MODULE 1

Introduction to C: Introduction to computers, input and output devices, designing efficient programs. Introduction to C, Structure of C program, Files used in a C program, Compilers, Compiling and executing C programs, variables, constants, Input/output statements in C,

Textbook: Chapter 1.1-1.9, 2.1-2.2, 8.1 - 8.6, 9.1-9.14

Chapter 1: Introduction to Computers

1.1 COMPUTER

- A computer can be defined as an electronic device that is designed to accept data, perform the required mathematical and logical operations at high speed, and output the result.
- We all have seen computers in our homes, schools, and colleges.
- In the past, computers were extremely large in size and often required an entire room for installation. These computers consumed enormous amounts of power and were too expensive to be used for commercial applications.
- These days, computers have become so prevalent in the market that all interactive devices such as cellular phones, global positioning system (GPS) units, portable organizers, automated teller machines (ATMs), and gas pumps, work with computers.

1.2 CHARACTERISTICS OF COMPUTERS

A computer accepts data, processes it, and produces information.

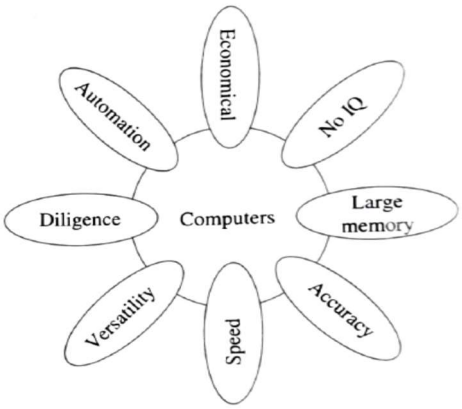


Figure 1.1 Characteristics of computers

Speed Computers can perform millions of operations per second, which means that data that may otherwise take many hours to process is output as information in the blink of an eye. The speed of computers is usually given in nanoseconds and picoseconds.

1 nanosecond = 1 x 10^{-9} seconds and 1 picosecond = 1 x 10^{-12} seconds.

Accuracy A computer is a very fast, reliable, and robust electronic device. It always gives accurate results provided the correct data and set of instructions are input to it. Hence, in the event of an error, it is the user who has fed the incorrect data/program is responsible. If the input data is wrong, then the output will also be erroneous. In computer terminology, this is known as garbage-in, garbage-out (GIGO).

Automation Besides being very fast and accurate, computers are automatable devices that can perform a task without any user intervention. The user just needs to assign the task to the computer, after which it automatically controls different devices attached to it and executes the program instructions.

Diligence Unlike humans, computers never get tired of a repetitive task. It can continually work for hours without creating errors. Even if a large number of executions need to be executed, each and every execution requires the same duration, and is executed with the same accuracy,

Versatile Versatility is the quality of being flexible. Today, computers are used in our daily life in different fields. For example, they are used as personal computers (PCs) for home use, for business-oriented tasks, weather forecasting, space exploration, teaching, railways, banking, medicine, and so on.

On the PC that we use at home - we may play a game, compose and send e-mails, listen to music, etc. Therefore, computers are versatile devices as they can perform multiple tasks of different nature at the same time,

Memory Similar to humans, computers also have memory. Just the way we cannot store everything in our memory and need secondary media, such as a notebook, to record certain important things, computers also have internal or primary memory (storage space) as well as external or secondary memory. While the internal memory of computers is very expensive and limited in size, the secondary storage is cheaper and of bigger capacity.

Some examples of secondary devices include floppy disks, optical disks (CDs and DVDs), hard disk drives (HDDs) and pen drives.

When data and programs have to be used, they are copied from the secondary memory into the internal memory, often known as random access memory (RAM).

No IQ Although the trend today is to make computers intelligent by inducing artificial intelligence (AI) in them, they still do not have any decision-making abilities of their own. They need guidance to perform various tasks.

Economical Today, computers are considered as short-term investments for achieving long-term gains. Computers save time, energy and money. When compared to other systems, computers can

do more work in lesser time. For example, using the conventional postal system to send an important document takes at least two to three days, whereas the same information when sent using the Internet (e-mail) will be delivered instantaneously.

1.3 STORED PROGRAM CONCEPT

All digital computers are based on the principle of stored program concept which was introduced by Sir John Von Neumann in the late 1940s.

The following are the characteristic features of this concept:

- Before any data is processed, instructions are read into memory.
- Instructions are stored in the computer's memory for execution.
- Instructions are stored in binary forms (using binary numbers only 0s and 1s).
- Processing starts with the first instruction in the program, which is copied into a control unit circuit. The control unit executes the instructions.
- Instructions written by the users are performed sequentially until there is a break in the current flow.
- Input / Output and processing operations are performed simultaneously. While data is being read/written, the central processing unit (CPU) executes another program in the memory that is ready for execution.

A stored program architecture is a fundamental computer architecture where-in the computer executes the instructions that are stored in its memory.

Today, a CPU chip can handle billions of instructions per second.

1.3.1 Types of Stored Program Computers

A computer with a Von Neumann architecture stores data and instructions in the same memory. There is a serial machine in which data and instructions are selected one at a time. Data and instructions are transferred to and from memory through a shared data bus. Since there is a single bus to carry data and instructions, process execution becomes slower.

Later **Harvard University** proposed a stored program concept in which there was a separate memory to store data and instructions. Instructions are selected serially from the instruction memory and executed in the processor. When an instruction needs data, it is selected from the data memory. Since there are separate memories, execution becomes faster.

