

PEARSON

# Computer Fundamentals

Anita Goel



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# PREFACE

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Computers play a key role in our everyday lives. In addition to communication media like television, radio and newspaper, we now have another communication medium, i.e. computers. We use computers to e-mail, to chat, for the Internet browsing, for teleconferencing, for video conferencing, etc. We also use them for e-learning, e-commerce, e-banking, e-governance, e-ticketing and for many more things. And the interesting part is, while we interact with the other media like television, radio, newspaper, etc. to merely get information, the interaction in computers is two ways—we can be a creator as well as a user. We may use a computer as a medium to get more information, as a tool to perform certain activities, or as an integral part of another component.

The fundamentals of computers are the stepping stones to computer science. Nowadays, all courses, related and unrelated to computer science, require using a computer. Knowledge of the basics of computers has become a fundamental requirement, in whatever area we choose to study or follow professionally. Computer fundamentals are also an introductory course to a more advanced study of computer science.

## ABOUT THE BOOK

This book is written with the aim of introducing the fundamentals of computers to the reader. Attention has been paid to include chapters that are required by the students studying different courses. The book deals with both the theoretical concepts and the practicals. The unique features of this book are as follows:

### ⊙ *Style of Writing*

- The *language used* in the book is lucid, is easy to understand, and facilitates easy grasping of concepts.
- The chapters have been *logically arranged* in sequence.
- The book is written in a *reader-friendly* manner both for the students and the teachers.
- Most of the content presented in the book is in the form of bullets, organized sequentially. This form of presentation, rather than in a paragraph form, facilitates the reader to view, understand and remember the points better.
- The explanation is *supported by diagrams, pictures and images* wherever required.
- Sufficient *exercises* have been included for practice in addition to the *solved examples*.
- The questions at the end of the chapter are given section-wise. It is easier for the reader to find answers for the *section-wise questions* in a particular section rather than the whole book.

### ⊙ *Content of Book—Theory (Chapters 1–14)*

- Several *latest topics* have been included in the book. Some of these topics are
  - USB, Zip disk, Flash memory
  - Wireless networking
  - Notebook, Netbook, PDA, smartphones
  - Aspect Oriented Programming (AOP)
  - Imparting education via multimedia
  - Cryptography, Digital signature, Firewall, Biometrics
  - System clock, BIOS, CMOS, SIMM & DIMM memory module
- In the theory chapters (Chapters 1–14), the *theory is supported with the practical information* like, the name of supercomputer of India, how to create mp3 file from CD, what is a streaming video and understanding machine configuration.

- This book *does not discuss in detail the old technologies* that have become too common or are no longer used, like, about keys in a keyboard, magnetic tape, using mouse, drum printers and message switching.
- Several *colored inserts* in the book provide a colored view of the photographs.
- ⊙ **Content of Book—Practical (Chapters 15–21) and Appendix**
  - This book describes *MS-Office* with the latest commercially available version, version 2007.
  - This book includes description of *Windows Vista and Windows 7* in addition to the detailed description of Windows XP.
  - The *solved examples* in the MS-Office chapters are described *step-wise*.
  - A *long list of practical exercises* is provided at the end of each chapter.
  - Some *chapters* contain topics that are new to a book on computers. These chapters are
    - Chapter 11—Information Systems
    - Chapter 12—Fundamentals of Database
    - Chapter 14—Computer Security
    - Chapter 19—MS-Access
    - Chapter 20—Network and Internet Connections
    - Chapter 21—Using LaTeX
    - Appendix D—Assembling a PC.

## TARGET AUDIENCE

This book has been written keeping in mind the readers familiar and not-so familiar with computers. Several chapters have been included that cover the syllabi of different universities in India. The book is well suited for the following target audience:

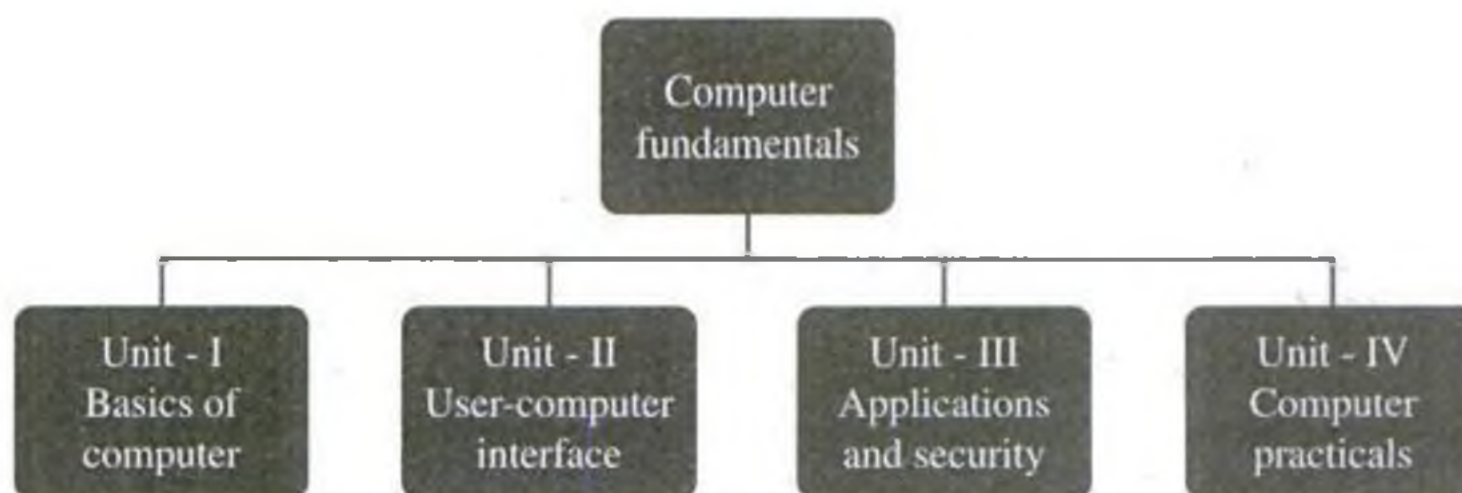
- ⊙ *Computer science students* undergoing a course in computer science—DCA, MCA, BSc(Gen), BSc(Hons), MSc(IT), BSc(IT), BCA, DOEACC level courses.
- ⊙ *Engineering students* of first year—BTech, BE.
- ⊙ *Science students* pursuing BSc in physics, chemistry, botany, zoology and mathematics.
- ⊙ *Non-science students* pursuing BCom(P), BCom(Hons), BA(P), BDP, BBA, MBA, BBE
- ⊙ *Students enrolled in short-term courses on IT* in polytechnics, training institutes, Technical Institutes.
- ⊙ *Any learner* interested in computer science.

## STRUCTURE OF THE TEXT

The book follows a structured and modular design, to facilitate the instructor in the teaching of the course and the students in the reading of the book. Figure 1 shows the design of the book. The following paragraphs present a brief review of the four units of the book.

Unit I comprises *five* chapters. This unit *introduces the reader to the computer as a machine*. Chapter 1 provides a brief introduction to computers—their evolution, types and applications. Chapter 2 discusses organization of the computer, different parts inside a computer case and their interaction. Chapter 3 provides an overview of the memory hierarchy, different kinds of memory of the computer and storage devices that are required for storing large quantities of data. The different devices that are used for providing input to the computer, and the presentation of output from the computer are discussed in Chapter 4. The computer uses the binary number system; Chapter 5 discusses binary coding schemes, logic gates, and the representation and conversion of numbers in the binary, octal and hexadecimal number system.





**Figure 1** Modular structure of text

Unit II comprises *five* chapters. This unit *focuses on the interaction of user and computer, and the Internet*. Chapter 6 provides a description of the system software and the application software. Chapter 7 describes the operating system in detail. The writing of the programming logic and the different programming paradigms are discussed in Chapter 8. Chapters 9 and 10 relate to networking and the Internet. Chapter 9 discusses computer networks and the communication of data across the network. The Internet and its services are detailed in Chapter 10.

