Unit-1, Module-4
Evolution of Computer

Question 1: Describe the basic differences between computer architecture and computer organization.

Solution 1:

Architecture comprises those parameters of a computer that can be used by a programmer. For example, the instruction set available to the programmer comes under the preview of architecture.

Computer organization refers to the operational blocks with their interconnections that implement the architectural. Organizational parameters are not directly available to a programmer. For example, the ADD instruction (architectural parameter) may be implemented by a Ripple Carry Adder or Carry look ahead Adder which is an organizational parameter. It may be noted that as a programmer we can use the ADD instruction, however, how an adder is implemented in the ALU is an organizational issue that cannot be controlled by a programmer.

A synonymous comparison is generally given as Architectural Engineering versus Civil Engineering. Civil engineering for a house refers to building blocks like types of bricks, type of wood for doors etc. while Architectural Engineering would refer to the size and position of the doors, number of floors etc. Thus, as an inhabitant we can directly feel the impact (or usage of) of Architectural Engineering while the Civil engineering aspects are transparent. So, Civil engineering is similar to Computer Organization while Architectural engineering is similar to Computer Architecture.

Question 2: Briefly write about evaluation of computer by giving emphasis on first generation, second generation computer, etc.

Solution 2:

The computer has evolved through the following stages:

1. **The mechanical era (1623-1945):** The first generation machines that could perform automatic computations were called mechanical computers. Charles Babbage, the father of computer was the first person to design such machines and named them as “Difference Engine” and ”Analytical Engine”. He also developed important programming techniques like conditional branches, iterative loops, index variables etc. One of the first uses of mechanical computers for real life applications was done by The US Census Bureau to tabulate data for the 1890 census. This system was designed by Herman Hollerith and it used punch cards for data inputs. In 1911 Hollerith's company merged with another corporation which in 1924 became International Business Machines (IBM).

2. **First Generation Electronic Computers (1937-1953):** After the mechanical computers, the next was the era of electronic and electrical computers. These devices used switches in the form of vacuum tubes and relays, instead of mechanical deceives. Among the first in this category was the Electronic Numerical Integrator and Computer (ENIAC) which designed by Eckert and Mauchly. Around 18000 vacuum tubes and 1500 relays were used to build ENIAC. It was used by US army to calculate trajectories for ballistic shells during World War II. ENIAC was controlled by a set of external switches and dials and programming required physically altering the settings on these controls

   EDVAC (Electronic Discrete Variable Automatic Computer), the successor of ENIAC, used the notion of stored program and Binary number system. EDVAC was able to run much faster than ENIAC and by storing instructions in the same medium as data. Towards the end of vacuum tube era, UNIVAC was buit in 1952 and was arguably the first commercially successful computer.

   Software technology during this period was very primitive. The first programs were written out in machine code, i.e. programmers directly wrote down the numbers that corresponded to the instructions they wanted to store in memory. By the 1950s programmers were using a symbolic notation, known as assembly language, then hand-translating the symbolic notation into machine code. Later programs known as assemblers performed the translation task.

Some main features of the computes of this era are

- Electron emitting devices
- Data and programs are stored in a single read-write memory
- Memory contents are addressable by location, regardless of the content
- Machine language/Assemble language
- Sequential execution

3. **Second Generation (1954-1962) (transistor):** In this generation the major paradigm shift was in the design of the switches which now were electronic and based on discrete diode and transistor technology. The switching time of these switches were approximately 0.3 microseconds, which made the operating of computes in this generation much faster, compared to their predecessors. Further, second generation also witnessed several important developments at the programming languages used to write scientific applications. A number of high level programming languages were introduced e.g., FORTRAN (1956), ALGOL (1958), COBOL (1959) etc. Some, important commercial machines of this age are the IBM 704 and its successors, the 709 and 7094. The first supercomputers were also designed during this time for numeric processing in scientific applications.

