1

BASIC CONCEPTS

1.1 INTRODUCTION

Let us begin with the word 'compute'. It means 'to calculate'. We all are familiar with calculations in our day-to-day life. We apply mathematical operations like addition, subtraction, multiplication, etc. and many other formulae for calculations. Simple calculations take less time. But complex calculations take much longer time. Another factor is accuracy in calculations. So man explored with the idea to develop a machine, which can perform this type of arithmetic calculation faster, and with full accuracy. This gave birth to a device or machine called 'computer'.

1.2 OBJECTIVES

After going through this lesson, you would be in a position to:

- define a computer
- identify the characteristics of a computer
- explain the origin and evolution of a computer
- identify the capability of computer in terms of speed and accuracy
- distinguish computer from human beings and calculator
- appreciate the evolution of computer through five generations
- define the different types of computers based on electronics
- explain the classification of computer on the basis of size of memory

1.3 WHAT IS A COMPUTER

The computer as we see today is quite different from the one made in the beginning. The number of applications of computer has increased and the speed and accuracy of calculation has also increased. You have already experienced the impact of computers in our day-to-day life. Reservation of tickets in Air Lines and Railways, Payment of telephone and electricity bills, Deposits and withdrawals of money from banks, Business data processing, Medical diagnosis, Weather forecasting, etc. are some of the areas where computer has become extremely useful.

But as you will see later it does much more than that. It can be compared to a magic box, which serves different purpose to different people. For a common man computer is simply a calculator, which works automatically and quite fast. For a person who knows much about it, computer is a machine capable of solving problems and manipulating data. It accepts data, processes the data by doing some mathematical and logical operations, and gives us the desired output.

Therefore, we may define computer as a device that transforms data into meaningful information. Data can be anything like marks obtained by you in various subjects. It can also be name, age, sex, weight, height, etc. of all the students in your class or income, savings, investments, etc., of a country. Computer can also be defined in terms of functions it can perform. A computer can i) accept data ii) store data, iii) process data as desired, iv) retrieve the stored data as and when required, and v) print the result in desired format. You will know more about these functions as you go through the later lessons.

Fig. 1.1 : A personal computer

1.4 CHARACTERSTICS OF A COMPUTER

Let us identify the major characteristics of a computer. These can be discussed under the headings of speed, accuracy, diligence, versatility and memory.

(a) Speed

As you know computer can work very fast. It takes only few seconds for calculations that we take hours to complete. Suppose you are asked to calculate the average monthly income of one thousand persons in your neighborhood. For this you have to add income from all sources for all persons on a day-to-day basis and find out the average for each one of them. How long will it take for you to do this? May be one day, two days or one week? Do you know your small computer can finish this work in few seconds? The weather forecasts that you see every day on TV is the result of compilation and analysis of huge amount of data on temperature, humidity, pressure, etc. from various places processed by computers. It takes few minutes for the computer to process this huge amount of data and give the result.

You will be surprised to know that computer can perform several million (1,000,000) of instructions and even more per second. Therefore, we determine the speed of computer in terms of microsecond (10^{-6} part of a second) or nano-second (10^{-9} part of a second). From this you can imagine how fast your computer can perform.

(b) Accuracy

Suppose some one calculates faster but commits a lot of errors in computing. Such result is useless. There is another aspect. Suppose you want to divide 15 by 7. You may work out up to 2 decimal places and say the quotient is 2.14. I may calculate up to 4 decimal places and say that the result is 2.1428. Some one else may go up to 9 decimal places and say the result is 2.142857143. Hence, in addition to speed, the computer provides very high level of accuracy or correctness in computing.

(c) Diligence

A computer is free from tiredness, lack of concentration, fatigue, etc. It can work for hours without creating any error. If millions of calculations are to be performed, a computer will perform every calculation with the same accuracy. Due to this capability it is better than human being in routine type of work.

