Ex : 0.8 μm fabrication proces
NMOS transistor

$t_{ox} = 8nm$

$\mu_n = 450 \frac{cm^2}{V\text{-}s}$

$W = 8\mu m$

$L = 0.8\mu m$

$V_t = 0.7V$

a) $C_{ox} = \frac{\epsilon_r \epsilon_0}{t_{ox}} = \frac{(3.9)(8.85 \times 10^{-12} F/m)}{8 \times 10^{-9} m}$

$C_{ox} = 4.31 \times 10^{-3} \frac{F}{m^2}$

b) $k'_n = \mu_n C_{ox}$

$= \frac{450 cm^2}{V\text{-}s} \left| \frac{4.31 \times 10^{-3} F}{m^2} \right| \frac{1 m^2}{100^2 cm^2}$

$= 194.15 \times 10^{-6} \frac{F}{V\text{-}s}$

$q = CV \qquad C = \frac{q}{V} = \left[\frac{C}{V}\right]$

$[F]$

b) cont

$$k'_n = 194.15 \times 10^{-6} \quad \frac{C/V}{V\text{-}s} = \frac{C}{s} \cdot \frac{1}{V^2}$$

$$k'_n = 194.15 \times 10^{-6} \quad \frac{A}{V^2}$$

$$k'_n = 194.15 \quad \frac{\mu A}{V^2}$$

c) NMOS $\Rightarrow$ $i_D = 100\,\mu A$

edge of saturation

$\rightarrow$ $v_{DS} = v_{GS} - V_t$

$$i_D = \frac{1}{2} k'_n \frac{W}{L} (v_{GS} - V_t)^2 = 100\,\mu A$$

$$i_D = \frac{1}{2}\left(194.15 \frac{\mu A}{V^2}\right)\left(\frac{8\,\mu m}{.8\,\mu m}\right)(v_{GS} - 0.7)^2$$

$$100 = \frac{1}{2}(194.15)(10)(v_{GS} - V_t)^2$$

$$v_{GS} = 1.02\,V$$

$$v_{DS} = v_{GS} - V_t$$

$$= 1.02 - 0.7$$

$$v_{DS} = 0.321\ V$$

v_{OV}, V_{OV} } overdrive voltage

$$v_{OV} = v_{GS} - V_t$$

$$V_{OV} = V_{GS} - V_t$$

- v_{GS} or i_D => ac + dc components
- V_{GS} or I_D => dc only
- v_{gs} or i_d => ac only (small signal)

EX 2 NMOS (from EX1) is in triode
v_{DS} is very small

NMOS device acts like 1000 Ω resistor. What is v_{GS}?

$$r_{ds} = \frac{v_{DS}}{i_D} = \frac{1}{k'_n\left(\frac{W}{L}\right)(v_{GS} - V_t)}$$

$$r_{ds} = \frac{1}{(194.15 \times 10^{-6})(10)(v_{GS} - 0.7)} = 1000$$

$$\boxed{v_{GS} = 0.915 \text{ V}}$$