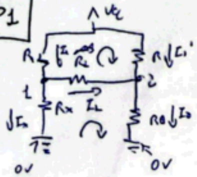
P1



$V_{cc} = 5V$

$R_1 = 18\ k\Omega$

$R_0 = 2'2\ k\Omega$

$R_x = 0'3\ k\Omega$

$R_L = 100\ k\Omega$

I_L ?

Con Kirchoff

$$\cancel{I_T = I_x + I_2} \qquad \cancel{I_L + I' = I_0}$$

$$\left.\begin{array}{l} I_1 = I_x + I_L \\ I_L + I' = I_0 \end{array}\right\} \rightarrow \frac{V_{cc} - V_1}{R_1} = \frac{V_1 - 0}{R_x} + \frac{V_1 - V_2}{R_L} \rightarrow V_1\left(\frac{1}{R_1} + \frac{1}{R_x} + \frac{1}{R_L}\right) - \frac{V_2}{R_L} = \frac{V_{cc}}{R_1}$$

$$\rightarrow \frac{V_1 - V_2}{R_L} + \frac{V_{cc} - V_2}{R_1} = \frac{V_2 - 0}{R_0} \rightarrow -\frac{V_1}{R_L} + V_2\left(\frac{1}{R_1} + \frac{1}{R_0} + \frac{1}{R_L}\right) = \frac{V_{cc}}{R_1}$$

Sustituimos y calculamos

$$\frac{V_{cc}}{R_1} = \frac{5V}{18\ k\Omega} = 0'2778\ mA$$

$$1/R_L = 1/100\ k\Omega = 0'01\ k\Omega^{-1}$$

$$\left(\frac{1}{R_1} + \frac{1}{R_x} + \frac{1}{R_L}\right) = \frac{1}{18} + \frac{1}{2'3} + \frac{1}{100} = 0'46556\ k\Omega^{-1}$$

$$\left(\frac{1}{R_1} + \frac{1}{R_0} + \frac{1}{R_L}\right) = \frac{1}{18} + \frac{1}{2'2} + \frac{1}{100} = 0'5201\ k\Omega$$

$$\rightarrow \left.\begin{array}{l} 0'4656 \cdot V_1 - 0'01 V_2 = 0'2778 \\ -0'01 V_1 + 0'5201 V_2 = 0'2778 \end{array}\right\}$$

$V_1 = 0'60837\ V$

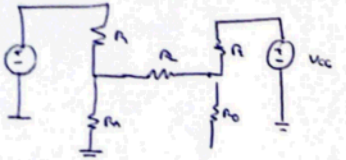
$V_2 = 0'54578\ V$

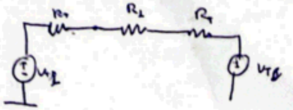
$$I_L = \frac{V_1 - V_2}{R_L} = \frac{0'60837 - 0'54578}{100\ k\Omega} =$$

$$\boxed{I_L = 0'6259\ \mu A}$$

Con thevenin

2=





$V_1 = V_{CC}\dfrac{R_2}{R_1+R_2} = V_{T1}$ $\qquad$ $V_2 = V_{CC}\dfrac{R_D}{R_1+R_D} = V_{T2}$

$$V_{T1} = \frac{5 \cdot 2.5\ k\Omega}{(18+2.5)\,k\Omega} = 0.60976\ V$$

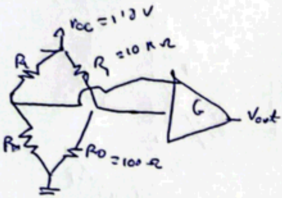
$$V_{T2} = \frac{5V \cdot 2.2\ k\Omega}{18\ k\Omega + 2.2\ k\Omega} = 0.54455\ V$$

$$R_{T1} = R_1 \parallel R_2 \quad \frac{R_1 R_2}{R_1+R_2} = \frac{18 \times 2.5}{18+2.5} = 2.19512\ k\Omega$$

$$R_2 = R_1 \parallel R_D = \frac{R_1 R_D}{R_1+R_D} = \frac{18 \times 2.2}{18+2.2} = 1.96039\ k\Omega$$

$$I_2 = \frac{V_{T1} - V_{T2}}{R_{T1}+R_2+R_{T2}} = \frac{0.60976 - 0.54455}{(2.19512+100+1.96039)} = 0.626\ \mu A$$

