Leonardo Rodrigues Marques, 178610 12/07/2020.

6.09)

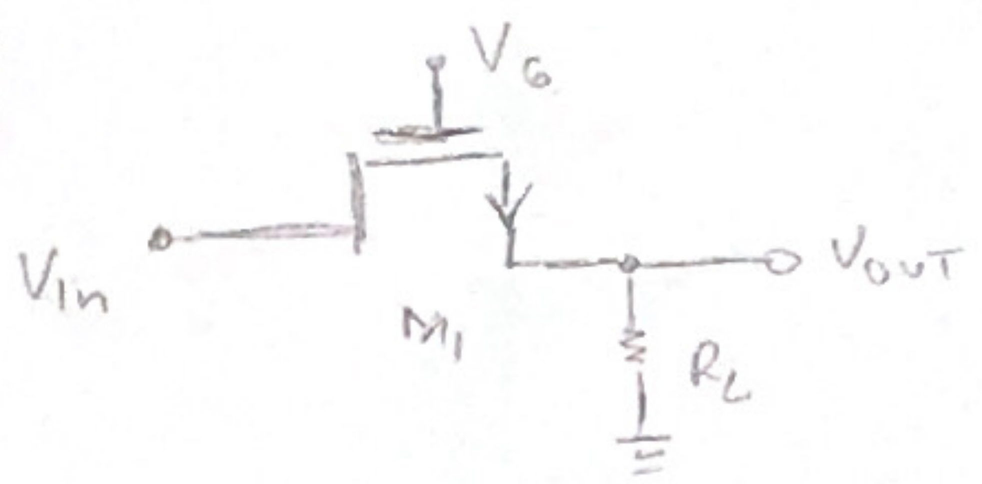
$V_{DD} = 1.8V \quad \frac{W}{L} = 20 \quad V_{th} = 0{,}4V \quad \mu_n C_{ox} = 200 \frac{\mu A}{V^2}$

$$R_{ON} = \frac{1}{\mu_n C_{ox} \frac{W}{L}(V_{DD} - V_{Th})} = \frac{1}{\left(200\frac{\mu A}{V^2}\right)(20)(1{,}8 - 0{,}4)V} = 179\,\Omega$$

6.12) $$R_{ON} = \frac{1}{\mu C_{ox} \frac{W}{L}(V_{GS} - V_{Th})} \Rightarrow \tau = R_{ON} C_{GS} = \frac{WLC_{ox}}{\mu C_{ox}\frac{W}{L}(V_{GS} - V_{Th})} = \frac{L^2}{\mu(V_{GS} - V_{Th})}$$

Para minimizar a constante de tempo, use o comprimento mínimo de um canal e maximize a tensão sobreposta

6.14)



$V_0 \sim$ few mV

(a) $V_{in} = V_0 \cos \omega t \qquad V_{OUT} = 0.95(V_0 \cos \omega t)$

$$V_{OUT} = \frac{R_L}{R_{ON} + R_L} \cdot V_{in} \Rightarrow \frac{R_L}{R_{ON} + R_L} = 0.95 V_0$$

