

NMOS CHARACTERISTICS AND PARAMETRIC ANALYSIS

OBJECTIVES:

To analyse the I-V Characteristics of NMOS Transistors

TOOLS:

Linux operated computing system, Cadence® Virtuoso, gpdk 180nm technology library.

THEORY:

An **NMOS (n-channel metal-oxide-semiconductor)** transistor is a type of MOSFET where electrons are the majority carriers. It operates in three main regions:

- Cutoff Region
- Linear Region
- Saturation Region

1. Cut-off Region:

- Condition: $V_{GS} < V_{TN}$
- Drain Current:

$$I_D = 0$$

- In the cut-off region, the MOSFET is off, and the drain current is zero.

2. Saturation Mode:

- Condition: $V_{GS} > V_{TN}$ and $V_{DS} \geq V_{GS} - V_{TN}$
- Drain Current Equation:

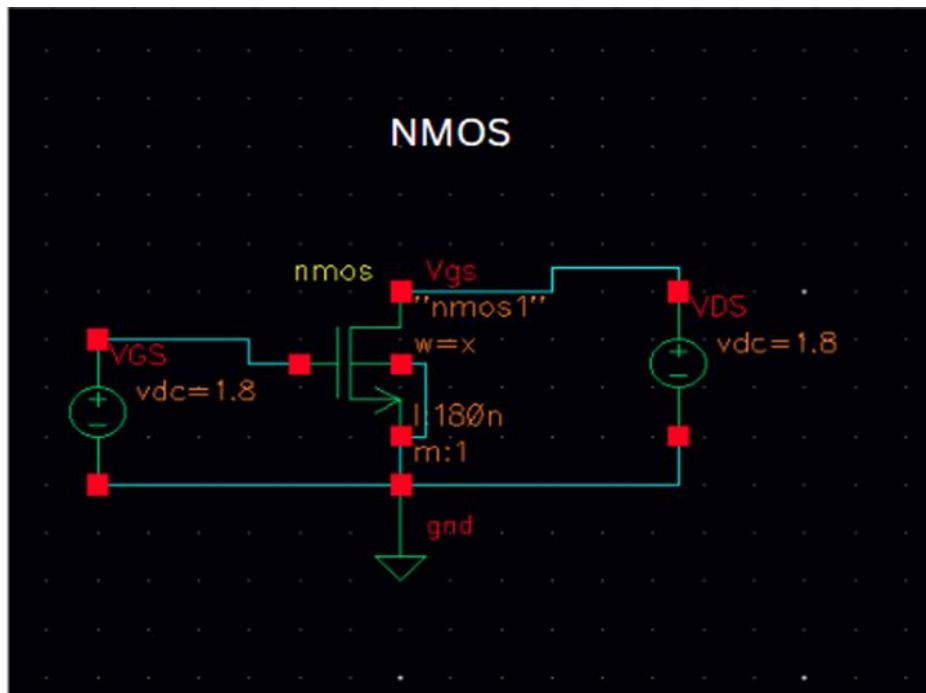
$$I_D = \frac{1}{2} \left(\mu C_{ox} \frac{W}{L} \right) (V_{GS} - V_{TN})^2$$