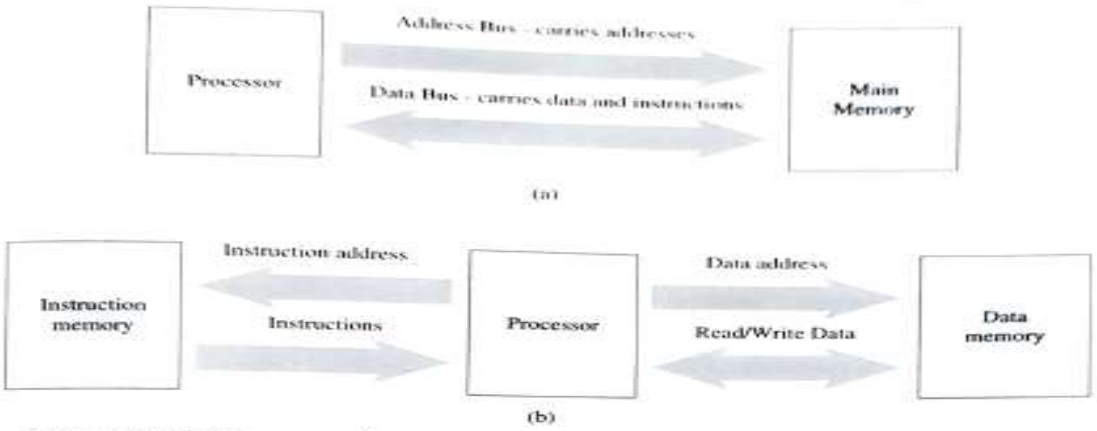


Figure 1.2 Von Neumann architecture (a) Shared memory for instructions and data (b) Separate memories for instructions and data

1.4 HISTORY OF COMPUTERS

Early computers were designed not for entertainment but for solving number-crunching problems. These computers were punch-card based computers that took up entire rooms.

Today, our smartphones have much more computing power than that was available in those early computers.

Timeline of Developments

300 BC: The abacus was an early aid for mathematical computations and was designed to aid human's memory while performing calculations. A skilled abacus operator can add and subtract with the same speed as that of a person performing the same calculation using a hand calculator.

1822: English mathematician Charles Babbage designed a steam-driven calculating machine that could compute tables of numbers. Though the project failed as he could not complete the construction of the engine, it laid the foundation for the first computer.

1890: Herman Hollerith, an American inventor, designed a punched card system to calculate the 1880 census. The system completed the task in three years saving the US government S5 million. Later Herman established a company that we today know as IBM.

1936: British mathematician Alan Turing introduced a universal machine called the Turing machine capable of computing anything that is computable. The central concept of the modern computer is based on this machine.

1941: John Vincent Atanasoff, a Bulgarian-American physicist, and his graduate student, Clifford Berry, at Iowa State College designed Atanasoff-Berry computer (ABC) that could solve 29 equations simultaneously. It was the first time a computer could store information in its main memory.

1943-1944: John W. Mauchly and J. Presper Eckert built the Electronic Numerical Integrator and Calculator (ENIAC), which is considered as the grandfather of digital computers. It filled a 20 x 40 feet room and had 18,000 vacuum tubes.

1946: Mauchly and Presper designed the UNIVAC, which was the first commercial computer for

business and government applications.

1947: William Shockley, John Bardeen and Walter Brattain of Bell Laboratories invented the transistor. Vaccuum tubes in computers were replaced by transistors.

1948: Grace Hopper developed the first computer language COBOL

1953: Grace Hopper developed the first computer language COBOL

1954: The FORTRAN programming language was developed.

1958: Jack Kilby of Texas Instruments and Robert Noyce at Fairchild Semiconductor corporation separately invented integrated circuit, which is commonly known as the computer chip.

1964: Douglas Engelbart developed a prototype of the modern computer, with a mouse and a graphical user interface (GUI). This was a remarkable achievement as it shifted computers from a specialized machine for scientists and mathematicians to general public

1969: Unix operating system was developed at Bell Labs, It was written in the C programming language and was designed to be portable across multiple platforms.

1970: DRAM chip was introduced by Intel

1971: Alan Shugart with his team in IBM invented the floppy disk which allowed data to be shared among computers.

1973: Robert Metcalfe, a research member at Xerox, developed Ethernet for connecting multiple computers and other hardware.

1974-1977: Personal computers started becoming popular.

1975: Paul Allen and Bill Gates started writing software for the Altair 8800 using the new BASIC Language. On April 4, they both formed their own software company, Microsoft.

1976: Steve Jobs and Steve Wozniak started Apple Computers and developed Apple 1, the first computer with a single-circuit board

1977: Apple II was launched that offered colour graphics and incorporated an audio cassette drive for storage.

1978: WordStar, a word processor application, was released by MicroPro International.

1979: VisiCalc, the first computerized spreadsheet program for personal computers, was unveiled.

1981: The first IBM personal computer was introduced that used Microsoft's MS-DOS operating system. The term PC was popularized.

1983: The first laptop was introduced. Moreover, Apple introduced Lisa as the first personal computer with a GUI with drop-down menus and icons

1985: Microsoft announced Windows as a new operating system.

1986 Compaq introduced Deskpro 386 in the market which was a 32 bit architecture machine that provides speed comparable to mainframes.

1990 Tim Berners-Lee invented World Wide Web with HTML as its publishing language.

1993: The pentium microprocessor introduced the use of graphics and music on PCS

1994: PC games became popular.

1996: Sergey Brin and Larry Page developed the Google search engine at Stanford University.

1999 The term Wi-Fi was introduced when users started connecting to the Internet without wires.

2001: Apple introduced Mac OS X operating system, which had protected memory architecture and pre-emptive multi-tasking, among other benefits. To stay competitive, Microsoft launched Windows XP.

2003: The first 64-bit processor, AMD's Athlon 64, was brought into the consumer market.

2004: Mozilla released Firefox 1.0 and in the same year Facebook, a social networking site, was launched.

2005: YouTube, a video sharing service, was launched. In the same year, Google acquired Android, a Linux-based mobile phone operating system.

2006: Apple introduced MacBook Pro, its first Intel- based, dual-core mobile computer.

2007: Apple released iPhone, which brought many computer functions in the smartphone.

2009: Microsoft launched Windows 7 in which users could pin applications to the taskbar.

2010: Apple launched iPad, which revised the tablet computer segment.

2011: Google introduced Chromebook, a laptop that runs on the Google Chrome operating system.

2015: Apple released the Apple Watch. In the same year, Microsoft launched Windows 10

Let us also understand the evolution of computers through different generations.

First Generation (1942-1955) – Vacuum tubes

Hardware Technology First generation computers were manufactured using thousands of vacuum tubes. A vacuum tube is a device made of fragile glass.

Memory Electromagnetic relay was used as primary memory and punched cards were used to store data and instructions.

Software Technology Programming was done in machine or assembly language.