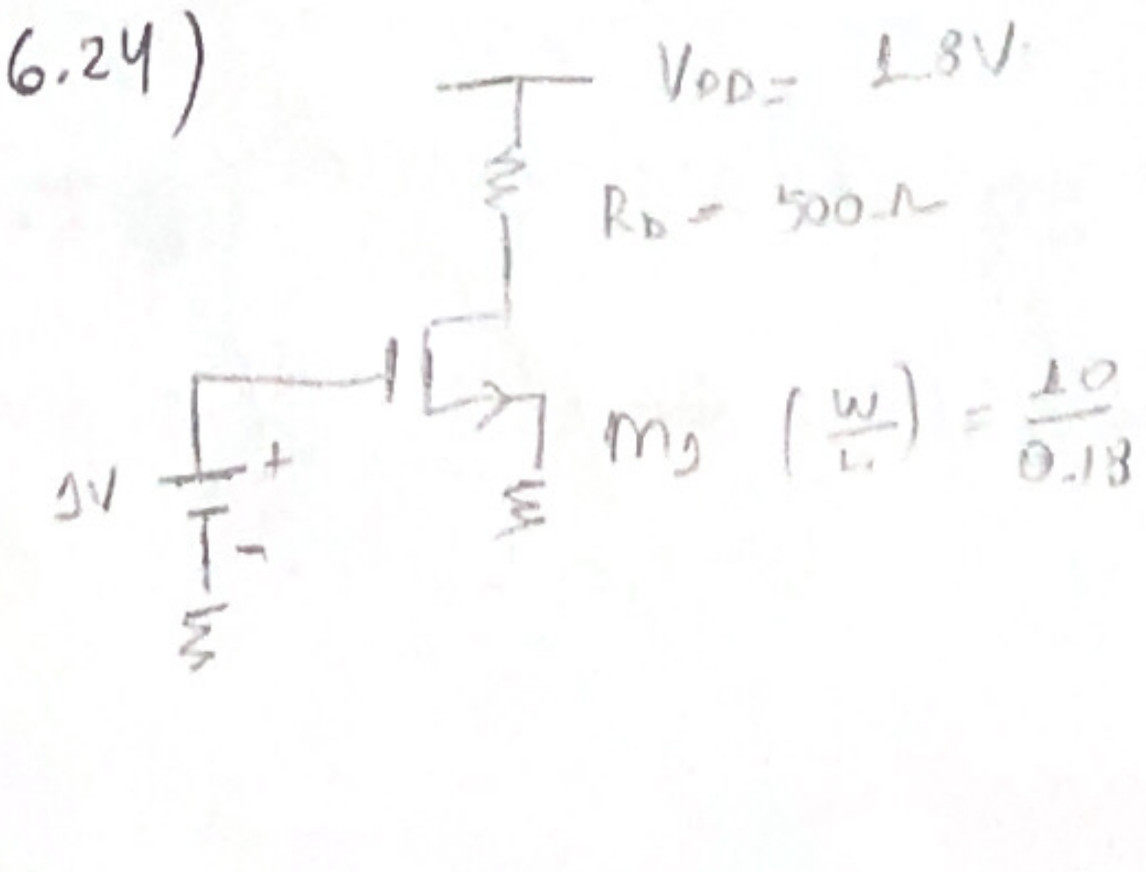
$$R_{ON} = \frac{R_L}{\left(\frac{0{,}95V_0}{1 - 0.95V_0}\right)} = \frac{1}{\mu_n C_{ox} \frac{W}{L}(V_G - V_{TH})} \Rightarrow \frac{W}{L} = \frac{0.95V_0/(1 - 0.95V_0)}{\mu_n C_{ox} R_L (V_G - V_{Th})}$$

(b) $V_{OUT} = 0.95 V_{in} = 0.95(V_0 \cos \omega t + 0.5) \approx 0.95 \times 0.5 = 0.475$

$\Rightarrow V_0$ é muito pequeno.

$$R_{ON} = \frac{R_L}{0.9} = \frac{1}{\mu_n C_{ox} \frac{W}{L}(V_G - V_{TH})} \Rightarrow \frac{W}{L} = \frac{0.9}{\mu_n C_{ox} R_L (V_G - V_{Th})}$$

6.24)



