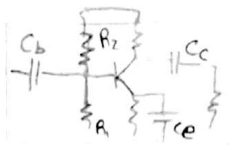


Repuesta en Frecuencia.

$$\overline{A}_V = \frac{R'c}{r'e + RE_1}$$

$R'c$ ↗ Rc(CA)

RE_1 ↳ si R_E no tiene capa en //

$R'c = Rc // RL$

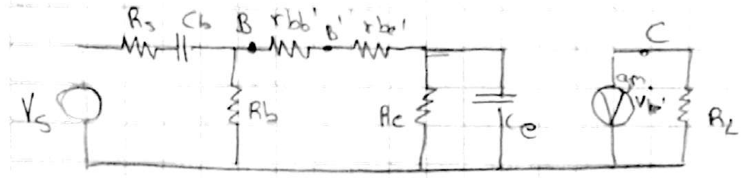
$r'e = \dfrac{25mV}{I_E}$

$V_{BB} = V_{cc}\,\dfrac{R_1}{R_1 + R_2}$

$V_E = V_{BB} - 0{,}7$

$I_E = \dfrac{V_E}{R_E}$

Baja Frecuencia



$rbb' = rx \simeq 10 \text{ a } 50\,\Omega$

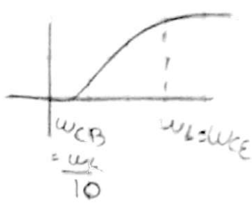
$rbe' = r_\pi = r'e \cdot \beta = \dfrac{h_{fe}}{g_m}$

Determinado por C_E

Ce = abierto

$$\boxed{f_L = \frac{1}{2\pi \cdot Req_1 \cdot Ce}}$$

$$Req_1 = Re \,//\left[\frac{(rbb' + rbe') + (Rs // Rb)}{hfe + 1}\right]$$



Cb = corto

$$W_{CB} = \frac{W_L}{10} = \frac{1}{Req_2 \cdot C_B}$$

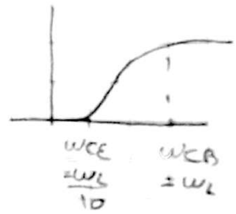
$$Req_2 = (Rs + Rb) // \left[rbb' + rbe' + Re(hfe + 1)\right]$$

Determinado por CB

Ce = cable (corto)

