Elektronik II

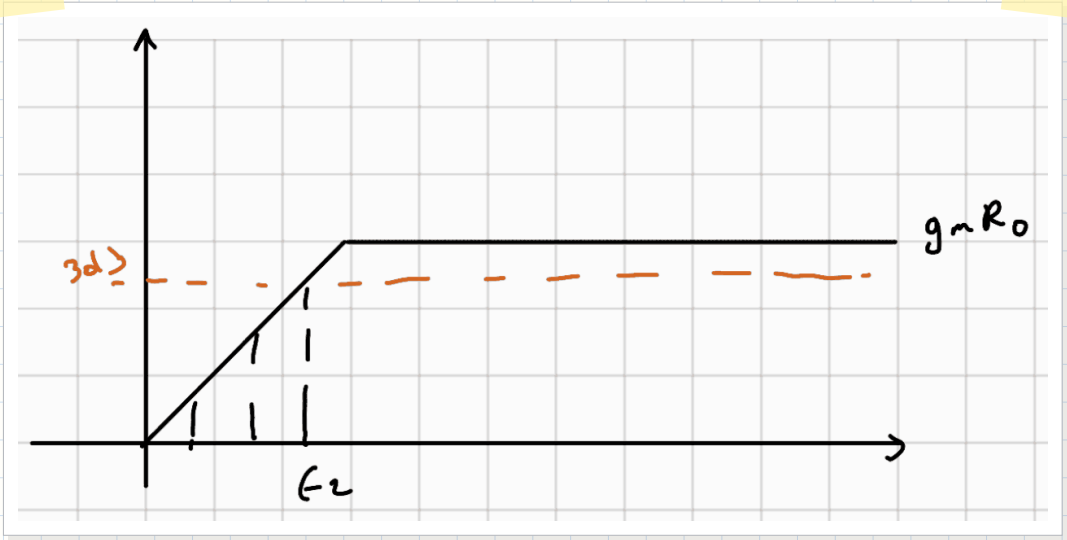
BJT yükselteç: alçak ve yüksek frekans cevabı

Original notes: Ders10.pdf

UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

NOTICE *This document was transcribed from handwritten lecture notes with the help of Claude (Anthropic). It is meant as a supplementary resource and may contain errors or omissions. Always check against the original notes and official course material.*

orig. p. 1



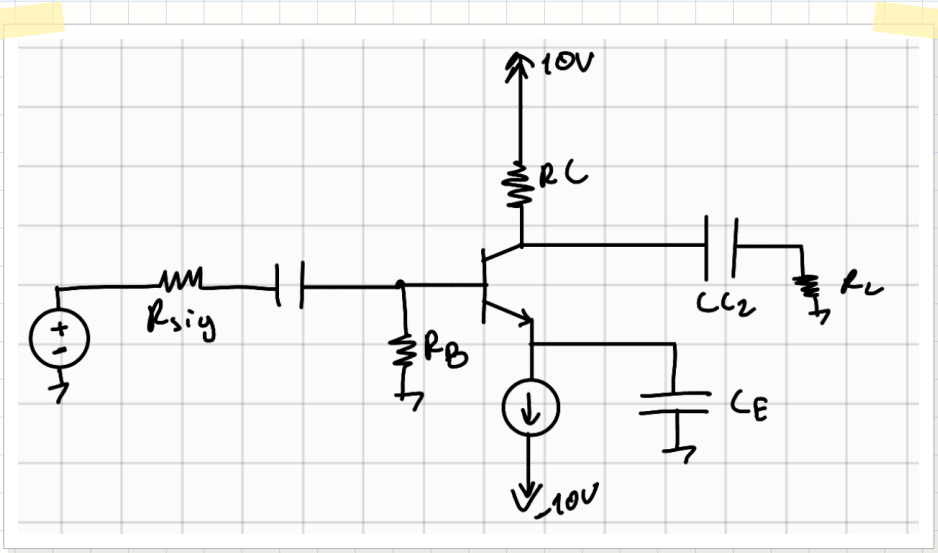
original drawing, p. 1

$$\tau_1 = R_1 C_1$$

çok küçük $\quad \tau_2 = R_2 C_2$

$$\tau_3 = R_3 C_3$$

↗ f_2 çok büyük $\qquad \frac{1}{2\pi RC} \downarrow \Uparrow$



original drawing, p. 1

Example

Calculate the time constants for all poles at low frequency and estimate f_L. Calculate A_M =?