Unit III contains *four* chapters. This unit is *about applications and security*. Chapter 11 describes the information systems. This chapter is included bearing in mind the non-science courses. For teaching this paper in a science course, you may skip this chapter. The fundamentals of databases are discussed in Chapter 12. Chapter 13 describes the different elements of the multimedia system—text, audio, graphics, video and animation. Chapter 14 on computer security discusses the security attacks, and the way to handle them.

Unit IV consists of *seven* chapters. This unit is *designed for the computer practicals*. A detailed discussion on Windows XP is provided in Chapter 15, including a brief description about Windows Vista and Windows 7. Chapters 16 through 19 are about the four main components of MS-Office 2007, i.e. MS-Word, MS-Excel, MS-Powerpoint and MS-Access. Chapter 20 is about Network and the Internet connections. This chapter facilitates the reader in the creation and managing of computer network and the Internet connection. Chapter 21 is about using LaTeX which is used for the production of publication-quality typeset documents.

## PEDAGOGICAL FEATURES

Pedagogy is the art and science of how something is taught and how students learn it. How the teaching occurs, the approach to teaching and learning, the way the content is delivered and what the students learn as a result of the process are all included in pedagogy. The following are the pedagogical features in this book:

### • *Start-of-Chapter Aids*

- Contents—An overall view of the topics discussed in the chapter is provided, at the beginning of each chapter.
- Why this chapter—It describes the need of including this chapter in computer fundamentals and why one should read it.

### • *In-Between Chapter Aids*

- Visualization—“A picture is worth a thousand words” is a famous quote. This book supports the concepts with figures, diagrams and images to facilitate visualization.
- Bulleted text—The book follows a bulleted approach of writing the text in contrast to the long paragraphs. The bulleted text approach is easier to read, understand and grasp.



⊙ ***End-of-Chapter Aids***

- **Summary**—It reviews the major concepts discussed in the chapter.
- **Keywords**—A list of keywords at the end of each chapter facilitates in locating a topic in the chapter.
- **Questions**—The questions at the end of each chapter are given section-wise. The reader has to search for the answers in this section, rather than the complete chapter.
- **Extra questions**—At the end of each chapter, the extra questions from the complete chapter are given in the form of short notes, abbreviations and differences.
- **Colored inserts**—A first initiative in a book on this topic, the colored inserts provide the reader with actual images in colour.

## **FEEDBACK**

For interacting with the author, or for suggestions and comments on this book, please send your e-mails at [goel.anita.book@gmail.com](mailto:goel.anita.book@gmail.com).

## ACKNOWLEDGEMENTS

---

It took me almost 2 years to write this book. During my journey of book writing, I have been helped and supported by my family, friends and colleagues. I express my gratitude to one and all for their extensive support in this endeavour.

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Since this is not the first book on this topic, I thank the authors of other books on similar topic, whose books have been a source of ideas for me.

I thank the Almighty without whose grace it would have been impossible for me to accomplish this task.

# INTRODUCTION TO COMPUTER

# 1

- ⊙ Digital and analog computers
- ⊙ Characteristics of computer—Speed, accuracy, diligence, storage capability, versatility
- ⊙ History of computer—Calculating machines, Napier's bones, slide rule, Pascal's adding and subtraction machine, Leibniz's multiplication and dividing machine, punch card system, Babbage's analytical engine, Hollerith's punched card tabulating machine
- ⊙ Generations of computer
  - First generation (1940 to 1956): Using vacuum tubes
  - Second generation (1956 to 1963): Using transistors
  - Third generation (1964 to 1971): Using integrated circuits
  - Fourth generation (1971 to present): Using microprocessors
  - Fifth generation (present and next): Using artificial intelligence
- ⊙ Classification of computer—Micro-computers (desktop computer or Personal Computer (PC), notebook computers or laptop, netbook, tablet computer, handheld computer or Personal Digital Assistant (PDA), smart phones), minicomputers, mainframe computers, supercomputers
- ⊙ The computer system—Hardware, software, data, users
- ⊙ The Input-process-output concept
- ⊙ Components of computer hardware—Input/output unit, central processing unit, storage unit
- ⊙ Application of computers—Education, entertainment, sports, advertising, medicine, science and engineering, government, home



### Why this chapter

Computers are an integral part of our lives. Wherever we are—sitting in our homes, working in the office, driving on roads, sitting in a movie hall, staying in a hotel, etc.—our lives are directly or indirectly affected by the computers. In this era of information, we are dependent on the storage, flow and processing of data and information, which can only be possible with the help of computers. The purpose of this chapter is to introduce you to the “computer”.

## 1.1 INTRODUCTION

Nowadays, computers are an integral part of our lives. They are used for the reservation of tickets for airplanes and railways, payment of telephone and electricity bills, deposit and withdrawal of money from banks, processing of business data, forecasting of weather conditions, diagnosis of diseases, searching



for information on the Internet, etc. Computers are also used extensively in schools, universities, organizations, music industry, movie industry, scientific research, law firms, fashion industry, etc.

The term computer is derived from the word *compute*. The word *compute* means *to calculate*. A *computer* is an electronic machine that accepts data from the user, processes the data by performing calculations and operations on it, and generates the desired output results. Computer performs both simple and complex operations, with speed and accuracy.

This chapter discusses the history and evolution of computer, the concept of input-process-output and the characteristics of computer. This chapter also discusses the classification of digital computers based on their size and type, and the application of computer in different domain areas.

## 1.2 DIGITAL AND ANALOG COMPUTERS

A *digital computer* uses distinct values to represent the data internally. All information are represented using the digits 0s and 1s. The computers that we use at our homes and offices are digital computers.

*Analog computer* is another kind of a computer that represents data as variable across a continuous range of values. The earliest computers were analog computers. Analog computers are used for measuring of parameters that vary continuously in real time, such as temperature, pressure and voltage. Analog computers may be more flexible but generally less precise than digital computers. Slide rule is an example of an analog computer.

This book deals only with the *digital computer* and uses the term *computer* for them.

## 1.3 CHARACTERISTICS OF COMPUTER

Speed, accuracy, diligence, storage capability and versatility are some of the key characteristics of a computer. A brief overview of these characteristics are—

- **Speed** The computer can process data very fast, at the rate of millions of instructions per second. Some calculations that would have taken hours and days to complete otherwise, can be completed in a few seconds using the computer. For example, calculation and generation of salary slips of thousands of employees of an organization, weather forecasting that requires analysis of a large amount of data related to temperature, pressure and humidity of various places, etc.
- **Accuracy** Computer provides a high degree of accuracy. For example, the computer can accurately give the result of division of any two numbers up to 10 decimal places.
- **Diligence** When used for a longer period of time, the computer does not get tired or fatigued. It can perform long and complex calculations with the same speed and accuracy from the start till the end.
- **Storage Capability** Large volumes of data and information can be stored in the computer and also retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory. Secondary storage devices like floppy disk and compact disk can store a large amount of data permanently.
- **Versatility** Computer is versatile in nature. It can perform different types of tasks with the same ease. At one moment you can use the computer to prepare a letter document and in the next moment you may play music or print a document.

Computers have several limitations too. Computer can only perform tasks that it has been programmed to do. Computer cannot do any work without instructions from the user. It executes instructions as specified by the user and does not take its own decisions.



