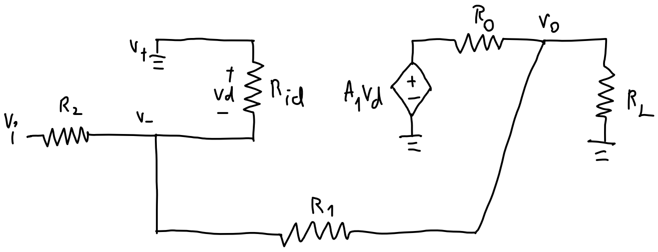
I 1) D

2) B

3) C

4) D

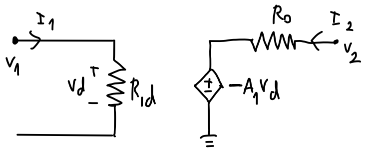
II a)



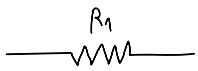
Paralelo – Paralelo

Transimpedância

b) A:



β:



$$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0} = \frac{1}{R_{id}} \qquad y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = 0$$

$$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = \frac{A}{R_0} \qquad y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{R_0}$$

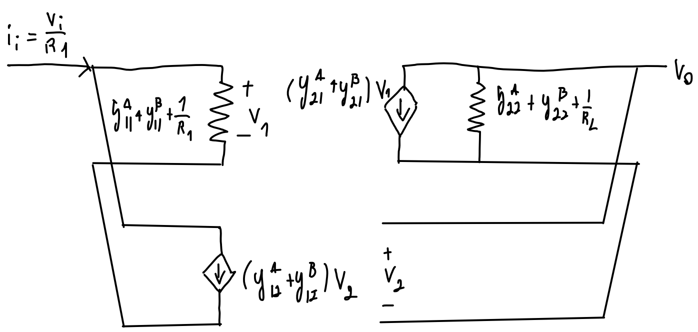
$$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0} = \frac{1}{R_1} \qquad y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = -\frac{1}{R_1}$$

$$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = -\frac{1}{R_1} \qquad y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{R_1}$$

$$A = \begin{bmatrix} \frac{1}{R_{id}} & 0 \\ \frac{A}{R_0} & \frac{1}{R_0} \end{bmatrix} = \begin{bmatrix} 2\mu & 0 \\ 100 & 1m \end{bmatrix} S$$

$$\beta = \begin{bmatrix} \frac{1}{R_1} & -\frac{1}{R_1} \\ -\frac{1}{R_1} & \frac{1}{R_1} \end{bmatrix} = \begin{bmatrix} 10\mu & -10\mu \\ -10\mu & 10\mu \end{bmatrix} S$$

c)



$A' = -4.095\,M\Omega$

$\beta' = -10\mu S$

d)

$$A_f = \frac{A}{1+A\beta} \approx \frac{1}{\beta} = -100\,k\Omega$$

$$K_V = \frac{V_0}{V_i} = \frac{V_0}{i_i R_1} = \frac{A_f}{R_1} = -1$$

$$Y_i' = y_{11}^A + y_{11}^\beta + \frac{1}{R_1}$$

$$Y_i' = (1 + A\beta)\left(y_{11}^A + y_{11}^\beta + \frac{1}{R_1}\right)$$

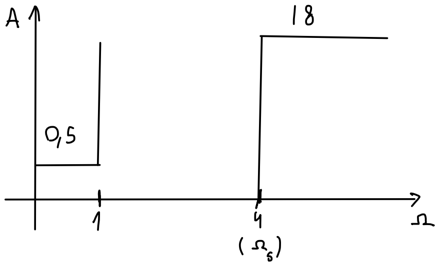
$$Y_i = Y_i' - \frac{1}{R_1} = 0.9\,S$$

$$Z_i = \frac{1}{Y_i} = 1.11\,\Omega$$

III a) Passa - alto

$A_p = 0{,}5\,dB \qquad A_s = 19\,dB$

$\omega_p = 2\pi \cdot 4\,kHz \qquad \omega_s = 2\pi \cdot 1\,kHz$



$$\Omega_s = \frac{\omega_p}{\omega_s} = 4$$

$$A(\Omega) = 10\log(1+\varepsilon^2 C_n^2(\Omega))$$

$$A(1) = 10\log(1+\varepsilon^2) \iff \sqrt{10^{\frac{A_p}{10}}-1} = \varepsilon \iff \varepsilon = 0.35$$

$$A(4) = 10\log(1+\varepsilon^2 C_n^2(4)) \iff n = 2$$

$$C_2 = 2\Omega^2 - 1$$

$n = 2 \Rightarrow \quad K = 1.431$

$D(s) = s^2 + 1.425s + 1.516$

$$T(s) = \frac{K}{D(s)} = \frac{1.431}{s^2 + 1.425s + 1.516}$$

$$T(s) = T(S)\Big|_{S = \frac{\omega_p}{s}} = \frac{1.431 s^2}{\omega_p^2 + 1.425\omega_p s + 1.516 s^2} = \frac{\frac{1.431}{1.516}s^2}{\frac{\omega_p^2}{1.516} + \frac{1.425\,\omega_p}{1.516}s + s^2} = \frac{0.943 s^2}{416.66\times10^6 + 23.62\times10^3 s + s^2}$$

b) $A(\Omega) = 0$

$$A(\Omega) = 10\log(1+\varepsilon^2 C_n^2(\Omega))$$

$$1 + \varepsilon^2(2\Omega^2-1)^2 = 1 \iff 2\Omega^2 - 1 = 0 \iff \Omega^2 = \frac{1}{2}$$

$$\Omega = \frac{\omega_p}{\omega} \iff \omega = \sqrt{2}\,\omega_p \Rightarrow f = \sqrt{2}\cdot 4\,kHz \iff f = 5.66\,kHz$$

c) FIR $\Rightarrow$ sempre estável

$$y_n = x_n + 0{,}2x_{n-1} + 0{,}4x_{n-2} + 0{,}2x_{n-3} + x_{n-4}$$

d) $T(e^{j\omega T}) = 1 + 0{,}2e^{-j\omega T} + 0{,}4e^{-j2\omega T} + 0{,}2e^{-j3\omega T} + e^{-j4\omega T} =$

