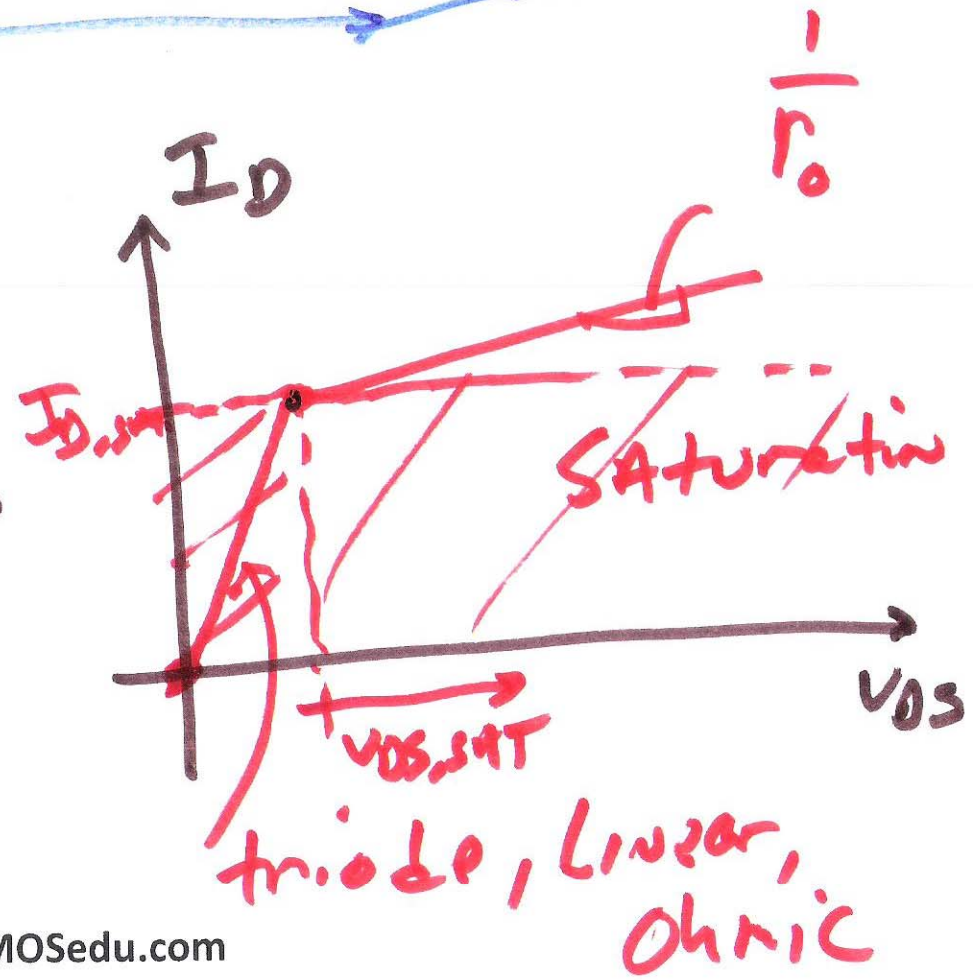
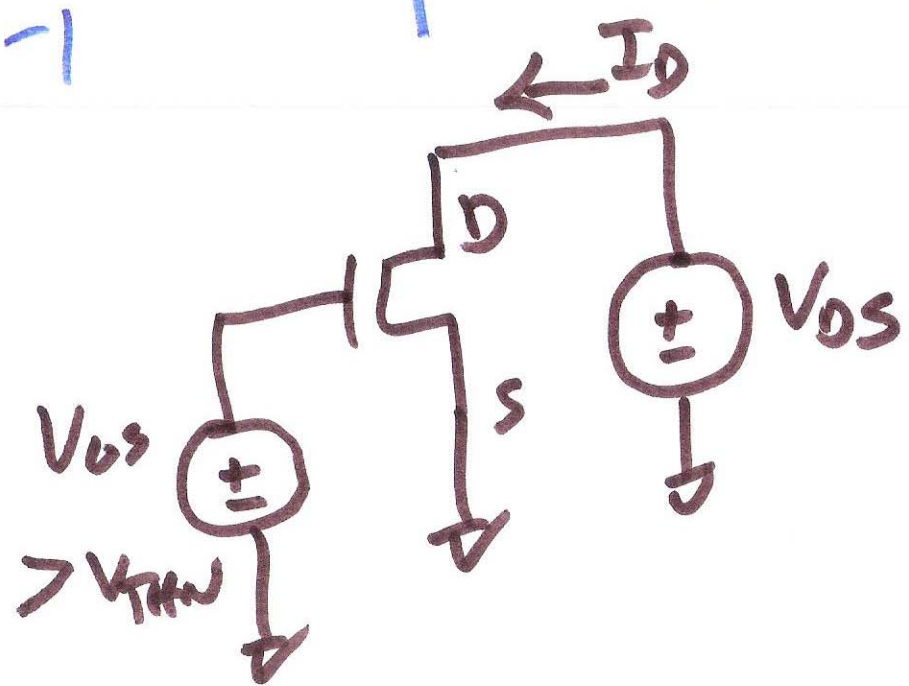