(d) Versatility

It means the capacity to perform completely different type of work. You may use your computer to prepare payroll slips. Next moment you may use it for inventory management or to prepare electricity bills or prepare accounts, etc. Therefore computer is highly versatile.

(e) Power of Remembering

Computer has the power of storing huge amount of information or data.Information can be stored and recalled as long as you require it, for any number of years. It depends entirely upon you, how much data you want to store in a computer and when to use or retrieve these data.

(f) No IQ

Computer is a dumb machine and it cannot do any work without instructions from the user. It is considered as a faithful idiot that can only perform the instructions given to it at tremendous speed and with high accuracy without understanding of the work being done. Computer has to be guided as to what you want to do and in what sequence. So a computer cannot take its own decision as you can.

(g) No Feeling

It does not have feelings or emotion, taste, knowledge and experience. Thus it does not get tired even after long hours of work. It does not distinguish between users.

(h) Storage

The computer has an in-built memory where it can store a large amount of data. You can also store data in secondary storage devices such as floppies and CDs, which can be kept outside your computer and can be carried to other computers.

INTEXT QUESTIONS

1. What is a computer? Why is it known as data processor?
2. What are the important characteristics of a computer?

1.5 HISTORY OF COMPUTER

History of computer could be traced back to the effort of man to count large numbers. This process of counting of large numbers generated various systems of numeration like Babylonian system of numeration, Greek system of numeration, Roman system of numeration and Indian system of numeration. Out of these the Indian system of numeration has been accepted universally. It is the basis of modern decimal system of numeration (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). Later you will know how the computer solves all calculations based on decimal system. However, you will be surprised to know that the computer does not understand the decimal system and uses binary system of numeration for processing.

We will briefly discuss some of the path-breaking inventions in the field of computing devices.

(a) Calculating Machines

It took generations for early man to build mechanical devices for counting large numbers. The first calculating device called ABACUS, was developed by the Egyptian and Chinese people.

The word ABACUS means calculating board. It consists of sticks in horizontal positions on which are inserted sets of pebbles. A modern form of ABACUS is shown in Fig. 1.2. It has a number of horizontal bars each having ten beads. Horizontal bars represent units, tens, hundreds, etc.

Fig. 1.2 : Abacus

(b) Napier's bones

English mathematician John Napier built a mechanical device for the purpose of multiplication in 1617 AD. The device was known as Napier's bones.

(c) Slide Rule

English mathematician Edmund Gunter developed the slide rule. This machine could perform operations like addition, subtraction, multiplication, and division. It was widely used in Europe in 16th century.

(d) Pascal's Adding and Subtraction Machine

You might have heard the name of Blaise Pascal. He developed a machine at the age of 19 that could add and subtract. The machine consisted of wheels, gears and cylinders.

(e) Leibniz's Multiplication and Dividing Machine

The German philosopher and mathematician Gottfried Leibniz build around 1673 a mechanical device that could both multiply and divide.

(f) Babbage's Analytical Engine

It was in the year 1823 that a famous English man Charles Babbage built a mechanical machine to do complex mathematical calculations. It was called difference engine. Later he developed a general-purpose calculating machine called analytical engine. You should know that Charles Babbage is called the Father of computers.

(g) Mechanical and Electrical Calculator

In the beginning of 19th century the mechanical calculator was developed to perform all sorts of mathematical calculations and it was widely used till 1960. Later the routine part of mechanical calculator was replaced by electric motor. It was called the electrical calculator.

Fig. 1.3 : Switching Devices used in different generations of Computers

(h) Modern Electronic Calculator

The electronic calculator used in 1960s was run with electron tubes, which was quite bulky. Later it was replaced with transistors and as a result the size of calculators became too small.

The modern electronic calculators can compute all kinds of mathematical computations and mathematical functions. It can also be used to store some data permanently. Some calculators have inbuilt programs to perform some complicated calculations.

INTEXT QUESTIONS

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3. What is the first mathematical device and when was it built?