Used for Scientific applications

Examples ENIAC, EDVAC, EDSAC, UNIVAC LIRM 701

Highlights

- They were the fastest, calculating device of those times
- Computers were too bulky and required a complete room for storage
- Highly unreliable as vacuum tubes emitted a large amount of heat and burnt frequently
- Required air-conditioned rooms for installation
- Costly
- Difficult to use

- Required constant maintenance because vacuum tubes used filaments that had limited life time. Therefore, these computers were prone to frequent hardware failures.

Figure 1.3 Vacuum tube
Source: Vladyslav Danilin/Shutterstock

Second Generation (1955-1964) - Transistors

Hardware Technology Second generation computers were manufactured using transistors. Transistors were reliable, powerful, cheaper, smaller, and cooler than vacuum tubes.

Memory Magnetic core memory was used as primary memory; magnetic tapes and magnetic disks were used to store data and instructions. These computers had faster and larger memory than the first generation computers.

Software Technology Programming was done in high level programming languages. Batch operating system was used.

Used for Scientific and Commercial Applications

Examples Honeywell 400, IBM 7030, CDC 1604, UNIVAC LARC

Highlights

- Faster, smaller, cheaper, reliable, and easier to use than the second generation computers.
- They consumed 1/10 th the power consumed by than first generation computers
- Bulky in size and required a complete room for its installation
- Dissipated less heat than first generation computers but still required air-conditioned rooms
- Costly
- Difficult to use

Figure 1.4 Transistors

***Third Generation (1964-1975)* – ICs with SSI, MSI**

Hardware Technology Third generation computers were manufactured using integrated chips (ICs). ICs consist of several components such as transistors, capacitors, and resistors on a single chip to avoid wired interconnections between components. These computers used SSI and MSI technology. Minicomputers came into existence.

Initially, it contained 10-20 components. This technology was called Small Scale Integration (SSI). Later, it was enhanced to contain about 100 components. This was called MSI (Medium Scale integration.

Memory Larger magnetic core memory was used as primary memory: larger capacity magnetic tapes and magnetic disks were used to store data and instructions

Software Technology Programming was done in high level programming languages such as FORTRAN, COBOL Pascal, and BASIC. Time sharing operating system was used. Software was separated from the hardware. This allowed users to invest only in the software they need.

Used for Scientific, commercial, and interactive online applications

Examples IBM 360/370, PDP-8, PADP-11, CDC6600

Highlights

- Faster, smaller, cheaper, reliable, the second generation computers
- They consumed less power than second generation computers
- Bulky in size and required a complete room for its installation
- Dissipated less heat than first generation computers but still required air-conditioned rooms
- Costly
- Easier to use and upgrade

Figure 1.5 Integrated circuits

<u>Fourth Generation (1975-1989) – </u>ICs with LSI, VLSI

Hardware Technology Fourth generation computers were manufactured using ICs with LSI (Large Scale Integrated) and later with VLSI technology (Very Large Scale Integration). Microcomputers came into existence.

Use of personal computers became widespread. High speed computer networks in the form of LAN, WAN, and MANS started growing. Besides mainframes, supercomputers were also used

LSI circuits contained 30,000 components on a single chip and VLSI technology had about one million electronic components on a single chip.

Memory Semiconductor memory was used as primary memory, large capacity magnetic disks were used as built- in secondary memory. Magnetic tapes and floppy disks were used as portable storage devices.

Software Technology Programming done in high level programming language such as C and C++. Graphical User Interface (GUI) based operating system (e.g. Windows) was introduced. It had icons and

menus among other features to allow computers to be used as a general purpose machine by all users. UNIX was also introduced as an open source operating system. Apple Mac OS and MS DOS were also released during this period. All these operating systems had multi-processing and multi- programming capabilities.

Used for Scientific, commercial, interactive online, and network applications

Examples IBM PC, Apple II, TRS-80, VAX 9000, CRAY- 1, CRAY-2, CRAY-X/MP

Highlights Faster, smaller, cheaper, powerful, reliable and easier to use than the previous generation computers.

Figure 1.6 VISI chip

Fifth Generation (1989-Present) – ICs with ULSI

Hardware Technology Fifth generation computers are manufactured using ICs with ULSI (Ultra Large Scale Integrated) technology. The use of Internet became widespread and very powerful mainframes, desktops, portable laptops, and smartphones are being used commonly Supercomputers use parallel processing techniques.

ULSI circuits contain about 10 million electronic components on a single chip.

Memory Semiconductor memory is used as primary memory; large capacity magnetic disks are used as built-in secondary memory, Magnetic tapes and floppy disks were used as portable storage devices, which have now been replaced by optical disks and USB flash drives.

Software Technology Programming is done in high-level programming languages such as Java, Python, and C#. Graphical User Interface (GUI)-based operating systems such as Windows, Unix, Linux, Ubuntu, and Apple Mac are being used. These operating systems are more powerful and user friendly than the ones available in the previous generations.

Used for Scientific, commercial, interactive online, multimedia (graphics, audio, video), and network applications

Examples IBM notebooks. Pentium PCs, SUM workstations, IBM SP/2, Param supercomputer

Highlights

- Faster, smaller, cheaper, powerful, reliable, and easier to use than the previous generation computers.
- Speed of microprocessors and the size of memory are growing rapidly

- High-end features available on mainframe computers in the fourth generation are now available on the microprocessors.
- They consume less power than computers of prior generations.
- Air-conditioned rooms required for mainframes and supercomputers but not for microprocessors.

Figure 1.7 ULSI chip

1.5 CLASSIFICATION OF COMPUTERS

Computers can be broadly classified into four categories based on their speed, amount of data that they can process and price. These categories are as follows:

- Supercomputers
- Mainframe computers
- Minicomputers
- Microcomputers

1.5.1 Supercomputers

Among the four categories, the supercomputer is the fastest, most powerful, and most expensive computer. Supercomputers were first developed in the 1980s to process large amounts of data and to solve complex scientific problems. Supercomputers use parallel processing technology and can perform more than one trillion calculations in a second.

A single supercomputer can support thousands of users at the same time. Such computers are mainly used for weather forecasting, nuclear energy research, aircraft design, automotive design, online banking, controlling industrial units etc.

