

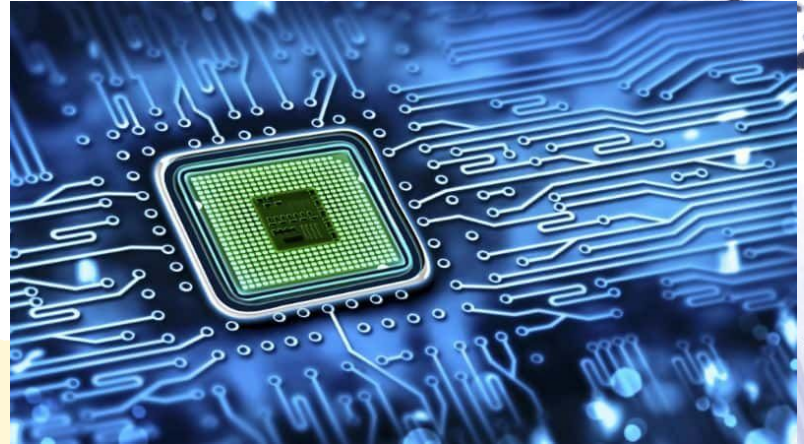


VLSI Design

Introduction to CMOS technology

INTRODUCTION

- Each IC has millions of transistors
- How is this possible?
- CMOS technology has helped us till now
- Will this be sufficient?