4. Who is called the father of computer technology?

1.6 COMPUTER GENERATIONS

You know that the evolution of computer started from 16th century and resulted in the form that we see today. The present day computer, however, has also undergone rapid changes during the last fifty years. This period, during which the evolution of computer took place, can be divided into five distinct phases known as Generations of Computers. Generation of computer means the technological evolution over the period of time. Computers are classified as belonging to specific “generations”. The term generations was initially intro-

duced to distinguish between different hardware technologies. Gradually it shifted to both hardware and software as the total system consists of both of them.

(a) First Generation Computers (1946-59)

First generation computers used Thermion valves or Vacuum tubes. These computes were large in size and writing programs on them was difficult. Some of the computers of this generation were:

ENIAC: It was the first electronic computer built in 1946 at University of Pennsylvania, USA by John Eckert and John Mauchly. It was named Electronic Numerical Integrator and Calculator (ENIAC). The ENIAC was 30 x 50 feet long, weighed 30 tons, contained 18,000 vacuum tubes, 70,000 resistors, 10,000 capacitors and required 150 kilowatts of electricity. Today your favourite computer is many times as powerful as ENIAC, still the size is very small.

EDVAC: It stands for Electronic Discrete Variable Automatic Computer and was developed in 1950. The concept of storing data and instructions inside the computer was introduced here. This allowed much faster operation since the computer had rapid access to both data and instructions. The other advantage of storing instruction was that computer could take logical decisions internally.

Other Important Computers of First Generation

EDSAC: It was developed by M.V. Wilkes at Cambridge University in 1949.

UNIVAC-1: Eckert and Mauchly produced it in 1951 by Universal Accounting Computer setup.

Followings were the major drawbacks of first generation computers.

1. They were quite bulky.
2. The operating speed was quite slow.
3. Power consumption was very high.
4. It required large space for installation.
5. They had no operating system.
6. The programming capability was quite low.

(b) Second Generation Computers (1959-64)

Around 1959 an electronic device called Transistor replaced the bulky

vacuum tubes in the first generation computer. A single transistor contained circuit produced by several hundred vacuum tubes. Thus the size of the computer got reduced considerably. Transistors therefore provided higher operating speed than vacuum tubes. They had no filament and require no heating. Manufacturing cost was also very low. It is in the second generation that the concept of Central Processing Unit (CPU), memory, programming language and input and output units were developed. The programming languages such as COBOL, FORTRAN were developed during this period. Some of the computers of the Second Generation were

IBM 1920 : Its size was small as compared to First Generation computers and mostly used for scientific purpose.

IBM 1401 : Its size was small to medium and used for business applications.

CDC 3600 : Its size was large and used for scientific purpose.

The salient features of this generation were:

1. relatively faster than the first generation computers.
2. smaller than the first generation computers
3. generated lower level of heat
4. more reliable
5. higher capacity of internal storage

(c) Third Generation Computers (1964-71)

The third generation computers were introduced in 1964. They used Integrated Circuits (ICs). These ICs are popularly known as Chips. A single IC has many transistors, resistors and capacitors built on a single thin slice of silicon. So it is quite obvious that the size of the computer got further reduced. Some of the computers developed during this period were IBM-360, ICL-1900, IBM-370, and VAX-750. Higher-level language such as BASIC (Beginners All purpose Symbolic Instruction Code) was developed during this period.

The features of computers belonging to this generation were:

- used tiny ICs
- relatively very small in size

- made use of operating system
- high processing speed
- more reliable
- power efficient and high speed
- use of high level languages
- large memory
- low cost

(d) Fourth Generation Computers (1971 onwards)

The present day computers that you see today are the fourth generation computers that started around 1975. It uses Large Scale Integrated Circuits (LSIC) built on a single silicon chip called microprocessors. Due to the development of microprocessor it is possible to place computer's central processing unit (CPU) on a single chip. These computers are called microcomputers. Later very large scale Integrated Circuits (VLSIC) replaced LSICs. These integrated circuits are so advanced that they incorporate hundreds of thousands of active components in volumes of a fraction of an inch.