$I = 1\,mA$ $\beta = 100$

$R_B = 100\,k\Omega$ $V_A = 100\,V$

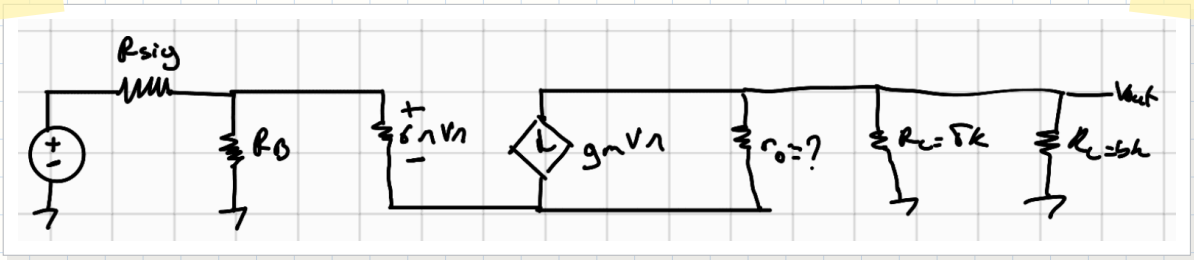
$R_C = 8\,k\Omega$ $C_{C1} = C_{C2} = C_E = 1\,\mu F$

$R_{sig} = 5\,k\Omega$

$R_L = 5\,k\Omega$

orig. p. 2

for mid band gain



original drawing, p. 2

$$g_m = \frac{I_E}{V_T} = \frac{1\,mA}{25\,mA^{1}} = 40\,mS$$

$$r_e = \frac{1}{g_m} \simeq 25\,\Omega$$

$$r_\pi = 25\,\Omega \times 101 = 2{,}5\,k\Omega$$

$$r_o = \frac{V_A}{I_C} = \frac{100}{1} = 100\,k\Omega$$

$$\frac{v_{out}}{v_{sig}} = \frac{v_{out}}{v_\pi} \cdot \frac{v_\pi}{v_{sig}}$$

$$v_{out} = -g_m v_\pi (r_o \parallel R_C \parallel R_L)$$

$$\frac{v_{out}}{v_\pi} = -40\,(2{,}91)$$

$$\frac{v_{out}}{v_\pi} = -116{,}5$$

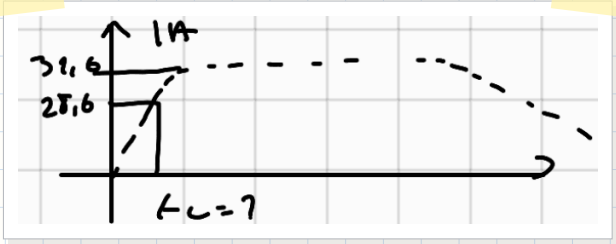
$$v_\pi = v_{sig} \frac{(R_B \parallel r_\pi)}{R_{sig} + (R_B \parallel r_\pi)}$$

$$= \frac{2{,}43}{7{,}43} v_{sig}$$

$$\frac{v_\pi}{v_{sig}} = \frac{2{,}43}{7{,}43} = 0{,}32$$

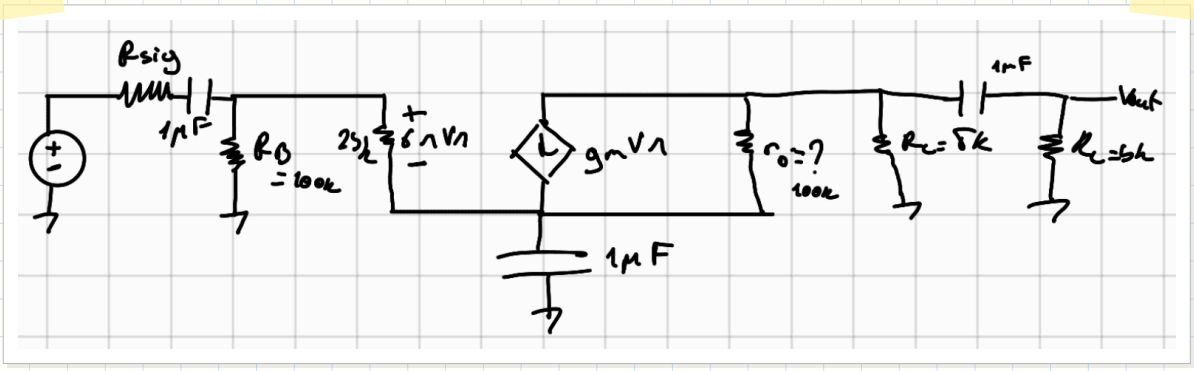
$$\frac{v_{out}}{v_{sig}} = -116{,}5 \times 0{,}32 = -38{,}1\ [V/V]$$

