CSE 251
Electronic Devices and Circuits
Lecture 1

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Inspiring Excellence

Mathematical Operations

- Addition: $4 + 5 \rightarrow 9$ (0100 + 0101 $\rightarrow$ 1001)
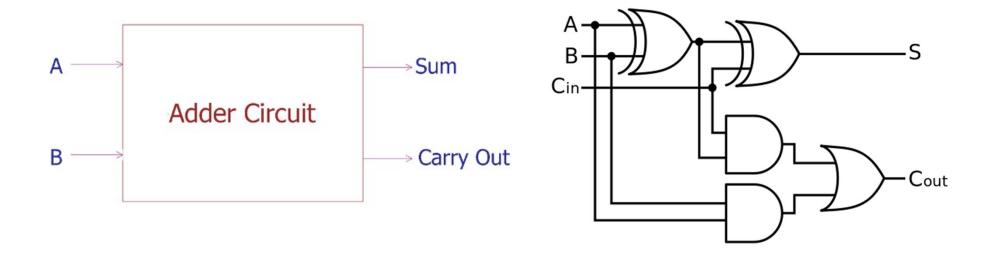
- Subtraction: $10 - 9 \rightarrow 1$ (1010 + 0111 $\rightarrow$ 0001)
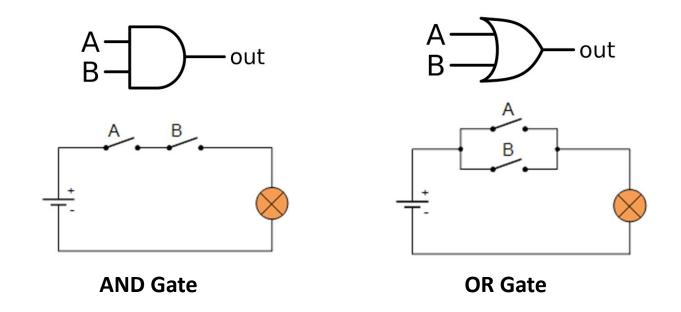
- Multiplication: $5 \times 4 = 4+4+4+4+4 = 20$

- Division: $10/2 = 2$ can be subtracted from 10, 5 times

Digital Logic Circuit

Addition: 4 + 5 ➜ 9   (0100 + 0101 ➜ 1001)

Logic gates are basically switches

AND Gate   OR Gate

The faster you can operate these switches, the faster you can complete the functions!!!

How can we make these switches?

- **Mechanical switch**

  o Bulky and heavy

  o Mechanical wear over time

  o Noisy

  o Ultra slow

  o Requires lots of energy to operate

SPST Switch   **Electromechanical Relay**

How can we make these switches?
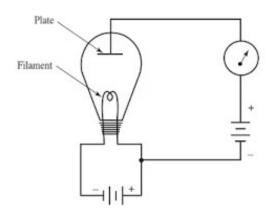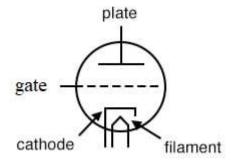
- **Vacuum tube**

- To ensure current passes along one direction and stops flowing in the other direction
- Gate allows us to control this is a more robust way

Image: From All Abouts Circuits Chapter 13 - Electron Tubes. Available online: allaboutcircuits.com/textbook/semiconductors/chpt-13/the-triode/ and Vacuum Tubes: The World Before Transistors. enginnering.com. Available online: engineering.com/story/vacuum-tubes-the-world-before-transistors
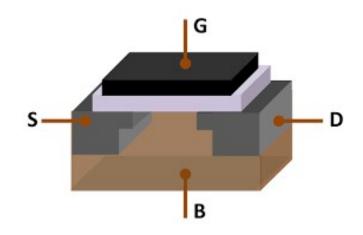
How can we make these switches?

- **Vacuum tubes**
  - Bulky
  - Lots of energy
  - Not scalable

How can we make these switches?

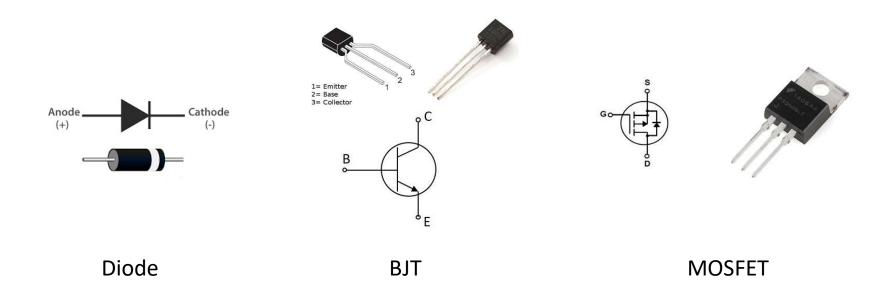- **Electronic switches**
  - No moving parts
  - Scalable
  - High speed

5GHz computer → 5 billion operations per second !!!

What are electronic circuits?

- Any circuit consisting of semiconductors.

Diode   BJT   MOSFET

- **Transistor:** probably the most impactful invention of the present world

- **Why do we need this course?**

High Level Programming → **Assembly language** → **Machine language** → **Architecture…**
    (C, C++, etc.)   (x86, ARM, CUDA, etc.)   (100110)   (RISC, CISC, etc.)

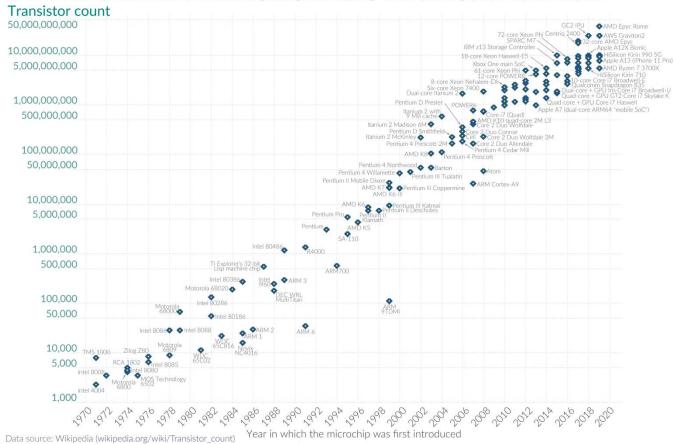**…Architecture** → **System level** → **Gate** → **Transistor**
           (Register,   (AND,
            Mux)   OR,
                     etc.)

Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years.
This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World in Data

Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)

Why do we need electronic circuits?

Digital Electronics
- Boolean logic
- Addition, subtraction, multiplication, division

Analog Electronics
- Amplifiers, radio transmitter and receivers, modulator

Power Electronics
- Motor control
- AC to DC conversion or vice versa
- HVDC circuits
- Charge control circuits

Thank you!