Thus the computer, which was occupying a very large room in earlier days, can now be placed on a table. The personal computer (PC) that you see in your school is a Fourth Generation Computer.

The salient features of this generation are:

- very fast
- very low heat generation
- smaller in size
- very reliable
- negligible hardware failure
- highly sophisticated

(e) Fifth Generation Computers

The computers, which can think and take decisions like human beings have been characterized as Fifth generation computers and are also referred as *thinking machines*. The speed is extremely high in fifth generation computer. Apart from this they can perform par-

allel processing. The concept of Artificial Intelligence has been introduced to allow the computer to take its own decision. It is still in a developmental stage. A lot of research and development work is going on in this area in United States and Japan but it will take some time before such machines are produced for use by the industry.

1.7 COMPUTER CLASSIFICATION

Differences in certain computer characteristics have led to the development of major computer classifications based on the type of electronic signal and memory size.

1.7.1 Types of computers based on electronic signal

Computers, in general are of three types as per the electronic signal they transmit.

(i) Analog Computers

(ii) Digital Computers

(iii) Hybrid Computers

Analog Computers

An analog computer operates on inputs of continuously varying electrical voltages. An example of the use of an electronic analog computer is that of controlling a flight simulator for training pilots. The computer responds to the cockpit simulator control movements made by the pilot and makes physical changes in the environment so that the pilot feels as if he is controlling an actual aeroplane. Analog computers are used mainly in scientific design and production environments. Each one has to be constructed to do a specific job and will respond very quickly to changes in the measurement of inputs.

Fig. 1.4

Digital Computers

In digital computers, mathematical expressions are represented as binary digits (0 and 1) and all operations are done using these digits at a very high rate. It means that the computer operates on electrical inputs that have only two states, ON and OFF. These computers are widely used in commercial and control systems. Now a days when we use the word computer, we mostly refer to a digital computer.

Fig. 1.5

Hybrid Computers

Hybrid computers are computers with combined features of both digital and analog type. Desirable features of analog and digital machines can be combined to create a Hybrid Computer. This type of computer operates by counting as well as by measuring. In other words, the output can be either in the form of numbers or required units of measurement, e.g., an analog device measures patient's heart beat (ECG). These measures will be converted into digital form and a digital device checks for any abnormality. Further, we can also input digital data like your marks and get digital results like the result of your class. Another example is a Modem. (which converts the digital signals into analog, carry it along the line and at the receiving end again changes it back into digital signal).

Fig. 1.6

1.7.2 Types of computers based on memory size

On the basis of size of memory computers can be divided into following categories:

1. **Microcomputer :** Microcomputer is at the lowest end of the computer range in terms of speed and storage capacity. Its CPU is a microprocessor. The first microcomputers were built of 8-bit microprocessor chips. The most common microcomputer is a personal computer (PC). The PC supports a number of input and output devices. An improvement of 8-bit chip is 16-bit and 32-bit chips. Examples of microcomputer are IBM PC, PC-AT.

2. **Mini Computer:** This is designed to support more than one user at a time. It possesses large storage capacity and operates at a high speed than a microcomputer. The mini computer is used in multi-user system in which various users can work at the same time. This type of computer is generally used for processing large volume of data in an organization. They are also used as servers in Local Area Networks (LAN).

3. **Mainframe Computer:** This type of computers are generally 32-bit computers. They operate at very high speed, have very large storage capacity and can handle the workload of many users. They are generally used in centralized databases. They are also used as controlling nodes in Wide Area Network (WAN). Example of mainframes are DEC, ICL and IBM 3000 series.

