

Resolução (compacta):

a. $I_1 = I_2 = I_3 = I_4 = 0,2\text{mA}/2 = 0,1\text{mA}$ $I_5 = 0,1\text{mA}$

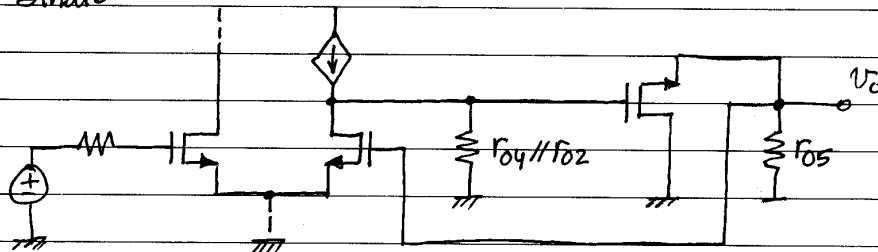
T_1 : $0,1\text{mA} = 0,1\text{mA} (V_{GS1} - 1)^2 \Rightarrow V_{GS1} = 1 \pm 1 \Rightarrow V_{GS1} = 2\text{V}$

Por analogia $V_{GS2} = V_{GS5} = V_{GS1} = 2\text{V}$ e $V_{GS3} = V_{GS4} = -2\text{V}$

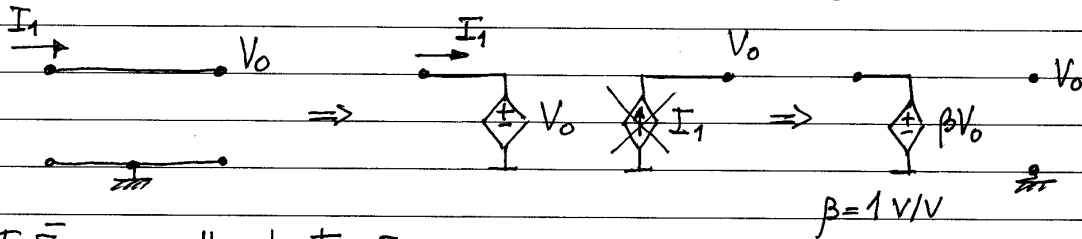
$V_{G1} = 0 \Rightarrow V_{S1} \equiv V_{S2} = -2\text{V} \Rightarrow V_{G2} \equiv V_{S5} = 0 \Rightarrow V_{G5} = V_{D4} = V_{D2} = 2\text{V}$

$V_{S3} \equiv V_{S4} = 5\text{V} \Rightarrow V_{G3} \equiv V_{D3} \equiv V_{D1} \equiv V_{G4} = 3\text{V}$ $V_{D5} = 5\text{V}$

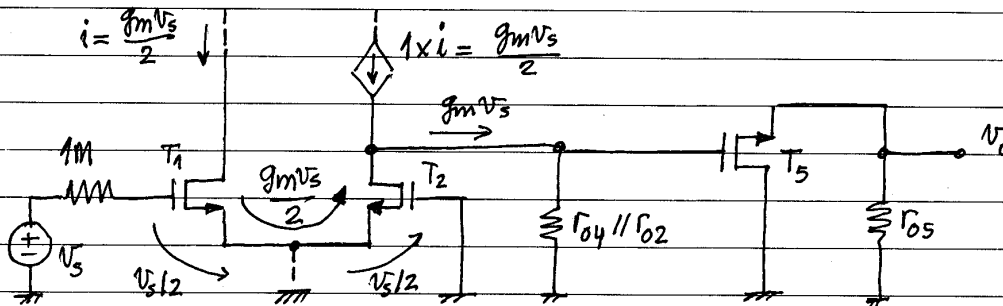
b. Para sinais



onde é claro que a topologia é tensão-série, logo:



Então, em malha aberta, temos:



$r_{o2} = r_{o4} = r_{o5} = \frac{20}{0,1\text{mA}} = 200\text{k}\Omega$ $g_{m1} = g_{m2} = g_{m5} = 2\sqrt{0,1\text{mA} \times 0,1\text{mA}} = 0,2\text{mA/V}$

$A_{1,2} = g_m (r_{o4} || r_{o2}) = 20\text{V/V}$ $A_5 = \frac{200\text{k}}{200\text{k} + 1/0,2\text{mA}} = 0,976\text{V/V}$

$A_v = A_{1,2} \times A_5 \approx 19,5\text{V/V}$

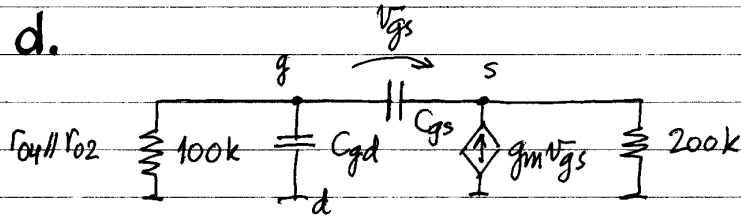
c.

$A_{v,fs} = \frac{A_v}{1 + \beta A_v} = \frac{19,5}{1 + 19,5} \approx 0,95\text{V/V}$

$$R_{out} = R_{of} \quad R_o = 200k // \frac{1}{0,2m} \cong 4,88 k\Omega$$

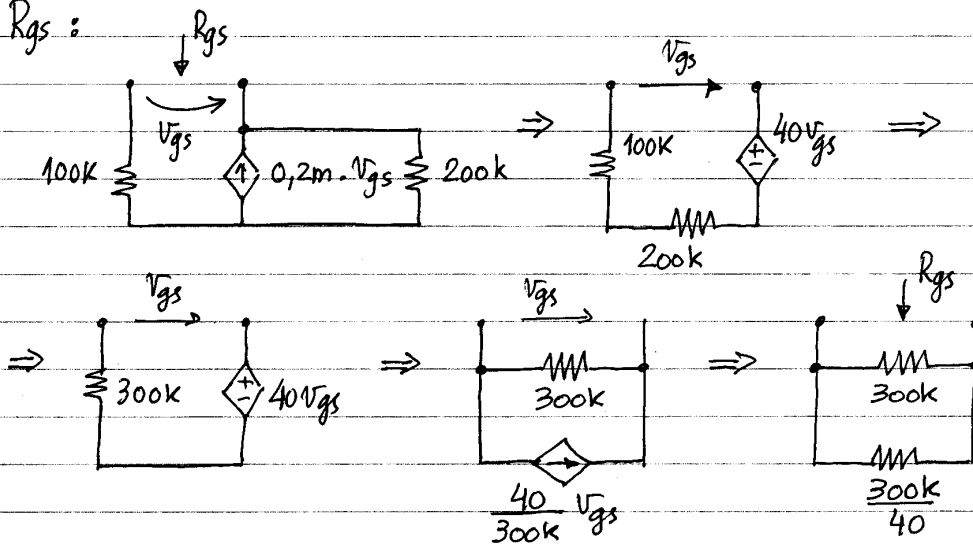
$$R_{of} = \frac{R_o}{1 + \beta A_v} \cong 238 \Omega$$

d.



Por simples inspeccão $R_{gd} = 100 k\Omega$

$R_{gs} :$



Finalmente $R_{gs} = 300k // \frac{300k}{40} \cong 7,32 k\Omega$

$$\tau = 100k \times 3p + 7,32k + 5p \cong 337 ns$$