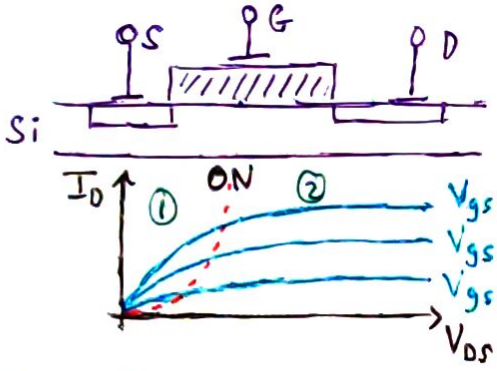
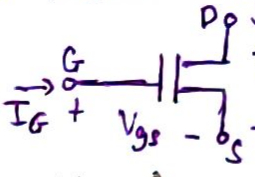
EECS 16B ##1.23 LECTURE 2

TRANSISTORS

MOSFET: Metal Oxide Semiconductor Field Effect Transistor





$I_G = 0$

$V_{gs} = 0$ } OFF ⓪

$V_{gs} < V_{th}$

Let V_{th}: [0.2, 0.3] V

0. OFF $V_{gs} < V_{th}$
1. ON $V_{gs} > V_{th}$ region near origin; "linear region"
2. ON $V_{gs} > V_{th}$ region to the right; "saturation"

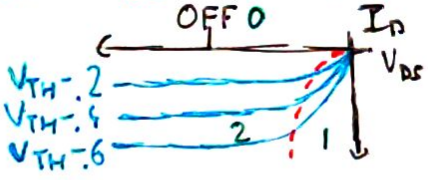
Regions 0 & 1 are good for implementing a switch.
Region 2 is good for implementing current sources, amplifiers, .., analog functions.

NMOS (1st MOSFET) see diagram & cross-section above

PMOS (2nd MOSFET)  cross-sec same, materials inverted

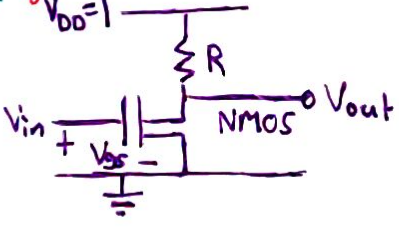
$V_{DS} \leq 0$ $I_D \leq 0$ V_{TH}: [-0.3, -0.2] V

at OFF, $V_{gs} = 0$, $V_{gs} \geq V_{TH}$



CMOS (complementary): has NMOS & PMOS

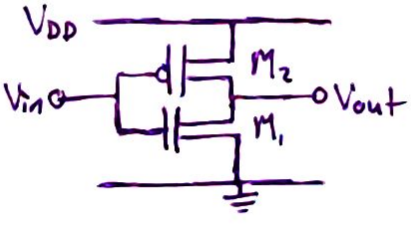
Inverter!



$V_{in} = 0 \Rightarrow V_{out} = V_{DD}$ OFF

$V_{in} = V_{DD} \Rightarrow V_{out} = 0$ ON

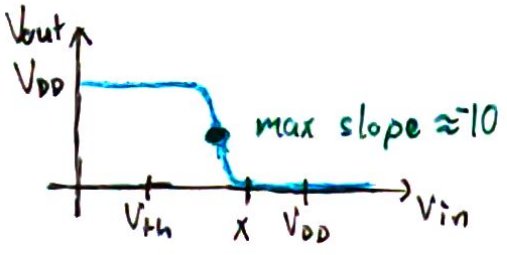
@ON, $I_D = V_{DD}/R$, $P = I_D V_{DD}$



$V_{in} = V_{DD} \Rightarrow V_{GS1} = V_{DD} > V_{TH} \Rightarrow M_1$ ON

$\Rightarrow V_{GS2} = 0 \Rightarrow M_2$ OFF

$V_{in} = 0 \Rightarrow V_{GS1} = 0, V_{GS2} = -V_{DD} \Rightarrow$ reverse



$$x = V_{DD} - |V_{thp}|$$