$\boxed{P2}$



$R = (100 + 0'39 \cdot 08\theta - 5'8 \cdot 10^{-5}\,\theta^2)\ \Omega$

$\theta \in [0, 280°C]$

$P_{Rx} < 10\,\mu W$

G para $v_0 \in [0, 2'5\ V]$

$v_0 = G\,(v_1 - v_2)$

$v_1 = V_{cc} \dfrac{R_x}{R_1 + R_x}$ $\left[v_2 = \dfrac{V_{cc} \cdot R_0}{R_1 + R_0} = \dfrac{5V \cdot 100\,\Omega}{(10000 + 100)\,\Omega} = 0'017822\ V \right]$

R_x a $0°C \rightarrow R_x = 100\,\Omega \rightarrow V_1 = 0'017822\ V$

R_x a $280°C = 204'9\,\Omega \rightarrow V_1 = \dfrac{1'8 \cdot 204'9\,\Omega}{[10000 + 204'9]} = 0'03641\ V$

$0'017822\ V \leq V_1 \leq 0'03641\ V$

$\theta = 280°C \rightarrow V_0 = 2'5 = G\,(0'03641 - 0'017822) \rightarrow \boxed{G = 134'96}$

*

$P_{Rx} = V_{Rx} \cdot I_{Rx} = V_1 \cdot \dfrac{V_1}{R_x} = \dfrac{V_1^2}{R_x} = \dfrac{V_{cc}^2 \cdot R_x^2}{(R_1 + R_x)^2 \cdot R_x} = \dfrac{V_{cc}^2 \cdot R_x}{(R_1 + R_x)^2}$

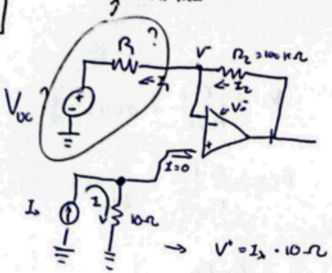
sustituimos y calculamos

$P_{Rx} = \dfrac{1'8^2 \cdot 204'9}{(10000 + 204'9)^2} = 6'375\,\mu W$

Uso para equivalencia de Thevenin

~~Podría Thevenin~~

P3



$4mA \leq I_x \leq 20mA$

$0 < V_o \leq 5V$

$\boxed{V^+ = V^-}$

$\rightarrow V^+ = I_x \cdot 10\Omega$

$I_2 = I_1 \rightarrow \dfrac{V_o - V^-}{R_2} = \dfrac{V^- - V_{oc}}{R_1} \rightarrow$ Despejamos V_o

$$V_o = V^- + \frac{R_2}{R_1}\left(V^- - V_{oc}\right) = V^- \cdot \left(1 + \frac{R_2}{R_1}\right) - V_{oc}\frac{R_2}{R_1}$$

Sustituyendo ahora $V^+ = V^- = I_x \cdot 10\Omega$ en la expresión anterior

$$\hookrightarrow V_o = I_x \cdot 10\Omega\left(1 + \frac{R_2}{R_1}\right) - V_{oc}\frac{R_2}{R_1}$$

V_o

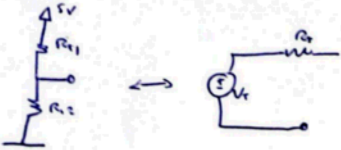
Aplicamos las condiciones $I_x = 4mA \rightarrow V_o = 0$ y la otra

$$\left.\begin{aligned} 0 &= 4mA \cdot 10\Omega\left(1 + \frac{100k\Omega}{R_1}\right) - V_{oc}\frac{100k\Omega}{R_1} \\ 5 &= 20mA \cdot 10\Omega\left(1 + \frac{100k\Omega}{R_1}\right) - V_{oc}\frac{100k\Omega}{R_1} \end{aligned}\right\}$$ Solucionamos el sistema de ec

~~R = ...kΩ~~

$$\boxed{\begin{aligned} R_1 &= 3306 \\ V_{oc} &= 0{,}0413\ V \end{aligned}}$$?

2) Equivalente de Thevenin



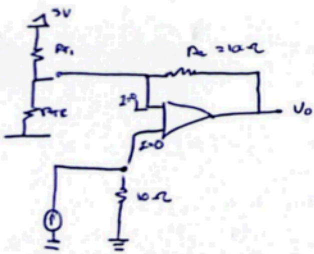
$$V_T = 5\,\frac{R_{T2}}{R_1+R_2} = 0'0413$$

$$R_T = \frac{R_1 R_{T2}}{R_{T1}+R_{T2}} = 3306$$

Dividiendo ambas expresiones

$$\frac{3306}{0'0413} = \frac{\dfrac{R_{T1}R_{T2}}{R_{T1}+R_{T2}}}{5V\,\dfrac{R_{T2}}{R_{T1}+R_{T2}}} = \frac{R_{T1}}{5V}$$