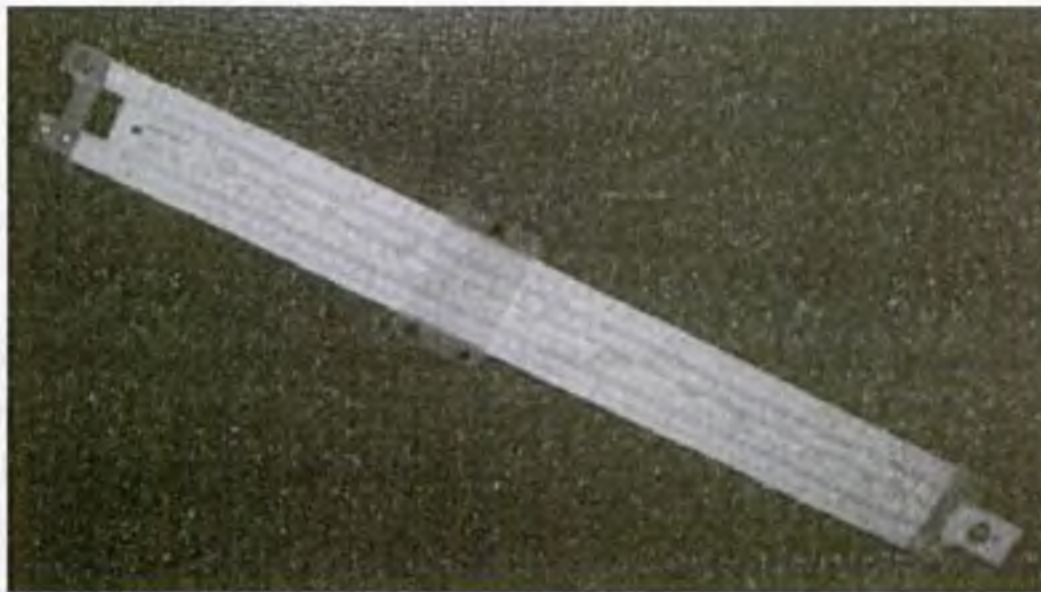
## 1.4 HISTORY OF COMPUTER

Until the development of the first generation computers based on vacuum tubes, there had been several developments in the computing technology related to the mechanical computing devices. The key developments that took place till the first computer was developed are as follows—

- ⊙ **Calculating Machines** ABACUS was the first mechanical calculating device for counting of large numbers. The word ABACUS means calculating board. It consists of bars in horizontal positions on which sets of beads are inserted. The horizontal bars have 10 beads each, representing units, tens, hundreds, etc. An abacus is shown in Figure 1.1
- ⊙ **Napier's Bones** was a mechanical device built for the purpose of multiplication in 1617 AD. by an English mathematician John Napier.
- ⊙ **Slide Rule** was developed by an English mathematician Edmund Gunter in the 16th century. Using the slide rule, one could perform operations like addition, subtraction, multiplication and division. It was used extensively till late 1970s. Figure 1.2 shows a slide rule.



**Figure 1.1** Abacus



**Figure 1.2** Slide rule

- ⊙ **Pascal's Adding and Subtraction Machine** was developed by Blaise Pascal. It could add and subtract. The machine consisted of wheels, gears and cylinders.
- ⊙ **Leibniz's Multiplication and Dividing Machine** was a mechanical device that could both multiply and divide. The German philosopher and mathematician Gottfried Leibniz built it around 1673.
- ⊙ **Punch Card System** was developed by Jacquard to control the power loom in 1801. He invented the punched card reader that could recognize the presence of hole in the punched card as binary one and the absence of the hole as binary zero. The 0s and 1s are the basis of the modern digital computer. A punched card is shown in Figure 1.3.



**Figure 1.3** Punched card



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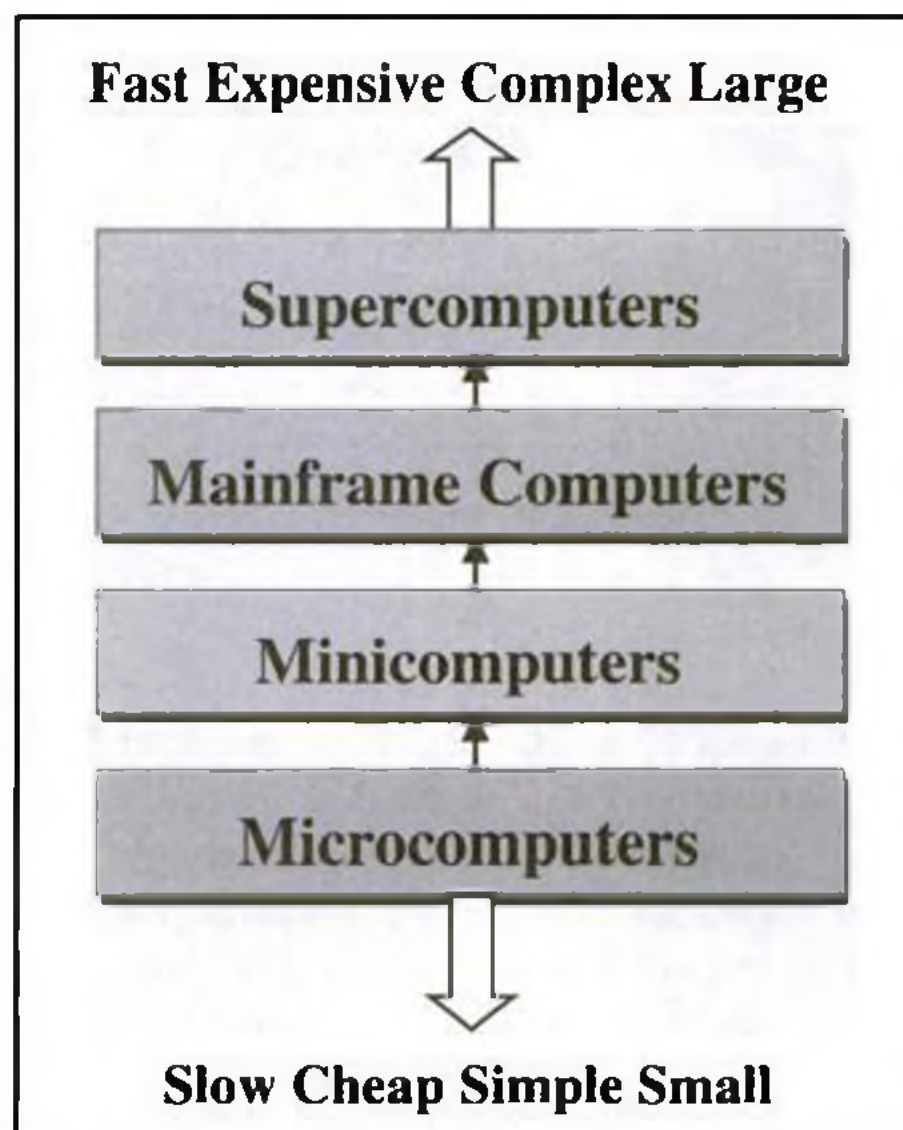
are able to store millions of components on a single chip. These computers have large memory requirements.

This generation of computers uses *parallel processing* that allows several instructions to be executed in parallel, instead of serial execution. Parallel processing results in faster processing speed. The Intel dual-core microprocessor uses parallel processing.

The fifth generation computers are based on *Artificial Intelligence (AI)*. They try to simulate the human way of thinking and reasoning. Artificial Intelligence includes areas like Expert System (ES), Natural Language Processing (NLP), speech recognition, voice recognition, robotics, etc.