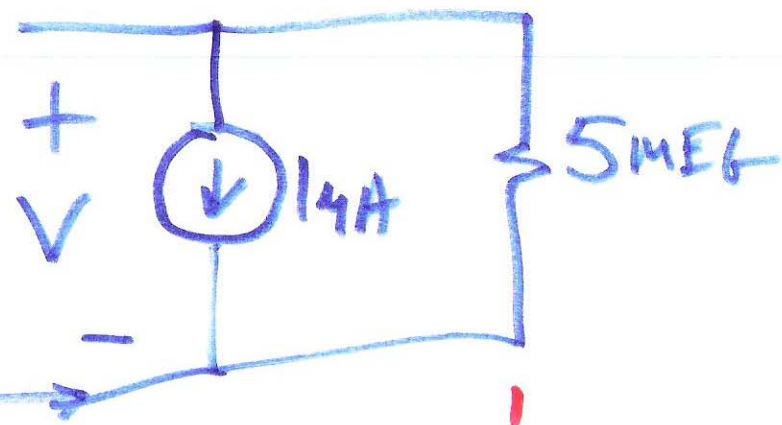
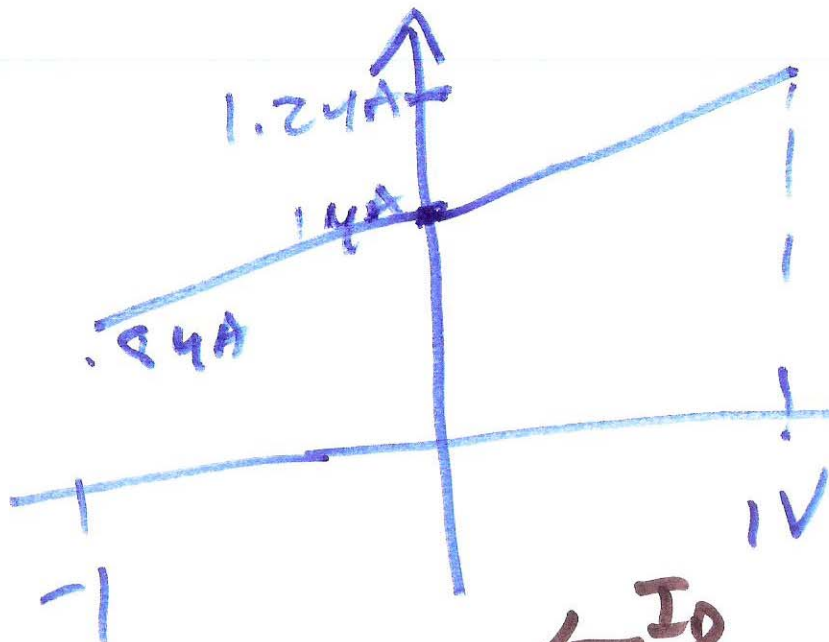


