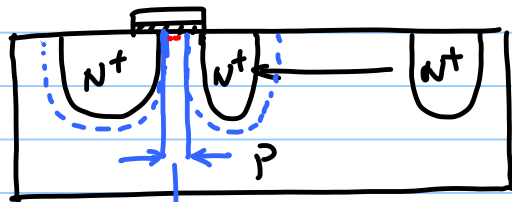EE5311

Module-1 - The Transistor
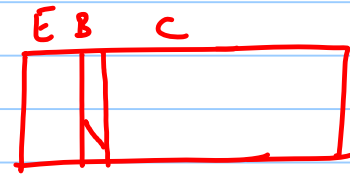
Short Channel Effects

1) CLM
2) DIBL
3) Velocity Sat

Level 1 spice model : $\left(k', \lambda, V_{DSAT}, V_{THO}, \gamma \right)$

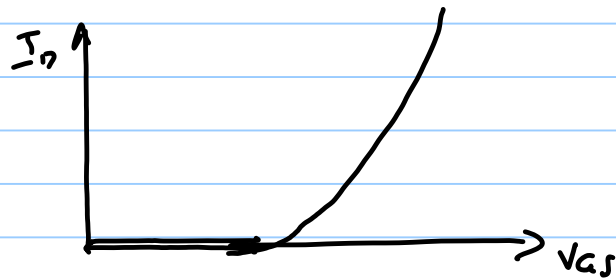## SUBTHRESHOLD LEAKAGE

THIN P REGION

$$I_{OFF} = I_0 \, e^{\left(\frac{V_{GS}-V_T}{n\phi_T}\right)} (1 - e^{-V_{DS}/\phi_T}) (1 + \lambda V_{DS}) \qquad (\sim nA)$$

SUB THRESHOLD   SLOPE (S)

$$\log_{10} I_D = \log_{10}(I_0) + \left(\frac{V_{GS} - V_T}{n\phi_t}\right) \cdot \log_{10} e + \cdots$$

$$\frac{d \log_{10} I_D}{dV_{GS}} = \frac{\log_{10} e}{n\phi_T}$$

$$S = \frac{1}{\left(\frac{d \log_{10} I_D}{dV_{GS}}\right)} = \frac{n\phi_T}{\log_{10} e} = \left(\log_e^{10} \, n\phi_T\right) \quad (1.5 = n)$$

$$= \log_e^{10} \times 1.5 \times 25mv \Big/ \text{decade}$$

$$\sim 90 \; mv/\text{decade}.$$

$\log(I_D)$

$V_{GS} = -0.3V$

GIDL

V_T

V_{GS}