## 1.6 CLASSIFICATION OF COMPUTER

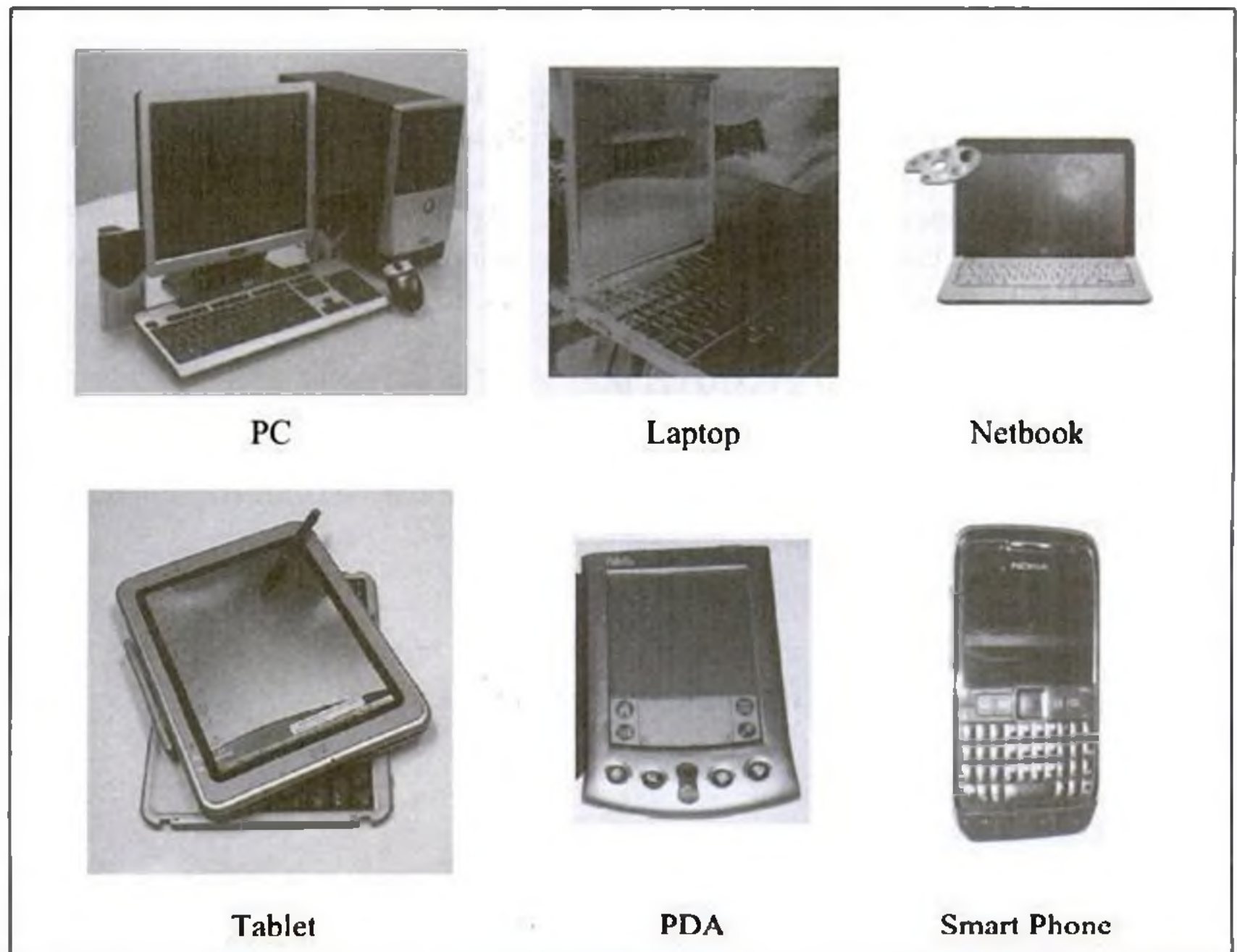
The digital computers that are available nowadays vary in their sizes and types. The computers are broadly classified into four categories (Figure 1.8) based on their size and type—(1) Microcomputers, (2) Minicomputers, (3) Mainframe computers, and (4) Supercomputer.



**Figure 1.8** Classification of computers based on size and type

### 1.6.1 Microcomputers

Microcomputers are small, low-cost and single-user digital computer. They consist of CPU, input unit, output unit, storage unit and the software. Although microcomputers are stand-alone machines, they can be connected together to create a network of computers that can serve more than one user. IBM PC based on Pentium microprocessor and Apple Macintosh are some examples of microcomputers. Microcomputers include desktop computers, notebook computers or laptop, tablet computer, handheld computer, smart phones and netbook, as shown in Figure 1.9.



**Figure 1.9** Microcomputers

- **Desktop Computer or Personal Computer (PC)** is the most common type of microcomputer. It is a stand-alone machine that can be placed on the desk. Externally, it consists of three units—keyboard, monitor, and a system unit containing the CPU, memory, hard disk drive, etc. It is not very expensive and is suited to the needs of a single user at home, small business units, and organizations. Apple, Microsoft, HP, Dell and Lenovo are some of the PC manufacturers.
- **Notebook Computers or Laptop** resemble a notebook. They are portable and have all the features of a desktop computer. The advantage of the laptop is that it is small in size (can be put inside a briefcase), can be carried anywhere, has a battery backup and has all the functionality of the desktop. Laptops can be placed on the lap while working (hence the name). Laptops are costlier than the desktop machines.
- **Netbook** These are smaller notebooks optimized for low weight and low cost, and are designed for accessing web-based applications. Starting with the earliest netbook in late 2007, they have gained significant popularity now. Netbooks deliver the performance needed to enjoy popular activities like streaming videos or music, emailing, Web surfing or instant messaging. The word *netbook* was created as a blend of *Internet* and *notebook*.
- **Tablet Computer** has features of the notebook computer but it can accept input from a stylus or a pen instead of the keyboard or mouse. It is a portable computer. Tablet computer are the new kind of PCs.



- ⊙ **Handheld Computer or Personal Digital Assistant (PDA)** is a small computer that can be held on the top of the palm. It is small in size. Instead of the keyboard, PDA uses a pen or a stylus for input. PDAs do not have a disk drive. They have a limited memory and are less powerful. PDAs can be connected to the Internet via a wireless connection. Casio and Apple are some of the manufacturers of PDA. Over the last few years, PDAs have merged into mobile phones to create smart phones.
- ⊙ **Smart Phones** are cellular phones that function both as a phone and as a small PC. They may use a stylus or a pen, or may have a small keyboard. They can be connected to the Internet wirelessly. They are used to access the electronic-mail, download music, play games, etc. Blackberry, Apple, HTC, Nokia and LG are some of the manufacturers of smart phones.

### 1.6.2 Minicomputers

Minicomputers (Figure 1.10) are digital computers, generally used in multi-user systems. They have high processing speed and high storage capacity than the microcomputers. Minicomputers can support 4–200 users simultaneously. The users can access the minicomputer through their PCs or terminal. They are used for real-time applications in industries, research centers, etc. PDP 11, IBM (8000 series) are some of the widely used minicomputers.



Figure 1.10 Minicomputer

### 1.6.3 Mainframe Computers

Mainframe computers (Figure 1.11) are multi-user, multi-programming and high performance computers. They operate at a very high speed, have very large storage capacity and can handle the workload of many users. Mainframe computers are large and powerful systems generally used in centralized databases. The user accesses the mainframe computer via a terminal that may be a dumb terminal, an intelligent terminal or a PC. A *dumb terminal* cannot store data or do processing of its own. It has the input and output device only. An *intelligent terminal* has the input and output device, can do processing, but, cannot store data of its own. The dumb and the intelligent terminal use the processing power and the storage facility of the mainframe computer. Mainframe computers are used in organizations like banks or companies, where many people require frequent access to the same data. Some examples of mainframes are CDC 6600 and IBM ES000 series.



Figure 1.11 Mainframe computer

### 1.6.4 Supercomputers

Supercomputers (Figure 1.12) are the fastest and the most expensive machines. They have high processing speed compared to other computers. The speed of a supercomputer is generally measured in FLOPS (FLoating point Operations Per Second). Some of the faster supercomputers can perform trillions of calculations per second. Supercomputers are built by interconnecting thousands of processors that can work in parallel.



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**Hardware** consists of the mechanical parts that make up the computer as a machine. The hardware consists of physical devices of the computer. The devices are required for input, output, storage and processing of the data. Keyboard, monitor, hard disk drive, floppy disk drive, printer, processor and motherboard are some of the hardware devices.



**Figure 1.13** Parts of computer system

**Software** is a set of instructions that tells the computer about the tasks to be performed and how these tasks are to be performed. *Program* is a set of instructions, written in a language understood by the computer, to perform a specific task. A set of programs and documents are collectively called software. The hardware of the computer system cannot perform any task on its own. The hardware needs to be instructed about the task to be performed. Software instructs the computer about the task to be performed. The hardware carries out these tasks. Different software can be loaded on the same hardware to perform different kinds of tasks.

**Data** are isolated values or raw facts, which by themselves have no much significance. For example, the data like 29, January, and 1994 just represent values. The data is provided as input to the computer, which is processed to generate some meaningful information. For example, 29, January and 1994 are processed by the computer to give the date of birth of a person.

**Users** are people who write computer programs or interact with the computer. They are also known as *skinware*, *liveware*, *humanware* or *peopleware*. Programmers, data entry operators, system analyst and computer hardware engineers fall into this category.

### 1.7.1 The Input-Process-Output Concept

A computer is an electronic device that (1) accepts data, (2) processes data, (3) generates output, and (4) stores data. The concept of generating output information from the input data is also referred to as *input-process-output* concept.





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relatives via Internet, for paying bills, for education and learning, etc. Microprocessors are embedded in house hold utilities like, washing machines, TVs, food processors, home theatres, security devices, etc.

