Resolução (compacta):

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

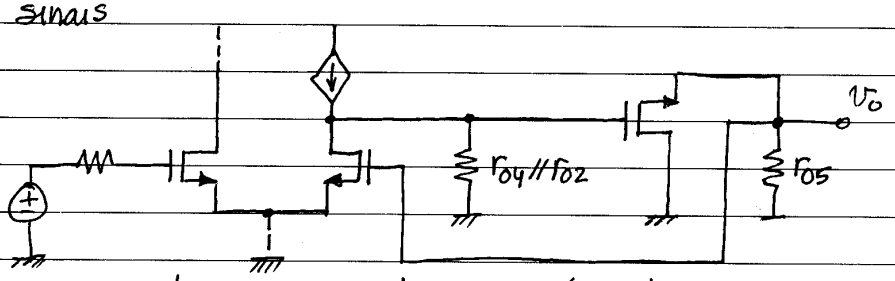
$T_1: \; 0{,}1m = 0{,}1m\,(V_{GS1} - 1)^2 \Rightarrow V_{GS1} = 1 \pm 1 \Rightarrow V_{GS1} = 2\,V$

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

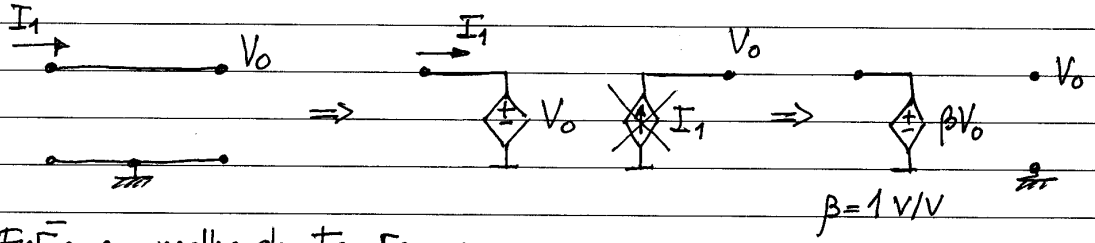
$V_{G1} = 0 \Rightarrow V_{S1} \equiv V_{S2} = -2\,V \Rightarrow V_{G2} \equiv V_{S5} = 0 \Rightarrow V_{G5} = V_{D4} = V_{D2} = 2V$

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

b. Para sinais

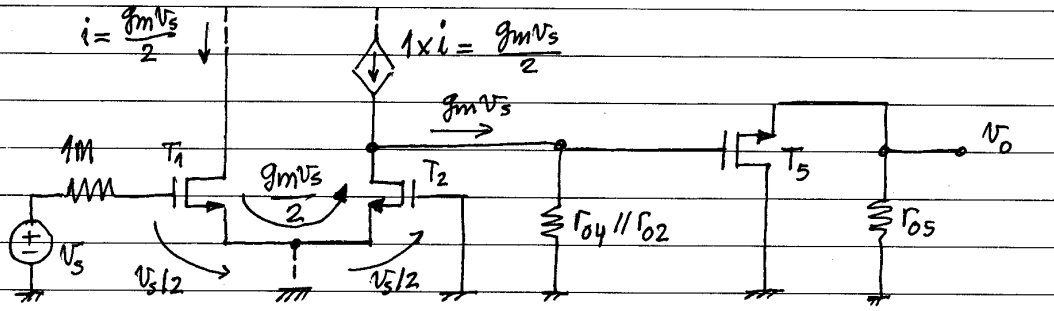


onde é claro que a topologia é tensão-série, logo:



$\beta = 1\,V/V$

Então, em malha aberta, temos:



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

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

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

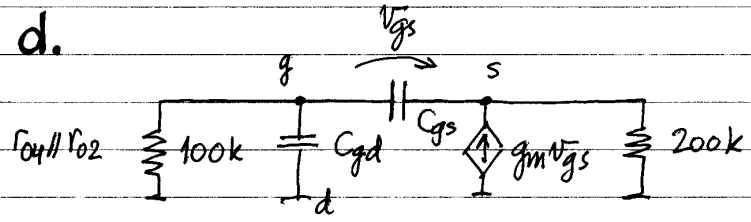
c.

$$A_{vf} = \frac{A_v}{1 + \beta A_v} = \frac{19{,}5}{1 + 19{,}5} \cong 0{,}95\,V/V$$

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

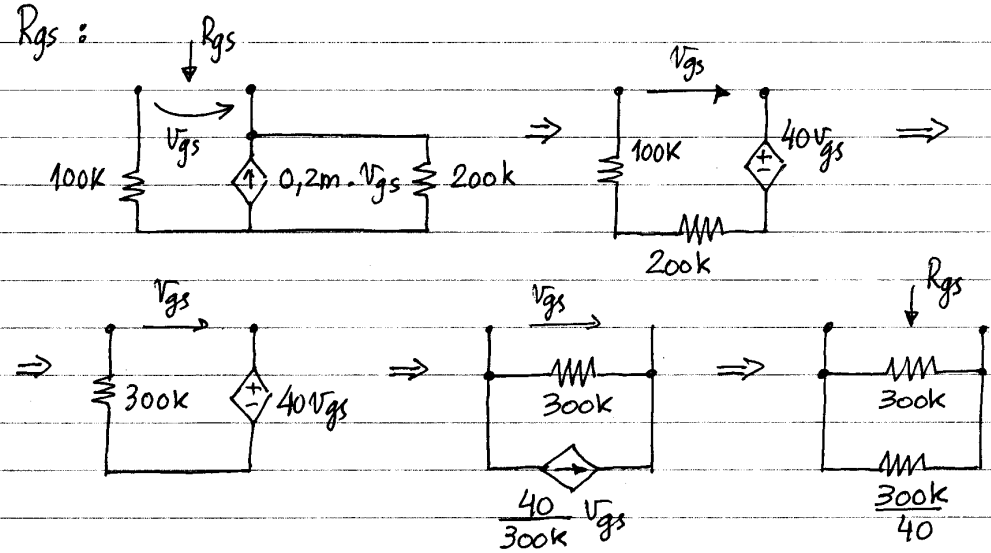
$R_{of} = \frac{R_o}{1+\beta A_v} \cong 238\,\Omega$

d.



Por simples inspecção $\quad R_{gd} = 100\,k\Omega$

R_{gs} :



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

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