HISTORY



SSI

Max 1-2 logic gates



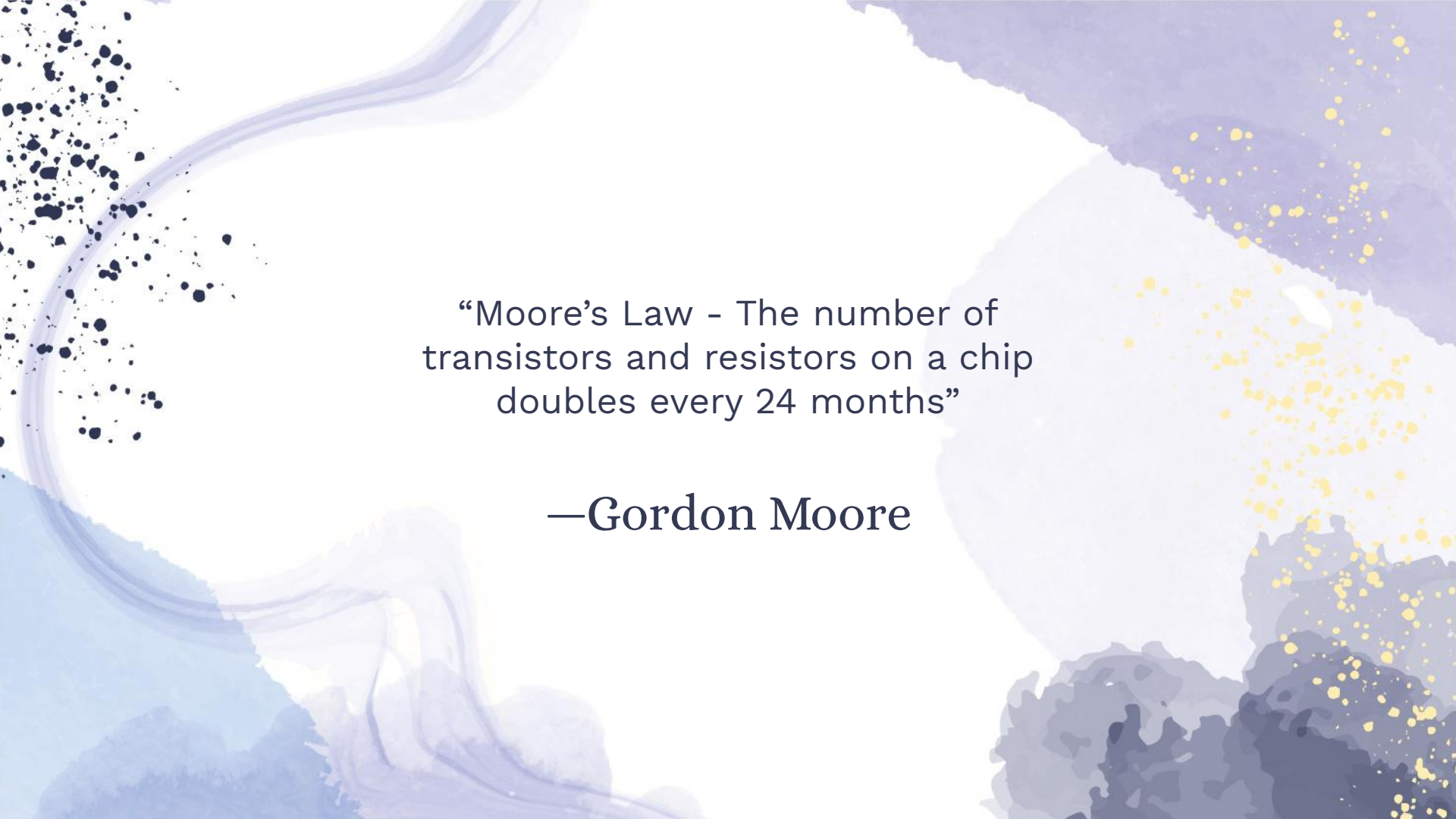
MSI

Few hundreds of
logic gates



LSI

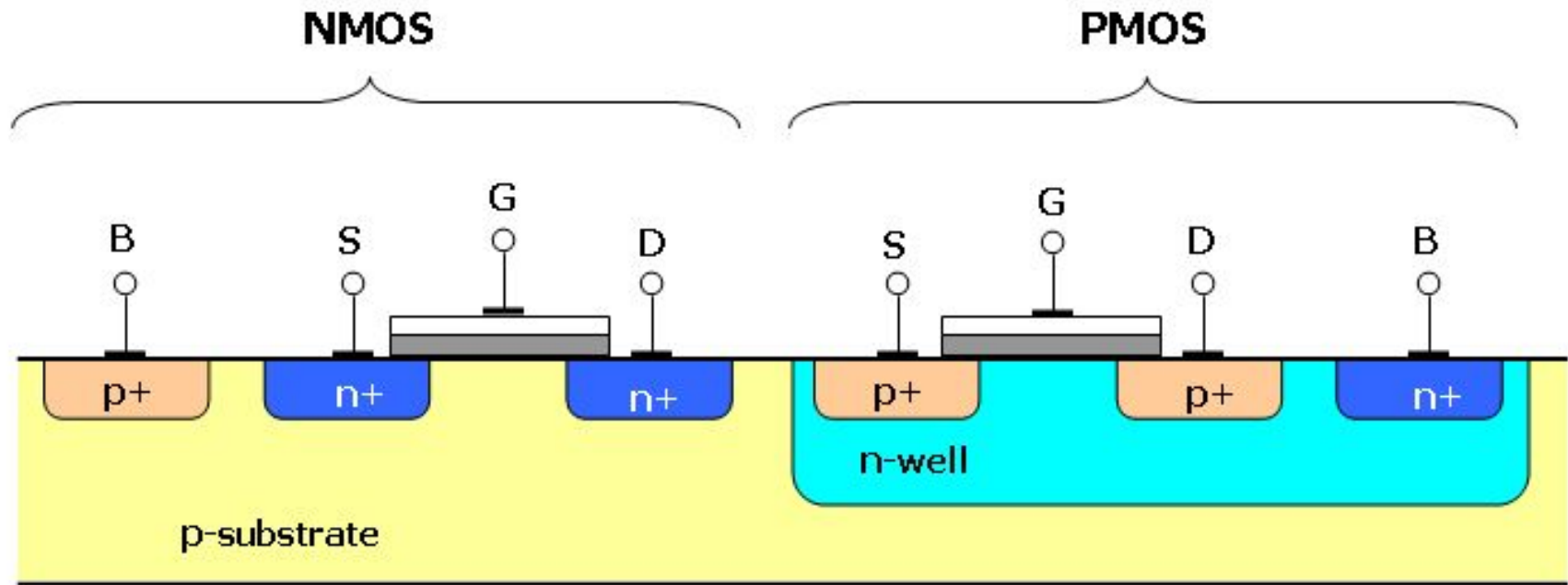
At Least a
thousand logic
gates



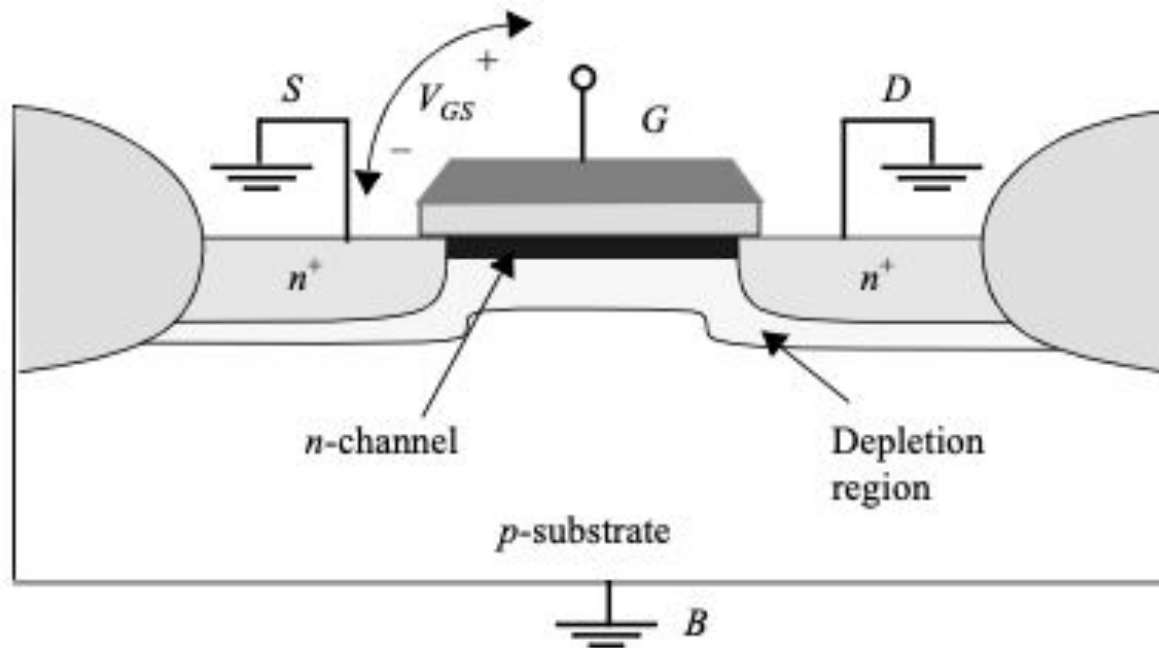
“Moore’s Law - The number of
transistors and resistors on a chip
doubles every 24 months”