1.5.2 Mainframe Computers

Mainframe computers are large-scale computers (but smaller than supercomputers). These are very expensive and need a very large clean room with air conditioning, thereby making them very costly to deploy. As with supercomputers, mainframes can also support multiple processors. For example, the IBM S/390 mainframe can support 50,000 users at the same time. Users can access mainframes by either using terminals or via PCs. The two types of terminals that can be used with mainframe systems are as follows:

Dumb Terminals

Dumb terminals consist of only a monitor and a keyboard (or mouse). They do not have their own CPU and memory and use the mainframe system's CPU and storage devices.

Intelligent Terminals

In contrast to dumb terminals, intelligent terminals have their own processor and thus can perform some processing operations. However, just like the dumb terminals, they do not have their own storage space. Usually, PCs are used as intelligent terminals to facilitate data access and other services from the mainframe system.

Mainframe computers are typically used as servers on the World Wide Web. They are also used in organizations such as banks, airline companies, and universities, where a large number of users frequently access the data stored their databases, IBM is the major manufacturer of mainframe computers. Some examples of mainframe computers include IBM S/390, Control Data CYBER 176, and Amdahl 580.

1.5.3 Minicomputers

Minicomputers are smaller, cheaper, and slower than mainframes. They are called minicomputers because they were the smallest computer of their times. Also known as midrange computers, the capabilities of minicomputers fall between mainframe and personal computers.

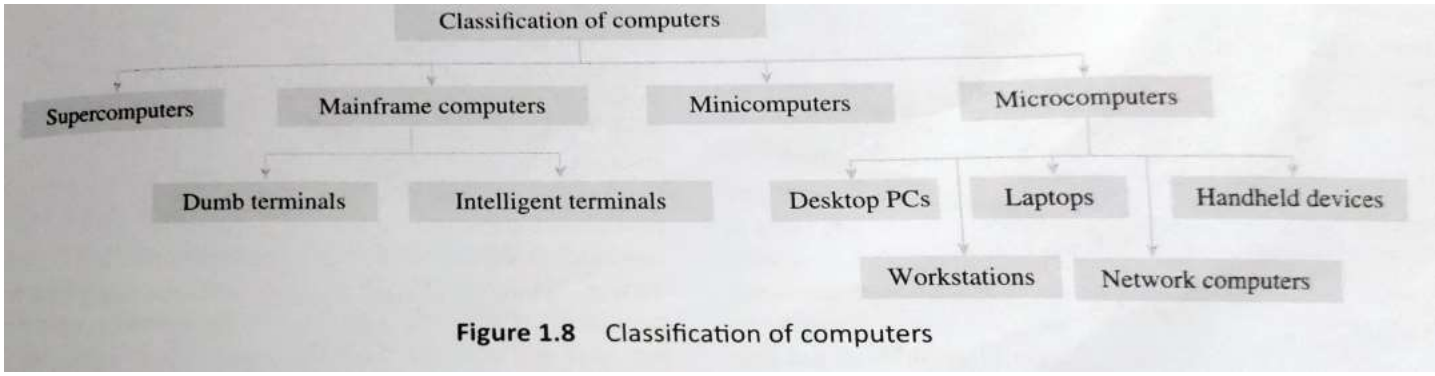


Figure 1.8 Classification of computers

Minicomputers are widely used in business, education, hospital government organizations, etc. While some minicomputers can be used only by a single user, others are specifically designed to handle multiple users simultaneously.

1.5.4 Microcomputers

Microcomputers, commonly known as PCs, are very small and cheap. The first microcomputer was designed by IBM in 1981 and was named IBM-PC, Later on, many computer hardware companies copied this design and termed their microcomputers as PC-compatible, which refers to any PC that is based on the original IBM PC design.

Another type of popular PC is designed by Apple. PCs designed by IBM and other PC-compatible computers have a different architecture from that of Apple computers.

PCs can be classified into the following categories:

Desktop PCs

A desktop PC is the most popular model of PCs. The system unit of the desktop PC can be placed flat on a desk or table. It is widely used in homes and offices.

Laptops

Laptops are small microcomputers that can easily fit inside a briefcase. They are very handy and can easily be carried from one place to another.

Figure 1.9 Laptop
Source: You can more/Shutterstock

Workstations

Workstations are single-user computers that have the same features as PCs, but their processing speed matches that of a minicomputer or mainframe computer. Workstation computers have advanced processors, more RAM and storage capacity than PCs. Therefore, they are more expensive and powerful than a normal desktop computer.

Network Computers

Network computers have less processing power, memory, and storage than a desktop computer. These are specially designed to be used as terminals in a networked environment. For example, some network computers are specifically designed to access data stored on a network (including the Internet and intranet), Some network computers do not have any storage space

Handheld Computers

The mid-1990s witnessed a range of small personal computing devices that are commonly known as handheld computers, or mobile computers. These computers are called handheld computers because they can fit in one hand, while users can use the other hand to operate them.

Handheld computers are very small in size, and hence they have small-sized screens and keyboards. These computers are preferred by business travelers and mobile employees whose jobs require them to move from place to place.

Some examples of handheld computers are as follows:

Smartphones

Tablet PCs

Smartphones These days, cellular phones are web-enabled telephones. Such phones are also known as smartphones because, in addition to basic phone capabilities, they also facilitate the users to access the Internet and send e-mails, edit Word documents, generate an Excel sheet, and create a presentation, and lots more.

Smartphones run an advanced mobile operating system that enables it to run various applications. The

four major mobile operating systems are iOS, Android, BlackBerry OS, and Windows Mobile Smartphones also have a CPU, more storage space, more memory, and a larger screen than a regular cell phone.
In a nutshell, smartphone refers to a multi-functional mobile phone handset that packs in varied functionalities from a camera to a web browser to a high-density display.

