1) Paralelo na saída => Impedância $\frac{Z}{1+A\beta}$

Logo $Z_{R_e} < Z$ => C//

2) D

3) D

4) $T(e^{jT\omega}) = 1 + 2e^{-jT\omega} + 3e^{-j2T\omega} + 3e^{-j3T\omega} + 2e^{-j4T\omega} + 1e^{-j5T\omega} =$

$= e^{-j2.5T\omega}\left(e^{j2.5T\omega} + e^{-j2.5T\omega} + 2e^{j1.5T\omega} + 2e^{-j1.5T\omega} + 3e^{j0.5T\omega} + 3e^{-j0.5T\omega}\right) =$

$= e^{-j2.5T\omega}\left(2\cos(2.5T\omega) + 4\cos(1.5T\omega) + 6\cos(0.5T\omega)\right)$

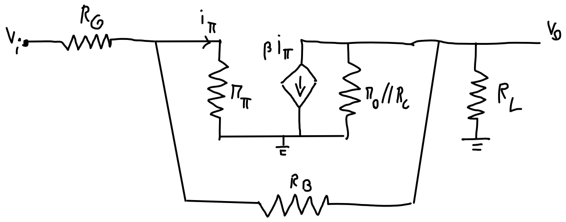
$\phi = -2.5T\omega$ Atraso $= -\frac{\partial\phi}{\partial\omega} = 2.5T = \frac{2.5}{1M} = 2.5\mu s$

D

5) B

II a) Paralelo - Paralelo => Transimpedancia

b)



Matriz Y:

A

$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0} = \frac{1}{r_\pi}$ $y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = 0$

$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = \frac{\beta}{r_\pi} = g_m$ $y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{R_C}$

$g_m = \frac{I_C}{V_T} = \frac{4mA}{25mV} = 0.16$

$A = \begin{bmatrix} \frac{0.16}{\beta}\,S & 0 \\ 0.16\,S & 0.1mS \end{bmatrix}$ $\beta = \begin{bmatrix} 10 & -10 \\ -10 & 10 \end{bmatrix}\mu S$

B

$y_{11} = \frac{1}{R_B}$ $y_{12} = -\frac{1}{R_B}$

$y_{21} = -\frac{1}{R_B}$ $y_{22} = \frac{1}{R_B}$

$A' = -\frac{(0.16 - 10\mu)}{\left(\frac{0.16}{\beta} + 10\mu + \frac{1}{R_G}\right)\left(0.1m + 10\mu + \frac{1}{R_L}\right)} = -629.6k\Omega$

$\beta' = -10\mu S$

$K_V = \frac{A_f}{R_G} = \frac{A'}{1+A'\beta'} \cdot \frac{1}{R_G} = -86.294$ <=>

<=> $R_G = \frac{A'}{1+A'\beta'} \cdot \frac{1}{-86.294} = 1k\Omega$ <=>

<=> $\frac{0.16}{\beta} = -\frac{(0.16-10\mu)}{(0.1m + 10\mu + \frac{1}{R_L})} \cdot \frac{1}{A'} - \frac{1}{R_G} - 10\mu$ <=> $\beta = 800$

c) $A_0 = 140\,dB$

$\omega_{p_1} = 2\pi \times 10^3\ rad/s \qquad \omega_{p_2} = 2\pi \times 10^7\ rad/s$