$R_{T1} = 400.24\ k\Omega \rightarrow R_{T2} = 3333\ \Omega$ el circuito queda



P4

$V_{cc} = 5V$ $\quad 500\,\Omega < R_x < 600\,\Omega$

$R_1 = 10\,000\,\Omega$

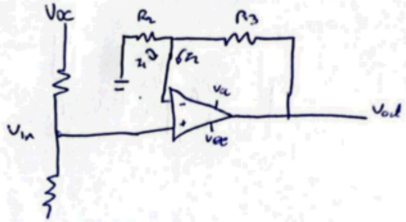
$R_2 = 2200\,\Omega$

$R_3 = 100\,000\,\Omega$

a) Vmin Vol

b) R_x p Vol = 5

c) R_x max?



a)

Calcul $v_{in} = V_{oc} \cdot \frac{R_x}{R_1 + R_x}$ $\begin{cases} V_{in}\ min = 5 \cdot \frac{500}{10000+500} = 0'2381\ V \\ V_{in}\ max = 5\ \frac{600}{10000+600} = 0'2830\ V \end{cases}$

$I_1 = I_2$

$$\frac{V^- - V_{in}}{R_2} = \frac{V^- - V_{out}}{R_3} \rightarrow V_{out} = \frac{R_3}{R_2} V_{in}$$

$V_{out}\ min = \frac{100\,000}{2200} = 8'5034\ V$

$V_{out}\ max = \frac{100000}{2200} = 10'103\ V$

b)

R_x per $V_{out} = 5 \rightarrow V_{in} \rightarrow V_{in} = V_{oc} \cdot \frac{R_x}{R_1 + R_x}$

$V_{in} = \frac{R_2}{R_3} \cdot V_{out} = \frac{2200}{100000} \cdot 5 = 0'11\ V$

$V_{in} = V_{oc} \cdot \frac{R_x}{R_1 + R_x} \rightarrow R_x = \frac{V_1(R_1 + R_x)}{V_{oc}} \Rightarrow V_1 R_1 + V_1 R_x = V_{oc} R_x$

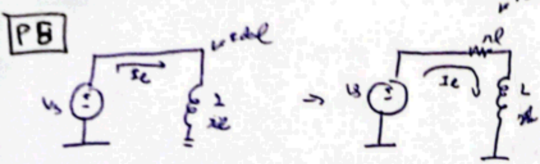
$\Rightarrow V_1 R_1 = V_{oc} R_x - V_1 R_x \rightarrow R_x = \frac{V_1 R_1}{(V_{oc} - V_1)} = \frac{0'11 \cdot 10\,000}{(5 - 0'11)} = 225\ \Omega$

c) $V_{sal} = V_{cc} \rightarrow V_m = \dfrac{2800 \cdot 15}{100000} = 0'42$

$$R_x = \frac{V_1 R_1}{(V_{cc} + V_1)} = \frac{0'42 \cdot 100\,000}{(5 - 0'42)} = 917'\,\Omega$$

PB

r no ideal, hay [illegible] en la L falta de [illegible]



$L = 300\,mH \quad r_L = 1\,\Omega \quad i_L(0) = 0 \quad V_S = 12\,V$ en $t > 0$

$i_L(\infty)$ $\quad$ t para $i_L = \frac{95}{100} i_L$

Aplicando malla $\rightarrow V_S = V_{rL} + V_L = i_L \cdot r_L + L \cdot \frac{di_L}{dt}$

$i_L(\infty) \longrightarrow \frac{V_S}{r_L} = \frac{12}{1\,\Omega} = 12\,A$

$\frac{V_S}{r_L} = \underbrace{\left(\frac{L}{r_L}\right)}_{\tau} \frac{di_L}{dt} + i_L \longrightarrow 12\,A = \tau \frac{di_L}{dt} + i_L$

$i_L(t) = 12\,A\left(1 - e^{-t/\tau}\right) \qquad \tau = \frac{0'3\,H}{0'1} = 0'3\,s$

[illegible] al 95% de la [illegible] y [illegible]

$0'95 \cdot 12\,A = 12\,A\left(1 - e^{-t/0'3}\right) \longrightarrow t$

$e^{-t/0'3} = 0'05 \rightarrow t = -0'35 \cdot \ln(0'6) \simeq \boxed{0'9\,s = t}$

$$\boxed{P_{pared} = i_L^2\, r_L = 12^2 A \cdot 1 = 144\,W}$$

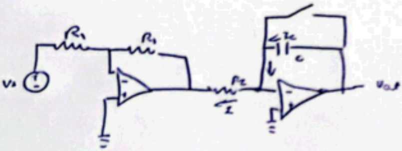
$\boxed{P6}$

Abre $\in [0, t_p)$ → $t_p = 10\,ms$, se cierra cada 10 ms y se vuelve a abrir cada 10 ms, regularmente