$\lambda = 0$

$V_{DS} \geq V_{GS} - V_{TH}$

$\Rightarrow V_{DS} \geq 1 - 0.4 = 0.6V$

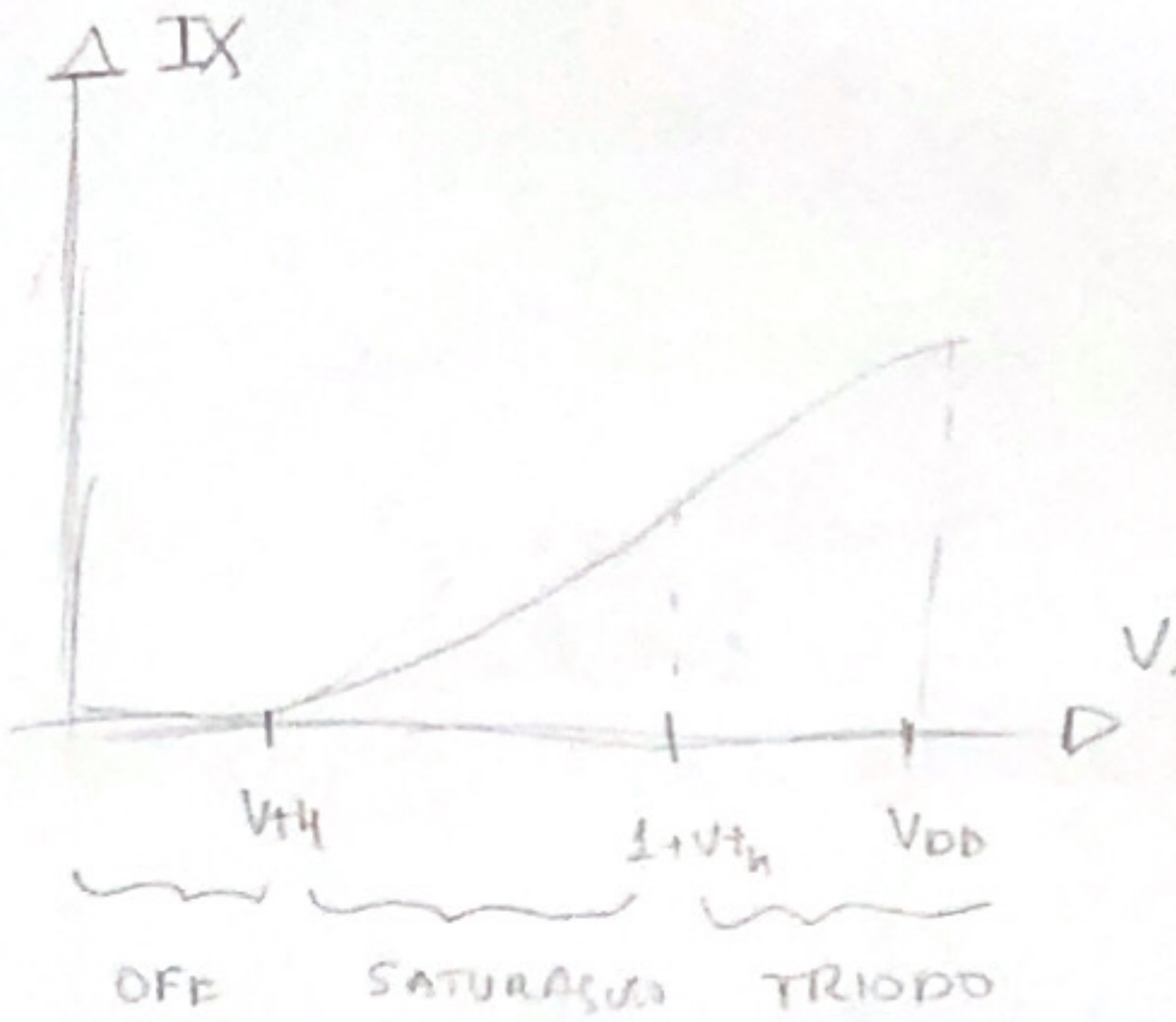
$\Rightarrow \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2$

$= \frac{1}{2}\left(200 \frac{\mu A}{V^2}\right)\left(\frac{10}{0.18}\right)(0{,}6)^2 = 2mA$