—Gordon Moore

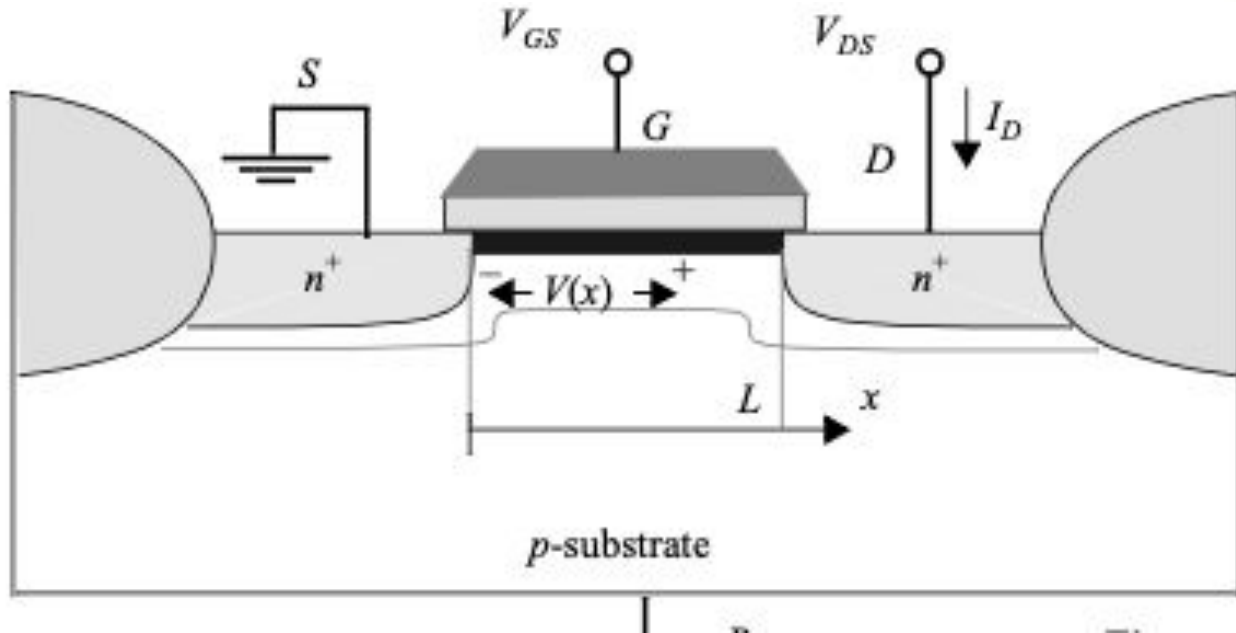
MOSFET



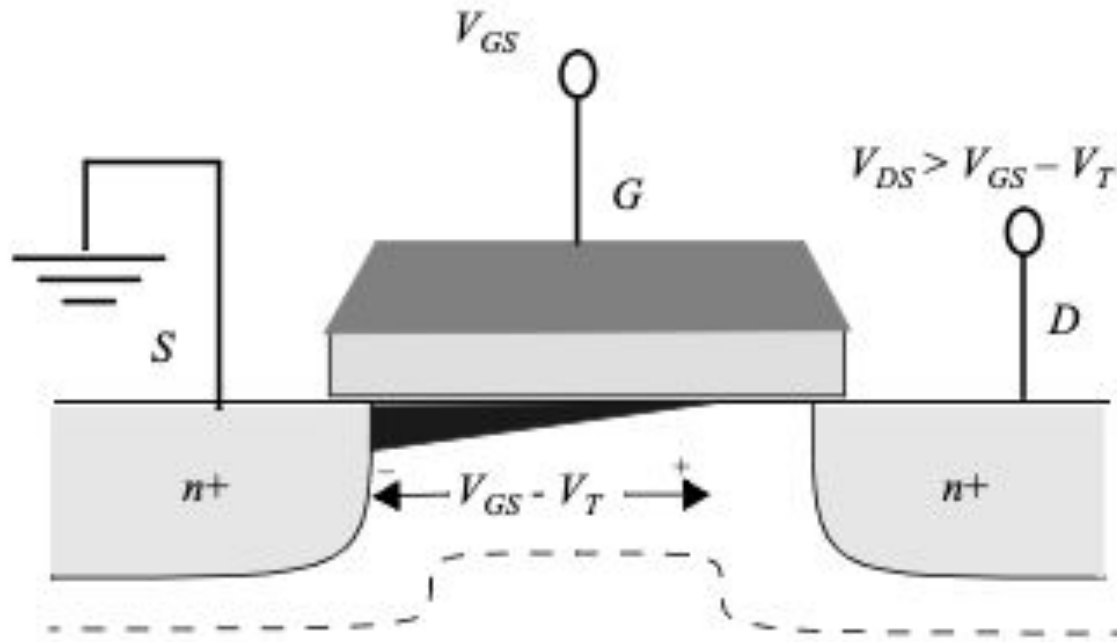
NMOS cross section



Resistive Region of Operation



Saturation Region



Important Formulae

Resistive
Region

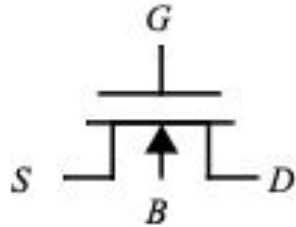
$$I_D = k'_n \frac{W}{L} \left[(V_{GS} - V_T) V_{DS} - \frac{V_{DS}^2}{2} \right] = k_n \left[(V_{GS} - V_T) V_{DS} - \frac{V_{DS}^2}{2} \right]$$

