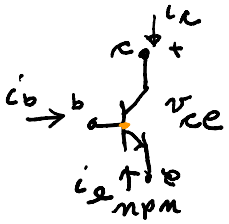
EE 303H
09/03/09

Transistors = transfer resistor

BJT = bipolar junction transistor

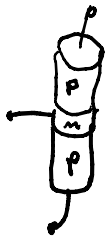
MOS = metal oxide silicon

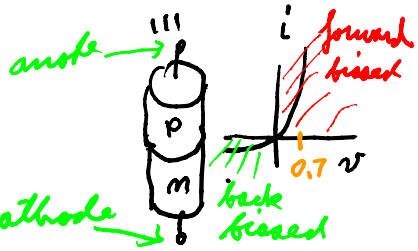
BJT



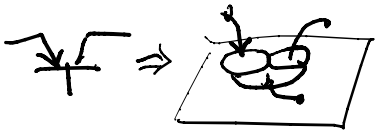
e = emitter
b = base
c = collector

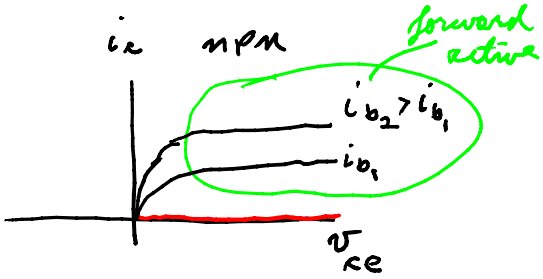
diode

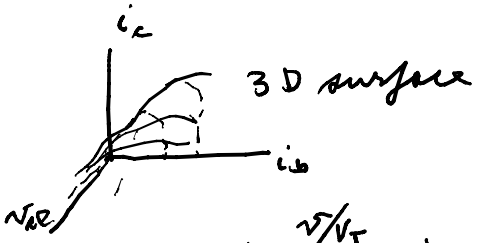




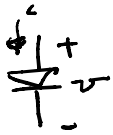
original







has equations which are exponential since in constructing the base is very thin

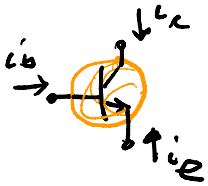


$i = I_S\left(e^{v/V_T} - 1\right)$

I_S = saturation current

V_T = thermal voltage $= \frac{kT}{|q|}$; T = temperature

set $|i_c| \approx |i_e|$



$i_b + i_c + i_e = 0$ by KCL

Here $i_c = -\alpha i_e$; $\alpha \approx 1$, < 1

$i_b + i_c + \left(-\frac{1}{\alpha} i_c\right) = 0$

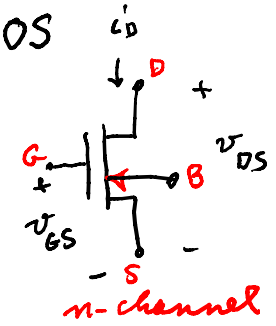
$i_b = \left(\frac{1}{\alpha} - 1\right) i_c = \frac{1-\alpha}{\alpha} i_c$

$\Rightarrow i_c = \frac{\alpha}{1-\alpha} i_b = \beta i_b$

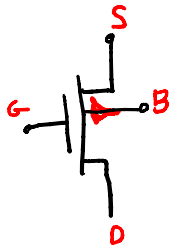
β = beta $= \frac{\alpha}{1-\alpha}$ large ($\approx 50 \to 500$)

(forward beta = β_F = BETAF)

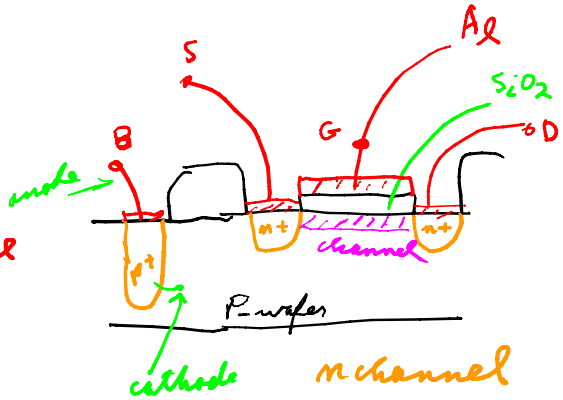
MOS



n-channel

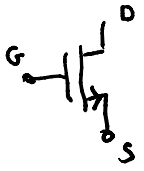


p-channel

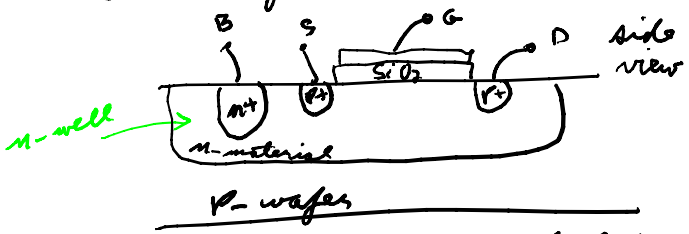


B = bulk
D = drain
G = gate
S = source

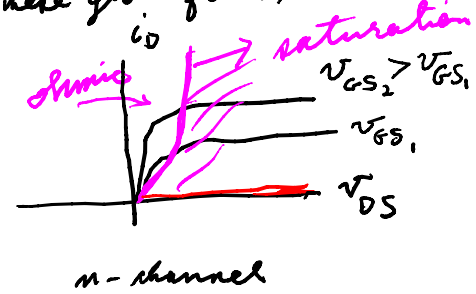
⇓ if B is connected to S



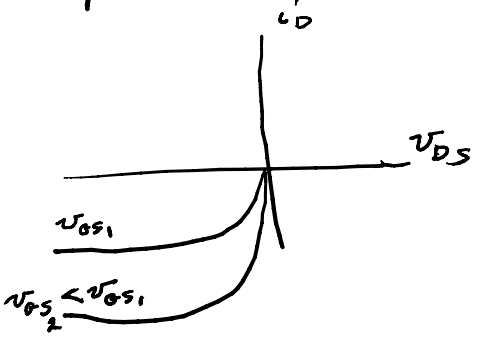
for a p channel



these give quadratic curves (if operate above threshold)



n-channel

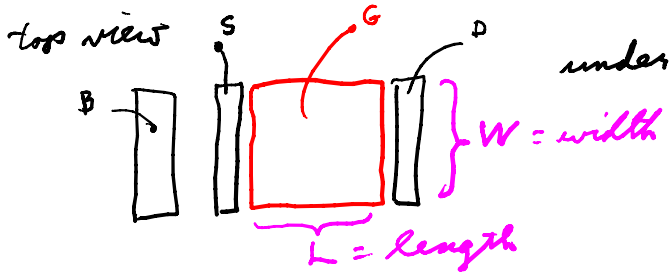


p-channel

equations

$$i_D = \begin{cases} 0 & \text{if } v_{GS} \le VTO = \text{turn on voltage} \\ \frac{KP}{2}\frac{W}{L}\begin{cases} (v_{GS}-VTO)^2 & \text{if } v_{DS} \ge v_{GS}-VTO \quad \text{saturation} \\ 2(v_{GS}-VTO)v_{DS} - v_{DS}^2 & \text{if } 0 \le v_{DS} \le v_{GS}-VTO \end{cases} \end{cases}$$

ohmic = triode



under G is the channel