- **First Generation(1940 to 1956):**
  - **Hardware Technology:**
    - The first generation of **computers used vacuum tubes** for circuitry and magnetic drums for memory. The **input** to the computer was through punched cards and paper tapes. The output was displayed as printouts.

First Generation Computers
Vacuum Tubes

  - **Software Technology:**
    - The instructions were written in **machine language.** Machine language uses 0s and 1s for coding of the instructions. The first generation computers could solve one problem at a time.
  - **Computing Characteristics:**
    - The computation time was **in milliseconds**.
  - **Physical Appearance:**
    - These computers were **enormous in size** and required a large room for installation.
  - **Application:**
    - They were used for scientific applications as they were the fastest computing device of their time.
  - **Examples:**
    - UNIVersal Automatic Computer (**UNIVAC**),

- Electronic Numerical Integrator And Calculator (**ENIAC**),
- Electronic Discrete Variable Automatic Computer (**EDVAC**)
  - **Disadvantages of 1st Generation:**
    - The first generation computers used a large number of vacuum tubes and thus generated a lot of heat.
    - They consumed a great deal of electricity and were **expensive to operate**.
    - The machines were prone to frequent malfunctioning and **required constant maintenance**.
    - Since first generation computers used machine language, they were **difficult to program.**
- **Second Generation (1956 to 1963):**
  - **Hardware Technology:**
    - **Transistors replaced** the vacuum tubes of the first generation of computers.
    - Transistors allowed computers to become smaller, faster, cheaper, energy efficient and reliable.
    - The second generation computers **used magnetic core technology for primary memory.** They used **magnetic tapes and magnetic disks for secondary storage.**
    - The input was still through punched cards and the output using printouts.
    - They used the **concept of a stored program**, where instructions were stored in the memory of computer.

Second Generation of Computers

Transistor

  - **Software Technology:**
    - The instructions were written using the assembly language.

- Assembly language uses mnemonics like ADD for addition and SUB for subtraction for coding of the instructions.
- High-level programming languages, such as early versions of COBOL and FORTRAN were also developed during this period
  - **Computing Characteristics**:
    - The computation time was **in microseconds.**
  - **Physical Appearance:**
    - Transistors are smaller in size compared to vacuum tubes, thus, the **size of the computer was also reduced.**
  - **Examples: PDP-8, IBM 1401 and CDC 1604.**
  - The cost of commercial production of these computers was very high, though less than the first generation computers. The transistors had to be assembled manually in second generation computers.

- **Third Generation (1964 to 1971)**
  - **Hardware Technology:**
    - The third generation computers used the **Integrated Circuit (IC) chips.**
    - In an IC chip, multiple transistors are placed on a silicon chip.
    - The use of IC chip increased the speed and the efficiency of computer, manifold.
    - The **keyboard and monitor were used** to interact with the third generation computer, instead of the punched card and printouts.
  - **Software Technology:**
    - The keyboard and the monitor were interfaced through the operating system. Operating system allowed different applications to run at the same time.
    - High-level languages were used extensively for programming, instead of machine language and assembly language.
  - **Computing Characteristics:**
    - The computation time was **in nanoseconds**.
  - **Physical Appearance:**

- The size of these computers was quite small compared to the second generation computers.
  - **Examples:** IBM 370, PDP 11.
  - The third generation computers used less power and generated less heat than the second generation computers. The cost of the computer reduced significantly, as individual components of the computer were not required to be assembled manually. The maintenance cost of the computers was also less compared to their predecessors.
- **Fourth Generation (1971 to present):**
  - **Hardware Technology:**
    - They use the **Large Scale Integration (LSI) and the Very Large Scale Integration (VLSI) technology.** Thousands of transistors are integrated on a small silicon chip using LSI technology. VLSI allows hundreds of thousands of components to be integrated in a small chip.
    - **Microprocessor is a chip containing millions of transistors** and components, and, designed using LSI and VLSI technology.
    - **Semiconductor memory** replaced the earlier magnetic core memory, resulting in fast random access to memory.
    - Secondary storage device like magnetic disks became smaller in physical size and larger in capacity.
    - The linking of computers is another key development of this era. The computers were linked to form networks that **led to the emergence of the Internet**. This generation also saw the development of pointing devices like mouse, and handheld devices.
  - **Software Technology:**
    - Several **new operating systems like the MS-DOS and MS-Windows developed during this time**. This generation of computers supported Graphical User Interface (GUI).
    - GUI is a user-friendly interface that allows user to interact with the computer via menus and icons.

- High-level programming languages are used for the writing of programs.
  - o **Computing Characteristics:**
    - The computation time is **in picoseconds.**
  - o **Physical Appearance:**
    - They are smaller than the computers of the previous generation.
  - o **Ted Hoff** produced the first microprocessor in 1971 for **Intel.** It was known as Intel 4004.
- **Fifth Generation (Present and Next)**
  - o The goal of fifth generation computing is to develop computers that **are capable of learning and self-organization**.
  - o The fifth generation computers use **Super Large Scale Integrated (SLSI)** chips that are able to store millions of components on a single chip.
  - o These computers have large memory requirements.
  - o This generation of computers **uses parallel processing** that allows several instructions to be executed in parallel, instead of serial execution. Parallel processing results in faster processing speed.
  - o **Quantum computation and molecular and nanotechnology** will radically change the face of computers in years to come.
  - o The goal of fifth-generation computing is to develop devices that respond to **natural language input** and are capable of learning and self-organization.