$$= 31{,}6\ dB$$



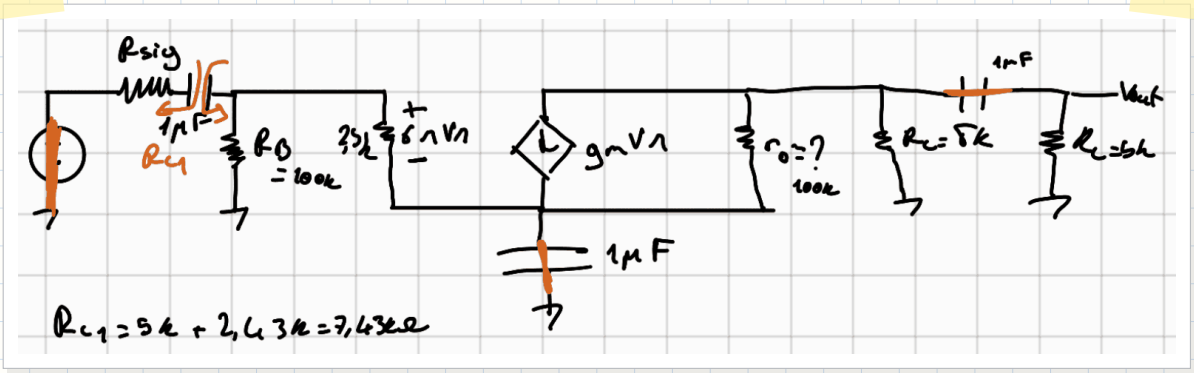
original drawing, p. 2

orig. p. 3



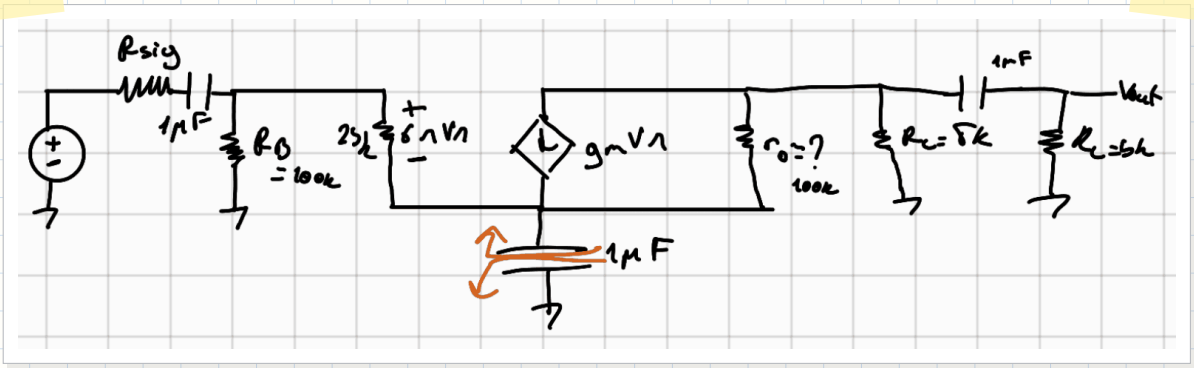
original drawing, p. 3

[1] Claude notu: muhtemelen 25 mV olmalı.



original drawing, p. 3

$$R_{C1} = 5k + 2{,}43k = 7{,}43\,k\Omega$$
$$\tau_1 = R_{C1} C_{C1} = 7{,}43\,k\Omega \cdot 1\,\mu F$$
$$\tau_1 = 7{,}43\,msec$$