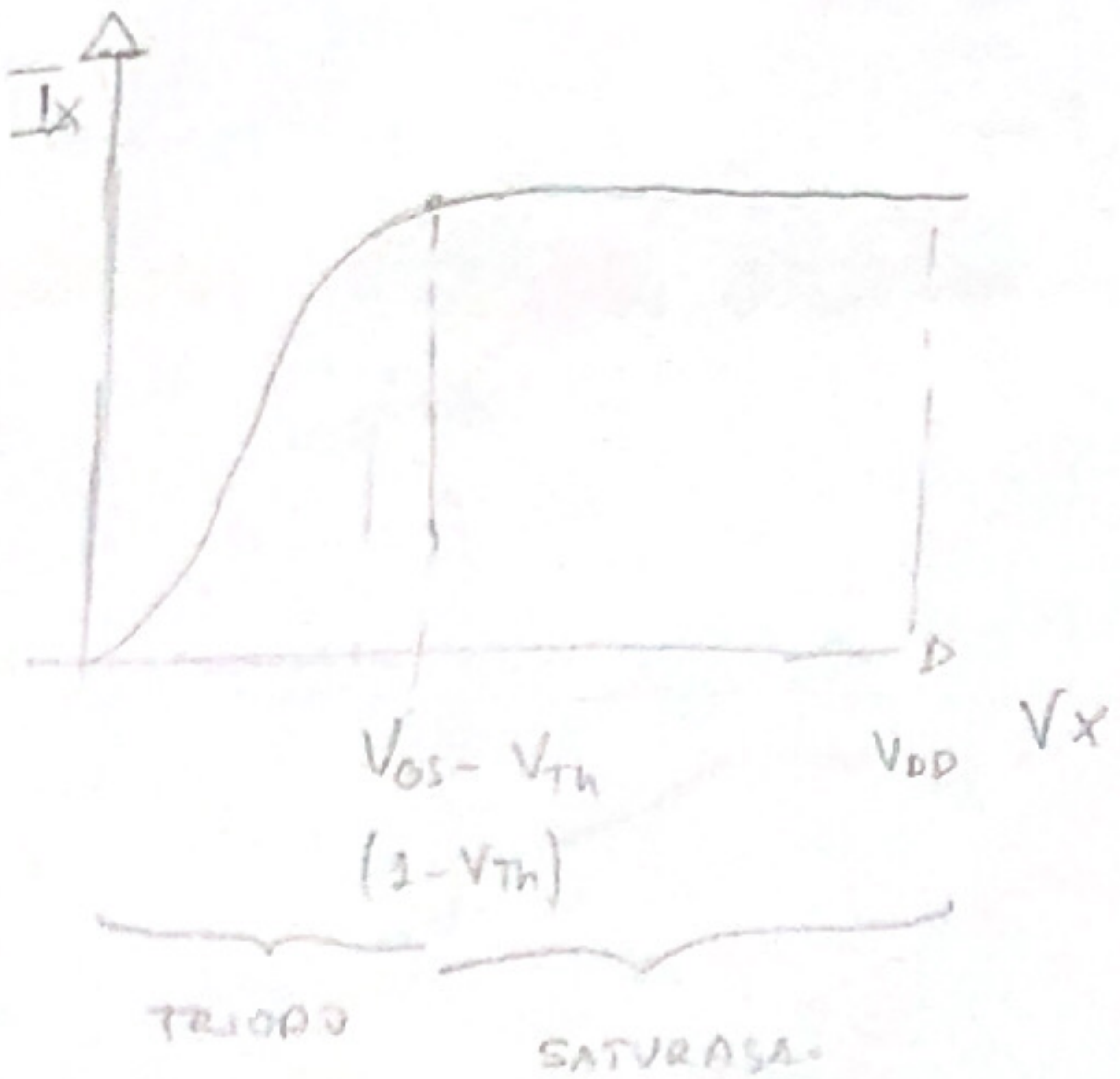
$$\frac{V_{DD} - V_{DS}}{R_D} = 2mA$$

6.28)