4. **Super Computer:** This is the fastest and most expensive machines. It has high processing speed compared to other computers. They also have multiprocessing technique. One of the ways in which supercomputers are built is by interconnecting hundreds of microprocessors. Supercomputer is mainly used for weather forecasting, biomedical research, remote sensing, aircraft design and other areas of science and technology. Examples of supercomputers are CRAY YMP, CRAY2, NEC SX-3, CRAY XMP and PARAM from India.

INTEXT QUESTIONS

5. Into how many generations the evolution of computer is divided?
6. What is VLSI?
7. The personal computer that you see today is which generation of computer?

1.8 APPLICATIONS OF COMPUTERS IN VARIOUS FIELDS

Computers have their application or utility everywhere. We find their applications in almost every sphere of life–particularly in fields where computations are required to be done at a very fast speed and where data is so complicated that the human brain finds it difficult to cope up with.

As you must be aware, computer now-a-days are being used almost in every department to do the work at a greater speed and accuracy. They can keep the record of all the employees and prepare their pay bill in a matter of minutes every month. They can keep automatic checks on the stock of a particular item. Some of the prominent areas of computer applications are:

In Tourism: Hotels use computers to speed up billing and checkout the availability of rooms. So is the case with railways and airline reservations for booking tickets. Architects can display their scale models on a computer and study them from various angles and perspectives. Structural problems can now be solved quickly and accurately.

In Banks: Banks also have started using computers extensively. Terminals are provided in the branch and the main computer is located centrally. This enables the branches to use the central computer system for information on things such as current balance,

deposits, overdrafts, interest charges, etc. MICR encoded cheques can be read and sorted out with a speed of 3000 cheques per minute by computers as compared to hours taken by manual sorting. Electronic funds transfer (EFT) allows a person to transfer funds through computer signals over wires and telephone lines making the work possible in a very short time.

In Industry: Computers are finding their greatest use in factories and industries of all kinds. They have taken over the work ranging from monotonous and risky jobs like welding to highly complex jobs such as process control. Drills, saws and entire assembly lines can be computerized. Moreover, quality control tests and the manufacturing of products, which require a lot of refinement, are done with the help of computers. Not only this, Thermal Power Plants, Oil refineries and chemical industries fully depend on computerized control systems because in such industries the lag between two major events may be just a fraction of a second.

In Transportation: Today computers have made it possible for planes to land in foggy and stormy atmosphere also. The aircraft has a variety of sensors, which measure the plane's altitude, position, speed, height and direction. Computer use all this information to keep the plane flying in the right direction. In fact, the Auto–pilot feature has made the work of pilot much easy.

In Education: Computers have proved to be excellent teachers. They can possess the knowledge given to them by the experts and teach you with all the patience in the world. You may like to repeat a lesson hundred times, go ahead, you may get tired but the computer will keep on teaching you. Computer based instructions (CBI) and Computer Aided Learning (CAL) are common tools used for teaching. Computer based encyclopedia such as Britannica provide you enormous amount of information on anything.

In Entertainment: Computers are also great entertainers. Many computer games are available which are like the traditional games like chess, football, cricket, etc. Dungeons and dragons provide the opportunity to test your memory and ability to think. Other games like Braino and Volcano test your knowledge.

APPLICATION OF COMPUTER

Computer, Its Development and Application

Fig. 1.7

1.9 DEVELOPMENTS IN THE FIELD OF GRAPHICS IN COMPUTERS

As we know computer graphics involves the generation, representation, manipulation, processing and evaluation of graphic images by a computer. Moreover, it combines graphic images with related non-graphic information residing in the computer files. Graphic objects may be photographic images or they may be created with the aid of a computer in the form of alphanumeric character, special symbols, line drawings or gray shaded areas.

We will learn here how new developments in the field of graphics in computers are changing the way we see the world of arts. The technique of 3D(Three Dimensional) rendering is responsible for this change.

1.9.1 What is 3D Graphics

The display screen or the paper in the dimensional rendering cannot display three-dimensional objects but only their projections. 2D graphics are just line drawings whereas a 3D–rendering involves modeling an object with the help of computers down to the details of lighting, shading and reflections so that it will look realistic.