The list of applications of computers is so long that it is not possible to discuss all of them here. In addition to the applications of the computers discussed above, computers have also proliferated into areas like banks, investments, stock trading, accounting, ticket reservation, military operations, meteorological predictions, social networking, business organizations, police department, video conferencing, telepresence, book publishing, web newspapers, and information sharing.

## SUMMARY

- *Computer* is an electronic device which accepts data as input, performs processing on the data, and gives the desired output. A computer may be *analog or digital computer*.
- Speed, accuracy, diligence, storage capability and versatility are the main *characteristics of computer*.
- The *computing devices* have evolved from simple mechanical machines, like ABACUS, Napier's bones, Slide Rule, Pascal's Adding and Subtraction Machine, Leibniz's Multiplication and Dividing Machine, Jacquard Punched Card System, Babbage's Analytical Engine and Hollerith's Tabulating Machine, to the first electronic computer.
- Charles Babbage is called the father of computer.
- The evolution of computers to their present state is divided into *five generations of computers*, based on the hardware and software they use, their physical appearance and their computing characteristics.
- *First generation computers* were vacuum tubes based machines. These were large in size, expensive to operate and instructions were written in machine language. Their computation time was in milliseconds.
- *Second generation computers* were transistor based machines. They used the stored program concept. Programs were written in assembly language. They were smaller in size, less expensive and required less maintenance than the first generation computers. The computation time was in microseconds.
- *Third generation computers* were characterized by the use of IC. They consumed less power and required low maintenance compared to their predecessors. High-level languages were used for programming. The computation time was in nanoseconds. These computers were produced commercially.
- *Fourth generation computers* used microprocessors which were designed using the LSI and VLSI technology. The computers became small, portable, reliable and cheap. The computation time is in picoseconds. They became available both to the home user and for commercial use.
- *Fifth generation computers* are capable of learning and self organization. These computers use SLSI chips and have large memory requirements. They use parallel processing and are based on AI. The fifth generation computers are still being developed.
- *Computers are broadly classified* as microcomputers, minicomputers, mainframe computers, and supercomputers, based on their sizes and types.
- *Microcomputers* are small, low-cost stand-alone machines. Microcomputers include desktop computers, notebook computers or laptop, netbooks, tablet computer, handheld computer and smart phones.

- ⊙ *Minicomputers* are high processing speed machines having more storage capacity than the microcomputers. Minicomputers can support 4-200 users simultaneously.
- ⊙ *Mainframe computers* are multi-user, multi-programming and high performance computers. They have very high speed, very large storage capacity and can handle large workloads. Mainframe computers are generally used in centralized databases.
- ⊙ *Supercomputers* are the most expensive machines, having high processing speed capable of performing trillions of calculations per second. The speed of a supercomputer is measured in FLOPS. Supercomputers find applications in computing-intensive tasks.
- ⊙ *Computer* is an electronic device based on the input-process-output concept. Input/

Output Unit, CPU and Memory unit are the three main *components of computer*.

- ⊙ *Input/Output Unit* consists of the Input unit which accepts data from the user and the Output unit that provides the processed data. *CPU* processes the input data, and, controls, coordinates and supervises the operations of the computer. CPU consists of ALU, CU and Registers. The memory unit stores programs, data and output, temporarily, during the processing. Additionally, storage unit or secondary memory is used for the storing of programs, data and output permanently.
- ⊙ Computers are used in various areas of our life. Education, entertainment, sports, advertising, medicine, science and engineering, government, office and home are some of the *application areas of the computers*.

## KEYWORDS

ABACUS 3	Input/Output Unit 12	Process 12
Analog computer 2	Integrated Circuit (IC) 5	Program 11
Arithmetic Logic Unit (ALU) 13	Intelligent terminal 9	Punched cards 4
Assembly language 5	Jacquard's punch card 3	Second Generation
Babbage's Analytical Engine 4	Large Scale Integration (LSI) 6	Computer 5
Central Processing Unit	Leibniz's Machine 3	Slide Rule 3
(CPU) 6	Machine language 4	Smart phones 9
Computer 2	Mainframe computers 9	Software 11
Control Unit (CU) 13	Memory 13	Storage unit 6
Data 11	Microcomputers 7	Supercomputer 9
Desktop computer 8	Microprocessor 6	Super Large Scale Integrated
Digital computer 2	Minicomputers 9	(SLSI) chips 6
Dumb terminal 9	Napier's bones 3	Tablet computer 8
Fifth Generation Computer 6	Netbook 8	Third Generation
First Generation Computer 4	Notebook computer 8	Computer 5
Floating point Operations	Output 12	Transistors 5
Per Second (FLOPS) 9	Parallel processing 7	Users 11
Fourth Generation Computer 6	Pascal's Machine 3	Vacuum Tubes 4
Hardware 4	Personal Computer (PC) 8	Very Large Scale Integration
Hollerith's tabulator 4	Personal Digital Assistant	(VLSI) 6
Input 11	(PDA) 9	

## QUESTIONS

### Section 1.2

1. Define an analog computer and a digital computer.
2. Give an example each of analog computer and digital computer.

### Section 1.3

3. List the main characteristics of the computer.
4. Describe the characteristics of the computer.
5. List three significant limitations of the computer.

### Section 1.4

6. Explain briefly the developments in computer technology starting from a simple calculating machine to the first computer.
7. What is a calculating machine?
8. What is the key feature of the Jacquard's punch card?
9. Name the first calculating device for the counting of large numbers.
10. Who is called the Father of Computer?

### Section 1.5.1

11. The first generation computers used \_\_\_\_\_ for circuitry.
12. Describe the first generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance, and (e) Their applications.
13. Give two examples of first generation computers.
14. List the drawbacks of the first generation computers.

### Section 1.5.2

15. The second generation computers used \_\_\_\_\_ for circuitry.
16. Describe the second generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
17. Give two examples of second generation computers.
18. List the drawbacks of the second generation computers.

### Section 1.5.3

19. The third generation computers used \_\_\_\_\_ for circuitry.

20. Describe the third generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance, and (e) Their applications.
21. Give two examples of third generation computers.
22. List the drawbacks of the third generation computers.

### Section 1.5.4

23. The fourth generation computers used \_\_\_\_\_ for circuitry.
24. Describe the fourth generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
25. Give two examples of fourth generation computers.
26. List the drawbacks of the fourth generation computers.

### Section 1.5.5

27. The fifth generation computers used \_\_\_\_\_ for circuitry.
28. Describe the fifth generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
29. Give two examples of fifth generation computers.
30. Compare in detail the five generations of computers based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications. Also give at least one example of each generation of computer.

### Section 1.6.1

31. Define microcomputer.
32. Give two examples of microcomputer.
33. List three categories of microcomputers.

### Section 1.6.2

34. Define minicomputers.
35. Give two examples of minicomputer.

### Section 1.6.3

36. Define mainframe computer.
37. Give two examples of mainframe computer.
38. Define a dumb terminal.
39. Define an intelligent terminal.



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# THE COMPUTER SYSTEM HARDWARE

# 2

## Contents

- ⊙ Central Processing Unit (CPU)
  - Arithmetic logic unit
  - Registers
  - Control Unit (CU)
- ⊙ Memory unit
  - Cache memory
  - Primary memory
  - Secondary memory
- ⊙ Instruction format
- ⊙ Instruction set
- ⊙ Instruction cycle—Fetching, decoding, executing, storing
- ⊙ Microprocessor—CISC, RISC
- ⊙ Interconnecting the units of a computer—System bus, expansion bus, external ports
- ⊙ Performance of a computer—Registers, RAM, system clock, bus, cache memory
- ⊙ Inside a computer cabinet—Motherboard, ports and interfaces, expansion slots, ribbon cables, memory chips, storage devices, processor

### Why this chapter

The computer as a machine consists of different components that interact with each other to provide the desired functionality of the computer. As a user of the computer, we need to be aware of the main components of the computer, their functions and the interconnection between the different components of the computer. This chapter describes the different hardware components of the computer.