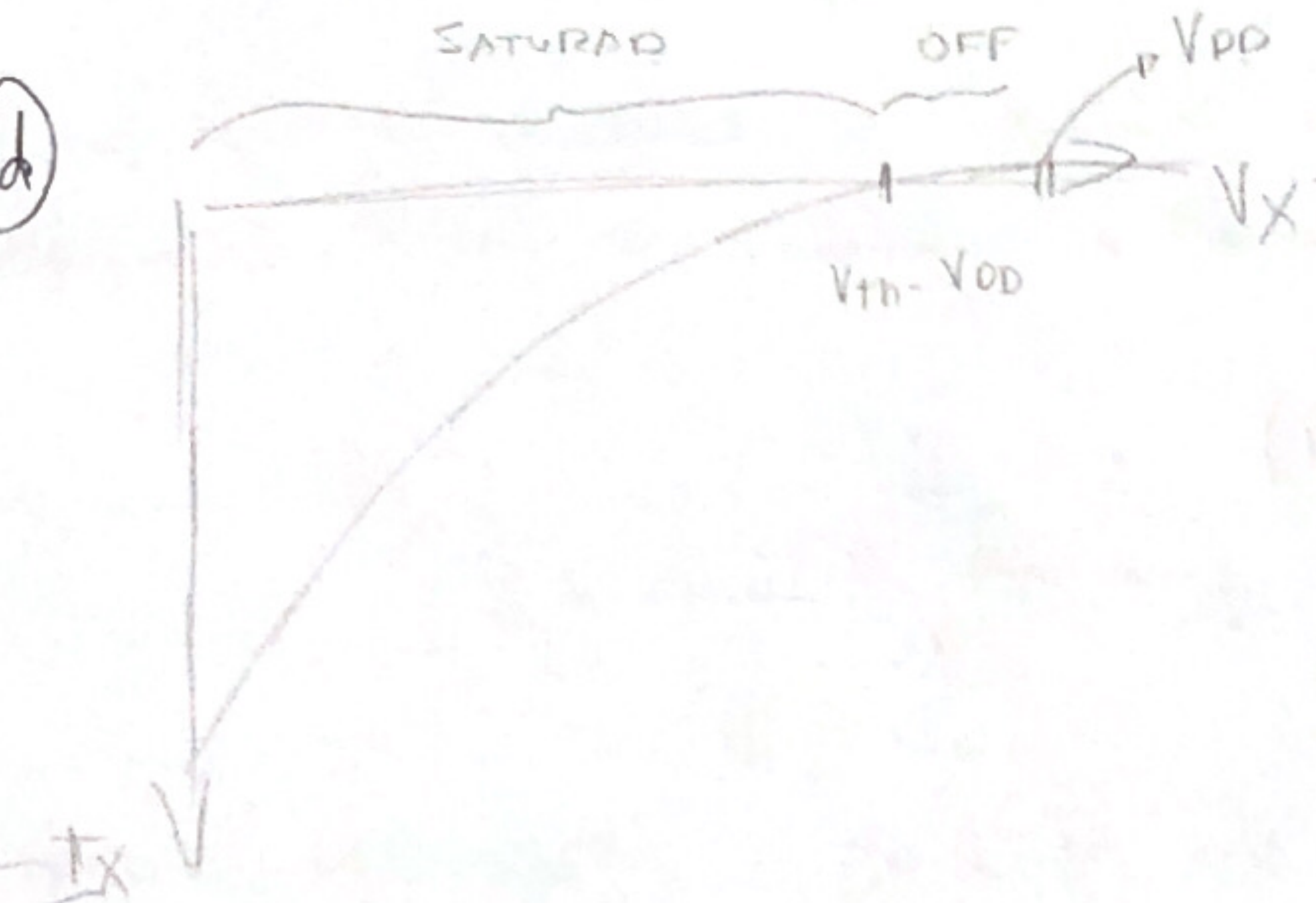
(a)



