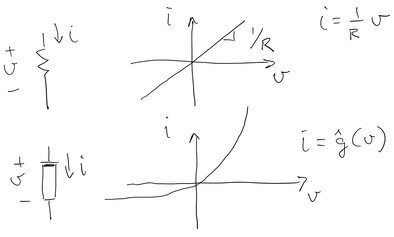
Intro to the MOSFET and digital electronics

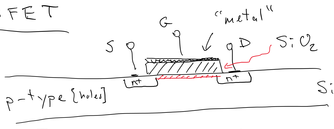
Monday, August 31, 2020 8:31 PM

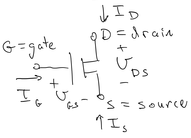
MOSFET = Metal Oxide Semiconductor Field Effect Transistor

- New device: transistor



MOSFET





gate G = control terminal

$I_G = 0$

* I think these 2 voltages $[V_{DS}, V_{GS}]$ to characterize all branch voltages.

$V_{DG} = V_{DS} - V_{GS}$ {KVL}

* How many terminal currents to char. behavior?

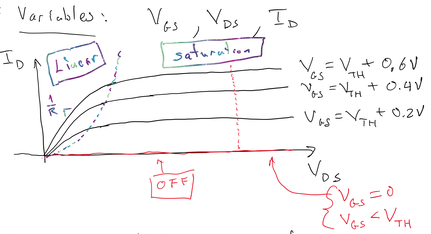
typically we use I_D and $I_G = 0$

[If we labeled I_S, would have

$I_S + I_D + I_G = 0$ {KCL}]

$I_G = 0 \Rightarrow I_S = -I_D$

* Variables: V_{GS}, V_{DS}, I_D



MOSFET: multiple regions of operation

(0) OFF $V_{GS} < V_{TH}$

(1) ON in "linear region" near origin

$V_{GS} > V_{TH}$; V_{DS} small

(2) ON in "saturation"

$V_{GS} > V_{TH}$, V_{DS} somewhat larger

Behaviors

(0) OFF is OFF

(1) linear ⟷ ON state of switch but with resistance

(2) saturation

$V_{DS} > 0$ constant

nice "analog" function; more V_{GS} gives more I_D

⇒ like voltage-controlled current source

V_{TH} = Threshold Voltage; $\approx 0.2 - 0.3$ V

$V_{GS} < V_{TH} \Rightarrow$ OFF

$V_{GS} > V_{TH} \Rightarrow$ ON → linear; low V_{DS}

→ saturation; more V_{DS}

[EE 130 – other electr. classes to become fluent]

First MOSFET called NMOS

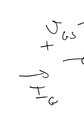
↑ electrons conducting carriers

Second MOSFET called PMOS

↑ holes [absence of an electron]

conducting carriers

n & p material reversed:



$I_G = 0$; $V_{TH} = -0.2$ to -0.3 V

typical: $V_{DS} < 0$; $I_D < 0$; $V_{GS} < 0$