3. Triode Mode:

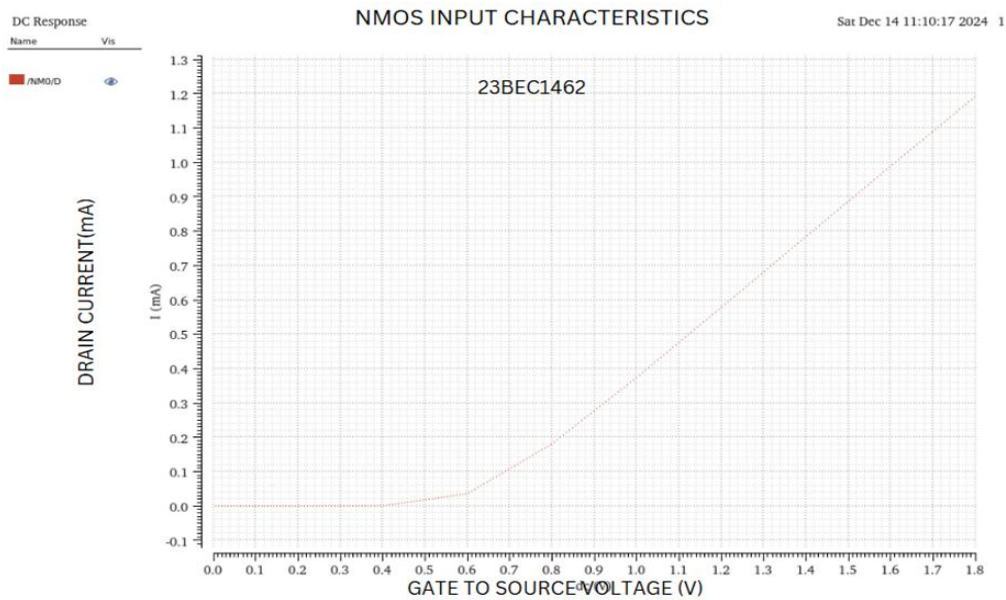
- Condition: $V_{GS} > V_{TN}$ and $V_{DS} < V_{GS} - V_{TN}$
- Drain Current Equation:

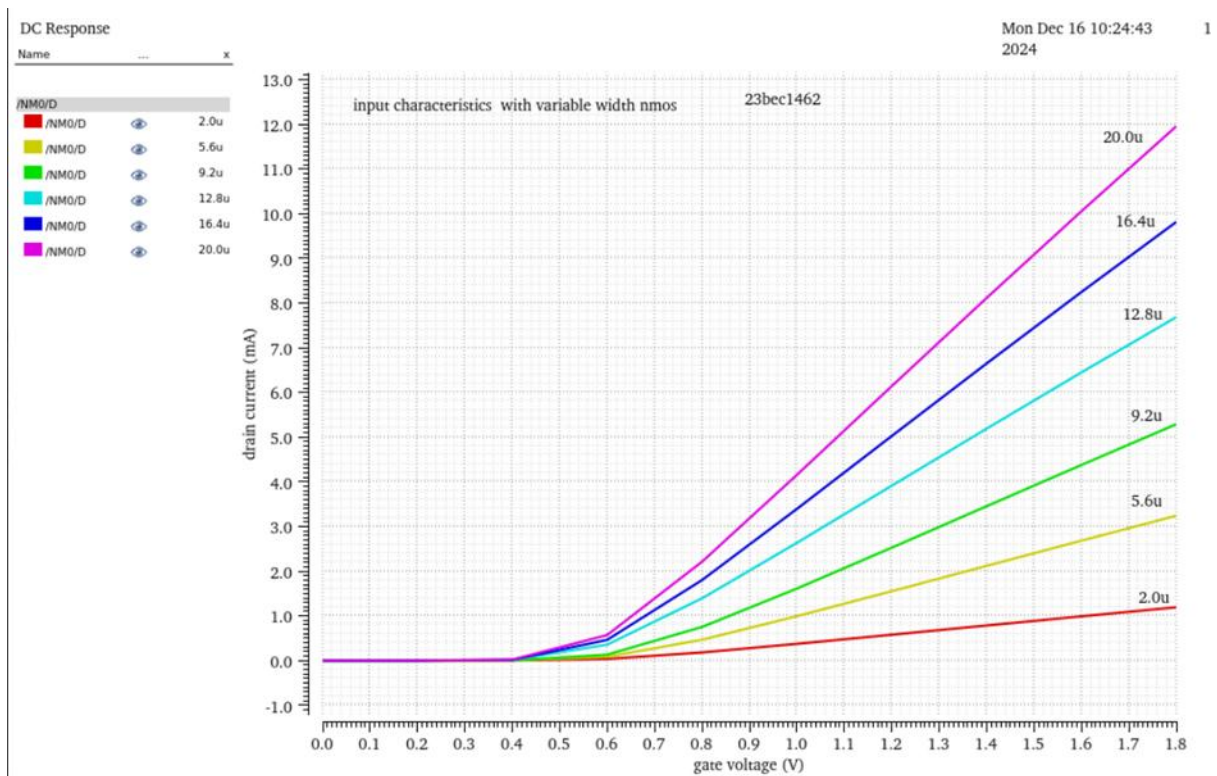
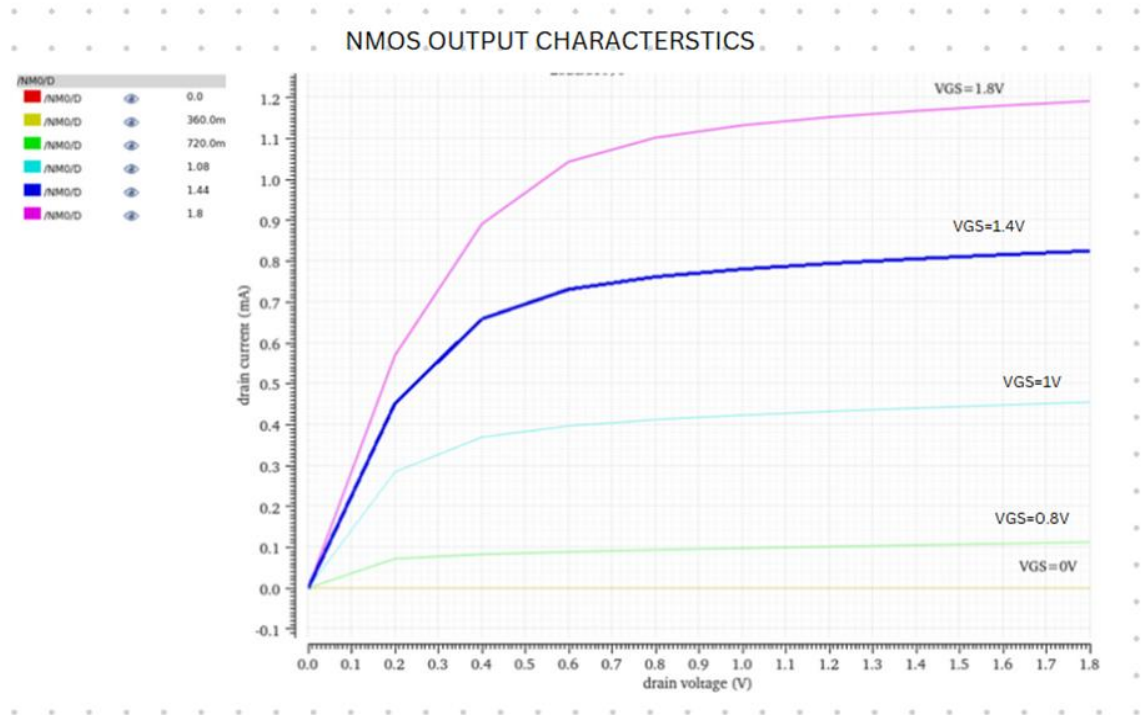
$$I_D = \left(\mu C_{ox} \frac{W}{L} \right) \left[(V_{GS} - V_{TN}) - \frac{V_{DS}}{2} \right] V_{DS}$$

CIRCUIT SCHEMATIC:



SIMULATION WAVEFORMS:





INFERENCE:

From the Output characteristics of NMOS you can observe that the things which is already discussed early in the theory section. From the input characteristics of NMOS we can clearly observe below the threshold voltage the channel is not formed so no

current flows once the channel is formed the current rises exponentially. With the help of Input characteristics, we can able to find the threshold voltage for the NMOS. When we vary the width of the NMOS then the drain current increase accordingly.