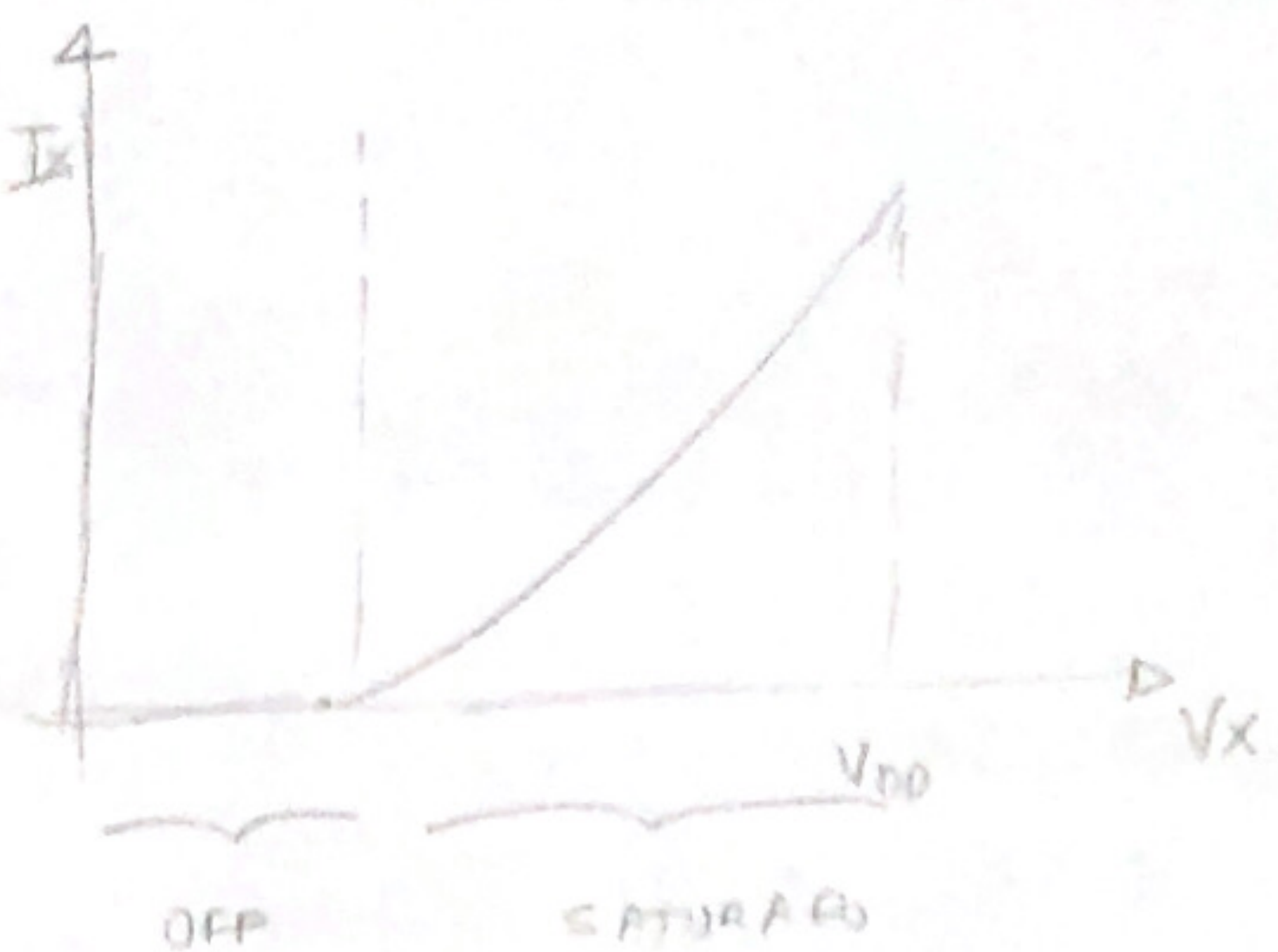
(b)



