

EE421 / ECG 621

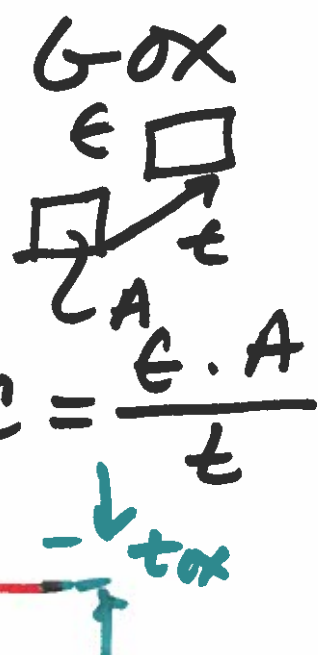
Digital IC Design

$$\frac{\epsilon_{ox}}{t_{ox}} = C'_{ox} \left(\frac{F}{4\pi \cdot qn} \right)$$

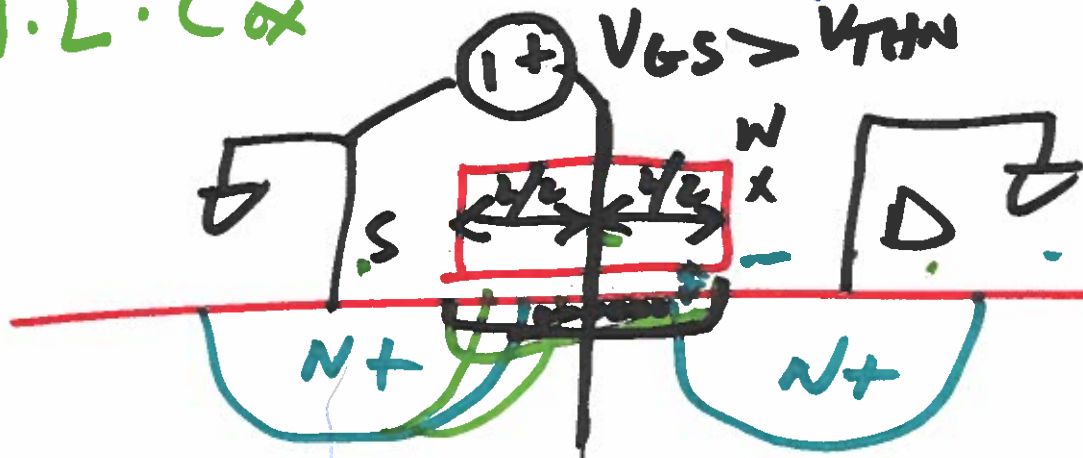
Lecture 12