$$k'_n = \mu_n C_{ox} = \frac{\mu_n \epsilon_{ox}}{t_{ox}}$$

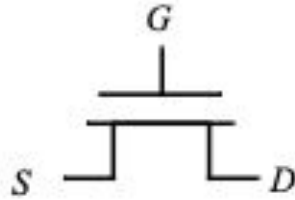
Saturation
Region

$$I_D = \frac{k'_n W}{2 L} (V_{GS} - V_T)^2$$

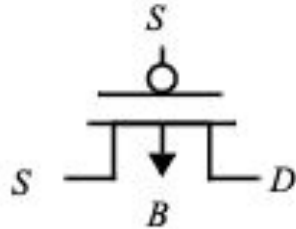
Symbol & Operation



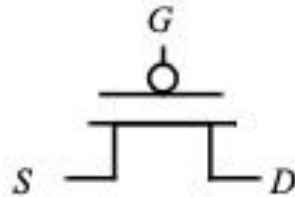
(a) NMOS transistor
as 4-terminal device



(b) NMOS transistor
as 3-terminal device



(a) PMOS transistor
as 4-terminal device



(d) PMOS transistor
as 3-terminal device

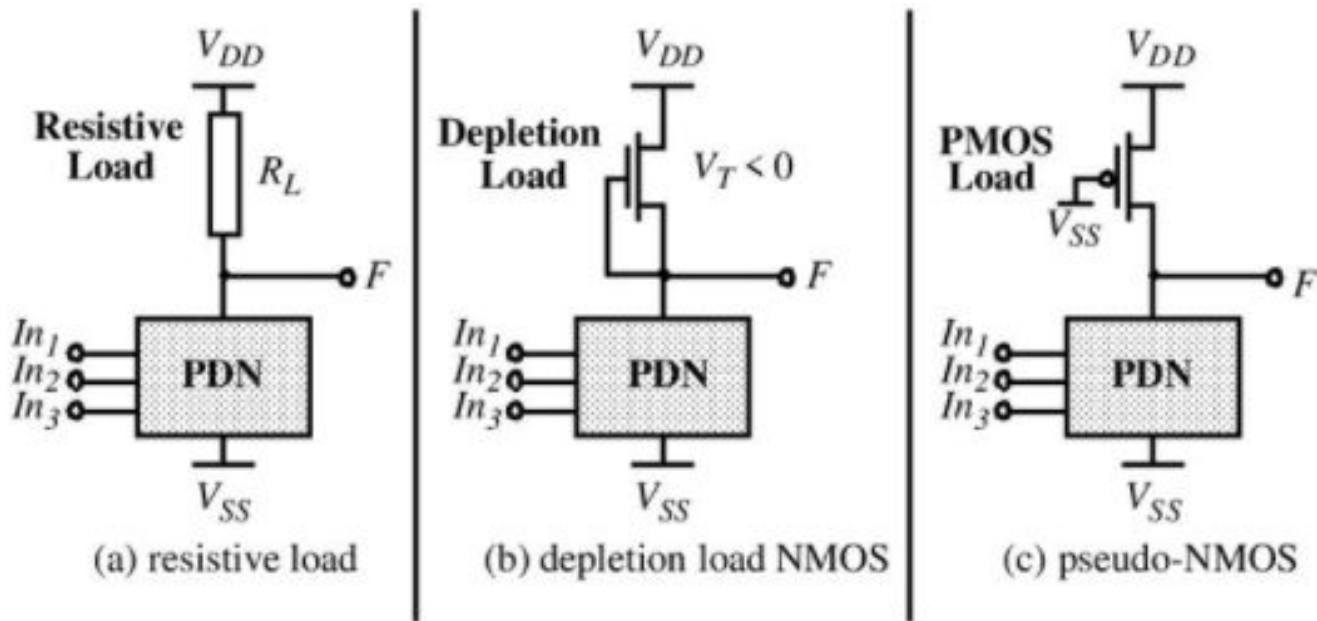
– Switch

Mostly used in Digital
Circuits

– Amplifier

Mostly used in
Analog Circuits

MOS Models



Also known as Ratioed Logic

Why is CMOS preferred in VLSI?

