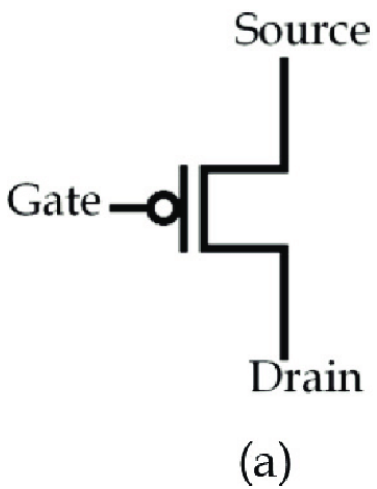
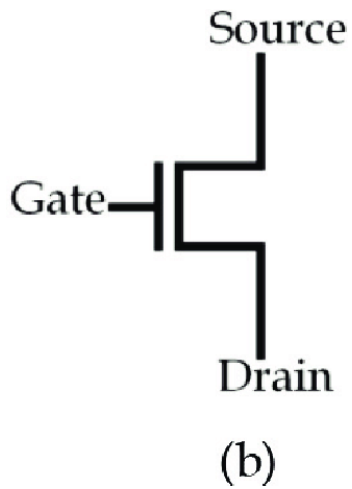
- MOS structure forms a capacitor, with gate and substrate are as two plates and oxide layer as the dielectric material.
- The thickness of dielectric material (SiO_2) is usually between 10 nm and 50 nm.
- It is a majority carrier device, where the current within a conducting channel in between the source & the drain is modulated by an applied voltage to the gate.
- MOS transistors are classified into two types PMOS & NMOS.

PMOS

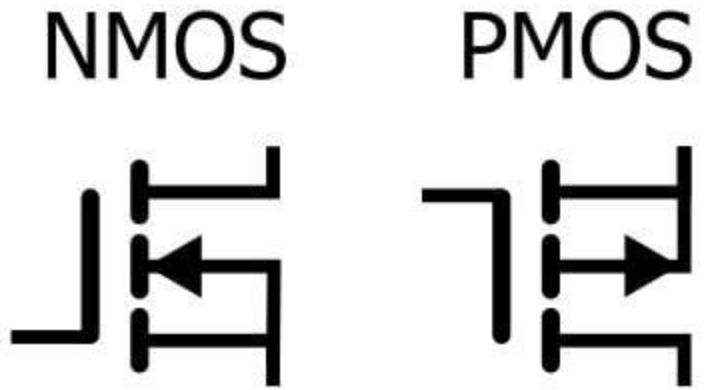


(a)

NMOS



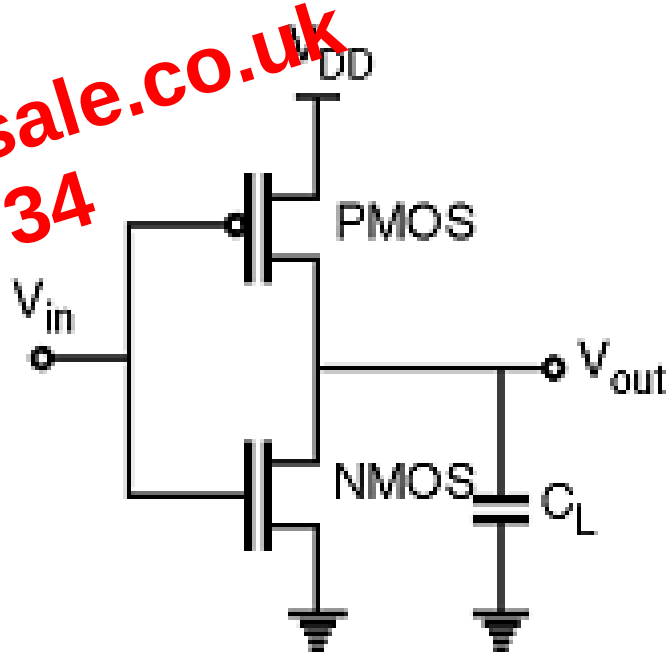
(b)



- The gate-to-source voltage that results in channel inversion is the threshold voltage V_{TH}.
- This is why NMOS require positive voltages (to attract electrons) and PMOS require negative voltages (to attract holes) for channel formation.
- The channel presents ohmic resistance for a fixed V_{GS} (linear operation mode) as long as V_{DS} remains smaller than the $V_{GS} - V_{TH}$.
- After that, the charge concentration near the drain is nulled, and the channel becomes “pinched”.
- This is called *channel pinch-off,* and marks the division between the saturation and linear regions.
- As V_{DS} increases, the pinch point moves and the effective length of the channel reduces, which results in the ***channel-length modulation*** effect.