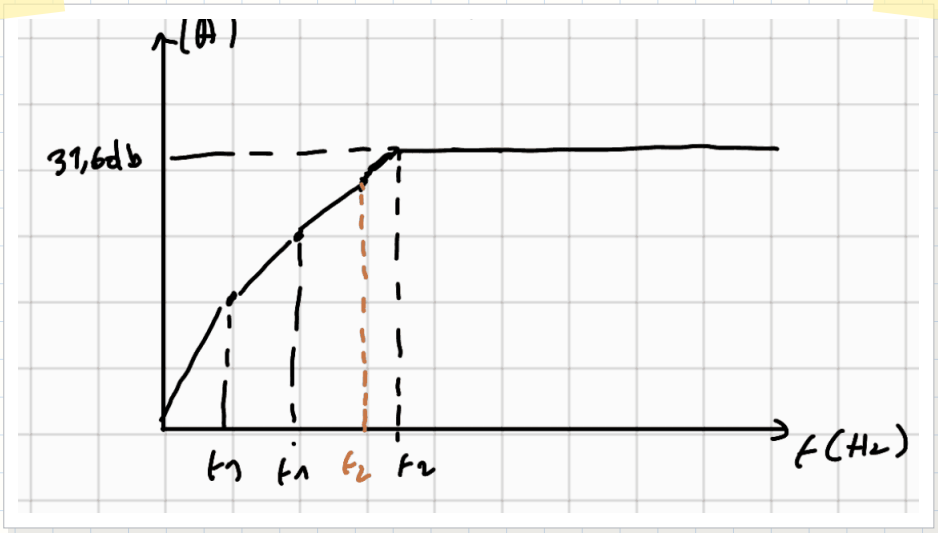
original drawing, p. 3

$$R_E = \frac{2{,}5k + 4{,}76}{101} \simeq 72$$
$$\tau_2 = R_E C_E = 72\,\Omega \times 1\,\mu F = 72\,\mu s$$

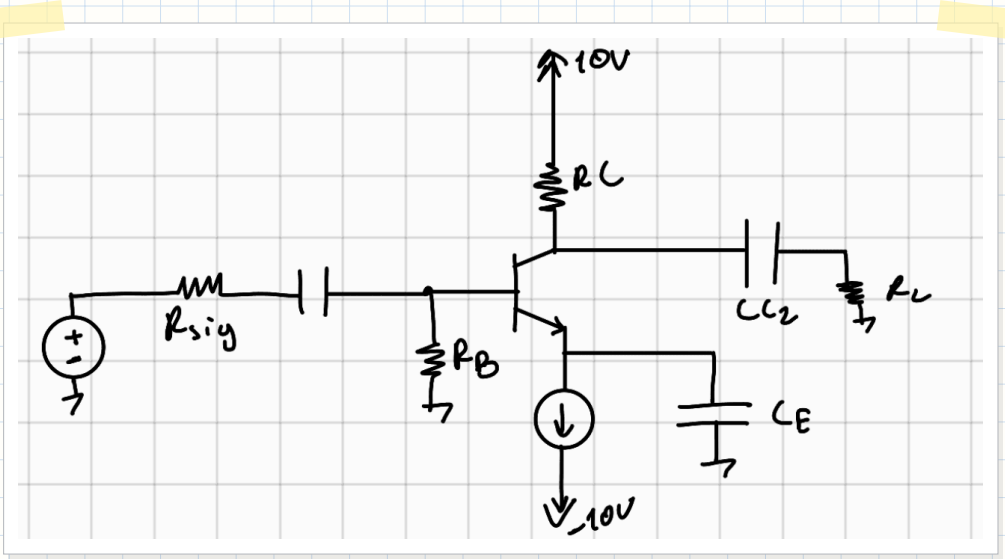
$$\tau_3 = R_{C2} C_{C2}$$
$$R_{C2} = 5k + 7{,}4 = 12{,}4\,k\Omega$$
$$\tau_3 = 12{,}4\,k\Omega \times 1\,\mu F = 12{,}4\,msec$$
$$f_1 = \frac{1}{2\pi\tau_1} = \frac{1}{2\pi \cdot 7{,}43} \simeq 21\,Hz$$
$$f_2 = \frac{1}{2\pi\tau_2} = \frac{1}{2\pi \cdot 72\,\mu sec} \simeq 2{,}2\,kHz$$

orig. p. 4

$$f_3 = \frac{1}{2\pi\tau_3} = \frac{1}{2\pi \cdot 12{,}4\,msec} \simeq 12{,}8\,Hz$$



original drawing, p. 4



original drawing, p. 4

Example

Calculate the time constants for all poles at high frequency and estimate f_L. Calculate A_m =?