OCT. 7, 2019

$$C_{ox} = W \cdot L \cdot C'_{ox}$$

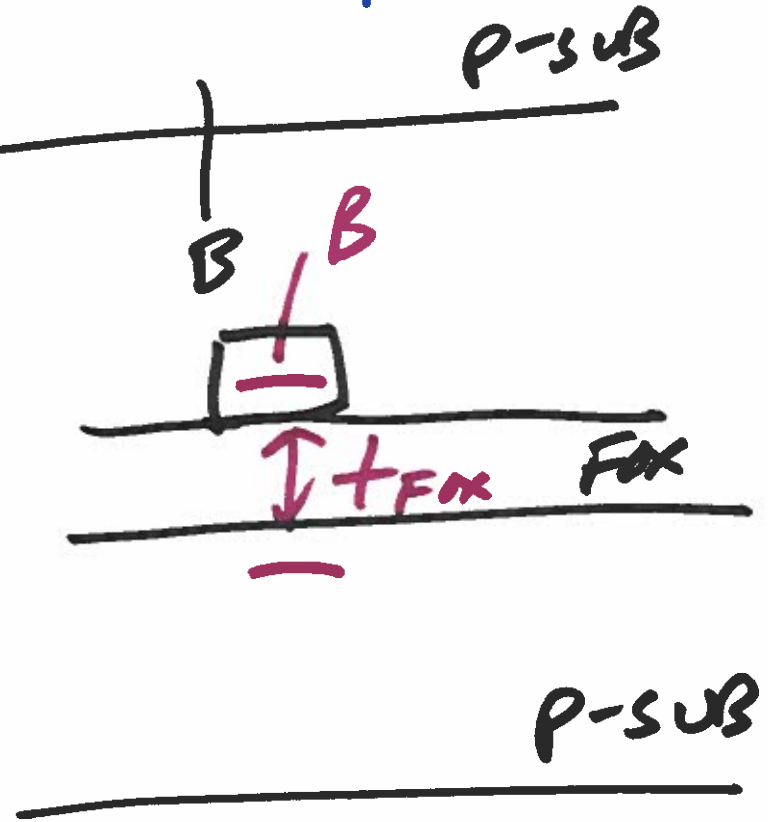
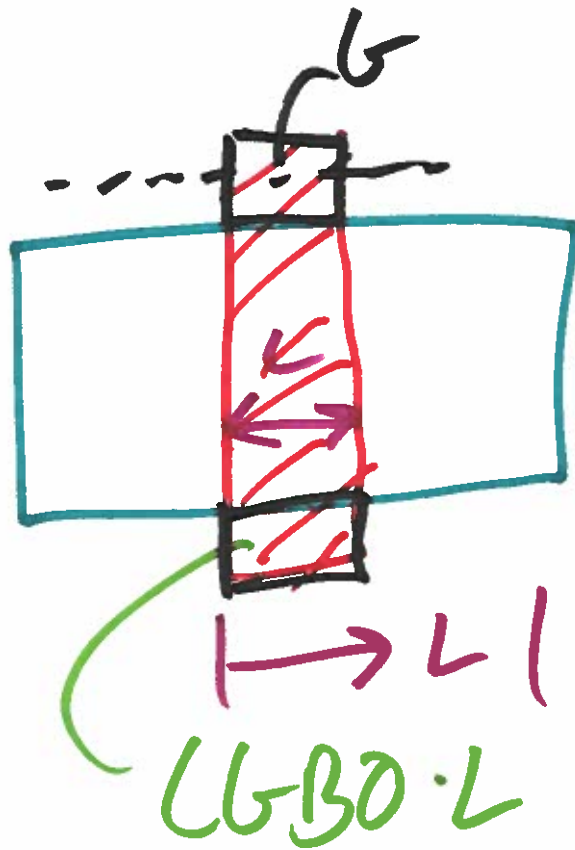
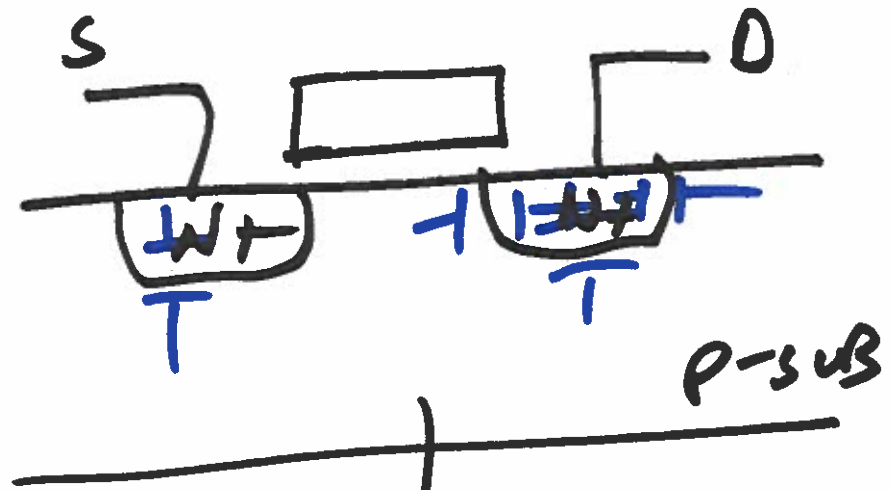
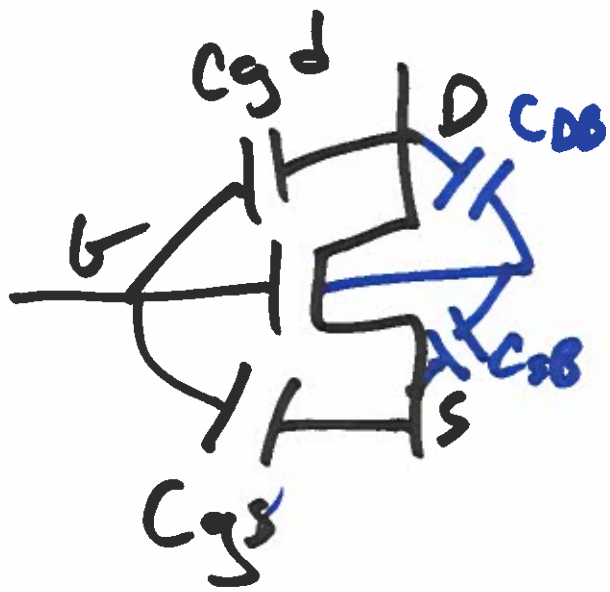