Tablet PCs A tablet PC is a computing device that is smaller than a laptop, but bigger than a smartphone. Features such as user-friendly interface, portability, and touch screen have made them very popular in the last few years. These days, a wide range of high-performance tablets are available in the market.
While all of them look similar from outside, they may differ in features such as operating system, speed of data connectivity, camera specifications, size of the screen. Processing power, battery life, and storage capability.
Some operating systems that are used in tablets are Android Jellybean (an open-source operating system built by Google), Windows 8, and iOS (developed by Apple). Each operating system has its own advantages and disadvantages and a proprietary app store, from which users can download applications, extending the tablet's functionality. These apps range from games to specialized word processors and even instruments.
While users can easily type directly on the surface of a tablet, some users prefer a wireless or bluetooth-connected keyboard. These days, tablets also offer an optional docking station with keyboards that transforms the tablet into a full-featured netbook.
Uses The following are the uses of Tablet PCs:

- View presentations
- Videoconferencing
- Reading e-books, e-newspaper
- Watching movies
- Playing games
- Sharing pictures, video, songs, documents, etc.
- Browsing the Internet
- Keeping in touch with friends and family on popular social networks, sending emails
- Business people use them to perform tasks such as editing a document, exchanging documents, taking notes, and giving presentations.
- Tablets are best used in crowded places such as airports and coffee shops, where size and portability become more important.

Note - Tablets may replace laptops if users don't have to perform heavy processing tasks and do not require a CD or DVD player.

Figure 1.10 Tablet

1.6 APPLICATIONS OF COMPUTERS

When the first computers were developed, they were used only in the fields of mathematics and science. Let us discuss how computers are being effectively utilized to perform important tasks.

Word processing Word processing software enables users to read and write documents. Users can also add images, tables, and graphs for illustrating a concept. The software automatically corrects spelling mistakes and includes copy paste features (which is very useful where the same text has to be repeated several times).

Internet The Internet is a network of networks that connects computers all over the world. It gives the user access to an enormous amount of information, much more than available in any library. Using e-mail, the user can communicate in seconds with a person who is located thousands of miles away. Chat software enables users chat with another person in real-time (irrespective of the physical location of that person). Video conferencing tools are becoming popular for conducting meetings with people who are unable to be present at a particular place.

Digital video or audio composition Computers make audio or video composition and editing very simple. This has drastically reduced the cost of equipment to compose music or make a film. Graphics engineers use computers for developing short or full-length films and creating 3-D models and special effects in science fiction and action movies.

Desktop publishing Desktop publishing software enables us to create page layouts for entire books.

After discussing how computers are used in today's scenario, let us now have a look at the **different areas where computers are being widely utilized.**

e-Business e-Business or electronic business is the process of conducting business via the Internet. This may include buying and selling of goods and services using computers and the Internet. Use of email and videoconferencing technology has revolutionized the way business is being conducted these days. Techniques in which e-commerce helps users to conduct business transactions:

Business-to-consumer or B2C In this form of electronic commerce, business companies deploy their websites on the Internet to sell their products and services to the customers. On their websites, they provide features such as catalogues, interactive order processing system, secure

electronic payment system, and online customer support,

Business-to-business or B2B This type of electronic commerce involves business transactions performed between business partners (customers are not involved). For example, companies use computers and networks (in the form of extranets) to order raw materials from their suppliers. Companies can also use extranets to supply their products to their dealers.

Consumer-to-consumer or C2C This type of electronic commerce enables customers to carry business transactions among themselves. For example, on auction websites a customer sells his/her product which is purchased by another customer.

Electronic banking Electronic banking, also known as cyberbanking or online banking, supports various banking activities conducted from home, a business, or on the road instead of a physical bank location.

Bioinformatics

Bioinformatics is the application of computer technology to manage large amount of biological information Computers are used to collect, store, analyze, and integrate biological and genetic information to facilitate gene-based drug discovery and development. The need for analysis has become even more important with enormous amount of genomic information available publicly from the Human Genome Project. Bioinformatics is an interdisciplinary field of molecular biology, computer science, statistics, and mathematics.

Health care

Last few years have seen a massive growth of computers and smartphone users. Like in our daily lives, computers have also become a necessary device in the health care industry. The following are areas in which computers are extensively used in the health care industry.

Storing records To begin with, computers are first and foremost used to store the medical records of patients. Earlier, patient records were kept on paper, with separate records dealing with different medical issues from separate healthcare organizations. With time, the number of prescriptions, medical reports, etc., grow in volume making it difficult to maintain and analyze. Use of computers to store patient records has been a game-changer in terms of improving the efficiency and accuracy of the entire process.

Surgical procedures Computers are used for certain surgical procedures. They enable the surgeon to use computer to control and move surgical instruments in the patient's body for a variety of surgical procedures. In such surgeries, a small incision is made, and then a small surgical tool with an attached camera is placed inside the patient's body. This reduces the risk of complications from a larger surgical wound, and minimizes damage done to the patient's body. In such a scenario, computers are not

only used to drive the tools but also used to relay images.

Better diagnosis and treatment Computers help physicians make better diagnoses and recommend treatments. Moreover, computers can be used to compare expected results with actual results in order to help physicians make better decisions.

Geographic Information System and Remote Sensing

A geographic information system (GIS) is a computer-based tool for mapping and analysing earth's features. It integrates database operations and statistical analysis to be used with maps. GIS manages location- based information and provides tools for display and analysis of statistics such as population count, types of vegetation, and economic development opportunities. Such type of information helps to predict outcomes and plan strategies.

Remote sensing is a sub-field of geography, which can be applied in the following areas to collect data of dangerous or inaccessible areas for the following:

- Monitoring deforestation in areas like the Amazon Basin
- Studying features of glaciers in Arctic and Antarctic regions
- Analysing the depth of coastal and ocean areas
- Studying land usage in agriculture
- Examining the health of indigenous plants and crops
- Determining the prospect for minerals
- Locating and measuring intensity of earthquakes (after they had occurred) by comparing the relative intensity and precise timings of seismograms collected from different locations

Meteorology

Meteorology is the study of the atmosphere. This branch of science observes variables of Earth's atmosphere such as temperature, air pressure, water vapour, and the gradients and interactions of each variable, and how they change over time.

Weather forecasting It includes application of science and technology to predict the state of the atmosphere (temperature, precipitation, etc.) for a future time and a given location. Weather forecasting is done by collecting quantitative data about the current state of the atmosphere and analysing the atmospheric processes to project how the atmosphere will evolve.

Aviation meterology

It studies the impact of weather on air traffic management.

Agricultural meterology

It deals with the study of effects of weather and climate on plant distribution, crop yield, water-use efficiency, plant and animal development.

Nuclear meterology

It studies the distribution of radioactive aerosols and gases in the atmosphere.