$I = 1\,mA$ $\quad$ $\beta = 100$

$R_B = 100\,k\Omega$ $\quad$ $V_A = 100\,V$

$R_C = 8\,k\Omega$ $\quad$ $C_{C1} = C_{C2} = C_E = 1\,\mu F$

$R_{sig} = 5\,k\Omega$ $\quad$ $f_T = 800\,MHz$

$R_L = 5\,k\Omega$ $\quad$ $r_x = 30\,\Omega$

$C_\mu = 1\,pF$

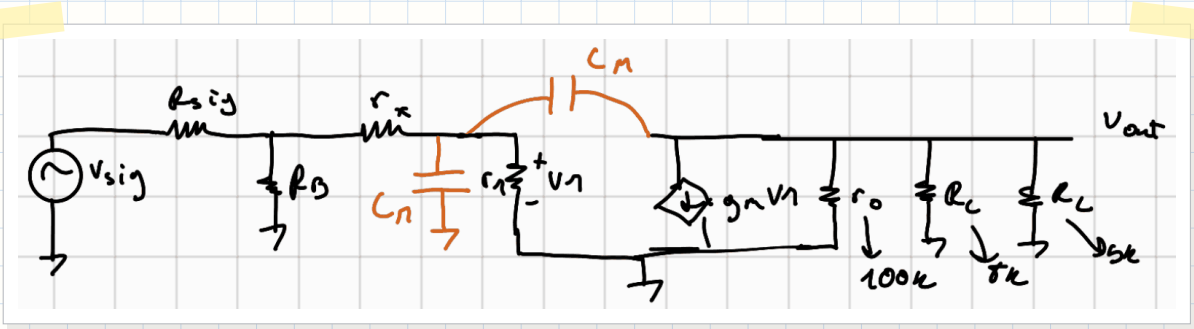
$g_m = \frac{I_C}{V_T}$

$$f_T = \frac{g_m}{2\pi(C_\mu + C_\pi)} = \frac{40\,mS}{2\pi(1\,pF + C_\pi)} = 800 \cdot 10^6$$

orig. p. 5

$$\underline{40 \cdot 10^{-3}} = 1600\pi \cdot 10^{-6} + 1600\pi \cdot 10^6\, C_\pi$$