FOF

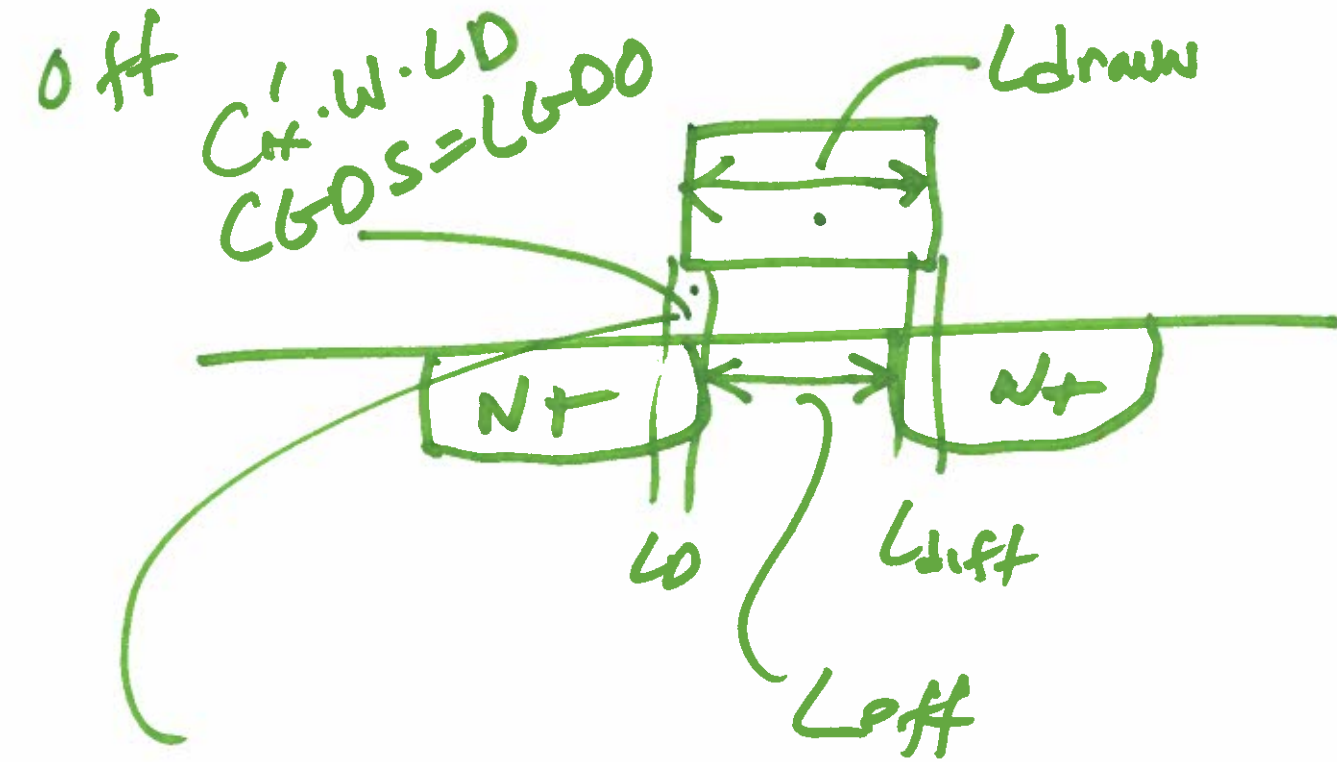


$$C_{gs} = C_{gd} = C'_{ox} \cdot W \cdot \frac{L}{2} = \frac{1}{2} C_{ox}$$

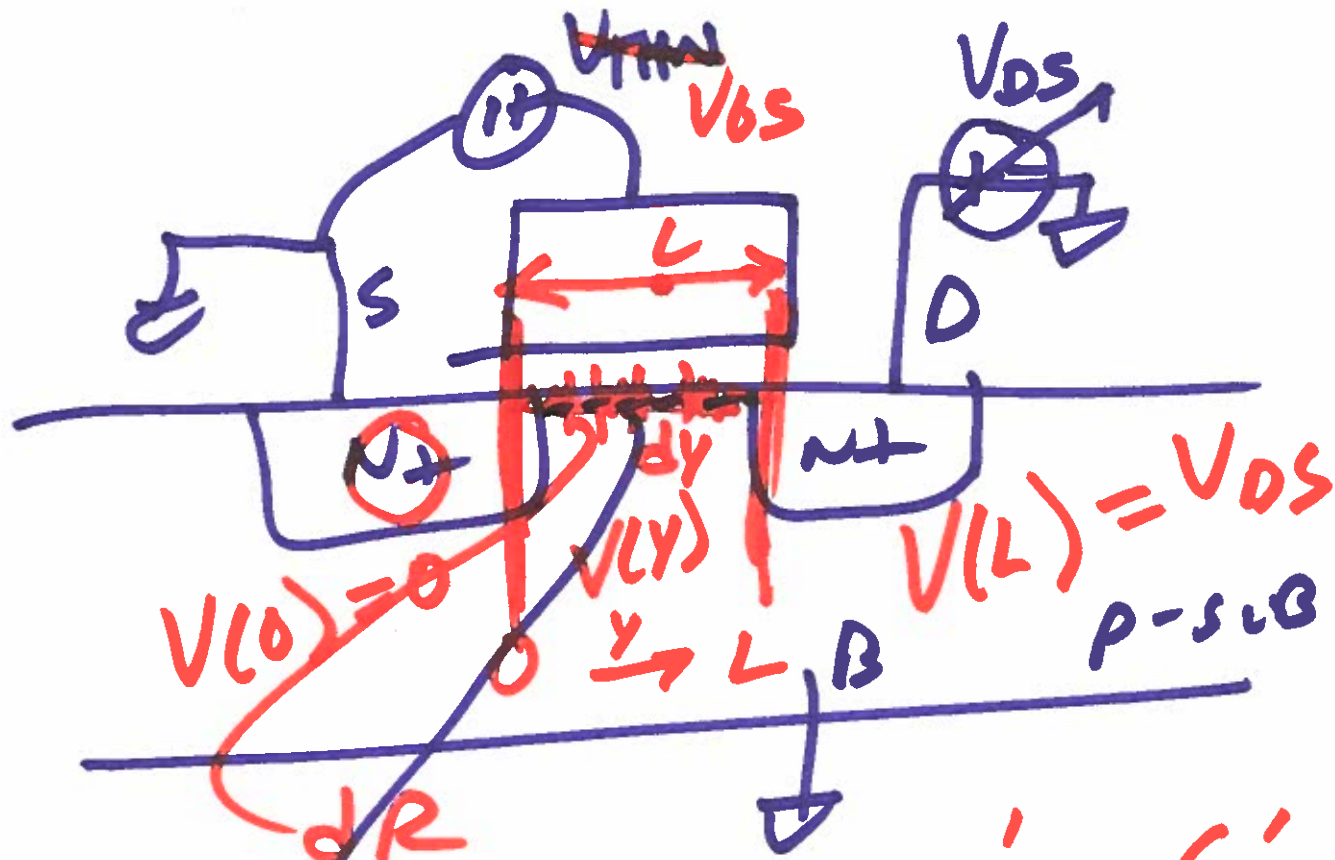
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2)



$$C_{gb} = C_{GDO} \cdot L + C_{ox}' \cdot W \cdot L_{eff}$$



$$\int_0^L dR = R \quad Q'_{bo}$$

$$Q'_{ch} = C'_{ox} (V_{GS} - V(y))$$

$$Q'_b = C'_{ox} \cdot V_{THN}$$

$$Q'_I = Q'_{ch} - Q'_b \quad V_{DS}$$

$$= C'_{ox} \cdot (V_{GS} - V_{THN} - V(y))$$

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$$dR = \frac{1}{Q_I'(y) \cdot \mu_n} \cdot \frac{dy}{W}$$