## 2.1 INTRODUCTION

When we talk of computer hardware, the three related terms that require introduction are—computer architecture, computer organization and computer design. *Computer architecture* refers to the structure and behavior of the computer. It includes the specifications of the components, for example, instruction format, instruction set and techniques for addressing memory, and how they connect to the other components. Given the components, *computer organization* focuses on the organizational structure. It deals with how the hardware components operate and the way they are connected to form the computer. Given the system specifications, *computer design* focuses on the hardware to be used and the interconnection of parts. Different kinds of computer, such as a PC or a mainframe computer may have different organization; however, basic organization of the computer remains the same.

A computer consists of three main components—(1) Input/Output (I/O) Unit, (2) Central Processing Unit (CPU), and (3) Memory Unit. The computer user interacts with the computer via the I/O unit. The purpose of I/O unit is to provide data and instructions as input to the computer and to present relevant



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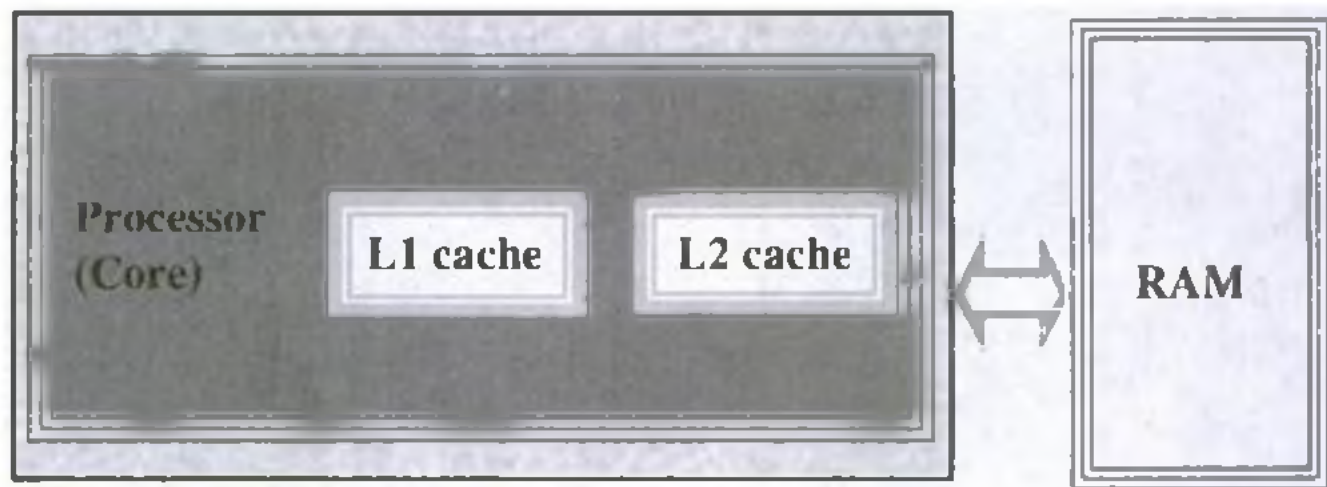


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**Figure 2.3** Illustration of cache memory

- Cache memory is built into the processor, and may also be located next to it on a separate chip between the CPU and RAM. Cache built into the CPU is faster than separate cache, running at the speed of the microprocessor itself. However, separate cache is roughly twice as fast as RAM.
- The CPU has a built-in *Level 1 (L1)* cache and *Level 2 (L2)* cache, as shown in Figure 2.3. In addition to the built-in L1 and L2 cache, some CPUs have a separate cache chip on the motherboard. This cache on the motherboard is called *Level 3 (L3)* cache. Nowadays, high-end processor comes with built-in L3 cache, like in Intel core i7. The L1, L2 and L3 cache store the most recently run instructions, the next ones and the possible ones, respectively. Typically, CPUs have cache size varying from 256KB (L1), 6 MB (L2), to 12MB (L3) cache.
- Cache memory is very expensive, so it is smaller in size. Generally, computers have cache memory of sizes 256 KB to 2 MB.

### 2.3.2 Primary Memory

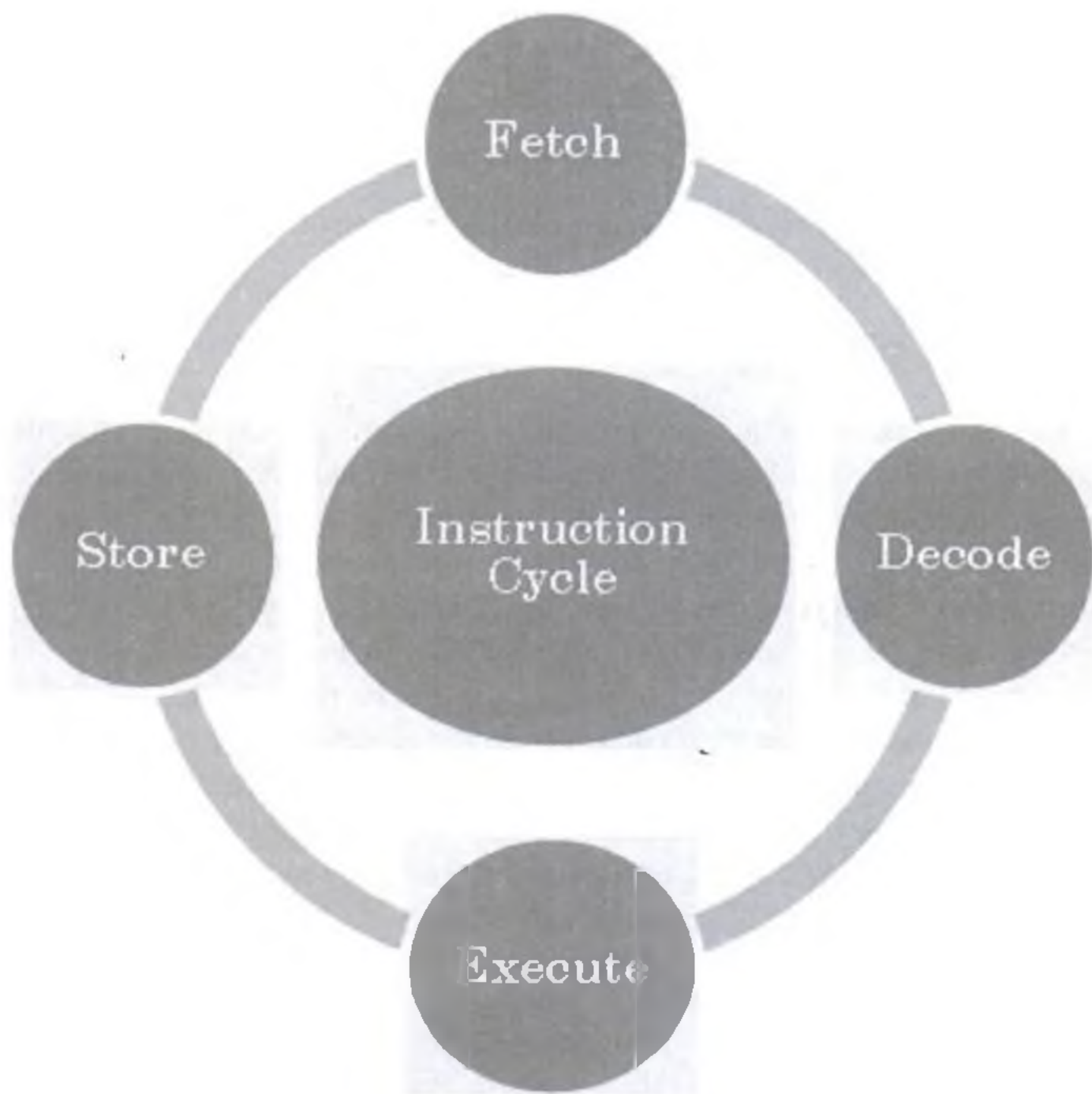
- Primary memory is the main memory of computer. It is used to store data and instructions during the processing of data. Primary memory is semiconductor memory.
- Primary memory is of two kinds—Random Access Memory (RAM) and Read Only Memory (ROM).
- RAM is volatile. It stores data when the computer is on. The information stored in RAM gets erased when the computer is turned off. RAM provides *temporary storage* for data and instructions.
- ROM is non-volatile memory, but is a read only memory. The storage in ROM is permanent in nature, and is used for storing standard processing programs that permanently reside in the computer. ROM comes programmed by the manufacturer.
- RAM *stores data and instructions during the execution* of instructions. The data and instructions that require processing are brought into the RAM from the storage devices like hard disk. CPU accesses the data and the instructions from RAM, as it can access it at a *fast* speed than the storage devices connected to the input and output unit (Figure 2.4).
- The input data that is entered using the input unit is stored in RAM, to be made available during the processing of data. Similarly, the output data generated after processing is stored in RAM before being sent to the output device. Any intermediate results generated during the processing of program are stored in RAM.
- RAM provides a *limited storage capacity*, due to its *high cost*.