$$\boxed{f_L = \frac{1}{2\pi \cdot Req_1 \cdot CB}}$$

$$Req_1 = (Rs + Rb) // (rbb' + rbe')$$



Cb = abierto

$$W_{CE} = \frac{W_L}{10} = \frac{1}{Req_2 \cdot Ce}$$

$$Req_2 = Re // \left[\frac{rbb' + rbe' + Rb}{hfe + 1}\right]$$

Circ. RC de entrada

$$f_L = f_{C_1(entr)} = \frac{1}{2\pi \cdot Rent \cdot C_b}$$

C_b ↳ C del emisor

$$Rent = R_1 // R_2 // \left[\beta\,(r'e + R_E)\right]$$

R_E ↳ si R_E no tiene C en //

Circ RC de salida

$$f_{C_2(sal)} = \frac{1}{2\pi (Rc + R_L) C_c}$$

C_c ↳ C de acoplamiento

Circ. RC de punteo

$$f_{C_3\,(punt)} = \frac{1}{2\pi (Rent_E // R_E) C_E}$$

C_E ↳ C de punteo

$Rent_E = r'e + \dfrac{R_{umbral}}{\beta}$

$R_{umbral} = R_s // R_1 // R_2$

Alta Frecuencia

Teorema de miller

$$C_{ent} = C_{bc}(A_v+1)$$

$$C_{sal} = C_{bc}\left(\frac{A_v+1}{A_v}\right) \simeq C_{bc}$$

$$\omega_T = \frac{g_m}{C_\pi + C_\mu}$$

$$C_{bc} = C_\mu$$

$$C_{be} = C_\pi = \frac{g_m}{\omega_T}$$

$$g_m = 40\, I_E$$

Circ. RC de entrada

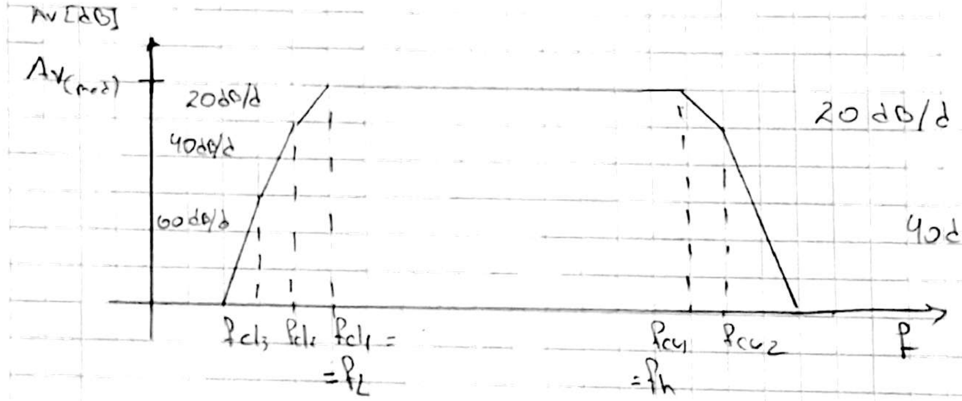
$$f_h = f_{cu_1(ent)} = \frac{1}{2\pi \cdot R_{ent(t)} \cdot C_{ent(t)}}$$

$$R_{ent(t)} = R_1 \| R_2 \| R_s \| \beta r'_e$$

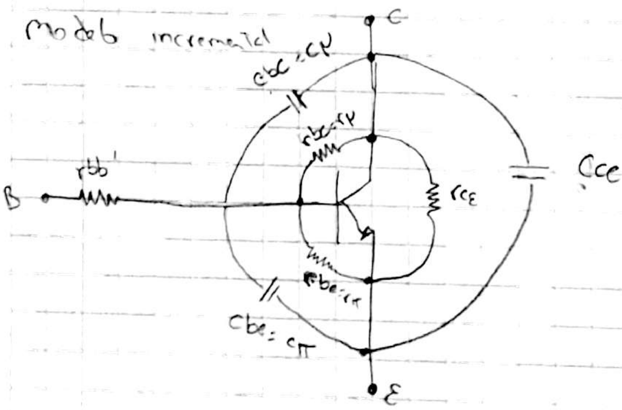
$$C_{ent(t)} = C_{ent} + C_{be}$$

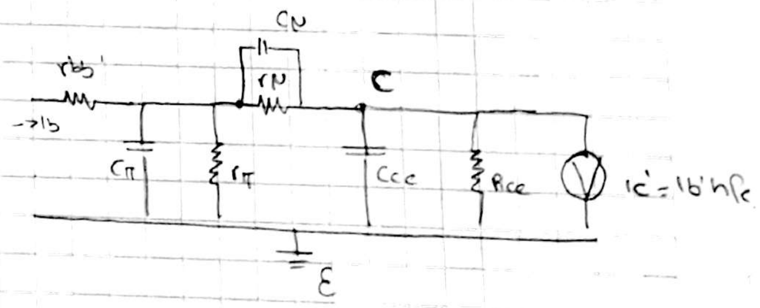
Circ. Rc de salida

$$f_{cu_2(sal)} = \frac{1}{2\pi \cdot R'_c \cdot C_{sal}}$$



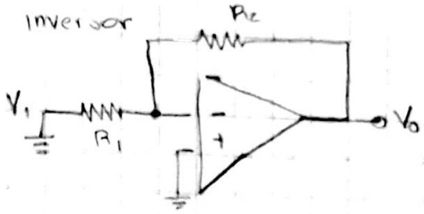
Modelo incremental





Amplificadores Operacionales

No inversor



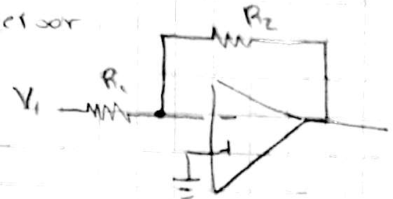
$$A_v = \frac{R_2}{R_1} + 1$$

Genera a

$$V_o = V_1\left(\frac{R_2}{R_1} + 1\right)$$

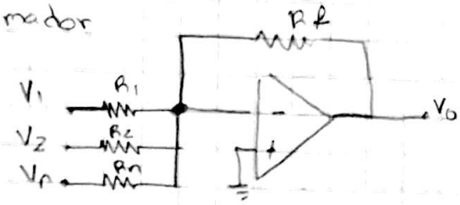
$$Z_i = \infty$$

Inversor



$$A_v = -\frac{R_2}{R_1} \qquad V_o = -V_{in}\frac{R_2}{R_1} \qquad Z_i = R_1$$

Sumador

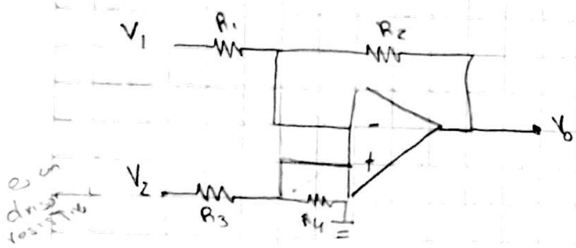


$$V_o = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \dots \frac{V_n}{R_n}\right)$$