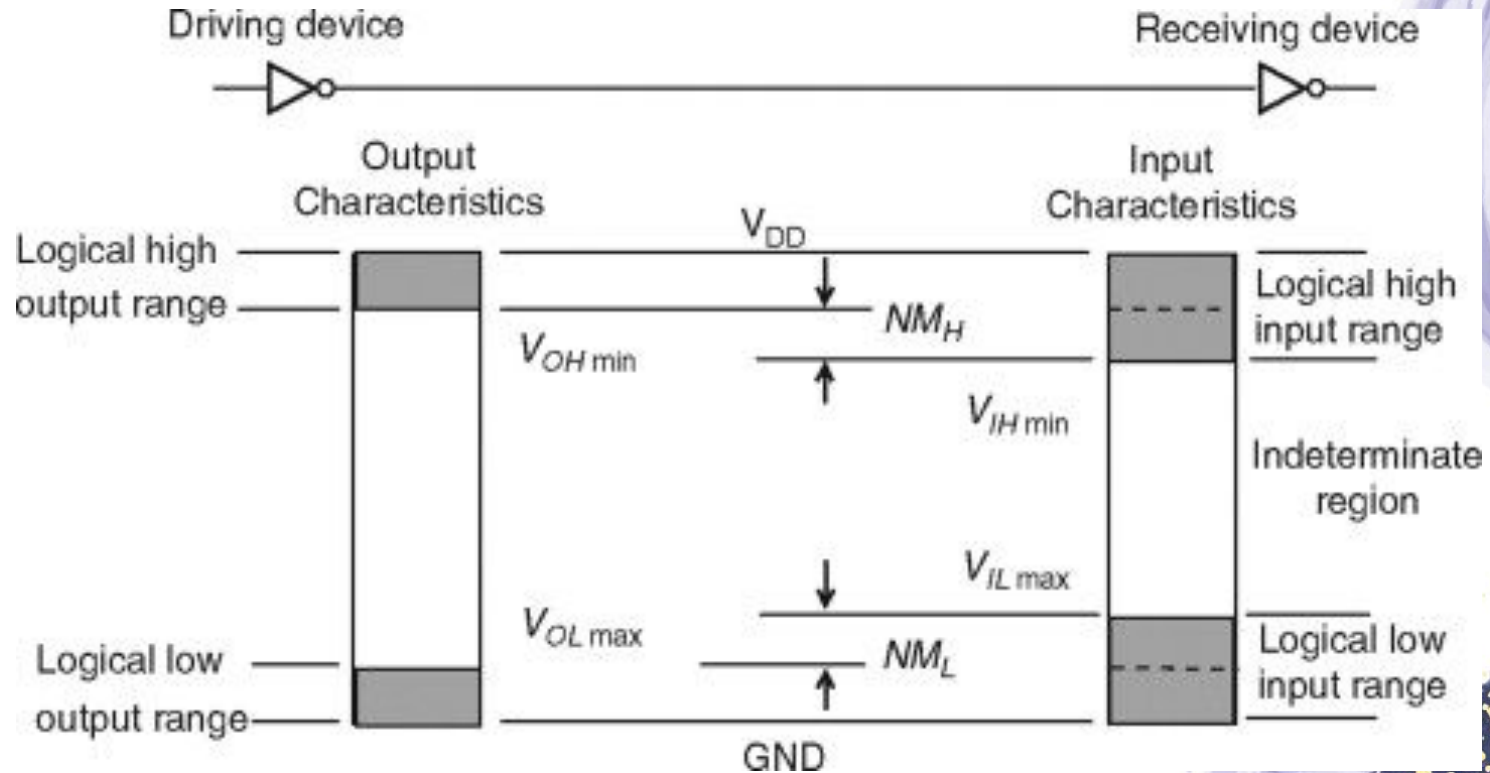
Low Static Power Consumption

Very less static power
compared to previous
model

High Noise Immunity

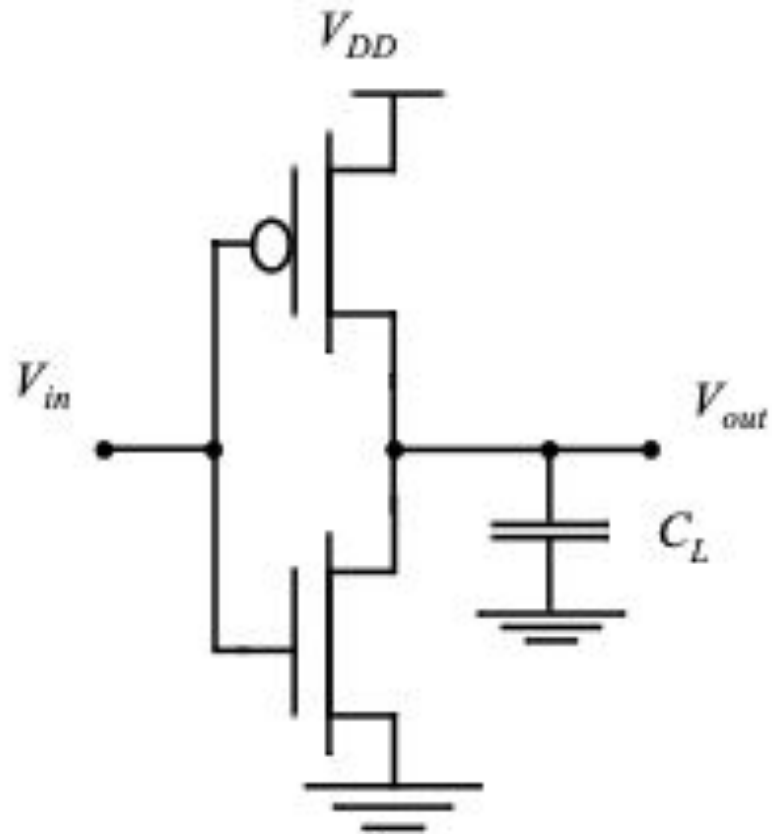
Noise margin is very
high

What is Noise Margin?