CMOS Inverter Schematic Diagram

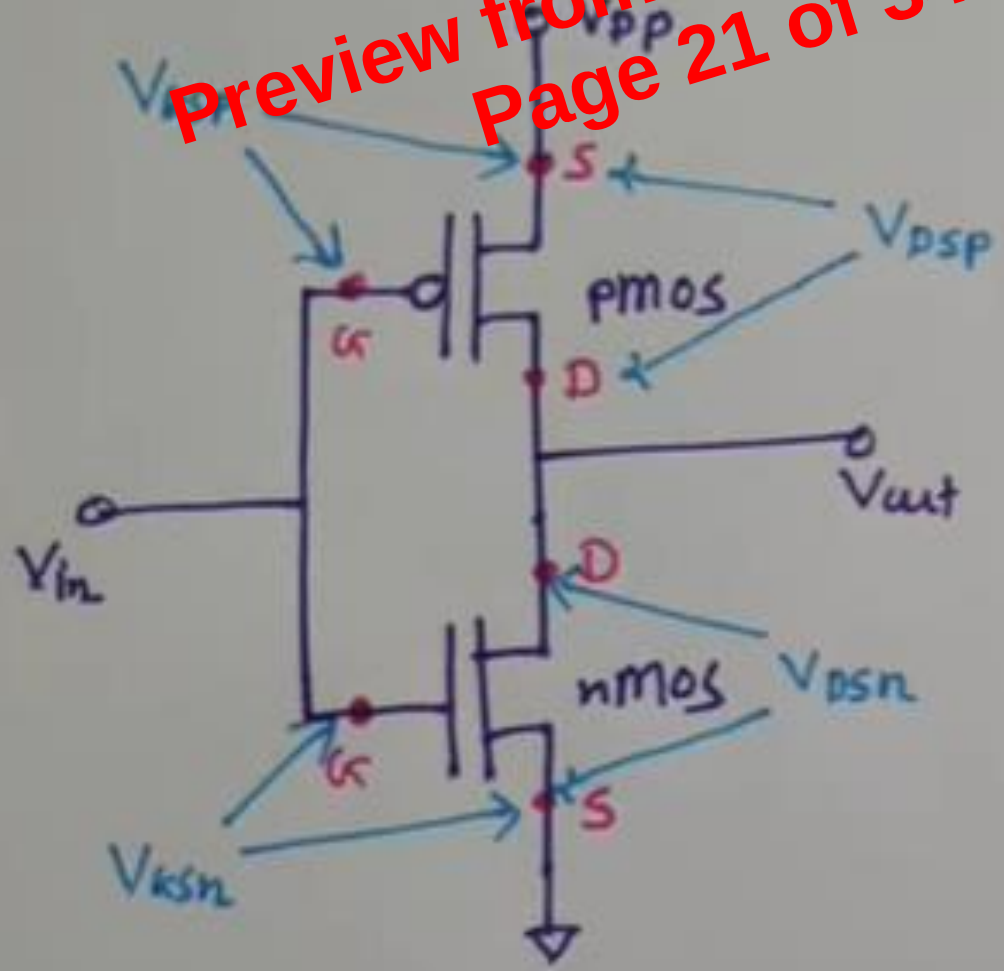
Once the input voltage of CMOS changes between 0 to 5 volts, then both the transistors state will be changed accordingly.



The general CMOS inverter structure is the combination of both the PMOS & NMOS transistors where the pMOS is arranged at the top & nMOS is arranged at the bottom. The NMOS transistor is connected at the drain (D) & gate (G) terminals, a voltage supply (VDD) is connected at the source terminal of PMOS & a GND terminal is connected at the source terminal of NMOS. Input voltage (Vin) is connected to both the gate terminals of transistors & output voltage (Vout) is connected to the drain (D) terminals of the transistor.

DC Transfer Characteristics of CMOS Inverter

CMOS Inverter Voltage Transfer Characteristics



- V_{Tn} $(+V_t)$
- V_{TP} $(-V_t)$
- $V_{GSn} = (V_G - V_S)_n = V_{in}$
- $V_{DSn} = (V_D - V_S)_n = V_{out}$
- $V_{GSP} = (V_G - V_S)_P = V_{in} - V_{DD}$
- $V_{DSP} = (V_D - V_S)_P = V_{out} - V_{DD}$

The DC input – output transfer characteristic is also called as Voltage Transfer Characteristics (VTC).

It is simply a plot of the output voltage as a function of the input voltage.

I - V CHARACTERISTICS OF NMOS