

Resolução (compacta):

a.

$$24 = R I_4 + V_{GS4} \Rightarrow I_4 = \frac{24 - V_{GS4}}{R} \quad \therefore R = \frac{24 - V_{GS4}}{I_4}$$

$$I_4 = K (V_{GS4} - V_t)^2 = 1 \text{ mA} \quad \therefore 1 = 0,25 (V_{GS4} - 1)^2 \Rightarrow V_{GS4} = 1 \pm 2$$

$$\text{donde } V_{GS4} = 3 \text{ V} \Rightarrow R = 21 \text{ k}\Omega$$

$$I_4 = 1 \text{ mA} \Rightarrow I_3 = I_5 = 1 \text{ mA} \quad \text{e} \quad I_5 = 1 \text{ mA} \Rightarrow I_C = 1 \text{ mA}$$

$$I_3 = 1 \text{ mA} \Rightarrow I_1 = I_2 = 0,5 \text{ mA}$$

$$T_1, T_2 : \quad 0,5 = 0,25 (V_{GS} - 1)^2 \Rightarrow V_{GS} = 1 \pm \sqrt{2} \Rightarrow V_{GS1} = V_{GS2} = 2,41 \text{ V}$$

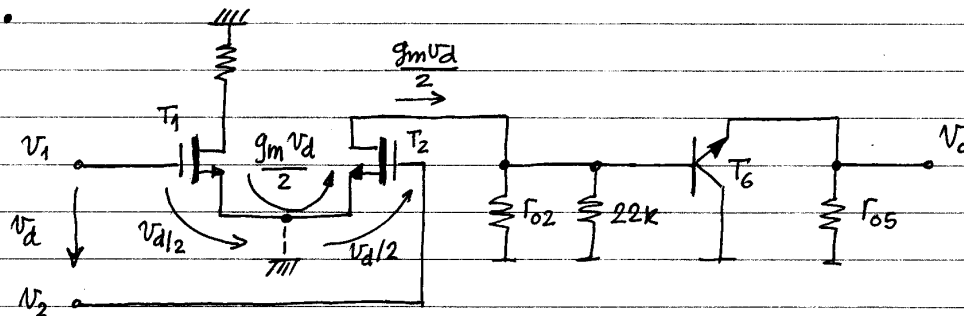
$$V_{GS1} = V_{GS2} = 0 \Rightarrow V_{S1} = V_{S2} = -2,41 \text{ V} = V_{D3}$$

$$V_{D1} = V_{D2} = V_{B6} = 12 - 22 \text{ k} \times 0,5 \text{ m} = 1 \text{ V}$$

$$V_{CC} = 12 \text{ V} \quad V_{EG} = V_{D5} = V_{B6} - 0,7 = 0,3 \text{ V}$$

$$V_{S3} = V_{S4} = V_{S5} = -12 \text{ V} \quad V_{G3} = V_{G4} = V_{D4} = V_{G5} = -9 \text{ V}$$

b.



$$r_{o2} = \frac{100}{0,5 \text{ m}} = 200 \text{ k}\Omega \quad r_{o5} = \frac{100}{1 \text{ m}} = 100 \text{ k}\Omega$$

$$g_{m1,2} = 2 \sqrt{0,25 \times 0,5} = 0,71 \text{ mA/V}$$

$$R_{i6} = r_{\pi 6} + (\beta + 1) r_{o5} > 201 \times 100 \text{ k} = 20,1 \text{ M}\Omega \gg 200 \text{ k} // 22 \text{ k}$$

logo

$$A_1 = \frac{v_{b6}}{v_d} \approx \frac{g_{m1,2}}{2} (200 \text{ k} // 22 \text{ k}) \approx 7,0 \text{ V/V}$$

$$\text{Como } r_{e6} \approx \frac{25 \text{ m}}{1 \text{ m}} = 25 \Omega \ll 100 \text{ k}\Omega \Rightarrow A_6 \approx 1 \quad \text{logo } A_d \approx 7,0 \text{ V/V}$$

$$\text{c. } r_{o3} = r_{o5} = 100 \text{ k}\Omega \quad A_{c1,2} \approx - \frac{200 \text{ k} // 22 \text{ k}}{2 \times 100 \text{ k}} = -99 \text{ mV/V} \approx A_{cm} \quad \text{pois } A_6 \approx 1$$

d. É o nó de entrada, i.e., \$G_1\$ ou \$G_2\$. Nesse nó teremos \$C_{gs}\$ em paralelo com \$C_{gd}\$ multiplicado pelo efeito de Miller \$(1+\beta)\$. Por outro lado, o CC \$T_6\$ tem resposta muito boa.