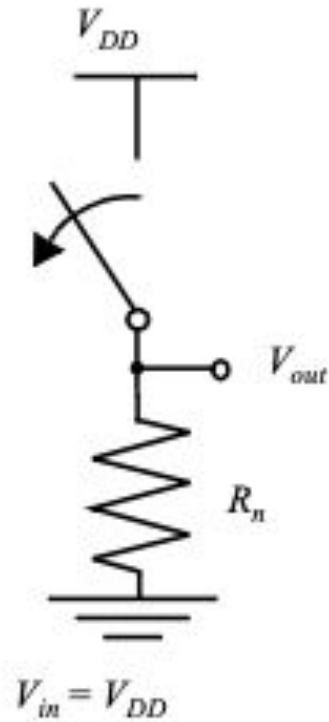




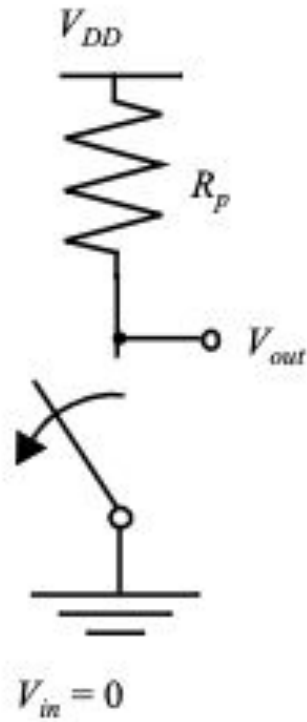
CMOS Inverter



Inverter



(a) Model for high input

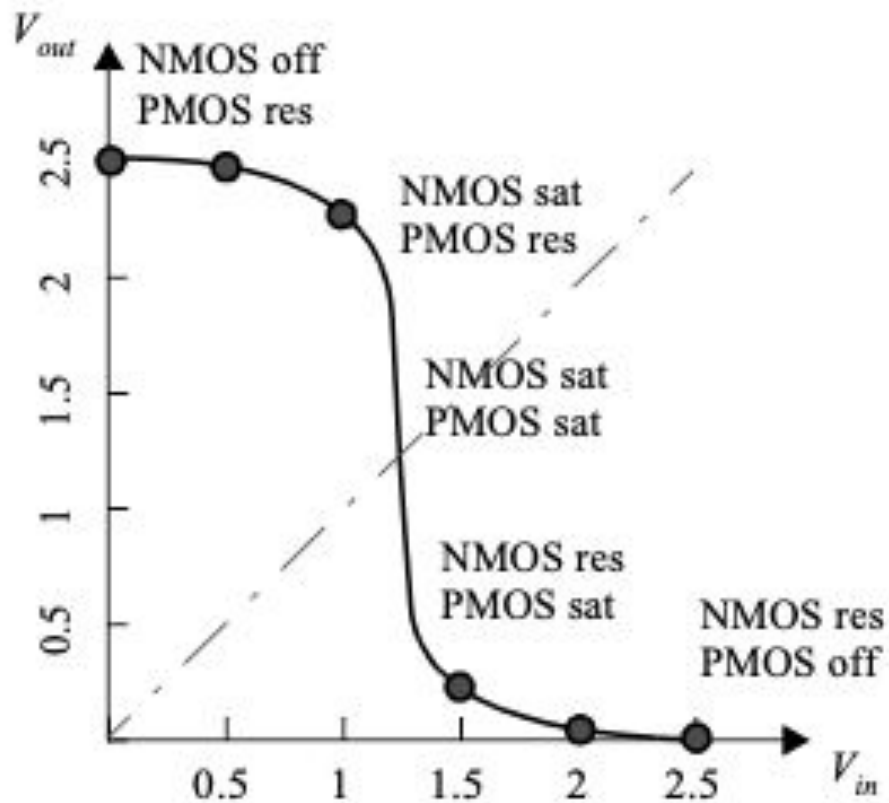


(b) Model for low input

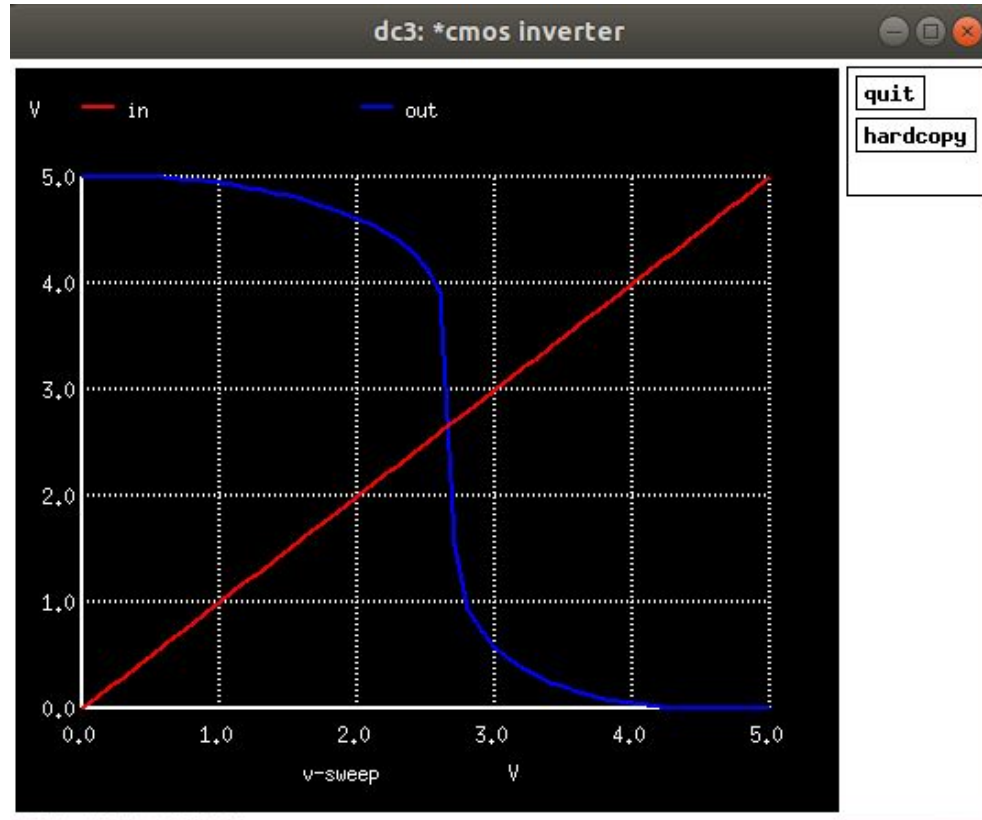
Input/Output Characteristics



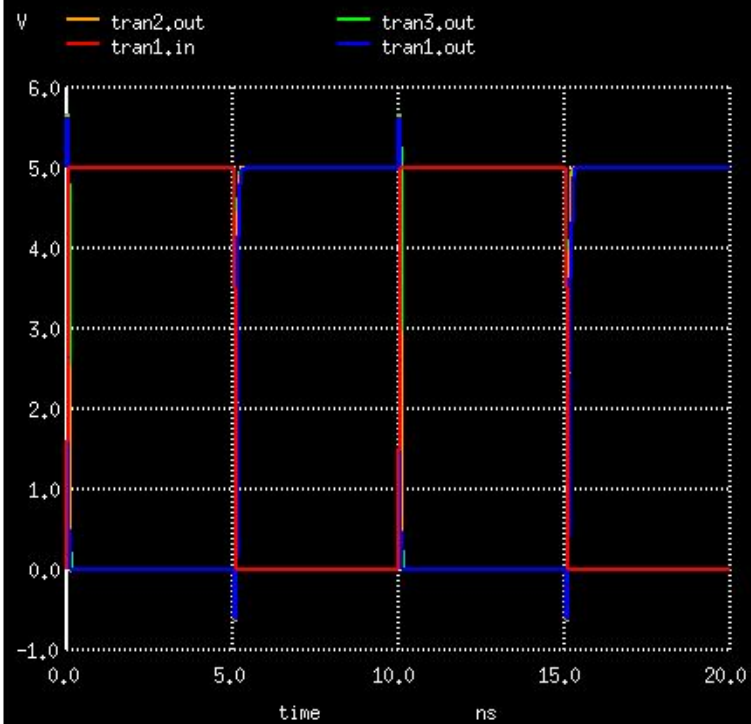
Graph



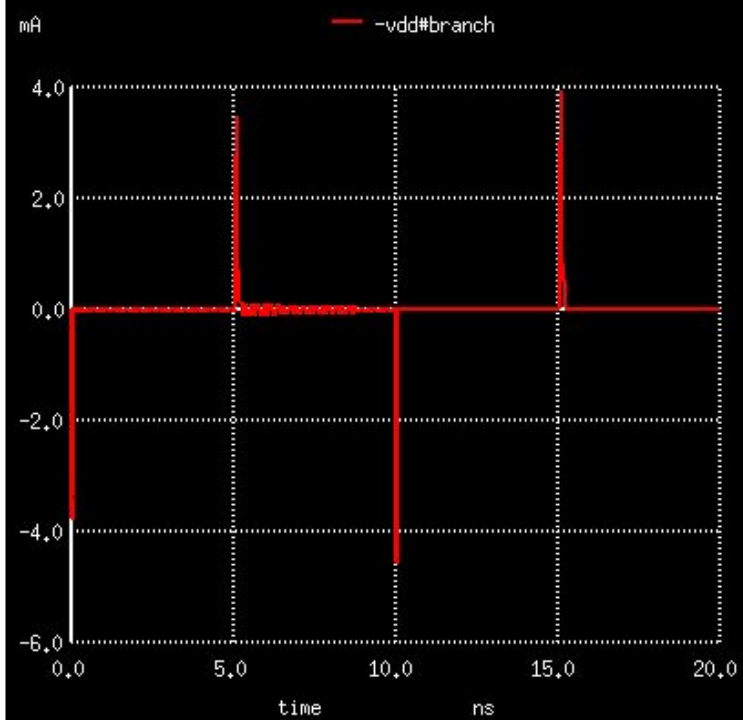