$A_f = 20\,dB = \frac{1}{\beta} \Leftrightarrow \beta = -20\,dB$

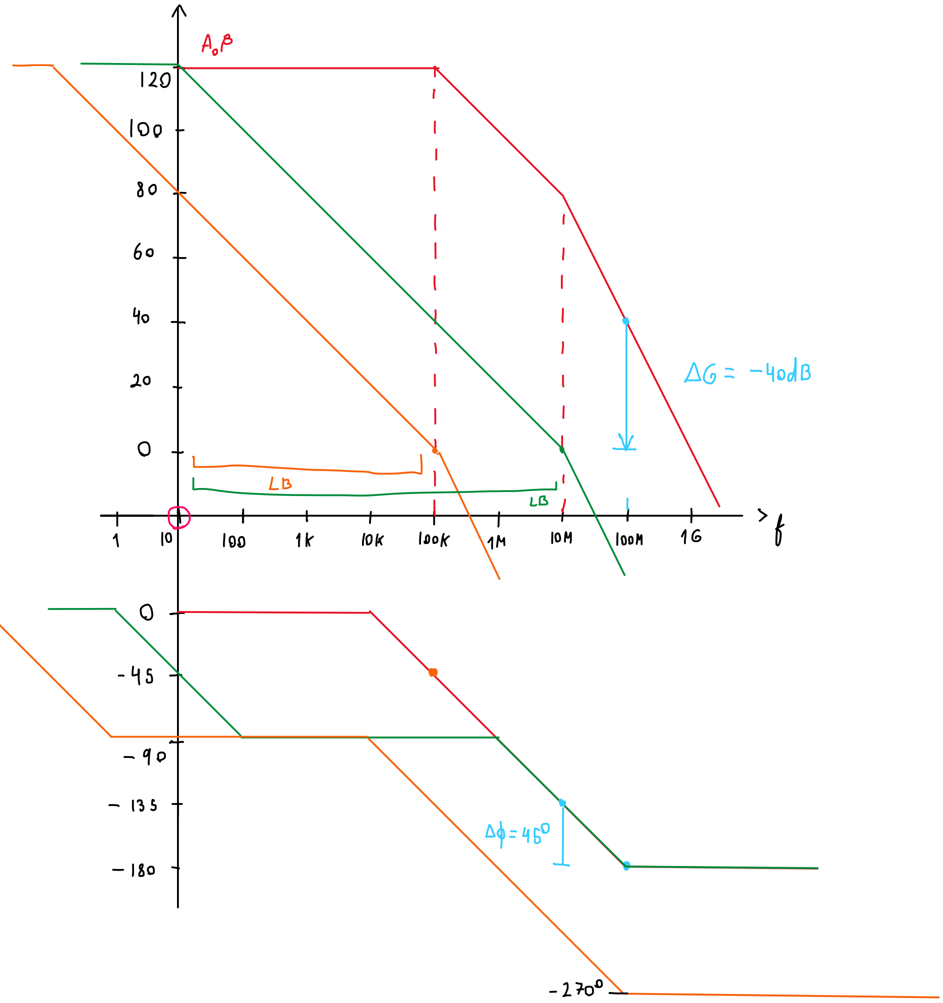
$A_0 \cdot \beta = 120\,dB$

Nova freq ⇒ 10 Hz

LB por deslocamento = 10M

LB por adição = 100 k

$\alpha = \frac{10M}{100k} = 100$ //



III a) Passa - Banda

$A_p = 3\,dB \qquad A_s = 20\,dB$

$\omega_{p_1} = 800\ Hz \qquad \omega_{s_1} = 160\ Hz$

$\omega_{p_2} = 1200\ Hz \qquad \omega_{s_2} = 4800\ Hz$

Queremos simetria ⇒ $\omega_{p_1} \times \omega_{p_2} = \omega_{s_1} \times \omega_{s_2}$

$960\,k \neq 768\,k$

Logo temos de aumentar ω_{s1} ⇒ $\omega_{s1} = \frac{\omega_{p_1} \times \omega_{p_2}}{\omega_{s2}} = 200\,K$

$\Omega_s = \frac{\omega_{s2} - \omega_{s1}}{\omega_{p2} - \omega_{p1}} = 11.5$

$A_B(\Omega) = 10 \log(1 + \varepsilon^2 \Omega^{2n})$

$A_B(1) = 3\,dB \Rightarrow 3 = 10 \log(1+\varepsilon^2) \Leftrightarrow \varepsilon = 1$

$A_B(11.5) = 20\,dB \Rightarrow n = 1$

$H(S) = S + 1$

$T(s) = \frac{1}{H(S)}\Big|_{S = \frac{s^2 + \omega_0^2}{Bs}} = \frac{Bs}{s^2 + \omega_0^2 + Bs} = \frac{Bs}{s^2 + Bs + \omega_0^2} =$

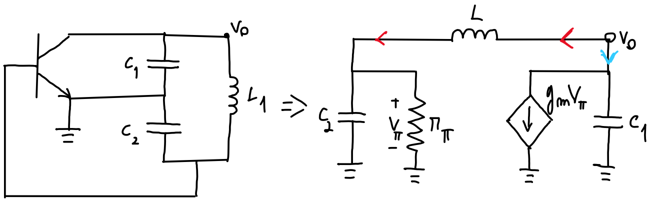
$\omega_0 = \sqrt{\omega_{p_1} \times \omega_{p_2}}$

$B = \omega_{p_2} - \omega_{p_1} = 400 \cdot 2\pi\ rad/s$

$= \frac{2513 s}{s^2 + 2513 s + 39.47 \times 10^6}$ //

b) Para $n = 1$ as aproximações de Chebyshev e Butterworth são iguais//

c) Esquema simplificado:



- $\dfrac{V_\pi}{\left(sC_2 + \frac{1}{r_\pi}\right)^{-1}}$
- $g_m V_\pi + V_0 sC_1$

$V_0 = \,? \iff V_0 - V_\pi = sL\left(\dfrac{V_\pi}{\left(sC_2+\frac{1}{r_\pi}\right)^{-1}}\right) \iff$

$\iff V_0 = V_\pi\left(1 + sL\left(sC_2 + \frac{1}{r_\pi}\right)\right)$

Logo: $\dfrac{\cancel{V_\pi}}{\left(sC_2+\frac{1}{r_\pi}\right)^{-1}} + g_m \cancel{V_\pi} + \cancel{V_\pi}\left(1 + sL\left(sC_2+\frac{1}{r_\pi}\right)\right)sC_1 = 0 \iff sC_2 + \frac{1}{r_\pi} + g_m + sC_1 + s^2C_1L\left(sC_2 + \frac{1}{r_\pi}\right) = 0$

Parte imaginária: $\omega C_2 + \omega C_1 - \omega^3 C_1C_2L = 0 \iff \omega^2 C_1C_2L = C_2 + C_1 \iff \omega = \sqrt{\dfrac{1}{L}\cdot\dfrac{C_2+C_1}{C_1C_2}} = 15.7\times10^3\ \text{rad/s} = 2.5\ \text{KHz}$

Parte real: $\dfrac{1}{r_\pi} + g_m - \omega^2\dfrac{C_1L}{r_\pi} = 0 \iff \dfrac{1}{r_\pi} + g_m - \dfrac{1}{\cancel{L}}\cdot\dfrac{C_2+C_1}{\cancel{C_1}C_2}\cdot\dfrac{\cancel{C_1L}}{r_\pi} = 0 \iff 1 + g_m r_\pi - \dfrac{C_2+C_1}{C_2} = 0 \iff g_m r_\pi = \dfrac{C_1}{C_2}$ Condição de oscilação

IV

a) Vantagens: − Entrada só liga a uma porta
- Menos hardware
- Menor área
- Menos atrasos

Desvantagens: − Tensão de saída LOW maior que zero
- Possíveis erros de transmissão
- Consumo estático não nulo

b) Programar

− Aplicar tensões elevadas no gate flutuante para aprisionar cargas

− Isto aumenta o V_{GS}, logo não é como não houvesse transístor

Apagar

− Aplicar tensões muito negativas no gate flutuante para soltar cargas