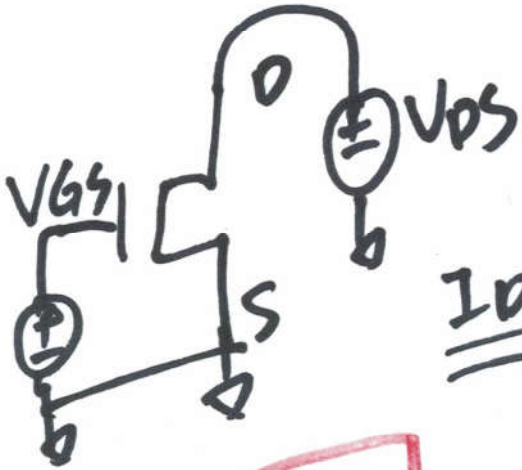


DC Operating Point of the CMOS

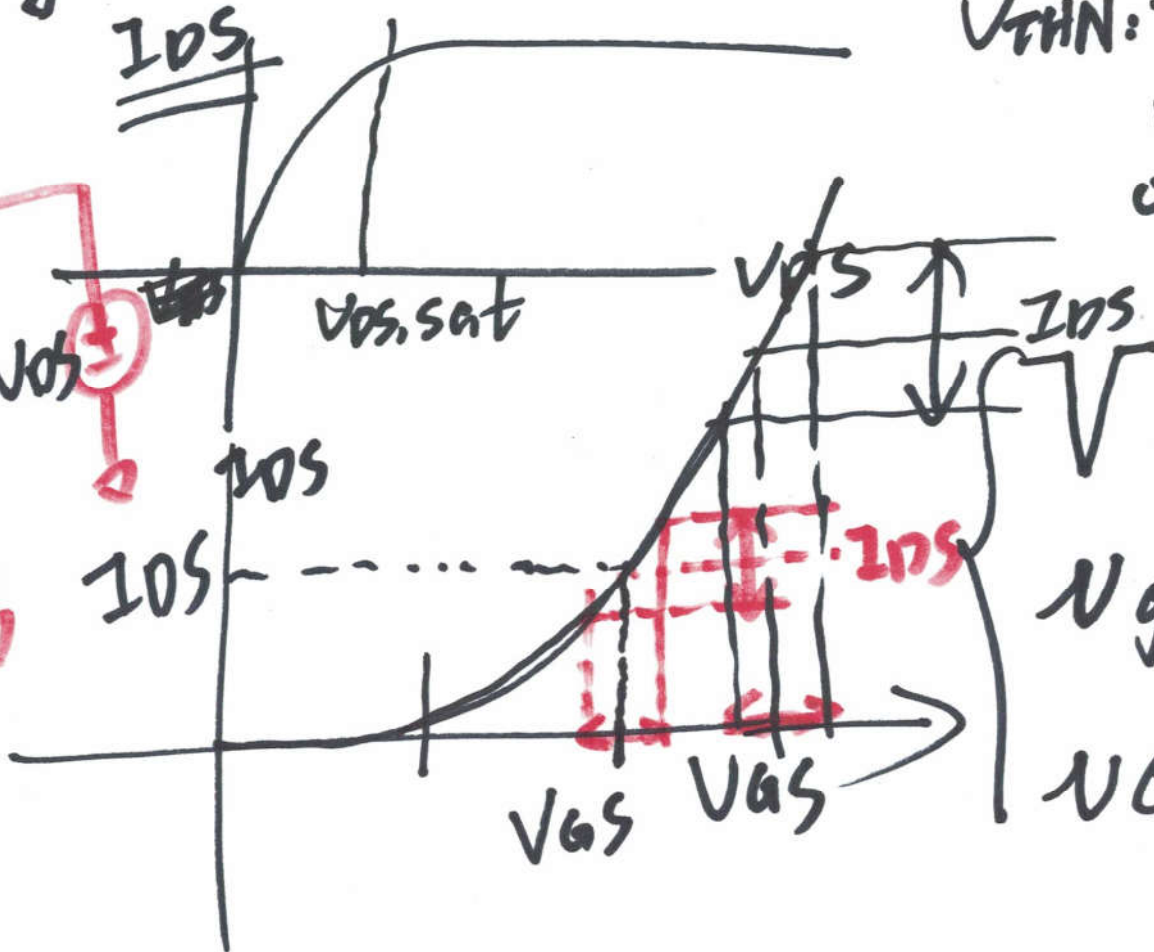
NMOS in Saturation:

$$I_{DS} = \frac{K_P N}{2} \frac{W}{L} (V_{GS} - V_{THN})^2 \quad (\text{Square-Law Equation})$$

$V_{GS} - V_{THN} = V_{DS, sat}$



V_{THN} : Threshold voltage of the NMOS.