Maritime meterology

It is the study of air and wave forecasts for ships operating at sea.

Multimedia and Animation

It combines still images, moving images, text, and sound in meaningful ways is one of most powerful aspects of computer technology. We all have seen cartoon movies, which are nothing but an example of computer animation

Displaying a number of images within a fraction of a second gives an animation effect. For example, displaying at least 30 images in a second gives an effect of a moving image.

Using animation software, we can reproduce real-world phenomena such as fire, smoke, fluids, and movement of chemicals through the air and ground, and the respiratory system to name a few. Animation is an easy and effective way to show complex interactions or events. Thus, it is an excellent tool for educating an audience.

A dynamic multimedia presentation (created using like MS PowerPoint) can make the message not only easily undertood but also effective. Multimedia presentation helps corporate people to share information or their ideas and graphically present information in a more understandable and persuasive manner.

Edutainment is the combination of education with entertainment

Legal System

Computers are used by lawyers to shorten the time required to conduct legal precedent and case research. Lawyers use computers to look through millions of individual cases and find whether similar or parallel cases have been approved, denied, criticized, or overruled in the past. This enables the lawyers to formulate strategies based on past case decisions. Moreover, computers are also used to keep track of appointments and prepare legal documents and briefs in time for filling cases

Retail Business

Computers are used in retail shops to enter orders, calculate costs, and print receipts. They are also used to keep an inventory of the products available and their complete description.

Sports

In sports, computers are used to compile statistics, identify weak players and strong players by analyzing statistics, sell tickets, create training programs and diets for athletes, and suggest game plan strategies based on the competitor's past performance. Computers are also used to generate most of the graphic art displays flashed on scoreboards

Travel and Tourism

Computers are used to prepare tickets, monitor the train's or airplane's route, and guide the plane to a safe

landing. They are also used to research about hotels in an area, reserve rooms, or to rent a car.

Simulation

Supercomputers that can process enormous amount of data are widely used in simulation tests. Simulation of automobile crashes or airplane emergency landings is done to identify potential weaknesses in designs without risking human lives. Supercomputers also enable engineers to design aircraft models and simulate the effects that winds and other environmental forces have on those designs.

Astronauts are trained using computer-simulated problems that could be encountered during launch in space, or upon return to earth.

Astronomy

Spacecrafts are usually monitored using computers that not only keep a continuous record of the voyage and of the speed, direction, fuel, and temperature, but also suggest corrective action if the vehicle makes a mistake.

The remote stations on the earth compare all these quantities with the desired values, and in case these values need to be modified to enhance the performance of the spacecraft, signals are immediately sent that set in motion the mechanics to rectify the situation. With the help of computers, all this is done within a fraction of a second.

Education

A computer is a powerful teaching aid and can act as another teacher in the classroom. Teachers use computers to develop instructional material. Teachers may use pictures, graphs, and graphical presentations to easily illustrate an otherwise difficult concept. Moreover, teachers at all levels can use computers to administer assignments and keep track of grades. Students can also give exams online and get instant results.

Industry and Engineering

Computers are found in all kinds of industries, such as thermal power plants, oil refineries, and chemical industries, for process control, computer-aided designing (CAD), and computer-aided manufacturing (CAM).

Computerized process control (with or without human intervention) is used to enhance efficiency in applications such as production of various chemical products, oil refining, paper manufacture, and rolling and cutting steel to customer requirements.

In CAD, computers and graphics-oriented software are integrated for automating the design and drafting process.

It helps an engineer to design a 3D machine part, analyse its characteristics, and then subject it to simulated stresses. In case a part fails the stress test, its specifications can be modified on the computer and retested. The final design specifications are released for production only when the engineer is satisfied that the part

meets strength and other quality considerations.

The CAM phase begins when the CAD phase is complete. In this phase, the metal or other materials are manufactured while complying with their specifications. For this computer controlled manufacturing, tools are used to produce high quality products.

Robotics

Robots are computer-controlled machines mainly used in the manufacturing process in extreme conditions where humans cannot work. For example, in high temperature, high Pressure conditions or in processes that demand very high levels of accuracy.

Decision Support Systems

Computers help managers to analyse their organization's data to understand the present scenario of their business, view the trends in the market, and predict the future of their products.

Expert Systems

Expert systems are used to automate the decision making process in a specific area, such an analysing the credit histories for loan approval and diagnosing a patient's condition for prescribing an appropriate treatment. Expert systems analyse the available data in depth to recommend a course of action. A medical expert system might provide the most likely diagnosis of patient's condition.

1.7 BASIC ORGANIZATION OF A COMPUTER

A computer is an electronic device that performs five major operations:

- Accepting data or instructions (input)
- Storing data
- Processing data
- Displaying results (output)
- Controlling and coordinating all operations inside a computer

Input This is the process of entering data and instructions (also known as programs) into the computer system. The data and instructions can be entered by using different input devices such as keyboard, mouse, scanner, and trackball. Note that computers understand binary language, which consists of only two symbols (0 and 1), so it is the responsibility of the input

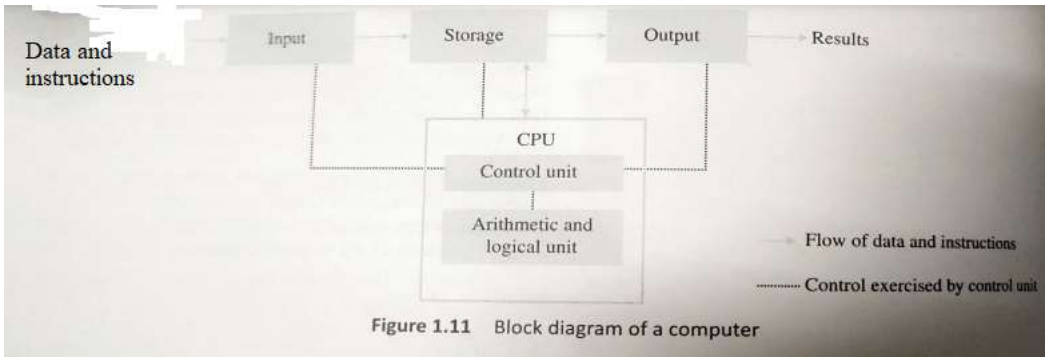


Figure 1.11 Block diagram of a computer

devices to convert the input data into binary codes

Storage - Storage is the process of saving data and instructions permanently in the computer so that they can be used for processing. The computer storage space not only stores the data and programs that operate on that data but also stores the intermediate results and the final results of processing.