$= e^{-j2\omega T}(0{,}4 + e^{j\omega T 2} + e^{-j2\omega T} + 0.2e^{-j\omega T} + 0.2e^{j\omega T}) =$

$= e^{-j2\omega T}(0{,}4 + 2\cos(2\omega T) + 0.4\cos(\omega T))$

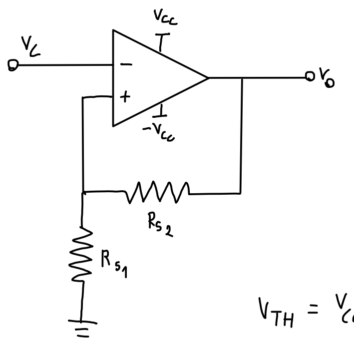
$\omega = 0$

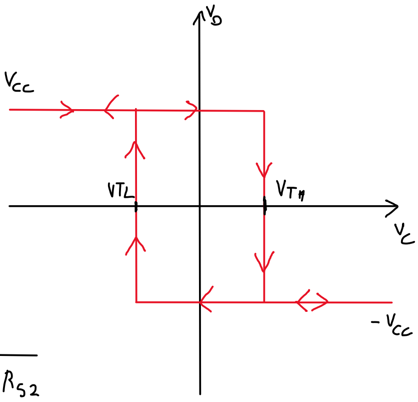
Fase $= -j2\omega T = 0$

Amplitude $= 0.4 + 2 + 0.4 = 2.8 \Rightarrow G = 8.94\,dB$

IV

a)





$$V_{TH} = V_{cc} \frac{R_{S1}}{R_{S1}+R_{S2}}$$

$$V_{LH} = -V_{cc} \frac{R_{S1}}{R_{S1}+R_{S2}}$$

$V_{cc} = 5$
$-V_{cc} = -5$
$V_{TH} = 1$
$V_{TL} = -1$

b) $R_1 = 15\,k\Omega$

$C_1 = 4{,}7\,mF$

$$V_c(t) = V_{cf} - (V_{cf} - V_{ci})\, e^{-\frac{t}{\tau}}$$

Carregamento:

$V_{ci} = -1 \quad V_{cf} = 5 \quad \tau = RC$

$$V_c(t) = 5 - (5+1)\, e^{-\frac{t}{\tau}}$$

Só chega até 1V

$$1 = 5 - 6\, e^{-\frac{t}{\tau}} \Leftrightarrow t = -R_1 C_1 \ln\left(\frac{4}{6}\right) = 28{,}58\,\mu s$$

Descarregamento:

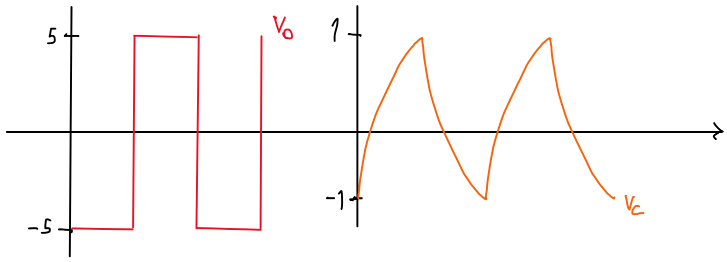
$V_{ci} = 1 \quad V_{cf} = -5 \quad \tau = RC$

$$V_c(t) = -5 - (-5-1)\, e^{-\frac{t}{\tau}}$$

Só chega até -1V

$$-1 = -5 + 6\, e^{-\frac{t}{\tau}} \Leftrightarrow t = -R_1 C_1 \ln\left(\frac{4}{6}\right) = 28{,}58\,\mu s$$

$T = t_{carga} + t_{descarga} = 57{,}16\,\mu s \qquad f = \frac{1}{T} = 17{,}495\,KHz \qquad DC = \frac{t_1}{T} = 0.5 \ (50\%)$



c) Se $V_{os} = 0.1\,V$ então $V_{TH} = 1.1V$ e $V_{LH} = -0.9V$, ora, já não é simétrico

Sendo assim, temos:

$$V_c(t) = V_{cf} - (V_{cf} - V_{ci})\, e^{-\frac{t}{\tau}}$$

$V_{ci} = -0.9$

$V_{cf} = 5$

$$1.1 = 5 - (5+0.9)\, e^{-\frac{t_c}{\tau}} \Leftrightarrow t_c = -RC \ln\left(\frac{1.1-5}{-5.9}\right) = 29.19\,\mu s$$

$$-0.9 = -5 - (-5-1.1)\, e^{-\frac{t_D}{\tau}} \Leftrightarrow t_D = -RC \ln\left(\frac{-0.9+5}{5+1.1}\right) = 28.01\,\mu s$$

$$\Rightarrow f = \frac{1}{t_c + t_D} = 17.48\,KHz$$

d)

$B > 2.5$
$\bar{B} < 2.5$ $\Rightarrow$ Bit = 1

O amplificador vai levar B a 5V e $\bar{B}$ a 0