Fig. 1.8

Thus, the process of creating three-dimensional models within a computer's memory such as setting lights and applying textures is called 3D Graphics. After you tell a computer about the angle from which you want to view the 3-D scene, it will generate an image that simulates the conditions you have defined for the scene.

3D–rendering involves modeling an object (using a mesh called a wire frame to represent the object) and then covering it with a smooth material having the right kind of optical properties to make it look real. The modeling is usually done entirely on a computer. Rendering the model to produce a real life appearance can be done in several ways. No scene, be it 3D–rendered or real, is perfectly shot the first time yet touching it up on a computer can work wonders. We all watch advertisements on the television. The famous Kawasaki Bajaj motor bike advertisement, the 3D animated logos for the samachar, the World this week, Newstrack are all examples of wonderful work of computer graphics.

1.9.2 Desk Top Publishing (DTP)

While computers have invaded various industries through the latest technology and software, they have entered the printing industry through a process called DTP. DTP has made printing procedure faster, more efficient and accurate. The traditional method of printing involves phototypesetting the text, cutting and pasting the typed

text by the artist, where the artist has to draw lines and boxes manually to create a ready to use artwork.

Fig. 1.9

The method of DTP involves, (i) typing the text on the computer keyboard, (ii) setting it in the page form with the help of DTP software, (iii) giving different fonts to Headings, captions, etc. by simple commands, and (iv) taking the final printout on a laser printer. Ventura, PageMaker, CorelDraw are some of the software using which very high class text setting, graphics designs and simple line drawings can be created faster and more accurately.

1.9.3 Computer and Medical Science

Computers have proved to be very useful in the field of medical science. In hospitals, computers are used for monitoring patients, raising the alarm if the pulse rate falls below a certain level, maintaining medical records, record of patient's treatment, laboratory test, billing, etc. Computer controlled electronic scanners can build up a picture of a patient slice by slice, measuring the strength of the rays which have been sent through the body. A computer uses this information to show a cross section of the body revealing any abnormalities which cannot be seen from outside. Computers also help a doctor to perform difficult surgical procedures.

1.9.4 Space Research

INSAT IIB and all the satellites and spacecraft could not have taken their flight but for the valuable assistance provided to the scientists by computers. Spacecrafts are monitored with the help of comput-

ers, which not only keep the continuous analog records of the voyage and the digital records of the speed direction, fuel, temperature, but also suggests corrective measures which are to be taken in case of some error. The picture shows an American Space shuttle lifting off. The space shuttle was totally designed using computers. Thus the computers have arrived in a big way and have become essential for our life.

Fig. 1.10

1.10 WHAT YOU HAVE LEARNT

In this lesson we have discussed about the major characteristics of computer. The speed, accuracy, memory and versatility are some of the features associated with a computer. But the computer that we see today has not developed over night. It has taken centuries of human effort to see the computer in its present form today. There are five generations of computer. Over these generations the physical size of computer has decreased. On the other hand, the processing speed of computer has improved tremendously. We also discussed about the varieties of computers available today. Various application areas of computers have also been discussed.

1.11 TERMINAL QUESTIONS

1. Why is computer known as data processor?
2. Explain in brief the various generations in computer technology?
3. Write a short note on the fifth generation of computer. What makes it different from Fourth generation computer?

4. Why did the size of computer get reduced in the third generation computer?
5. Discuss briefly the computer applications in various fields.

1.12 KEY TO INTEXT QUESTIONS

1. A computer is an electronic device, which is used to accept, store, retrieve and process the data. It is called a data processor because it is mainly used for processing data for producing meaningful information.
2. The characteristics of computer are speed, accuracy, diligence, versatility and storage.
3. Analytical engine, 1823.
4. Charles Babbage
5. Five generations
6. Very Large

Scale Integration

7. Fourth Generation