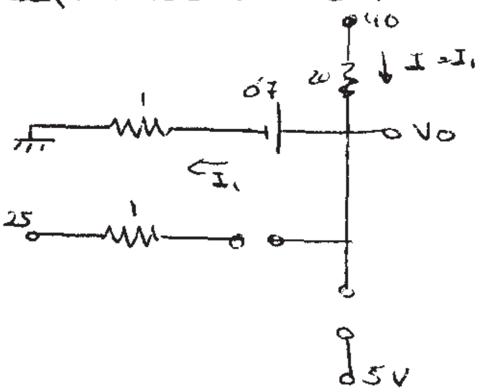
=> D1 ON



Suponemos D2 OFF



Suponemos D3 OFF



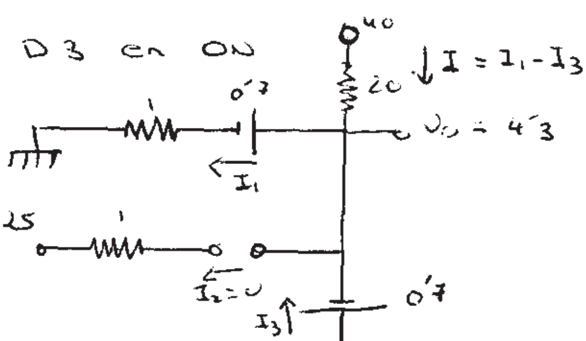
$$40 = 20 I_1 + 0'7 + 1 \cdot I_1 + 0$$

$$I_1 = \frac{40 - 0'7}{21} = 1'871 \text{ mA}$$

$$V_o = 40 - 20 \cdot I_1 = 40 - 20 \cdot 1'871 = 2'57 \text{ V}$$

=> Contradice que D3 no puede estar en OFF

=> D3 en ON



Cálculo de I_1, I_2, I_3

$4'3 = 0'7 + 1 \cdot I_1 + 0$

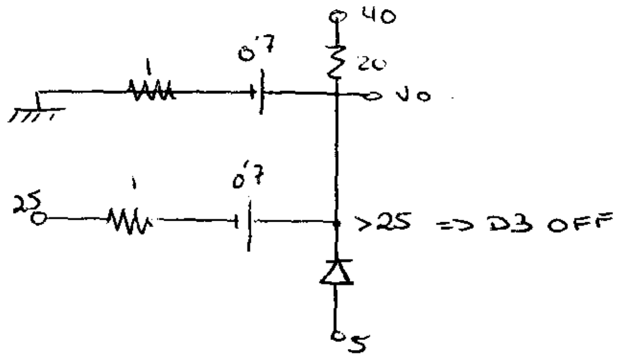
$\Rightarrow I_1 = 4'3 - 0'7 = 3'6 \text{ mA}$

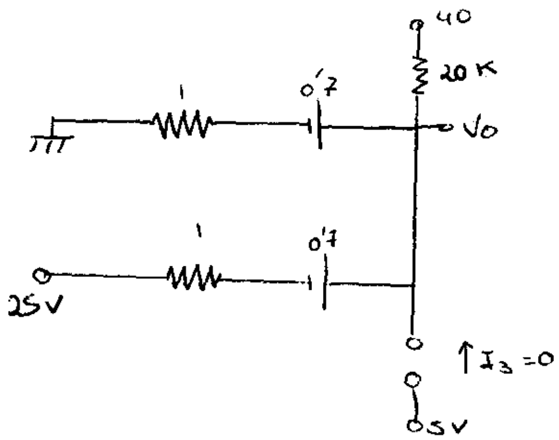
$40 = 20 \cdot (I_1 - I_3) + 4'3$

$$I_3 = \frac{40 - 4'3 - 20 I_1}{-20} = \frac{35'7 - 20 \cdot 3'6}{-20} = 1'815 \text{ mA}$$

$\Rightarrow I_1 > 0, I_3 > 0$ respetan D1 ON D3 ON $\Rightarrow$ (OK)

Que hubiese pasado si hubiesemos supuesto D2 ON





$$\begin{cases} 40 = 20(I_1 + I_2) + 0'7 + 1 I_1 + 0 \\ 40 = 20(I_1 + I_2) + 0'7 + 1 \cdot I_2 + 25 \end{cases}$$