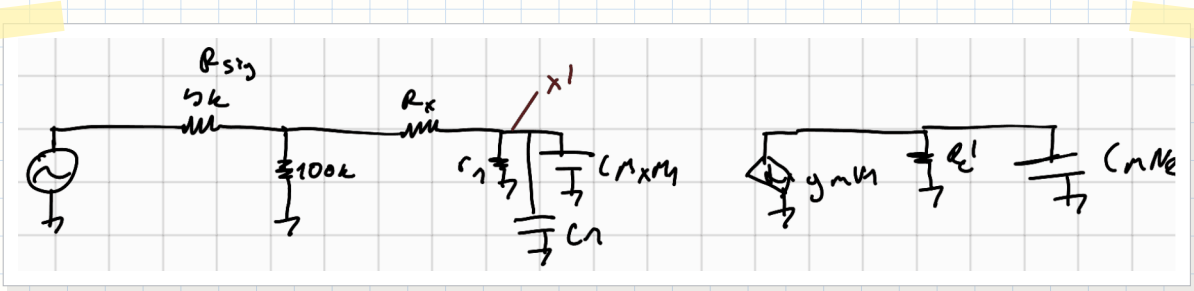
$$C_\pi = 6{,}95\,pF$$



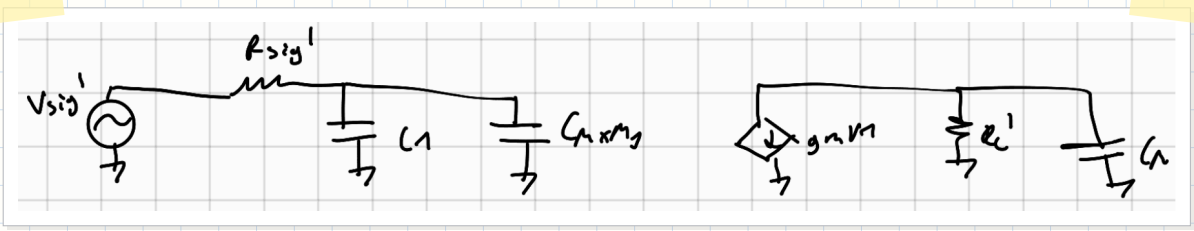
original drawing, p. 5

$$f_T = \frac{g_m}{2\pi(C_\mu + C_\pi)}$$

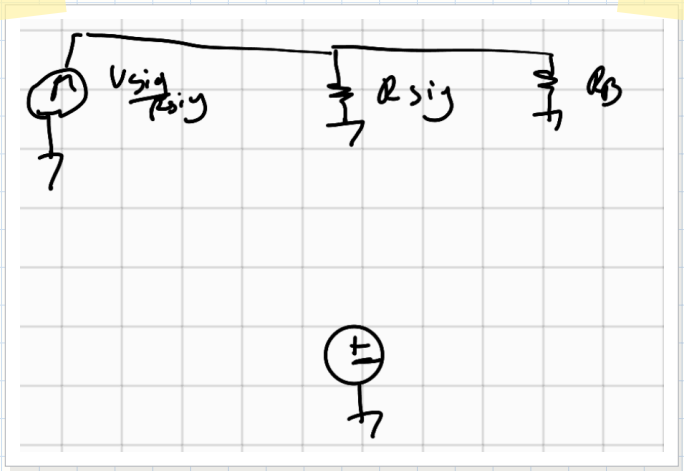
$$\Rightarrow C_\pi = 6{,}95\,\text{pF}$$



original drawing, p. 5

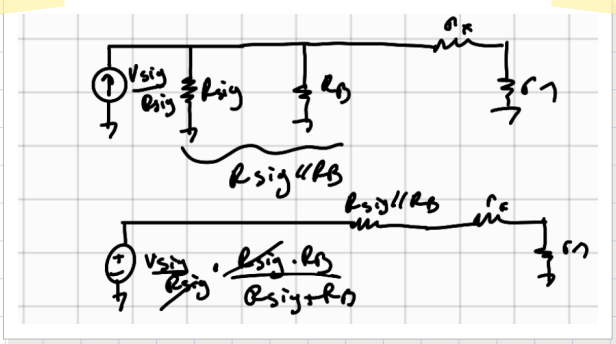


original drawing, p. 5



original drawing, p. 5

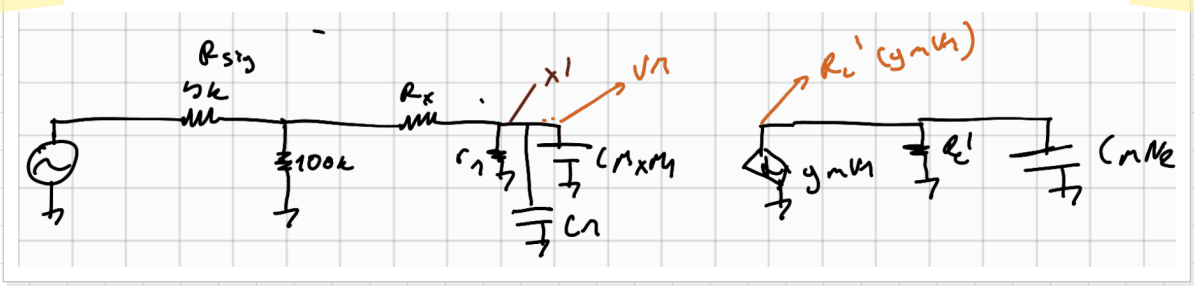
V'_{sig} kaynak dönüşümü yaparak bulalım



original drawing, p. 5

$$V = V_{sig} \cdot \frac{R_B}{R_{sig} + R_B} \cdot \frac{1}{(R_{sig} \parallel R_B) + r_x + r_\pi} \cdot r_\pi$$