$\mu = \text{Mobility} = \frac{\text{Velocity of carriers}}{\text{Electric field}}$



$$dV(y) = I_0 \cdot dR = \frac{I_0}{Q_I'(y) \cdot \mu_n} \cdot \frac{dy}{W}$$

$$I_0 \cdot dy = dV(y) \cdot Q_I'(y) \cdot \mu_n \cdot W$$

5)

$$\int_0^L I_D \cdot dy = \int_0^{V_{DS}} W \mu_n \cdot C'_{ox} \cdot (V_{GS} - V_{THN} - V(y)) \cdot dV(y)$$

$$K_{PN} = \mu_n \cdot C'_{ox} = \mu_n \cdot \frac{\epsilon_{ox}}{t_{ox}}$$

$$K_{PP} = \mu_p \cdot C'_{ox} = \mu_p \cdot \frac{\epsilon_{ox}}{t_{ox}}$$

$$I_D \cdot L = W \mu_n C'_{ox} \left[\int_0^{V_{DS}} V_{DS} \cdot dV(y) - \int_0^{V_{THN} \cdot V_{DS}} V_{THN} \cdot dV(y) - \int_0^{V_{DS}} V(y) \cdot dV(y) \right]$$

$\frac{1}{2} V_{DS}^2$

b)

$$I_0 \cdot L = W \mu_n C_{ox} \left(V_{GS} - V_{THN} - \frac{1}{2} V_{DS} \right) V_{DS}$$

$$I_0 = \frac{W}{L} \mu_n \cdot C_{ox} \left((V_{GS} - V_{THN}) V_{DS} - \frac{V_{DS}^2}{2} \right)$$