$40 - 0'7 = 21 I_1 + 20 I_2 \iff I_1 = \dfrac{39'3 - 20 I_2}{21}$

$\downarrow$

$40 = 20 \left(\dfrac{39'3 - 20 I_2}{21} + I_2 \right) + 25'7 + I_2$

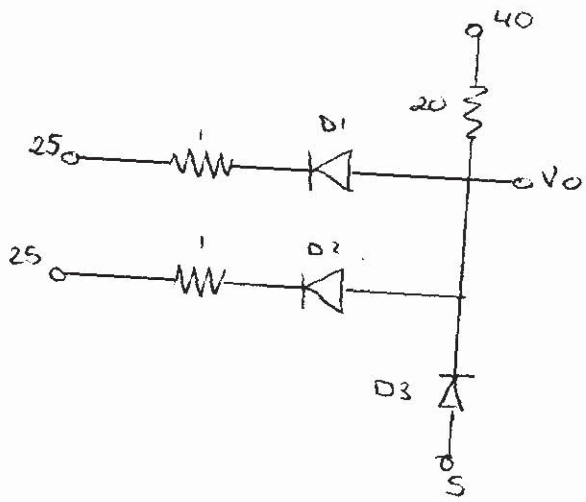
$40 - 25{,}7 = \dfrac{20}{21} 39{,}3 - 20 \cdot \dfrac{20}{21} I_2 + 20 I_2 + I_2$

$14'3 - \dfrac{20}{21} 39{,}3 = \left(-20 \dfrac{20}{21} + 21 \right) I_2$

$$2 \Rightarrow I_2 = \frac{\overbrace{14'3 - \frac{20}{21}\,38'3}^{<0}}{\underbrace{21 - \frac{20}{21}\cdot 20}_{>0}} < 0$$

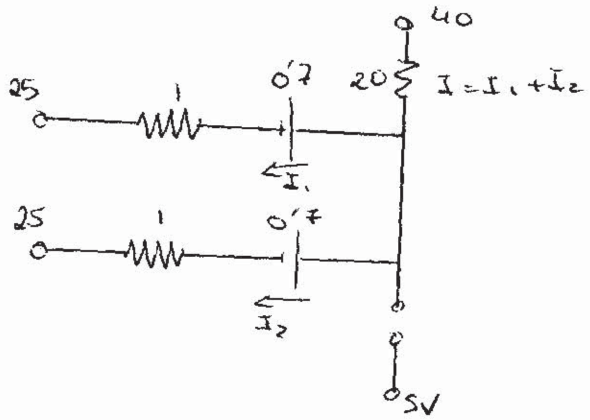
$I_2 < 0 \Rightarrow D_2$ no puede estar ON.

b) $V_1 = V_2 = 25\ V$



Suponemos D1 ON, D2 ON

$\Rightarrow V_o > 25 \Rightarrow D3$ OFF



$$\left.\begin{aligned} 40 &= 20(I_1 + I_2) + 0'7 + 1\cdot I_1 + 25 \\ 40 &= 20(I_1 + I_2) + 0'7 + 1\cdot I_2 + 25 \end{aligned}\right\}$$

$$\left.\begin{aligned} 40 - 25 - 0'7 &= 21 I_1 + 20 I_2 \\ 40 - 25 - 0'7 &= 21 I_2 + 20 I_1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 14'3 &= 21 I_1 + 20 I_2 \\ 14{,}3 &= 21 I_2 + 20 I_1 \end{aligned}\right\}$$

$$I_1 = \frac{14'3 - 20 I_2}{21}$$

$$\downarrow$$

$$14'3 = 21\, I_2 + 20\left(\frac{14'3 - 20 I_2}{21}\right)$$

$$21\cdot 14'3 = 21\cdot 21 I_2 + 20\cdot 14'3 - 20\cdot 20 I_2$$

$$I_2 = \frac{21\cdot 14'3 - 20\cdot 14'3}{21\cdot 21 - 20\cdot 20} = \frac{14'3}{41} =$$

$$\overset{*}{\Leftarrow} \quad = 0'35\ mA$$

$$\overset{*}{\Rightarrow} I_1 = 14'3 - 20\cdot\frac{14'3}{41} =$$

$$= \frac{14{,}3}{41} \quad (= I_2)$$

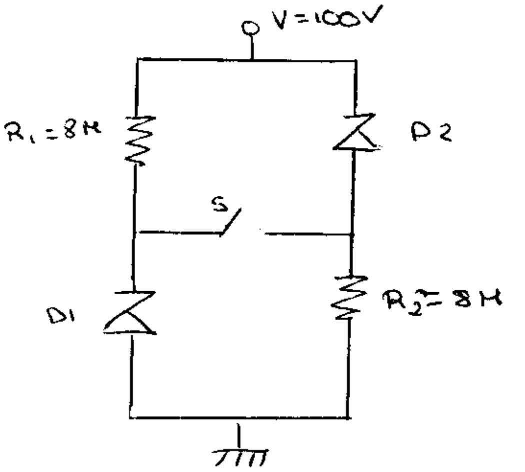
$$\Rightarrow V_o = 40 - 20(I_1 + I_2)$$

$$= 40 - 20\cdot 2\cdot\frac{14'3}{41} = 26V$$

(respeta D_1, D_2 ON)