A computer has two types of storage areas:

Primary storage - Primary storage, also known as the main memory, is the storage area that is directly accessible by the CPU at very high speeds. It is used to store the data and parts of programs, the intermediate results of processing and the recently generated results of jobs that are currently being worked on by the computer. Primary storage space is very expensive and therefore limited in capacity. Another drawback of main memory is that it is volatile in nature; that is, as soon as the computer is switched off, the information stored gets erased. Hence, it cannot be used as a permanent storage of useful data and programs for future use. An example of primary storage is random access memory (RAM).

Secondary storage - Also known as auxiliary memory. This memory is just the opposite of primary memory. It overcomes all the drawbacks of the primary storage area. It is cheaper, non-volatile, and used to permanently store data and programs of those jobs that are not being currently executed by the CPU. Secondary memory supplements the limited storage capacity of the primary memory. An example is the magnetic disk used to store data, such as C and D drives, for future use.

Output - Output is the process of giving the result of data processing to the outside world (external to the computer system). The results are given through output devices such as monitor, and printer. Since the computer accepts data binary form, the result cannot be directly given to the user. The output devices, therefore, convert the results available in binary codes into a human-readable language before displaying it to the user.

Control - The control unit (CU) is the central nervous system of the entire computer system. It manages and controls all the components of the computer system. It is the CU that decides the manner in which instructions will be executed and operations performed. It takes care of the step-by-step processing of all operations that are performed in the computer.

The CPU is a combination of the arithmetic logic unit (ALU) and the CU. The CPU is better known as the brain of the computer system because the entire processing of data is done in the ALU, and the CU activates and monitors the operations of other units (such as input, output, and storage) of the computer system.

Processing the process of performing operations on the data as per the instructions specified by the user (program) is called processing. Data and instructions are taken from the primary memory and transferred to the ALU, which performs all sorts of calculations. The intermediate results of processing may be stored in the main memory, as they might be required again. When the processing completes, the final result is then transferred to the main memory. Hence, the data may move from main memory to the ALU multiple times before the processing is over.

ALU, CU, and CPU are the key functional units of a computer system.

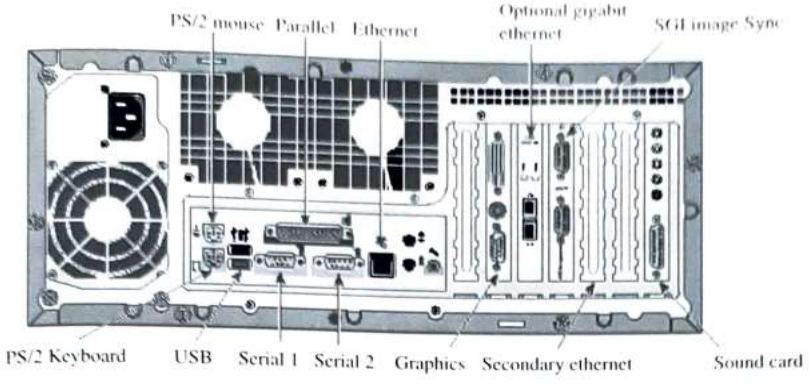
1.8 INSIDE THE COMPUTER

The following are some of the major parts of the computer.

CPU The CPU is the brain of the computer. It performs all calculations and controls the devices connected to the computer system. The faster the CPU, the quicker programs can process the instructions.

RAM A fast CPU is of no use if the computer does not have sufficient RAM. RAM is the computer's memory which stores information used by applications that are currently being executed by the CPU. More memory means more applications can be executed at the same time without degrading the system's performance.

Hard disk drive (HDD) The HDD of the computer is the secondary memory of the computer system where information is stored permanently. All types of data, documents, and programs are stored on the hard disk. The larger the hard disk, the more the amount of data that can be stored on the drive. Though the size of the HDD does not affect the speed of execution of the program, it does affect the speed at which the user can access his/her files.



Computer case and its parts

Video card The video card is a board that plugs into the motherboard of the computer and generates images

for display. Many video cards these days have their own RAM and processor to enhance the speed of the graphics display. Many computers come with an in-built video chip. In such a computer, a separate video card is used only if the computer has to be used for high-end multimedia work or to play video games.

Sound card - As with video cards, sound cards are expansion boards that are used to enable a computer to manipulate sound. For example, sound cards allow the users to plug in speakers and a microphone. Some sound cards also provide the jacks for hooking our computer up to a common stereo. These days, many computers come with a built-in sound chip, which makes it unnecessary to buy a separate card unless a higher quality of sound is needed.

Modem A modem (modulator-demodulator) is a device that enables the computer to use a telephone line to communicate and connect to the Internet.

Network card A network card is used to connect the computer either to other computers or to the Internet (in case we are using a fast Internet connection such as cable or DSL).

Fans There are one or more fans inside the computer to keep the air moving and the computer cool.

Cables There are multiple wires inside the computer that are flat, ribbon-like cables. They are used to provide power and communication to the various parts inside the computer.

1.9 MOTHERBOARD

The motherboard, also known as the mainboard or the parent board, is the primary component of a computer. It is used to connect all the components of the computer. The motherboard is a printed circuit that has connectors for expansion cards, memory modules, the processor, etc.

1.9.1 Characteristics of a Motherboard

A motherboard can be classified depending on the following characteristics:

- Form factor
- Chipset
- Type of processor socket used
- Input-Output connectors

Form factor Form factor refers to the motherboard's and electrical geometry, dimensions, arrangement, requirements. The industry has defined a few standards for the form factors, so that they can be used in different brands of cases.

Integrated components some of the motherboard's components are integrated into its printed circuitry. These include the following:

- The **chipset** is a circuit that controls the majority of the computer's resources such as the bus interface with the processor, cache memory, RAM, and expansion cards.
- CMOS clock and battery
- BIOS

- System bus and expansion bus

In addition to these, the latest motherboards also have a number of onboard multimedia and networking devices (which can be disabled), such as integrated network card, integrated graphics card, integrated sound card, and upgraded hard drive controllers.

