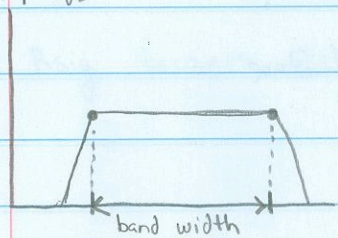
respuesta de freq 22/Enero/2013

$|A|_{dB}$ Magnitude Bode Plot



$$A_{dB} = 20 \log A$$

funcion de transf. $A(s) = A_0 \dfrac{\prod_{i=1}^{n} (s + W_{zi})}{\prod_{j=1}^{m} (s + W_{pj})}$

$\boxed{\text{ganancia calc. electronica I}}$

$W_{pj} \rightarrow$ poles

$W_{zi} \rightarrow$ zeroes

$$A_{dB}(s) = A_{o\,dB} + \sum_{i=1}^{n} |s + w_{zi}| - \sum_{j=1}^{m} |s + w_{pj}|$$

$|s + w_{pj}|$ = magnitude of $s + w_{pj}$

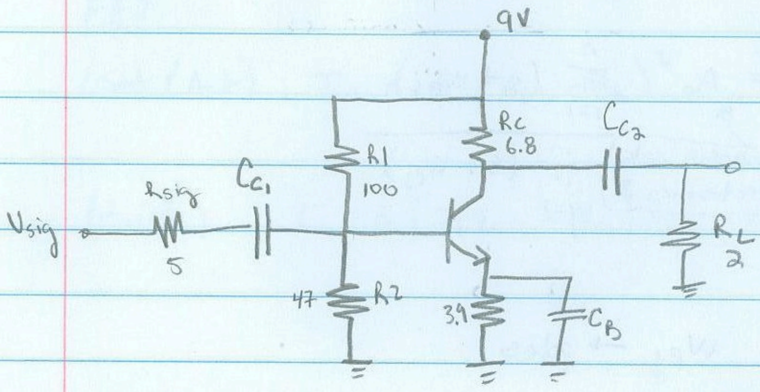
$$s = jw$$

$$|s + w_{pj}| = \sqrt{w^2 + w_{pj}^2}$$

poles $\longrightarrow$ -20 dB/dec $= -6$ dB/octave

zeroes $\longrightarrow$ $+20$ dB/dec $= +6$ dB/octave

Example - amp from class 1 but single stage



all R's are expressed in kΩ

$$A_v = \frac{V_o}{V_s} = \frac{-g_m \, R_c \| R_L}{1 + g_m R_e} \; \frac{R_b'}{R_{sig} + R_b'}$$

$$R_b' = 100 \| 47 \| [r_\pi + (\beta+1) R_e]$$

4201

w/o C_B

Simplified proc: consider 1 cap at a time; others are shorts

- Take C_{C1} into account and let the other external caps be short.

- R_{sig} becomes $Z_{sig} = R_{sig} + \frac{1}{sC_{C1}} = \frac{sC_{C1}R_{sig} + 1}{sC_{C1}}$

$$= R_{sig}\,\frac{s + 1/R_{sig}C_{C1}}{s}$$

- $A(s) = -g_m (R_C \| R_L)\,\frac{R'_b}{Z_{sig} + R'_b}$; $R'_b = 100 \| 47 \| r_\pi$

short in C_E makes $R_e \to 0$

Sustituyendo: $A(s) = -g_m (R_C \| R_L)\,\frac{R'_b}{R_{sig}\frac{s + \frac{1}{R_{sig}C_{C1}}}{s} + R'_b}$

$$A(s) = -g_m (R_C \| R_L)\,\frac{sR'_b}{s[R_{sig} + R'_b] + \frac{1}{C_{C1}}}$$

// Aislando la parte q tiene que ver con freq.

Zero at origin

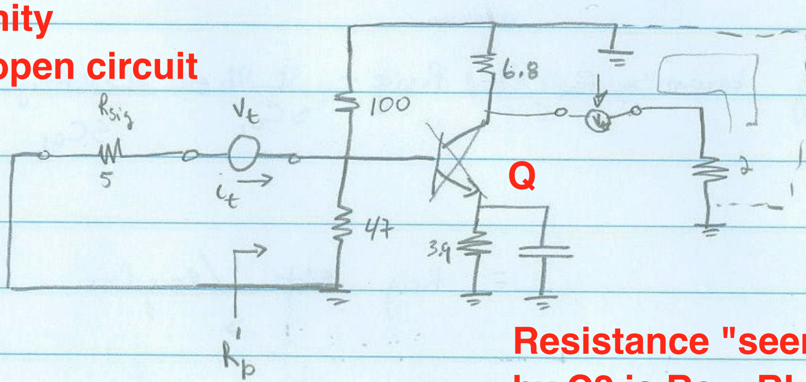
$$A(s) = \boxed{-g_m (R_C \| R_L)\,\frac{R'_b}{R_{sig} + R'_b}}\;\frac{s}{s + \frac{1}{C_{C1}(R_{sig} + R'_b)}}$$

$\leftarrow \omega_p$

midband gain

Otra forma con resistenuia equivalente:

ro = infinity
Q is an open circuit



Resistance "seen" by C2 is Rc + RL

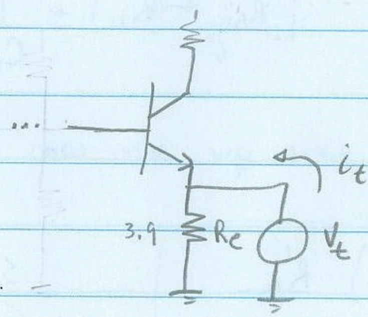
// El condensador de bypass es un poco más complicado:

Resultado es:

Electronica I → $A_{MB} \dfrac{s + W_z}{s + W_p}$; $W_z = \dfrac{1}{C_B\, R_e}$; $W_p = \dfrac{1}{C_B\, R_{eq}}$

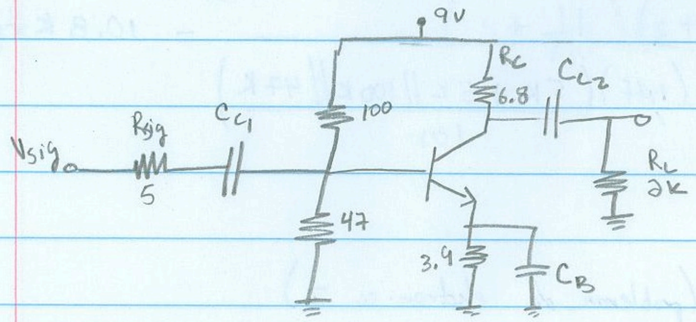
Amb = midband gain = gain calc. in 4201

R_{eq} = equivalent resistant seen from the terminals where C_B is connected.



$$R_{eq} = R_e \,\Big\|\, \frac{r_\pi + R_{Beq}}{\beta+1}$$

$$= R_e \,\Big\|\, \left[\frac{1}{g_m} + \frac{R_{Beq}}{\beta+1}\right]$$



All R's are in kΩ

I) Find low-freq poles and zeroes if $C_{C1} = C_{C2} = C_B = 1\mu F$

$\underline{C_{C1}}$

Zero at origin

$$\omega_{p_1} = \frac{1}{(1\mu F)(5 + 100\|47\|5\ k\Omega)} \approx 100 \text{ rps}$$

$\underline{C_{C2}}$

zero at origin

$$\omega_{p_2} = \frac{1}{(1\mu F)(6.8K + 2k)} = 11.4 \text{ rps}$$

$\underline{C_B}$

zero at $\omega_z = \dfrac{1}{(1\mu F)(3.9k\Omega)} = 256$ rps

pole at $\omega_{p3} = \dfrac{1}{(1\mu F)\left(\dfrac{5k + 5k \| 100k \| 47k}{101}\right)} = 10.8k$ rps

(2) Find $A_{\text{mid Band}}$ (problema de electronica I)

(3) Write an expression for $A(s)$

(2) $A_{mid} = -g_m R_c' \dfrac{R_b'}{r_\pi + R_b'}$

$R_c' = R_c \| R_L = 6.8K \| 2K = 1.55K$

$R_b' = 5K \| 47k \| 100K = 4.3K.$

$g_m = 20 \dfrac{mA}{V}$ (resultado anterior)

$$A_{mid} = -20\ \frac{mA}{V}\ (1.55\ K)\left(\frac{4.3K}{9.3K}\right) = -14.3\ \frac{V}{V}$$

(3)

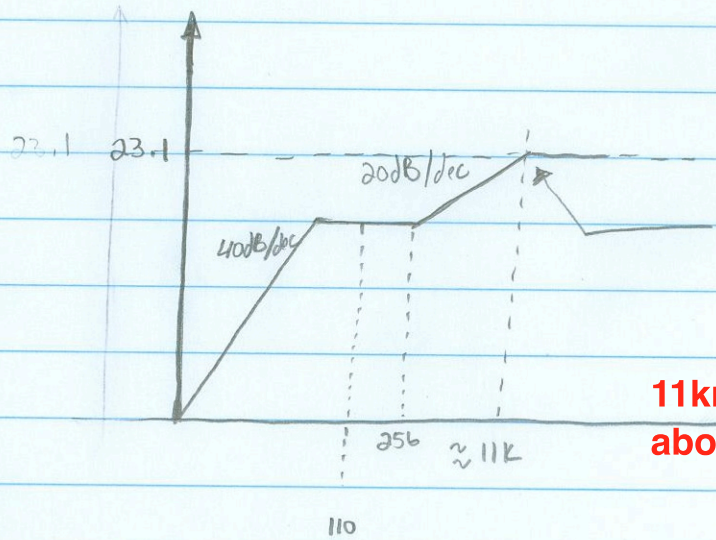
$$A(s) = \left(-14.3\ \frac{V}{V}\right)\frac{s^2\left(s+\frac{1}{256}\right)}{\left(s+\frac{1}{100}\right)\left(s+\frac{1}{114}\right)\underbrace{\left(s+\frac{1}{10.8K}\right)}_{\approx(11K)}}$$

Este es el dominante porque esta a freq más baja

Rule of thump: if a pole is a decade or more above other low freq poles it is dominant. The -3dB freq. is approx. equal to the pole freq.

It's more that a decade above other poles

(4) sketch the Magnitude Bode plot



effective low-freq pole at 11 Krps

11krps: over 2 dec above other poles/zeroes

If no pole is dominant: effective pole = feff =∑poles - ∑zeroes (this is one way to estimate feff; there are other ways)

(5) Select the caps so that $\omega_{eff} \approx 1$ krps

Do for homework:

Hint: make bypass cap pole dominant; select other poles so that they are 1-2 decades below