$V_s = 1\,V$

$R_2 = 10\,k\Omega$

$C = 100\,nF$



$$\frac{V_s - 0}{R_1} = \frac{0 - V_{o1}}{R_1} \Rightarrow V_{o1} = -V_s \;;\; V_{o1} = -1V$$

→ S_1 → está cerrado → $V_o = V^-$ → $V_o = 0V$ → $V_c = 0$

→ S_1 → está abierto → $I_c = I$ → $I = \frac{0 - V_{o1}}{R_2} = \frac{1}{10} = 0'1\,mA$

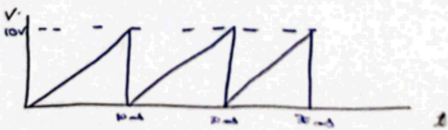
$$I_c = C \cdot \frac{dV_c}{dt} = cte$$

$$\frac{dV_c}{dt} = \frac{0'1}{C} \;;\; \int_0^{V_c(t)} dV_c = \frac{1}{C} \cdot \int_0^t 0'1\,mA\,dt$$

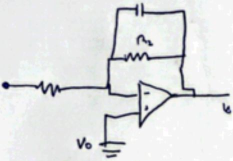
$$V_c(t) = \frac{10^{-4}}{100 \cdot 10^{-9}} \cdot t = 10^3\,\frac{V}{s} \cdot t$$

$t = t_p = 10\,ms$

$$\Rightarrow V_c(t) = 10^3 \cdot 10 \cdot 10^{-3} = 10\,V$$



P7



$R_1 = 10\ k\Omega$

$R_2 = 47\ k\Omega$

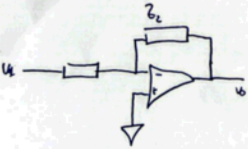
$C = 33\ nF$

Vo en función de Vi?

Diagrama de Bode?

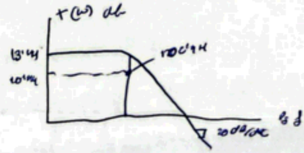
$$\frac{1}{Z_2} = \frac{1}{R_2} + \frac{1}{\frac{1}{j\omega C}} = \frac{1}{R_2} + j\omega C = \frac{1 + j\omega C R_2}{R_2} = \frac{1}{Z_2}$$

$$\boxed{Z_2 = \frac{R_2}{1 + j\omega C R_2}}$$



$Z_1 = R_1$

$$Z_2 = R_2 \parallel \left(\frac{1}{j\omega C}\right) = \frac{R_2 \cdot \frac{1}{j\omega C}}{R_2 + \frac{1}{j\omega C}} = \frac{R_2}{j\omega C R_2 + 1}$$



$V^+ = 0 \rightarrow V^- = 0$

$$I_2 = I_1 \Rightarrow \frac{V_0 - 0}{Z_2} = \frac{0 - V_i}{Z_1} \rightarrow \frac{V_0}{V_i} = -\frac{Z_2}{Z_1}$$

Sacar T(ω) para Bode

$$\Rightarrow T(\omega) = \frac{V_0}{V_i} = -\frac{Z_2}{Z_1} = -\frac{\frac{R_2}{j\omega C R_2 + 1}}{R_1} = \frac{-R_2/R_1}{1 + j\omega R_2 C}$$

$R_2/R_1 = 4.7$

Tomamos $T_0 = -4.7$

$R_2 C = 47 \cdot 10^3 \cdot 33 \cdot 10^{-9}\ F = 1.551\ \mu s$

$\omega R_2 C = 2\pi f \cdot R_2 C = f/f_c$

$$T(\omega) = \frac{T_0}{1 + j f/f_c}$$

$$f_c = \frac{1}{2\pi R_2 C} = \frac{f}{2\pi \cdot 1.551\ \mu s} = 102.6\ Hz$$

$$T\omega = \frac{T_0}{\sqrt{1 + (f/f_c)^2}} \angle 180 - \tan^{-1}(f/f_c)$$

fase del numerador que al ser negativo es $-180°$ y la del real y menos la del denominador

si $f \rightarrow 0 \Rightarrow T(\omega) = |T_0| \cdot \angle 180°$

si $f = f_c \rightarrow \frac{T_0}{\sqrt{2}} \angle 180 - 45°$

si $f \rightarrow \infty \Rightarrow \frac{|T_0|}{f/f_c} \angle 180 - 90°$