Simulation Results



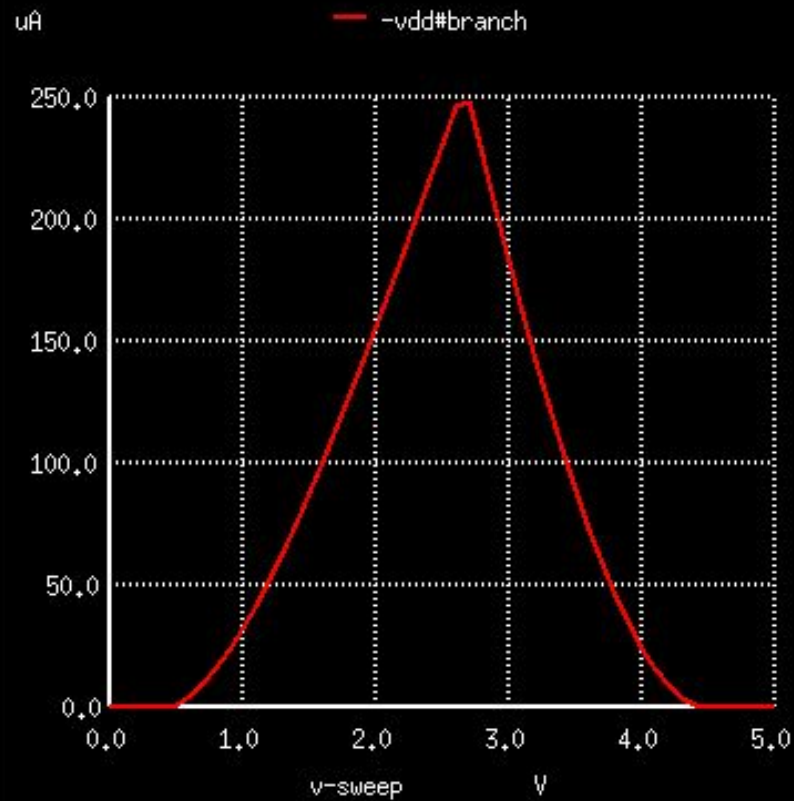
dc3: *cmos inverter



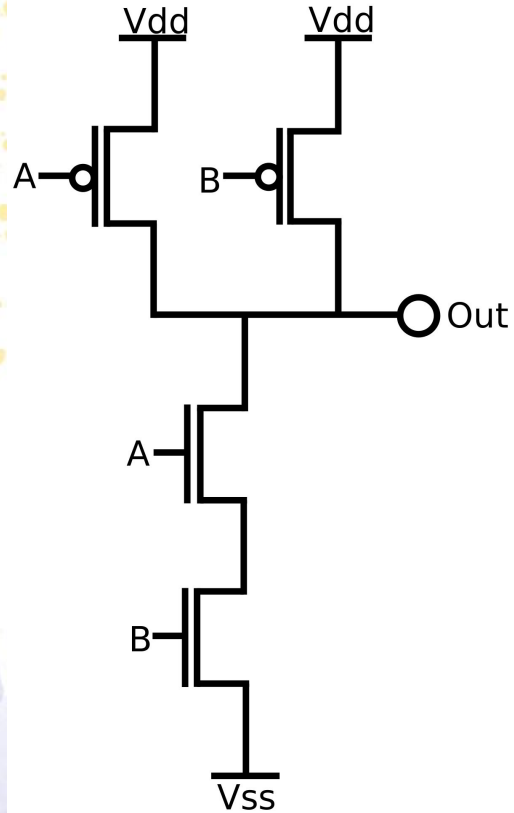
tran3: *cmos inverter



dc3: *cmos inverter

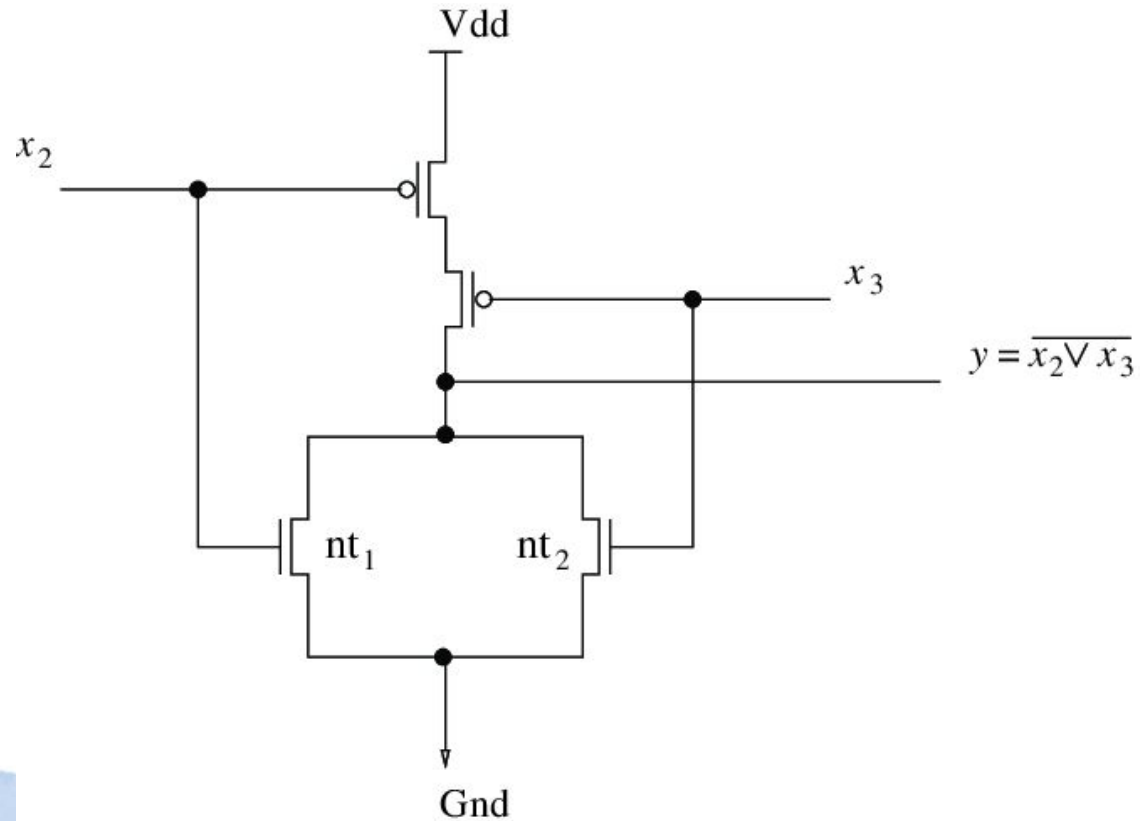


CMOS Nand2



A	B	Out
0	0	1
0	1	1
1	0	1
1	1	0

CMOS Nor2



Simulation Tools Installation

How to Install VirtualBox on Windows 10

<https://youtu.be/8mns5yqMfZk>

How to Install Ubuntu 18.04 on LTS VirtualBox

<https://youtu.be/QbmRXIJKsvs>

Install Magic on Ubuntu

[http://www.eng.ucy.ac.cy/theocharides/Courses/ECE307/Linux\(Tutorial\).pdf](http://www.eng.ucy.ac.cy/theocharides/Courses/ECE307/Linux(Tutorial).pdf)

Install Ngspice on Ubuntu

<https://zoomadmin.com/HowToInstall/UbuntuPackage/ngspice>



Thank You!

Any Questions?