Triode

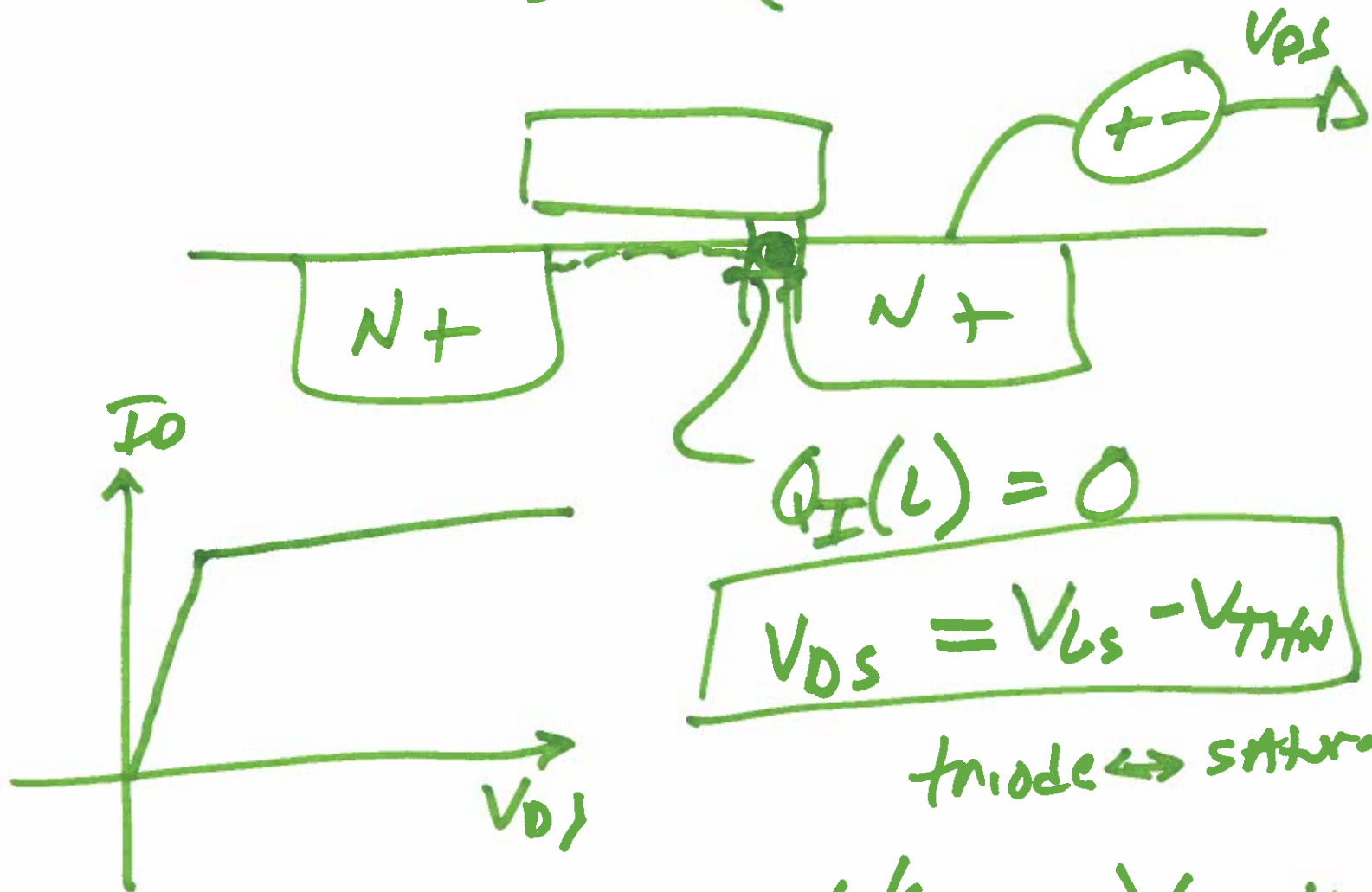
$$V_{GS} > V_{THN}$$

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

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



$$Q_I = C_{ox}' (V_{GS} - V_{THN} - V_{DS})$$



$$Q_I(L) = 0$$

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

triode ↔ saturation

$$I_D = \frac{W}{L} \mu_n C_{ox}' \left((V_{GS} - V_{THN})(V_{GS} - V_{THN}) - \frac{(V_{GS} - V_{THN})^2}{2} \right)$$

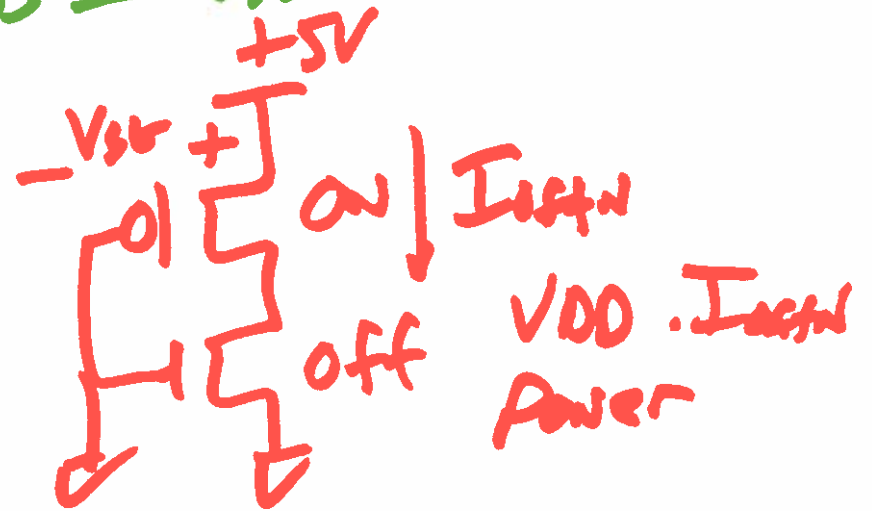
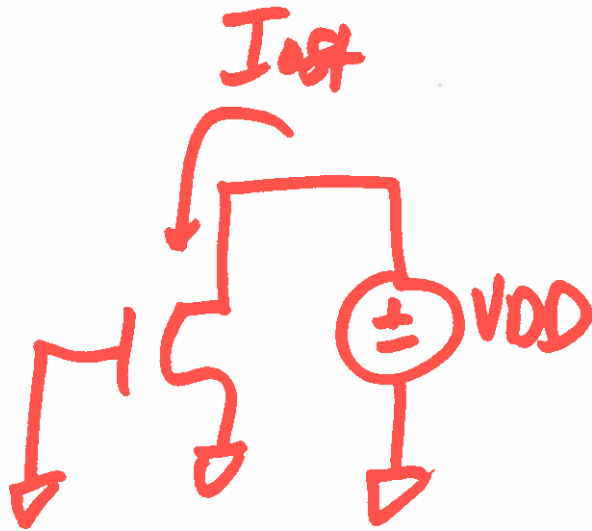
8)

SATURATION

$$I_D = \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{THN})^2$$

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

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



9)