(d)



(c)



6-33)
a)

$$V_{DS} = V_{DD} - I_D R_D = V_{DD} - R_D \cdot \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 (1 + \lambda V_{DS})$$

$$= 1.8 - 100 \frac{1}{2} 200 \left(\frac{20}{0.18}\right) (1 - 0.4)^2 (1 + \lambda V_{DS}) \Rightarrow V_{DS} = 1.35V$$

$V_{DS} > V_{GS} - V_{TH}$ $\quad g_m = \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH}) = (200)\left(\frac{20}{0.18}\right)(1 - 0.4)$

$\simeq 0.013 \ 1/\Omega$

$$R_o = \frac{1}{\lambda I_D} = \frac{1}{\lambda \left(\frac{V_{DD} - V_{DS}}{R_D}\right)} = \frac{1}{0.1 \left(\frac{0.45}{100}\right)} = 2222\ \Omega.$$

7.17)

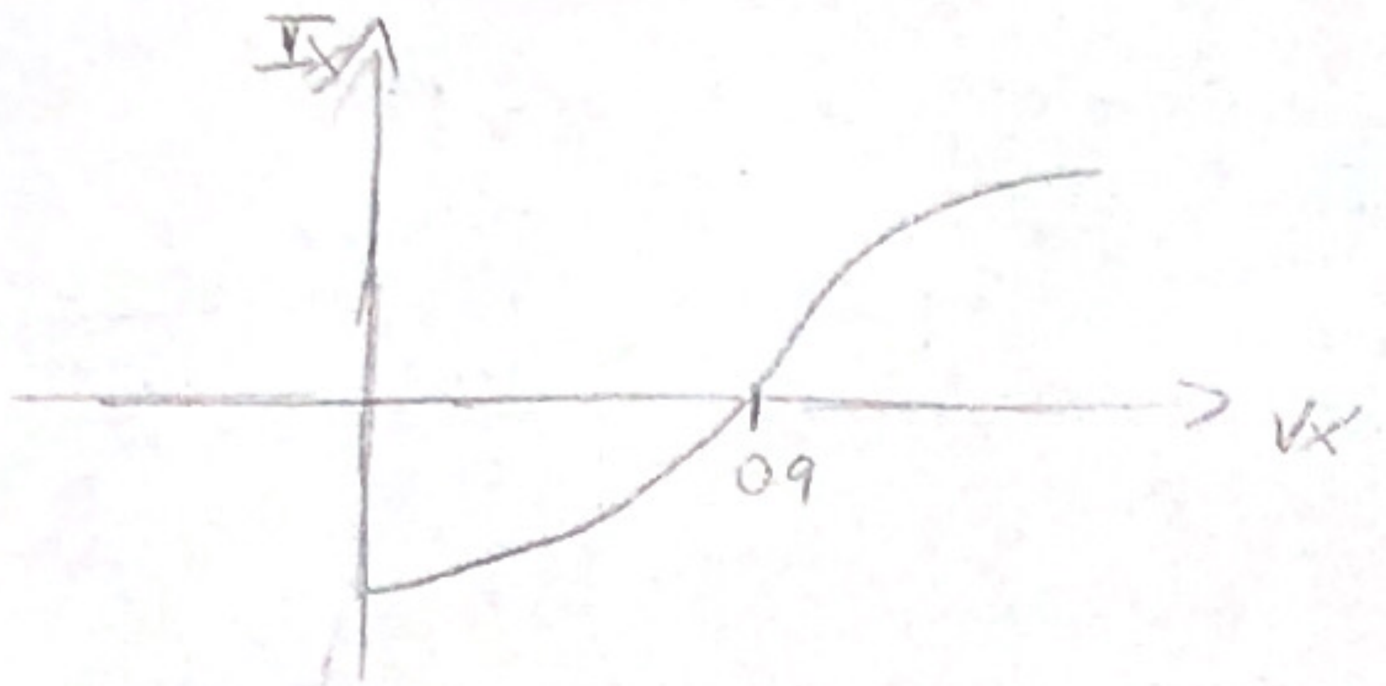
a) $I_{D1} = \frac{1}{2}(200\times 10^{-6})\left(\frac{5}{0.18}\right)(V_B - 0.4)^2 = (2 + 0.1\times 0.8) \Rightarrow V_B = 0.806\ V$