$Z_1 = R_1$ $Z_2 = R_2$ $Z_n = R_n$

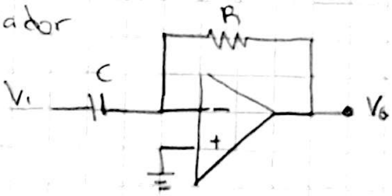
Si $R_1 = R_2 = R_f$
$V_o = -(V_1 + V_2 + V_n)$

Restador (diferencial)



$$V_o = \left(1 + \frac{R_2}{R_1}\right) \cdot \left(\frac{R_4}{R_3 + R_4}\right) V_2 - \left(\frac{R_2}{R_1}\right) V_1$$

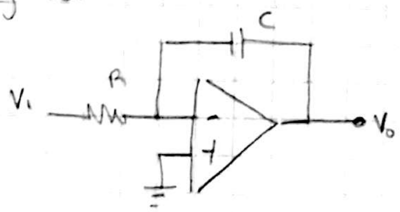
Derivador



Triangular a cuadrada

$$V_o = -R \cdot C\left(\frac{dV_1}{dt}\right)$$

Integrador

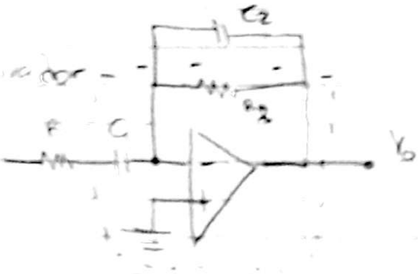


$$V_o = \left[-\frac{V_1}{R \cdot C}\int_0^{t/2} dt + V(t_0)\right]$$

cuadrada a triang

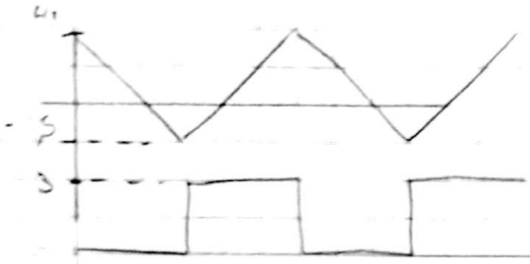
Análisis de integración y derivación (práctico)

Derivador



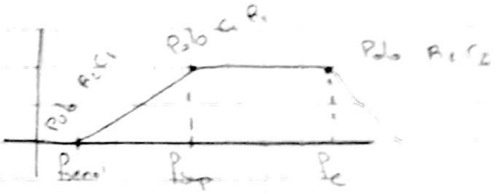
$V_0 = -R_2 C_1 \frac{dV_1}{dt}$

Datos:
$f = 4{,}3k$
$V_{op} = 1{,}5V$ ($V_{opp} = 3V$)
precisión = 99%



Primer rampa $\Rightarrow V_1 = at \pm b = 150000t - 1{,}95$

$\therefore \frac{dV_1}{dt} = 150000$



1) Si $\boxed{C_1 = 100p}$ $V_{op} = 1{,}5$

$R_2 = \frac{V_0}{C_1} \frac{1}{dV_1/dt} = 100k \rightarrow \boxed{R_2 = 100k\Omega}$

2) P/ precisión = 99%

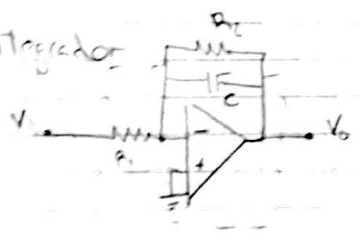
$f_{(sup)} = 10 . f_{señal}$ (década mayor) $\rightarrow \boxed{f_{sup} = 43k}$

$f_{sup} = \frac{1}{2\pi . R_1 C_1} \rightarrow R_1 = \frac{1}{2\pi\, C_1 . f_{sup}} = 37k \rightarrow \boxed{R_1 = 37k\Omega}$

3) Si $f_{corte} = 45k$

$f_c = \frac{1}{2\pi\, R_2 C_2} \rightarrow C_2 = \frac{1}{2\pi\, R_2\, f_c} = 35p \rightarrow \boxed{C_2 = 35pF}$

Integrador



$V_0 = \frac{-V_1}{R_1 . C} \int_0^{T/2} dt$

Datos:
$f = 4{,}3k$
$V_{opp} = 5{,}5V$
$V_{1pp} = 2{,}5V$

$T = 232{,}56\ \mu seg$

1) Si $A_{v(un)} = 1$ $\boxed{C = 1\mu}$

$A_v = \frac{T}{2 . R_1 C} \rightarrow R_1 = \frac{T}{2 C A_v} = 100 \rightarrow \boxed{R_1 = 100\Omega}$

