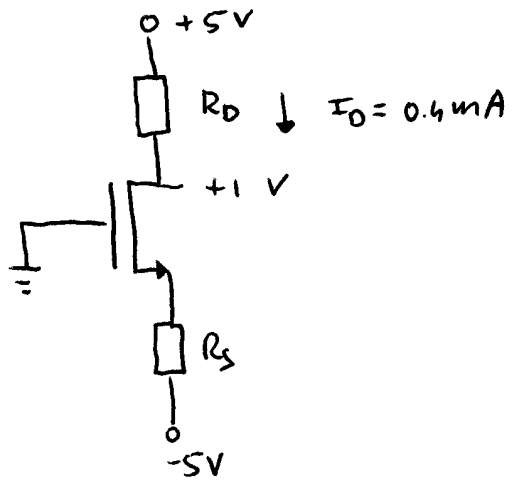
1)



$$R_D = \frac{(+5-1)V}{0.4\,mA} = 10\,k\Omega$$

em saturação:

$$I_D = \frac{1}{2} \mu_N C_{ox} \frac{W}{L} (V_{GS} - V_T)^2$$

$$0.4\,mA = \frac{1}{2} \cdot 20 \cdot 10^{-6} \cdot \frac{400}{10} (V_{GS} - 2)^2$$

$$V_{GS} = 3\,V \quad (V\ V_{GS} = 1\,V \Rightarrow V_{GS} < V_T\ !)$$

$$\Downarrow$$

$$V_S = -3\,V$$

$$\Downarrow$$

$$R_S = \frac{-3-(-5)\,A}{0.4\,mA} = 5\,k\Omega$$

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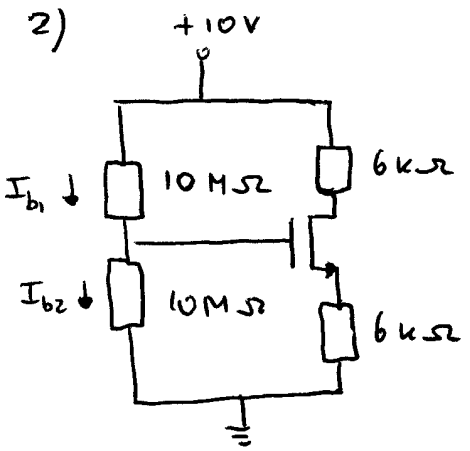
2)



$$V_g = \frac{10\,M}{10\,M + 10\,M} \times 10\,V = 5\,V$$

$$I_{b1} = I_{b2} = \frac{10-5\,V}{10\,M\Omega} = 5\,\mu A$$

vamos asumir que o transistor está a funcionar na zona de saturação

$$I_D = \frac{1}{2} \mu_N C_{ox} \frac{W}{L} (V_{GS} - V_T)^2$$

$V_G = 5\,V$

$V_S = 6 \cdot 10^3\, I_D$

$V_D = 10 - 6 \cdot 10^3\, I_D$

$\frac{1}{2} \mu_N C_{ox} \frac{W}{L} = 0.5\,10^{-3}$

$V_T = 1\,V$

$$I_D = 0.5\,10^{-3} (5 - 6 \cdot 10^3\, I_D - 1)^2$$

soluções: $I_D = 0.89\,mA$ V $\boxed{I_D = 0.5\,mA}$

$$\Downarrow$$

$V_S = 5.34\,V$

$V_G = 5\,V$

$$\Downarrow$$

$V_{GS} < V_T$!

erro!

$V_S = 3\,V$

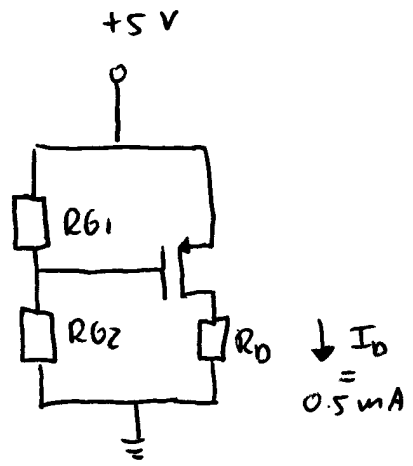
$V_D = 7\,V$

$V_{DS} = 4\,V$

$V_{GS} = 2\,V$

$V_{DS} > V_{GS} - V_T \Rightarrow$ zona de

3)



$$R_D = \frac{V_D}{I_D} = \frac{3V}{0.5mA} = 6\,k\Omega$$

saturação $V_{SD} > V_{SG} + |V_T|$

$V_G > +2V$

Em saturação:

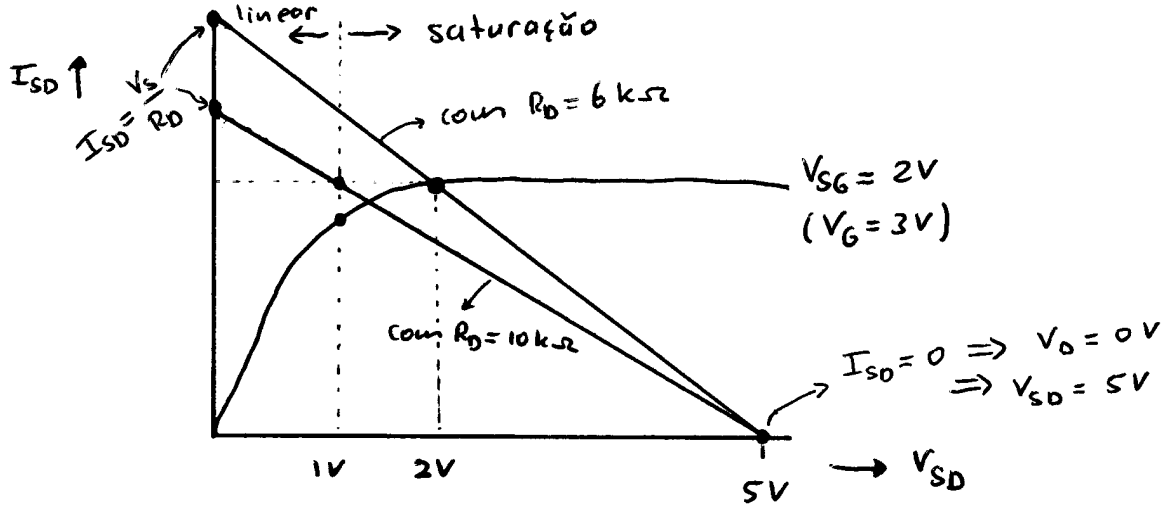
$$I_D = \frac{1}{2} \mu_p C_{ox} \frac{W}{L} (V_{SG} - |V_T|)^2$$

$$0.5\,10^{-3} = \frac{1}{2} \cdot 10^{-3} (5 - V_G - 1)^2$$

$$\Rightarrow V_G = 3V \Rightarrow RG2 = \frac{3}{2} RG1$$

(ex. RG1 = 2 MΩ, RG2 = 3 MΩ)

R_D máxima (com saturação)



saturação: $V_{SD} \geq V_{SG} - |V_T|$

$V_{SD} \geq 2 - 1 = 1$

$V_D \leq 4V \Rightarrow R_D \leq \frac{4V}{0.4mA} = 10\,k\Omega$

NB: I_D independente de V_{SD} (saturação)