

MOS TRANSISTOR THEORY

Introduction:

A MOS transistor is a majority-carrier device, in which the current in a conducting channel between the source and the drain is modulated by a voltage applied to the gate.

Symbols

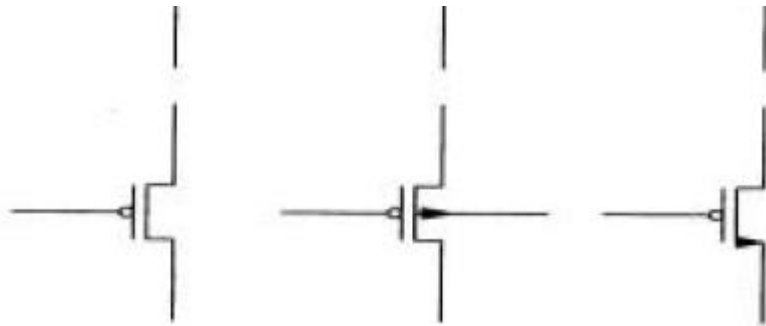


Figure 17: symbols of various types of transistors.

NMOS (n-type MOS transistor)

- (1) Majority carrier = electrons
- (2) A positive voltage applied on the gate with respect to the substrate enhances the number of electrons in the channel and hence increases the conductivity of the channel.
- (3) If gate voltage is less than a threshold voltage V_t , the channel is cut-off (very low current between source & drain).

PMOS (p-type MOS transistor)

- (1) Majority carrier = holes
- (2) Applied voltage is negative with respect to substrate.

Relationship between V_{gs} and I_{ds} , for a fixed V_{ds} :

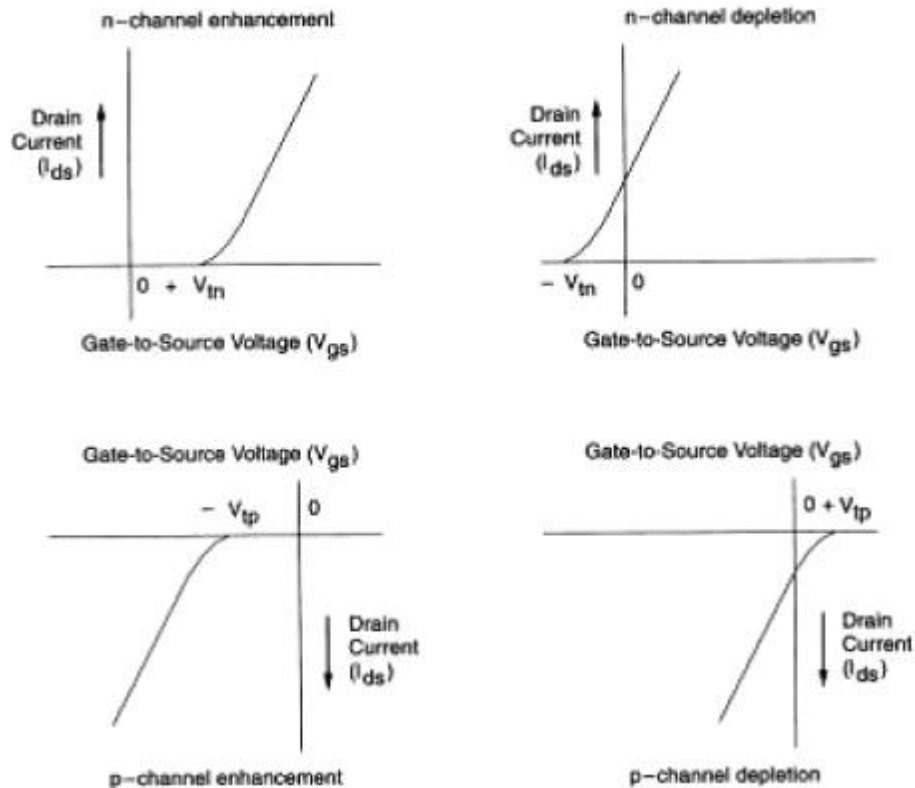


Figure 18: graph of V_{gs} vs I_{ds}

Devices that are normally cut-off with zero gate bias are classified as "**enhancementmode**" devices.

Devices that conduct with zero gate bias are called "**depletion-mode**" devices.

Enhancement-mode devices are more popular in practical use.

Threshold voltage (V_t):

The voltage at which an MOS device begins to conduct ("turn on"). The **threshold voltage** is a function of

- (1) Gate conductor material
- (2) Gate insulator material
- (3) Gate insulator thickness
- (4) Impurity at the silicon-insulator interface
- (5) Voltage between the source and the substrate V_{sb}
- (6) Temperature