Agenda
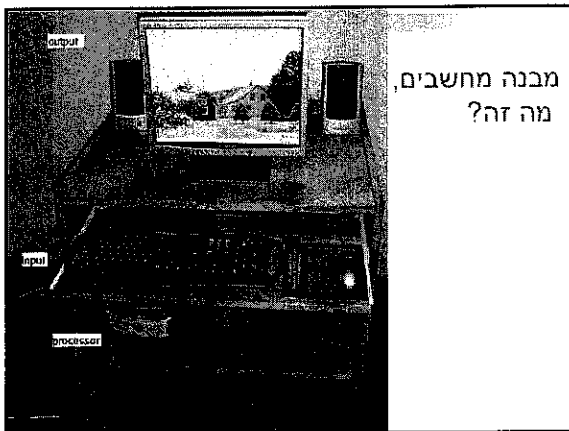
- Administration
- Introduction to Computer Structure
- CMOS Transistors

מבנה מחשבים
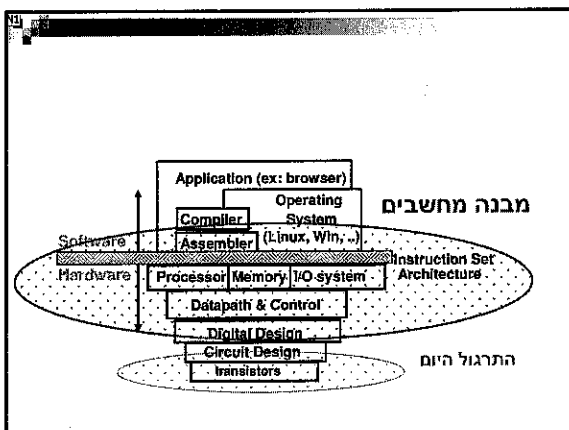תרגול 1

תמר נוביק
www.tau.ac.il/~tamarnov/
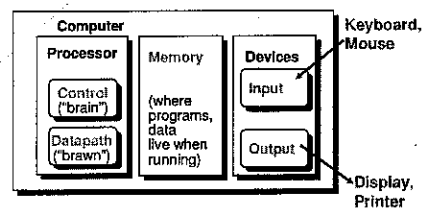

מבנה מחשבים,
מה זה?

Administration

- **Mail**: tamarnov@post.tau.ac.il
- **Mailbox**: Schreiber 1st floor, box 297
- **Homepage**: www.tau.ac.il/~tamarnov/comp_struct
- **Office hour:** Thursday 14:00 – 15:00 (please send me an email in advance)
- **Please submit the exercises to the checker's mailbox.**
- 7 mandatory exercises
- **Exercises Checker:**
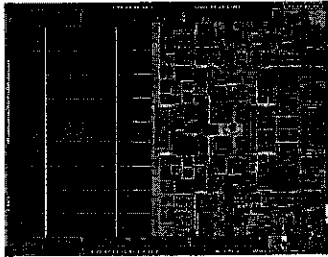 - Yaara Tam
  - **mailbox:** Schreiber 1st floor, box 295

מבנה מחשבים

Application (ex: browser)

Operating System
Compiler
Assembler (Linux, Win, ...)

Software

Instruction Set Architecture
Hardware Processor Memory I/O system

Datapath & Control

Digital Design
Circuit Design
Transistors

התרגול היום

Anatomy: 5 components of any Computer (since 1946)

Computer
Processor
Control ("brain")
Datapath ("brawn")

Memory
(where programs, data live when running)

Devices
Input
Output

Keyboard, Mouse

Display, Printer

Intel's Core 2 Duo Processor

- 291 Million Transistors

Integrated Circuits (IC)

- Electronic circuit built on a single semiconductor substrate. Also known as a "chip".
- An electric circuit is made from different electrical components such as transistors, resistors and capacitors
- Examples: microprocessor, memory.