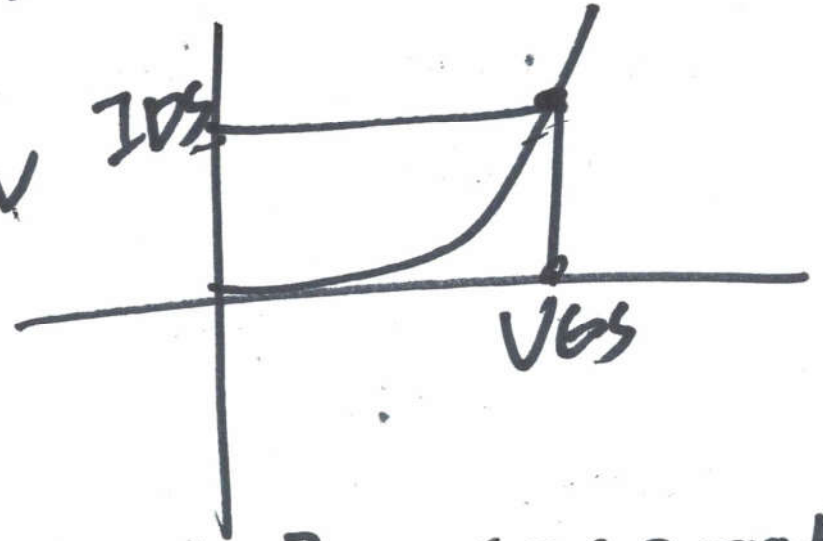
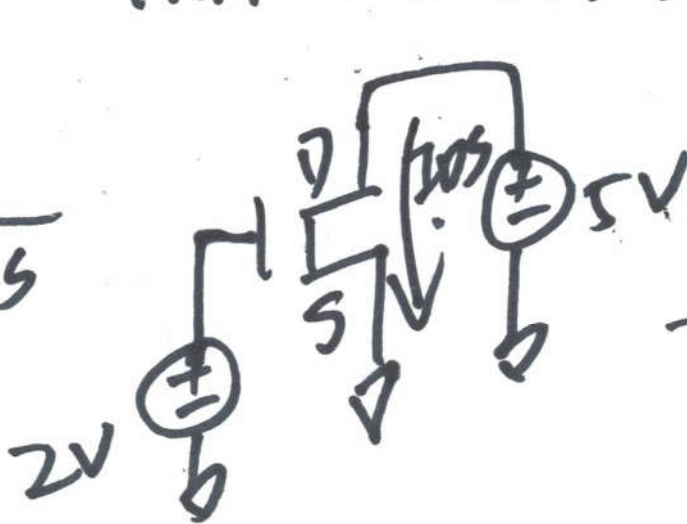
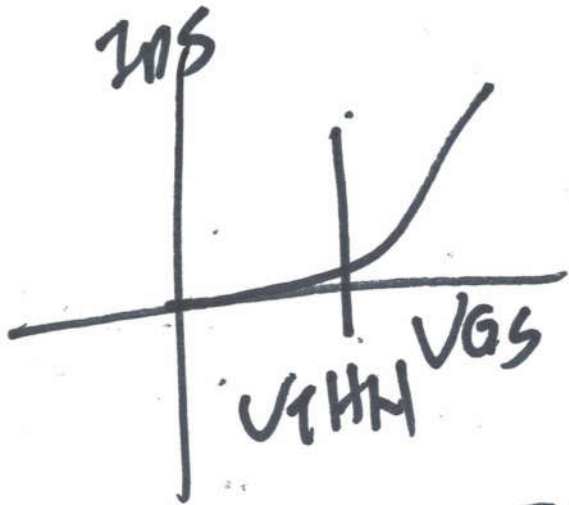
V_{GS} : Pure DC