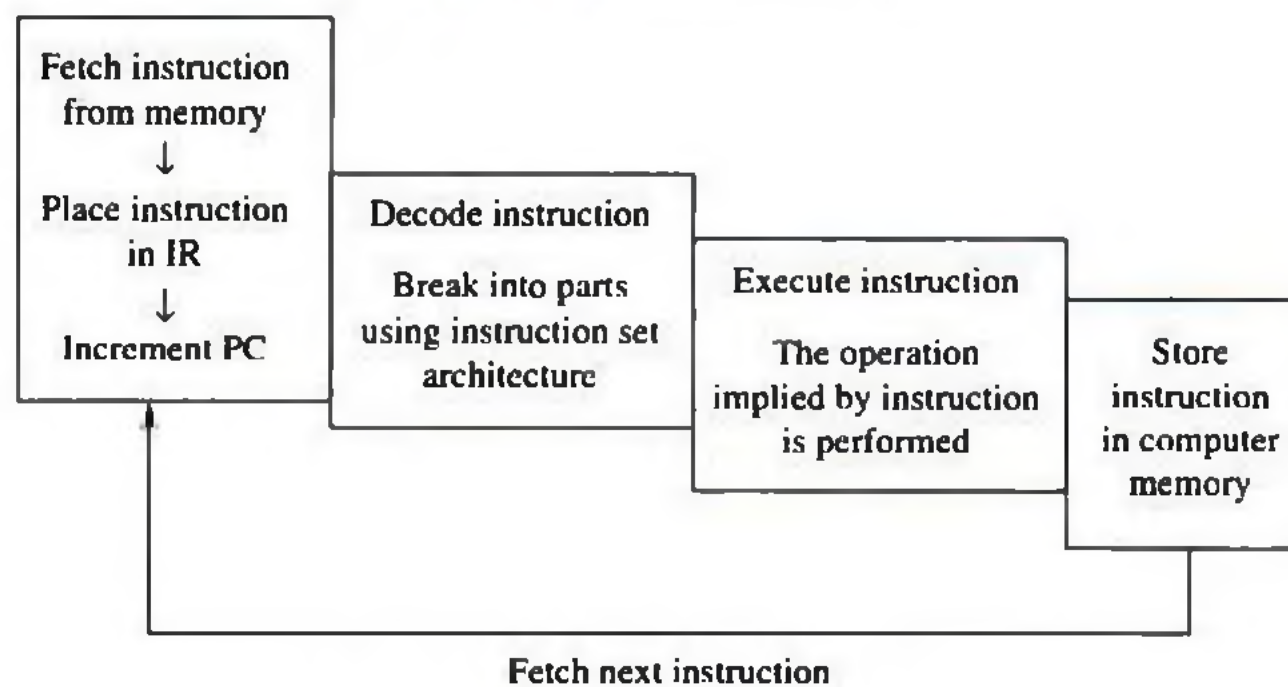
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**Figure 2.8** Instruction cycle



**Figure 2.9** Steps in instruction cycle

- ⊙ Instructions are of different categories. Some categories of instructions are—
- Memory access or transfer of data between registers.
  - Arithmetic operations like addition and subtraction.
  - Logic operations such as AND, OR and NOT.
  - Control the sequence, conditional connections, etc.



A CPU performance is measured by the number of instructions it executes in a second, i.e., **MIPS** (million instructions per second), or **BIPS** (billion instructions per second).

## 2.7 MICROPROCESSOR

A processor's instruction set is a determining factor in its architecture. On the basis of the instruction set, microprocessors are classified as—Reduced Instruction Set Computer (RISC), and Complex Instruction Set Computer (CISC). The x86 instruction set of the original Intel 8086 processor is of the CISC type. The PCs are based on the x86 instruction set.

- ⊙ **CISC** architecture hardwires the processor with complex instructions, which are difficult to create otherwise using basic instructions. CISC combines the different instructions into one single CPU.
  - CISC has a large instruction set that includes simple and fast instructions for performing basic tasks, as well as complex instructions that correspond to statements in the high level language.
  - An increased number of instructions (200 to 300) results in a much more complex processor, requiring millions of transistors.
  - Instructions are of variable lengths, using 8, 16 or 32 bits for storage. This results in the processor's time being spent in calculating where each instruction begins and ends.
  - With large number of application software programs being written for the processor, a new processor has to be backwards compatible to the older version of processors.
  - AMD and Cyrix are based on CISC.
- ⊙ **RISC** has simple, single-cycle instructions, which performs only basic instructions. RISC architecture does not have hardwired advanced functions. All high-level language support is done in the software.
  - RISC has fewer instructions and requires fewer transistors, which results in the reduced manufacturing cost of processor.
  - The instruction size is fixed (32 bits). The processor need not spend time in finding out where each instruction begins and ends.
  - RISC architecture has a reduced production cost compared to CISC processors.
  - The instructions, simple in nature, are executed in just one clock cycle, which speeds up the program execution when compared to CISC processors.
  - RISC processors can handle multiple instructions simultaneously by processing them in parallel.
  - Apple Mac G3 and PowerPC are based on RISC.

Processors like Athlon XP and Pentium IV use a hybrid of both technologies.

**Pipelining** improves instruction execution speed by putting the execution steps into parallel. A CPU can receive a single instruction, begin executing it, and receive another instruction before it has completed the first. This allows for more instructions to be performed, about, one instruction per clock cycle.

**Parallel Processing** is the simultaneous execution of instructions from the same program on different processors. A program is divided into multiple processes that are handled in parallel in order to reduce execution time.

## 2.8 INTERCONNECTING THE UNITS OF A COMPUTER

CPU sends data, instructions and information to the components inside the computer as well as to the peripherals and devices attached to it. **Bus** is a set of electronic signal pathways that allows information



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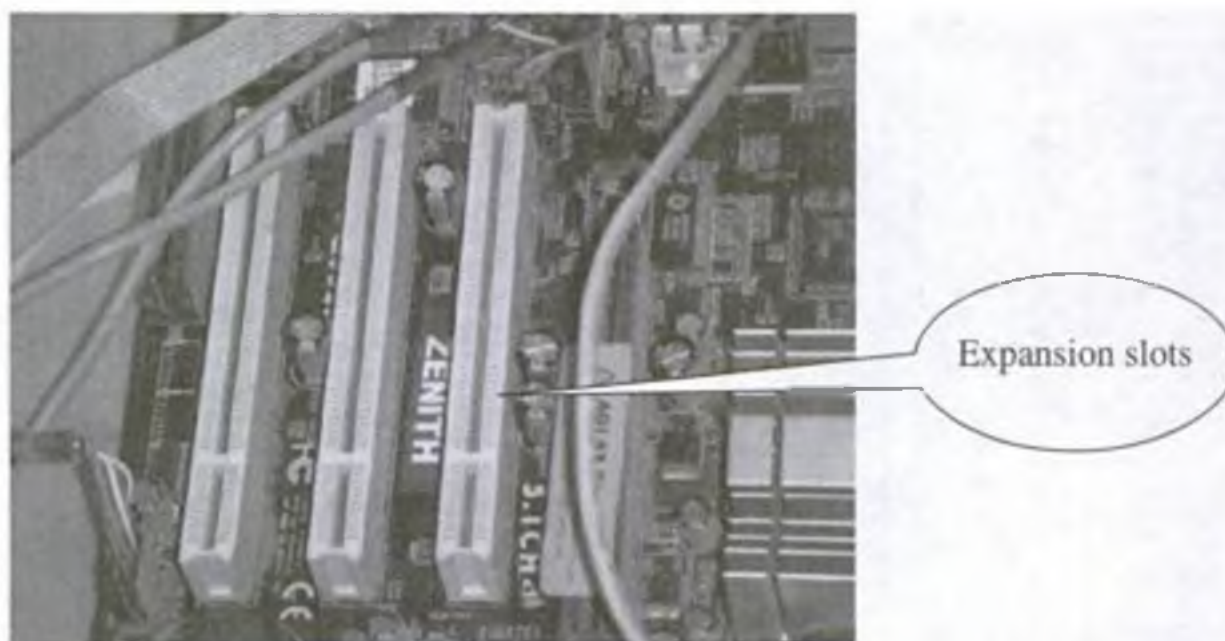
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- USB Ports—to connect newer peripherals like cameras, scanners and printers to the computer. It uses a thin wire to connect to the devices, and many devices can share that wire simultaneously.
- Firewire is another bus, used today mostly for video cameras and external hard drives.
- RJ45 connector (called LAN or Ethernet port) is used to connect the computer to a network. It corresponds to a network card integrated into the motherboard.
- VGA connector for connecting a monitor. This connector interfaces with the built-in graphics card.
- Audio plugs (line-in, line-out and microphone), for connecting sound speakers and the microphone. This connector interfaces with the built-in sound card.
- PS/2 port to connect mouse and keyboard into PC.
- SCSI port for connecting the hard disk drives and network connectors.