(OK)

Junio 93



$V_{Z1} = 80V$

$V_{Z2} = 120V$

$I_{D1} = 1\mu A$

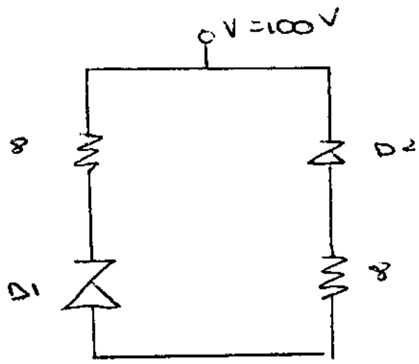
$I_{D2} = 2\mu A$

a) V, I en cada diodo (S abierto)

b) " " " " (S cerrado)

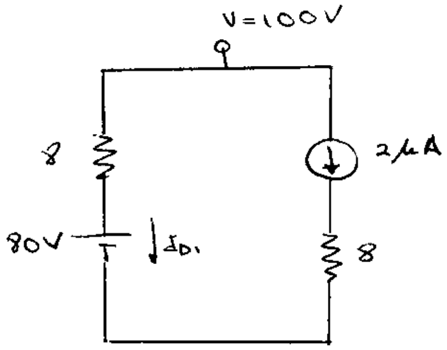
c) Con S cerrado, valor minimo de V para que D1 ruptura.

a)



Suponemos D1 zener

D2 OFF ($V=100 < V_{Z2}=120$)



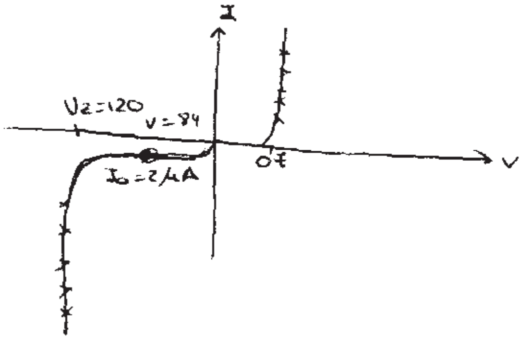
Cálculo de I_{D1} i I_{D2}

$100 = 8 \cdot I_{D1} + 80$

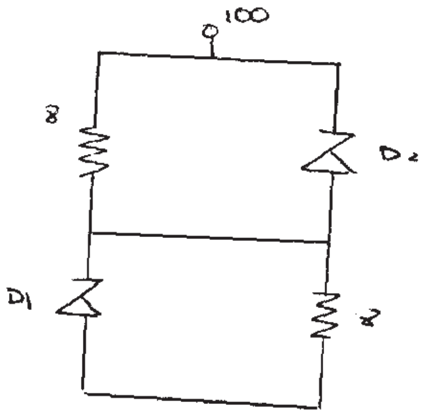
$\Leftrightarrow I_{D1} = \frac{100 - 80}{8} = \frac{20}{8} = 2'5 \mu A$

$I_{D2} = I_{o2} = 2 \mu A$

$100 = V_{D2} + 8 \cdot 2 \Leftrightarrow V_{D2} = 100 - 8 \cdot 2 = 84 V$

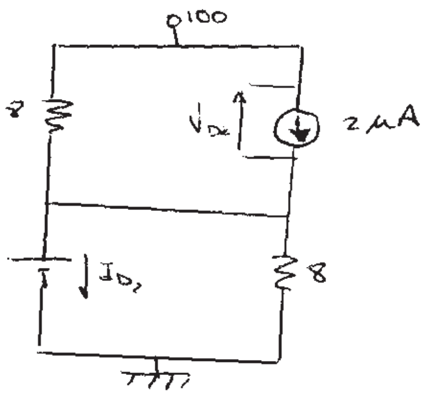


b)