V_{gs} : Pure AC

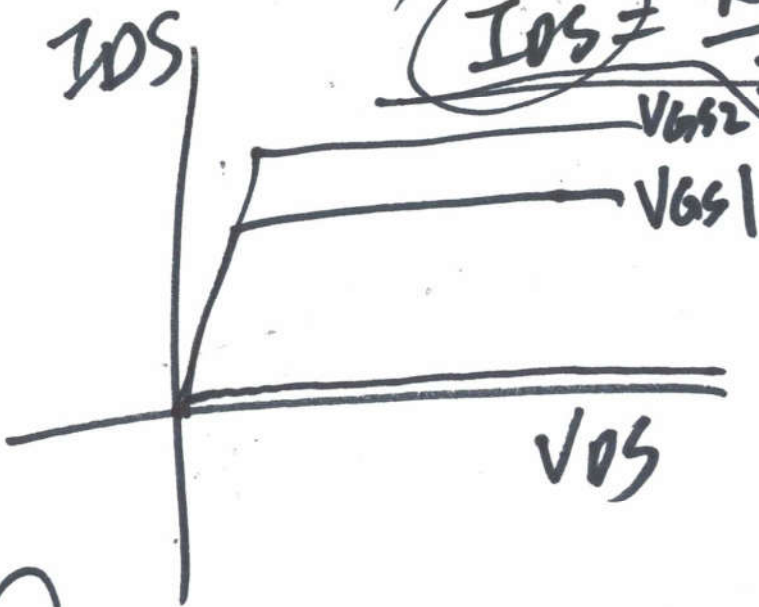
V_{GS} : AC + DC

Example: $W = 10 \mu\text{m}$, $L = 1 \mu\text{m}$, $K_{PN} = 100 \mu\text{A}/\text{V}^2$

$V_{THN} = 1\text{V}$, $I_{DS}?$



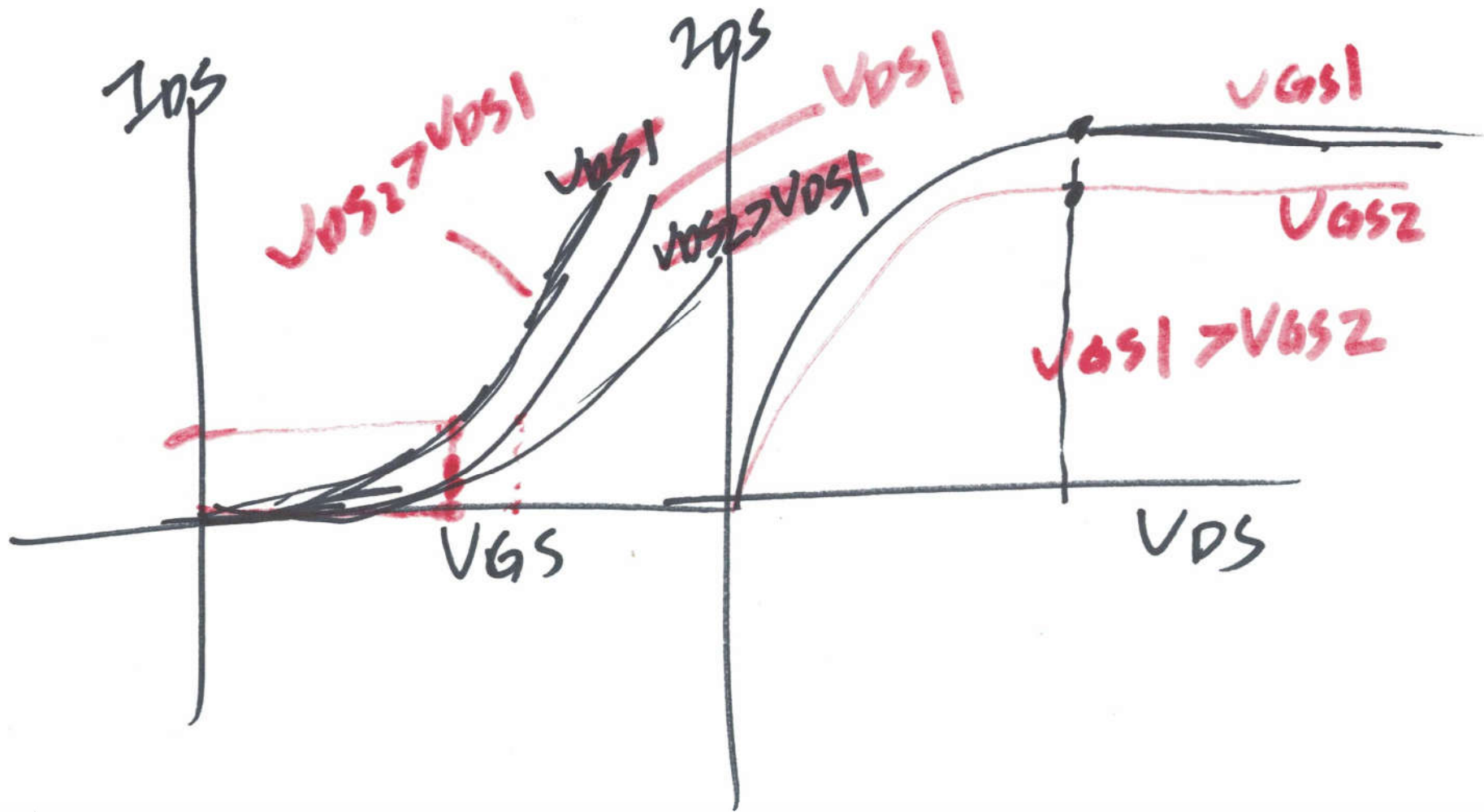
$I_{DS} = \frac{K_{PN} W}{2 L} (V_{GS} - V_{THN})^2$ (DC operating point)