Chipset The chipset is an electronic circuit that basically coordinates data transfers between the different components of the computer (such as the processor and memory). In order to enhance the computer's upgradeability, one must choose a motherboard that has the latest chipset integrated in it. Some chipsets may include a graphics or audio chip, which makes it unnecessary to install a separate graphics card or sound card. However, in case we need very high quality of audio and visual capabilities, then we must disable the graphics/audio chip in the BIOS setup and install high-quality expansion cards in the appropriate slots.

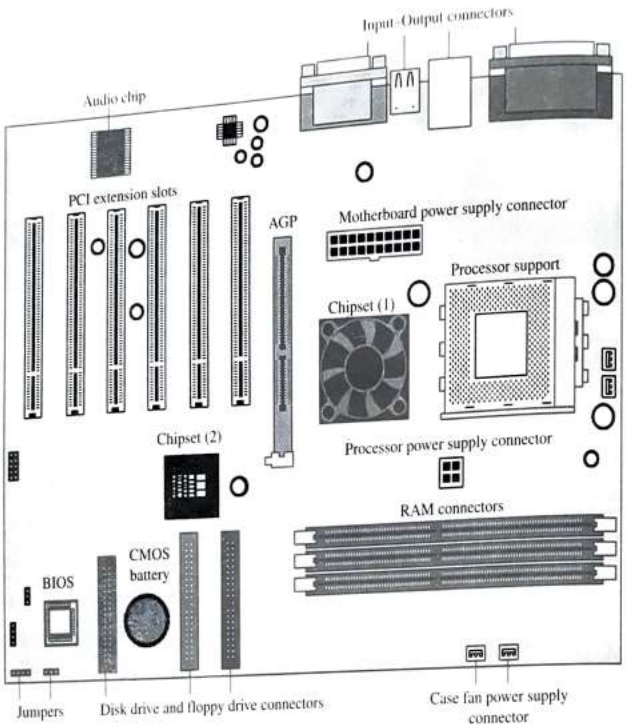
CMOS clock and battery The real-time clock (or RTC) is a circuit that is used to synchronize the computer's signals. When the computer is switched off, the power supply stops providing electricity to the motherboard. We must have observed that when we turn on the system, it always displays the correct time. This is because an electronic circuit, called the complementary metal-oxide semiconductor (CMOS) chip, saves some system information, such as the time, date, and other essential system settings.

The CMOS chip is powered by a battery located on the motherboard. Information on the hardware installed in the computer (such as the number of tracks or sectors on each hard drive) is stored in the CMOS chip. Since the CMOS chip is quite slow, some systems prefer to copy the CMOS chip's content into the RAM, which is a comparatively faster storage. This process of copying data into RAM is better known as memory shadow,

At times, the system time gets reset automatically, or the clock runs late? This indicates that we need to change the battery.

BIOS The basic input/output system (BIOS) is an interface between the operating system and the motherboard. The BIOS is stored in the read-only memory (ROM), which cannot be rewritten. The BIOS uses data stored in the CMOS chip to know about the system's hardware configuration.

To configure the BIOS, the user can use an interface known as BIOS setup, which can be accessed when the computer is booting. To enter BIOS setup, the user must press the DEL key. Fl and F2 keys can also be used.



Computer's motherboard

Processor socket The processor (also called the micro- processor) is the brain of the computer. The processor is characterized by its speed or frequency, which is the rate at which it executes instructions. For example, an 800-MHz processor can perform 800 million operations per second.

The slot on the motherboard into which the processor is inserted is called the processor socket or slot. Irrespective of whether we use a slot or a socket, you must gently insert the processor, so that none of its pins are bent (it has hundreds of them). Usually, a concept called zero insertion force (ZIF) is used. The ZIF sockets allow the processor to be inserted very gently and easily

when the computer is on, the processor is working and it releases heat, which must be dissipated to keep the circuits from melting. Therefore, the processor is generally mounted on a cooler that is made of metal (such as copper or aluminum), which conducts heat well. In addition to the cooler, there is also a fan to improve air circulation around it and to improve the heat transfer. The fan vents hot air from the case and lets fresh air come in from outside.

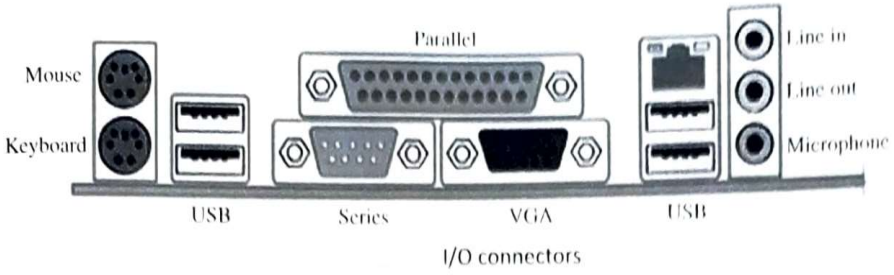
RAM connectors RAM is the primary storage area that stores data while the computer is running. However, its contents are erased when the computer is turned off or restarted. While the hard disk can store data permanently, we still need RAM because it is extremely fast when compared to mass storage devices such as hard drives. Therefore, the fast processor accesses data from RAM and not from the hard disk. The data is transferred from the hard disk to the RAM, from where it is used by the processor RAM is available in the form of modules that plug into motherboard connectors.

Expansion slots Expansion slots are compartments into which expansion cards can be inserted. Such cards render new features or enhance the computer's performance. For example, the AGP slot (also known as

Accelerated Graphic Port) is a fast port used for graphics cards.

I/O connectors The motherboard has a number of input- output sockets on its rear panel, some of which include:

- A serial port to connect some old peripherals
- A parallel port to connect old printers
- USB ports to connect more recent peripherals such as mouse and pen drive.
- RJ45 connector (also known as LAN or Ethernet port) to connect the computer to a network. It corresponds to a network card integrated into the motherboard.
- Video graphics array (VGA) connector to connect a monitor. This connector interfaces with the built-in graphics card.
- Audio plugs that include the line in, line out, and microphone to connect sound speakers, hi-fi system, or microphone. This connector interfaces with the built-in sound card.



I/O connectors