1)



2)

NMOS, Long-channel devices

$$I_D = \frac{K_{PN}}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2 (1 + \lambda (V_{DS} - V_{DS,SAT}))$$

$V_{DS} \geq V_{GS} - V_{THN}$
 $I_D = I_{D,SAT} + I_{D,SAT} \cdot \lambda (V_{DS} - V_{DS,SAT})$

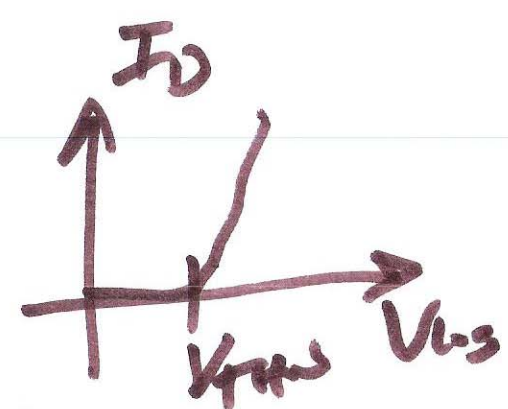
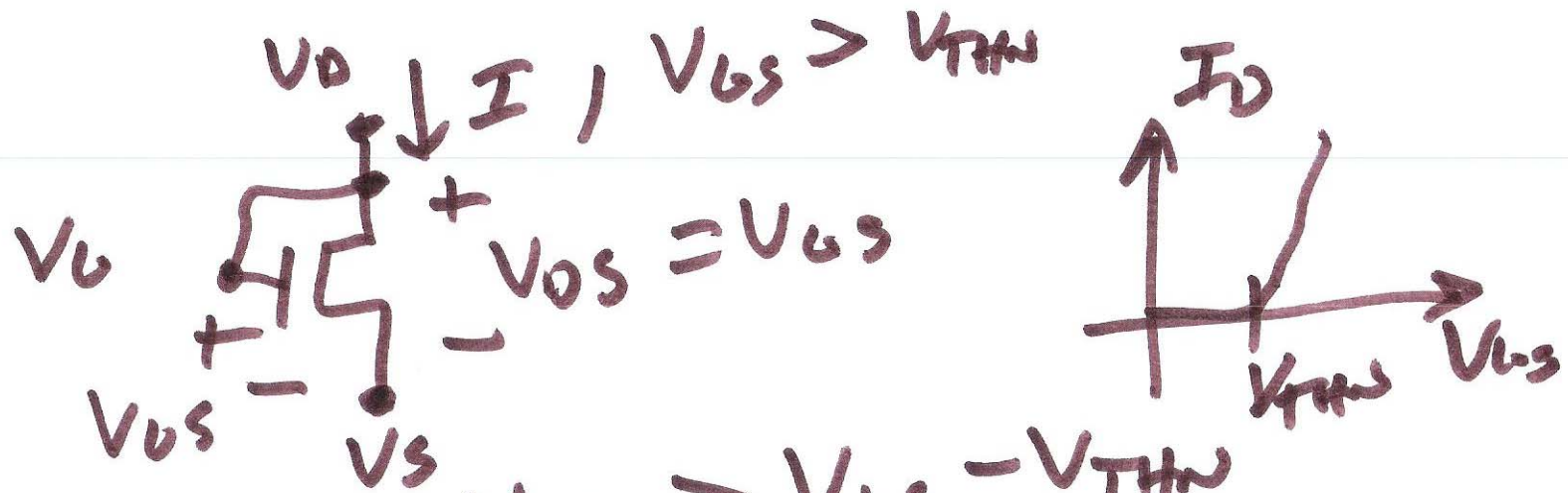
$V_{DS,SAT}$ overdrive voltage, V_{OVN}

$$V_{GS} \geq V_{THN}$$

$$I_{D,SAT} = \frac{K_{PN}}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2$$