Terms

- **Semiconductor (ex: silicon)** - a solid material that has electrical conductivity in between a conductor and an insulator
- **Doping** - is the process of intentionally introducing impurities into an extremely pure semiconductor to change its electrical properties
  - Negatively doped silicon is rich in electrons (negatively charged) and positively doped silicon is rich in holes (the dual of electrons and positively charged)
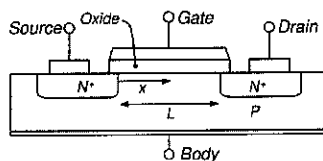
Transistor

- Term derived from "transfer resistor". A semiconductor device commonly used to amplify or switch electronic signals.
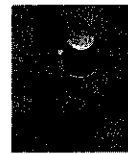
MOSFET

- MOSFET = metal–oxide–semiconductor field-effect transistor
- Terminals: *gate, drain, source* and *body (/substrate)*

Source○ Oxide ○ Gate ○ Drain

N⁺   x   N⁺

L   P

○ Body

CMOS

- Complementary metal–oxide– semiconductor (CMOS)
- Most commonly used integrated circuit
- Uses two types of transistors:
  - N-type transistor (nMOSFET)
  - P-type transistor (pMOSFET)

MOSFET Transistor Switches - 1

- nMOSFET switch (N-SWITCH):
  - switch is closed or 'ON' when drain and source are connected. This occurs when there is a '1' on the GATE
- pMOSFET switch (P-SWITCH):
  - switch is closed or 'ON' when drain and source are connected. This occurs when there is a '0' on the GATE

nMOSFET and pMOSFET

nMOSFET and pMOSFET Switches - Summary

MOSFET	GATE (during switch ON)	PASSES
N	1	0
P	0	1

MOSFET Transistor Switches - 2

S = Gate
a = Drain
b = Source

FIGURE 1.2 MOS transistors viewed as switches

Parallel CMOS Switches

?   OR

Serial CMOS Switches

?   AND

CMOS Inverter – step 1

Truth Table:

INPUT	OUTPUT
0	1
1	0
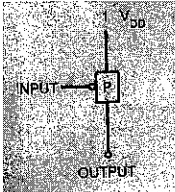
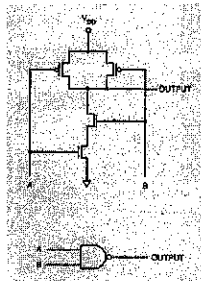# Power Supply

- 2 power supplies:
  - V_{DD} / POWER - "1" = high voltage (5 volts)
  - V_{SS} / GROUND - "0" – low voltage (0 volts)

(handwritten Hebrew notes)
הגורם
שני סוגים של מתח
V_{DD} – (5v) גבוה
V_{SS} –(0 v) נמוך

⊗ המתח לוקח
מצב אחד
או 0 !

NAND Gate

Truth Table:

A	B	Output
0	0	1
1	0	1
0	1	1
1	1	0

(handwritten Hebrew note, left)
סימון ←
של NAND
בתרשים

CMOS Inverter – Step 2

(handwritten Hebrew note) סימון של Not את

(handwritten Hebrew, right)
– סימון
של תרשים
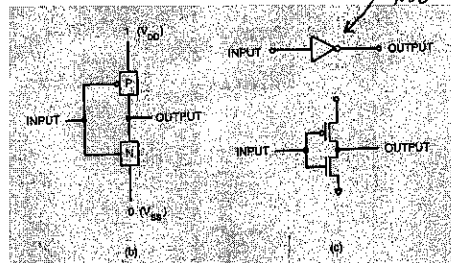
AND Gate
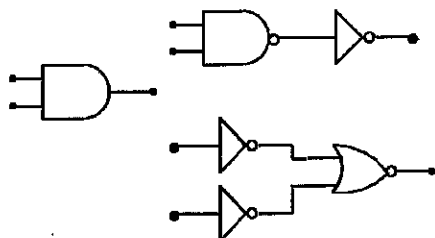
NOR Gate
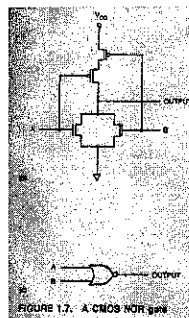
Truth Table:

A	B	Output
0	0	1
1	0	0
0	1	0
1	1	0

FIGURE 1.7. A CMOS NOR gate

Backup

References

- Neil Weste, Karman Eshraghian.
Principles of CMOS VLSI Design.
Addison-Wesley Publishing Company, 1985

IC Pin Layout