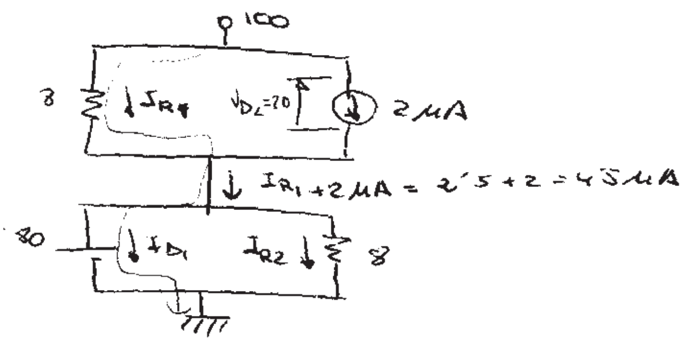


D2 OFF ($V_{Z2} = 120 > V = 100$)

Suponemos D1 zener:



$\Leftrightarrow$



$100 - I_{R1} \cdot 8 + 80 = 0$

$I_{R_2} = \frac{80}{8} = 10\mu A$

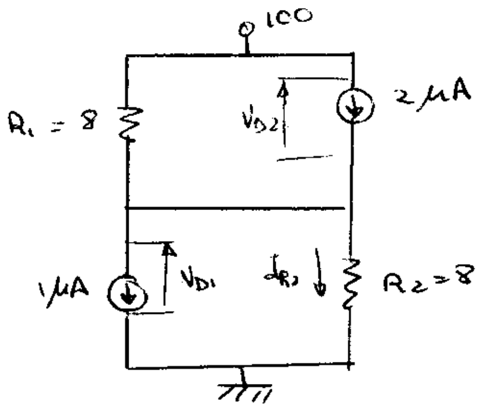
$I_{R_1} = \frac{100-80}{8} = 2'5\ \mu A$

$I_{R_1} + 2 = 4'5 = I_{D_1} + I_{R_2} = I_{D_1} + 10\mu A$

$I_{D_1} = 4'5 - 10 = -5'5\ mA$ (respeta NO Di zener)

$V_{D2} = 100 - 80 = 20V$ (respeta D2 OFF)

=> D1 OFF



$100 = 8 I_{R_1} + 8 I_{R_2}$ $\Big\{$ $100 = 8(I_{R_2} - 1) + 8 I_{R_2} <=>$

$I_{R_1} + 2 = 1 + I_{R_2}$. $\Big\{$ $I_{R_1} = I_{R_2} - 1$

$<=> 108 = 16 I_{R_2} <=> I_{R_2} = \frac{108}{16} = \frac{27}{4}\ (\mu A)$

$=> I_{R_1} = \frac{27}{4} - 1 = \frac{23}{4}\ (\mu A)$

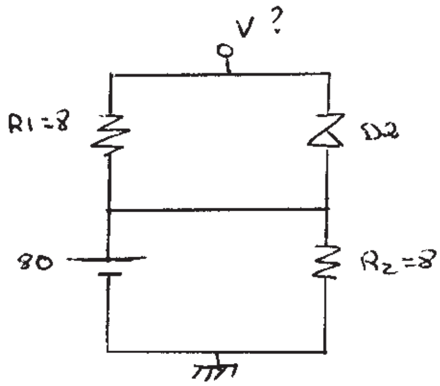
(>0, <80 : D1 OFF OK)

$=> V_{D_1} = V_{R2} = R_2 . I_{R_2} = 8 . \frac{27}{4} = 54 V$

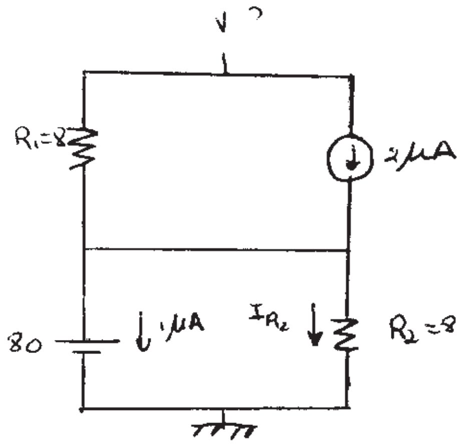
$=> V_{D2} = V_{R_1} = R_1 . I_{R_1} = 8 \cdot \frac{23}{4} = 46 V$

(>0, <120 para zener : D2 OFF OK)

c)



Suponemos D2 OFF



$I_{R_2} = \frac{80}{8} = 10\mu A$

Para V_{min} => se cumple aquello que implique D1 OFF ($\equiv I_{D_1} = I_{D_1} = 1\mu A$)

Como $I_{D_1} + I_{R_2} = I_{R_1} + I_{D_2}$

$1 + 10 = I_{R_1} + 2$

$I_{R_1} = 9\mu A$

$\Rightarrow V_{min} = V_{R_1} + V_{D_1} = 8 \cdot 9 + 80 = 152V$