$$= \frac{K_{PN}}{2} \cdot \frac{W}{L} (V_{DS,SAT})^2$$

$r_o = \frac{1}{\lambda I_{D,SAT}}$



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

$$V_D - V_S \geq V_G - V_S - V_{THN}$$

$$V_D = V_G$$

$$0 \geq -V_{THN}$$

Always true

$$V_{DS} \rightarrow V_{SD}$$

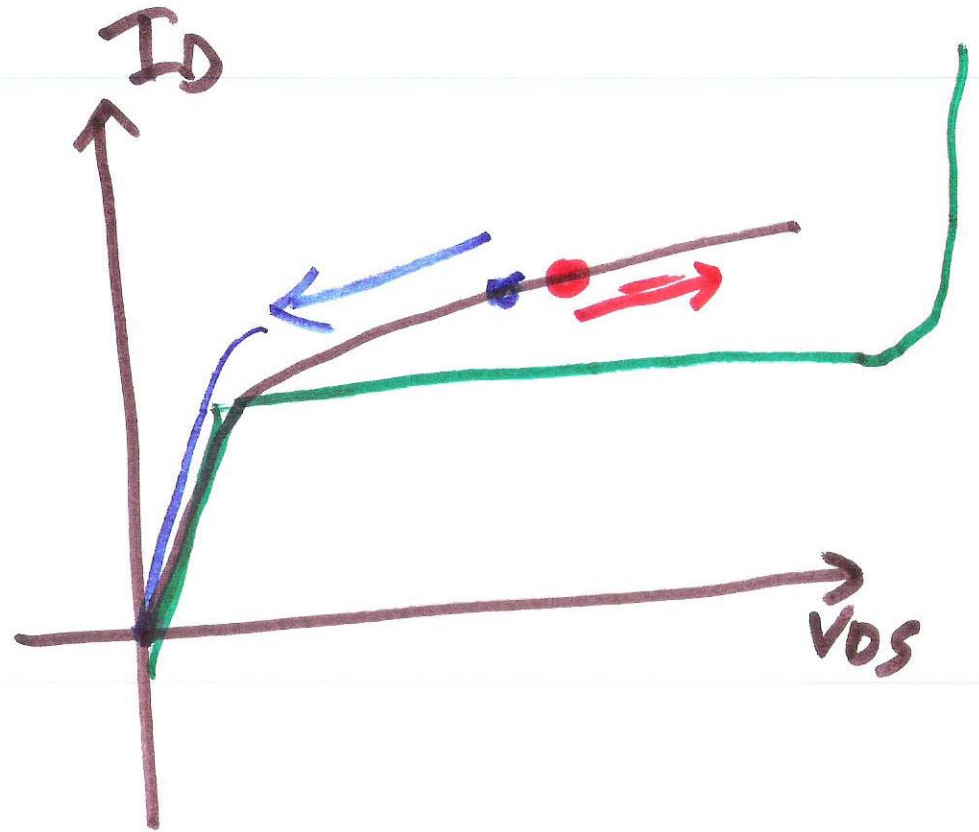
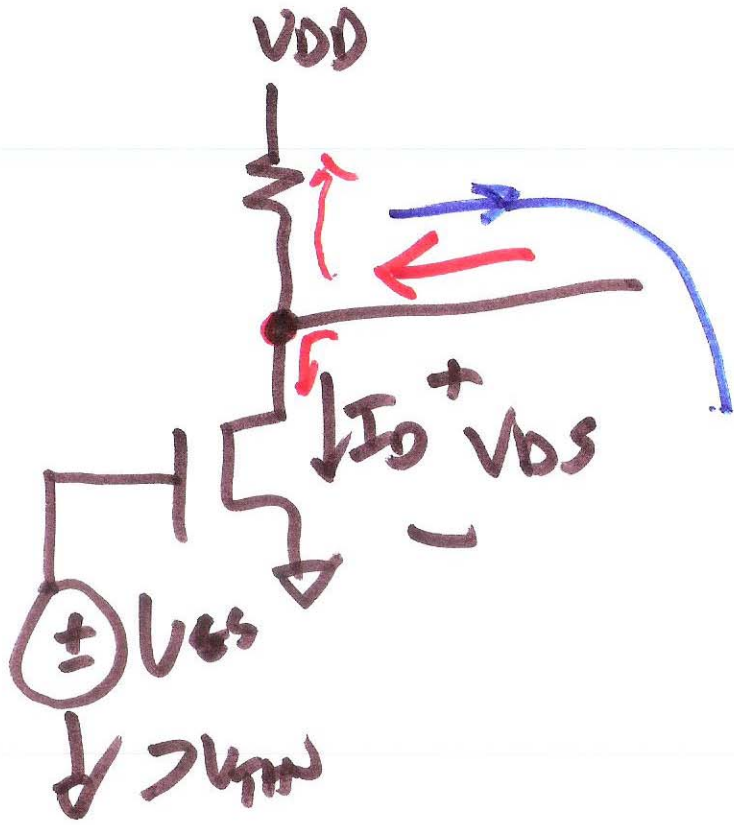
$$V_{DS} \rightarrow V_{SG}$$

$$V_{THN} \rightarrow V_{THP}$$

$$I_D = \frac{K_{PP}}{2} \cdot \frac{W}{L} (V_{SG} - V_{THP})^2$$

$$\left(1 + \lambda (V_{SD} - V_{SD,SAT})\right)$$

$$\beta_N = K_{PN} \cdot \frac{W}{L} \quad \beta_P = K_{PP} \cdot \frac{W}{L}$$



b)