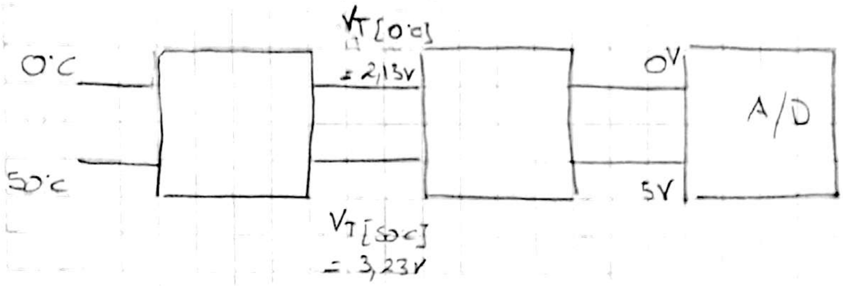
2) P/ precisión 99%

$f_{inf} = \frac{f}{10} \rightarrow \boxed{f_{inf} = 430}$

Si $f_{(inf)} A_{v(inf)} = A_{v(un)}\, f \rightarrow A_{v(inf)} = \frac{A_{v(un)}\, f}{f_{(inf)}} = 10$

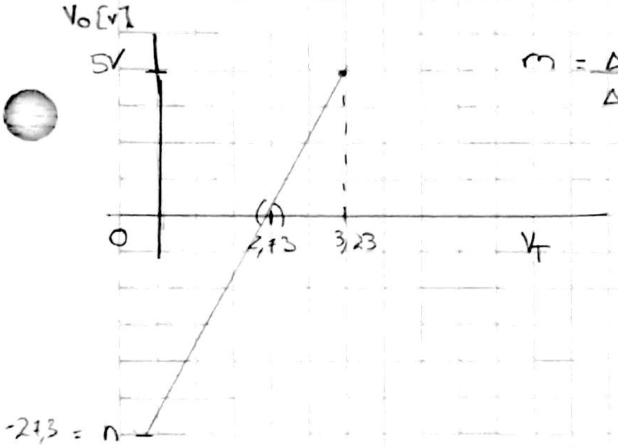
$A_{v(inf)} = \frac{R_2}{R_1} \rightarrow R_2 = A_{v(inf)}\, R_1 \rightarrow \boxed{R_2 = 1{,}1k\Omega}$

CAS



$$V_{T[°K]} = \frac{10mV}{°K} \cdot temp\ °K$$

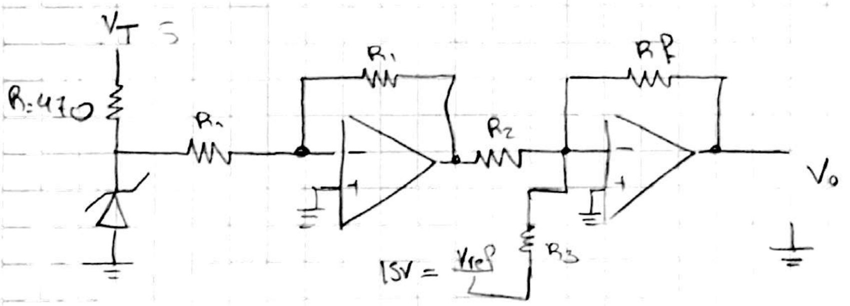
$$V_{T[°C]} = \frac{10mV}{°C} \cdot tem\ °C + 2{,}73V$$



$$m = \frac{\Delta Y}{\Delta X} = \frac{0-5}{2{,}73-3{,}23} = 10 \quad \therefore \quad y = mx+n$$

$$0 = 10 \cdot 2{,}73 + n \rightarrow \underline{n = -27{,}3V}$$

$$\therefore V_O = \underbrace{10 \cdot V_T}_{\text{Amplifique}} - \underbrace{27{,}3V}_{\text{desplaze (offset)}}$$



$$V_O = \left(-\frac{R_1}{R_1}\right) \cdot \overbrace{\left(-\frac{Rf}{R_2}\right)}^{=10} \cdot V_T - Vref \cdot \left(\frac{Rf}{R_3}\right)$$

Si $R_1 = 10k$, $Rf = 100k$

$$\frac{Rf}{R_2} = 10 \rightarrow R_2 = \frac{Rf}{10} = 10k$$

$$\frac{Rf}{R_3} Vref = 27{,}3 \rightarrow R_3 = \frac{Rf\ Vref}{27{,}3} = 54{,}94k$$

$$V_{O[0°C]} = 0V$$

$$V_{O[50°C]} = 5V$$