$$= \frac{100 \mu\text{A}/\text{V}^2}{2} \frac{10 \mu\text{m}}{1 \mu\text{m}} (2 - 1)^2 \text{ (0.5)}$$

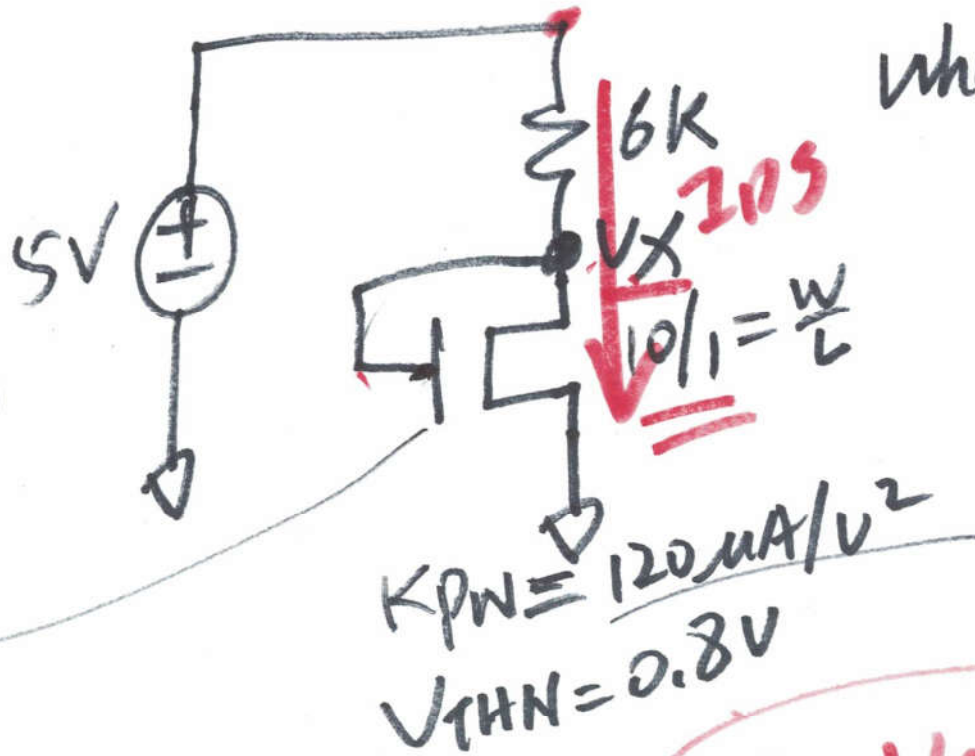
$$= 500 \mu\text{A}$$

(2)



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Always saturation



What is I_{DS} ?
 V_{GS} ?
 V_x ?

$$V_x = V_{GS} = V_{DS}$$

$$= 5V - 6k \cdot I_{DS}$$

$$I_{DS} = \frac{K_{PN} W}{2 L} (V_{GS} - V_{THN})^2$$

$$V_{DS} > V_{DS, sat}$$

$$= V_{GS} - V_{THN}$$

$$V_{DS} = V_{GS}$$

$$I_{DS} = V_{GS} - V_{THN}$$

$$= V_{DS} - V_{THN}$$

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