b) há 3 regiões de operação

- $V_X < V_B - V_{TN}$ (triodo) $|I_{DS2}| > |I_{DS1}|$
- $|V_X - V_{DD}| > |V_B - V_{DD} - V_{TH}|$ (triodo) $I_{DS1} > |I_{DS2}|$
- $V_B - V_{TH} < V_X$ $|V_X - V_{DD}| < |V_B - V - V_{TH2}|$

M_1 e M_2 em saturação e $I_{S1} = |I_{DS2}| = 0.5\ mA$ $V_X = 0.9V$

Todos os casos $\Rightarrow$ $I_X = I_{DS1} - |I_{DS2}|$



7.19) $(A_V) = 5$ $\rightarrow$ $P(W) = I_{DS}\times V_{DD}$ $P < 1\,mV$ $I_{DS}\cdot 1.8 \leq 1\,mV$

$g_m R_D = 5$ $I_{DS} \leq 0.556\ mA$ $g_m = \sqrt{2 A I_{DS}}$

$g_{m\,max} = \sqrt{2\times 200\times 10^{-6}\times\left(\frac{20}{0.19}\right)\times 0.556\ mA} = 0.00487\ \Omega^{-1}$ $R_D = \frac{5}{0.00487}$

$= 1006\ \Omega$

15.25) Considere os circuitos a) b) c) respectivamente

Considere os gráficos 1) 2) 3) respectivamente

a) $\rightarrow$ 1) b) $\rightarrow$ 3) c) $\rightarrow$ 2)

15.28) $R_D = 2K$ $\left(\frac{W}{L}\right)_1 = 3/0.18$ $\left(\frac{W}{L}\right)_2 = \frac{5}{0.18}$ $V_{OL}, V_{OH}, V_{margin} = ?$

$I_{D2} = \frac{1}{2}\mu_p C_{ox}\left(\frac{W}{L}\right)_2\left[2(V_{DD} - V_{TH2})(V_{DD} - V_{out}) - (V_{DD} - V_{out})^2\right]$

$\frac{V_{OUT}}{R_D} = \frac{1}{2}\mu_p C_{ox}\left(\frac{W}{L}\right)_2\left[2(V_{DD} - V_{TH})(V_{DD} - V_{out}) - (V_{DD} - V_{OUT})^2\right]$

$V_{OUT}^2 - 0.2\,V_{OUT} - 1.44 = 0$ $V_{OUT} = V_{OH} = 1.348\ V$

ⓐ $V_{in} = V_{OUT}$

$I_{D2} = I_{D1} + \frac{V_{OUT}}{R_P}$ $\quad \frac{1}{2} \mu_p C_{ox} \left(\frac{W}{L}\right)_2 \left(V_{DD} - V_{in} + |V_{TH2}|\right)^2 =$

$$\frac{1}{2} \mu_n C_{ox} \left(\frac{W}{L}\right)_1 \left(V_{in} - V_{TH1}\right)^2 + \frac{V_{OUT}}{200}$$

$0.05 V_{OUT}^2 + 0.59 V_{OUT} - 0.3945 = 0 \rightarrow V_{in} = V_{OUT} = 0.6V$