orig. p. 6



original drawing, p. 6

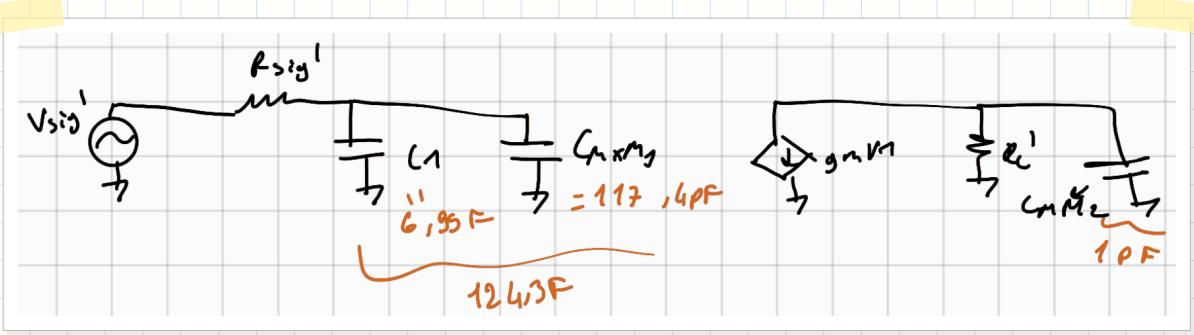
$k = g_m R_L'$

$Z = \frac{1}{j\omega C}$

$$M_1 = (1 + g_m R_L') \quad = 117{,}4$$

$$M_2 \left(1 + \underbrace{\frac{1}{g_m R_L'}}_{40\,mS}\right) \quad = 1$$

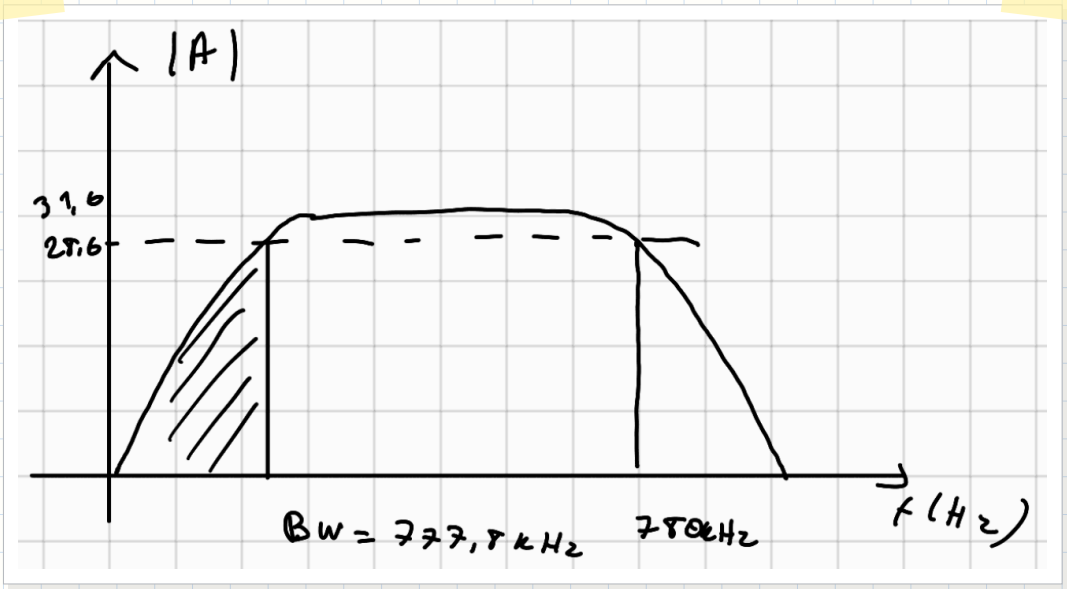
$$R_L' = 100k \parallel 8k \parallel 5k\Omega = 2{,}91\,k\Omega$$



original drawing, p. 6

$$R'_{sig} = 2{,}5k \parallel (4{,}76k)$$
$$= 1{,}64\,k\Omega$$
$$f_1 = \frac{1}{2\pi \cdot 1{,}64 \cdot 10^3 \cdot 124{,}3 \cdot 10^{-12}} = 780\,kHz$$
$$f_2 = \frac{1}{2\pi(2{,}91k \cdot 1 \cdot 10^{-12})} \simeq 55\,MHz$$

orig. p. 7



original drawing, p. 7