   Some main features of the computes of this era are

   - Switches based on transistors and diodes.
   - First operating Systems: handled one program at a time
   - High level languages
- Floating point arithmetic

4. **Third Generation (1963-1972) (Integrated circuits):** Compared to the second generation, now the switching technology changed to integrated circuits or ICs (semiconductor devices with several transistors built into one physical component). The first ICs were based on small-scale integration (SSI) technology, which had around 10 devices per circuit (or 'chip'), and then advanced to medium-scale integrated (MSI) circuits, which had up to 100 devices per chip. The memory technology also changed to include semiconductor memories and microprogramming was adopted for efficient design of complex processors. This era also saw the introduction of operating systems with time-sharing philosophy. Multilayered printed circuits were developed during this time.

   Some main features of the computes of this era are

   - IC based chips to built computers, which helped in reduction of the size of computers drastically
   - Semiconductor memory
   - OS with time sharing
   - Multiple computer models with different performance characteristics

5. **Fourth Generation (1972-1984):** The integration technology improved to Large scale integration (LSI - 1000 devices per chip) and very large scale integration (VLSI - 100,000 devices per chip), which were now used in the construction of the fourth generation computers. The key point in the computers of this age is marked by processors that fit onto a single chip. Frequency of operation improved greatly reaching about hundreds of MHz. Also, semiconductor memories came into use and replaced core memories. The most widely accepted high level programming language "C" was developed in 1972 by Dennis Ritchie from CPL

(Common Programming Language) and Thompson's B. Thompson and Ritchie then used C to write a version of one of the most widely accepted operating system UNIX. Other developments in software include very high level languages such as FP (functional programming) and Prolog (programming in logic). What we call the PC (Personal Computer) today, was developed by IBM and Microsoft during the 1980s. IBM PC was introduced in October 1981 and it worked with the operating system (software) called 'Microsoft Disk Operating System (MS DOS) 1.0.

Some main features of the computes of this era are

- Combines millions of transistors
- Single-chip processor
- Creation of the Personal Computer (PC)
- Start of the use of data communications

6. **Fifth Generation (1984-1990) :**
   By fourth generation, most of the basic principles of computing were developed. Broadly speaking, fifth and sixth generations were only marked by improvements. In the Fifth generation the scale of integration in semiconductors technology increased and so more number of components in a chip could be accommodated. Also, fabrication of on-chip memories became possible and so semiconductor memories became standard on all computers. Fifth generation saw the introduction of servers with several processors that could all be working on different parts of a single program. Computer networks and data communication became popular with Wide area network (WAN) and local area network (LAN) technology developing rapidly.

7. **Sixth Generation (1990 - present) :**
   The present generation saw the widespread use of computers and networks, even at the laymen level. Network bandwidth and speed of operation have increased tremendously. Modern computing devices include Personal computers (PCs) operating at Gigabit frequency, Terabyte disks, Mbytes of RAM, color printers, high-resolution graphic monitors, stereo sound cards graphical user interfaces etc. Regarding software, hundreds of operating systems and application software are available today. Scripting languages, Graphical User Interface (GUI) based platforms are being widely used for programming where coding can be done at very high level which makes programming easy and fast. Hand held computing and communication devices like Mobile Phones, Tablets, Laptops etc. are taking over desktop PCs. Also, wired communication is being replaced with wireless communication.

Question 4: What is the concept of family of computers and what are the basic characteristics of a family of computers?

Solution 4: A computer family can be defined as a class of computers with the same design and microprocessors that are compatible with each other. Some examples are the IBM or PC family versus the Apple or Mac family of computers.

Some of the key characteristics of a computer family are:

- Similar or identical instruction set: The same set of machine instructions is supported on all members of the family. Thus, a program that executes on one machine will also execute on any other. However, with upgradation new instructions may be added but supports backward compatibility.
- Similar or identical operating system
- Increasing speed: The frequency of operation increases in from lower to higher family members.
- Increasing Number of I/O ports
- Increasing memory size