### 2.10.3 Expansion Slots

The expansion slots (Figure 2.17) are located on the motherboard. The expansion cards are inserted in the expansion slots. These cards give the computer new features or increased performance. There are several types of slots:

- ISA (Industry Standard Architecture) slot—To connect modem and input devices.
- PCI (Peripheral Component InterConnect) slot—To connect audio, video and graphics. They are much faster than ISA cards.
- AGP (Accelerated Graphic Port) slot—A fast port for a graphics card.
- PCI (Peripheral Component InterConnect) Express slot—Faster bus architecture than AGP and PCI buses.
- PC Card—It is used in laptop computers. It includes Wi-Fi card, network card and external modem.



**Figure 2.17** Expansion slots

### 2.10.4 Ribbon Cables

Ribbon cables (Figure 2.18) are flat, insulated and consist of several tiny wires moulded together that carry data to different components on the motherboard. There is a wire for each bit of the word or byte and additional wires to coordinate the activity of moving information. They also connect the floppy drives, disk drives and CD-ROM drives to the connectors in the motherboard. Nowadays, Serial Advanced Technology Attachment (SATA) cables have replaced the ribbon cables to connect the drives to the motherboard.



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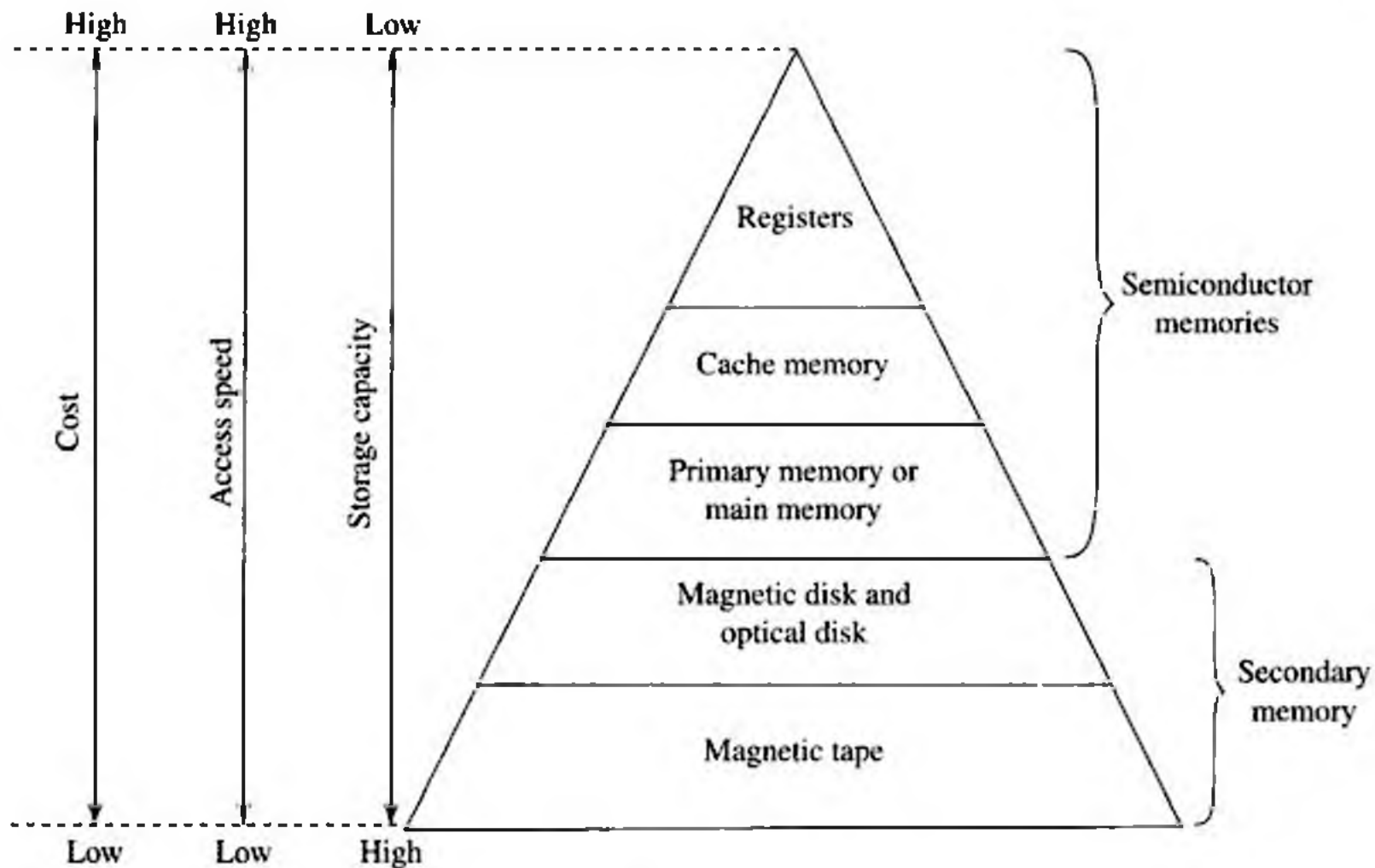
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**Figure 3.2** Memory hierarchy

The internal memory and external memory are the two broad categories of memory used in the computer. The internal memory consists of the CPU registers, cache memory and primary memory. The internal memory is used by the CPU to perform the computing tasks. The external memory is also called the secondary memory. The secondary memory is used to store the large amount of data and the software.

In general, referring to the computer memory usually means the internal memory.

- ⊙ **Internal Memory**—The key features of internal memory are—(1) limited storage capacity, (2) temporary storage, (3) fast access, and (4) high cost. Registers, cache memory, and primary memory constitute the internal memory. The primary memory is further of two kinds—RAM and ROM. Registers are the fastest and the most expensive among all the memory types. The registers are located inside the CPU, and are directly accessible by the CPU. The speed of registers is between 1–2 ns (nanosecond). The sum of the size of registers is about 200B. Cache memory is next in the hierarchy and is placed between the CPU and the main memory. The speed of cache is between 2–10 ns. The cache size varies between 32 KB to 4MB. Any program or data that has to be executed must be brought into RAM from the secondary memory. Primary memory is relatively slower than the cache memory. The speed of RAM is around 60ns. The RAM size varies from 512KB to 3GB.
- ⊙ **Secondary Memory**—The key features of secondary memory storage devices are—(1) very high storage capacity, (2) permanent storage (non-volatile), unless erased by user, (3) relatively slower access, (4) stores data and instructions that are not currently being used by CPU but may be required later for processing, and (5) cheapest among all memory. The storage devices consist of two parts—drive and device. For example, magnetic tape drive and magnetic tape, magnetic disk drive and disk, and, optical disk drive and disk. The speed of magnetic disk is around 60ms.





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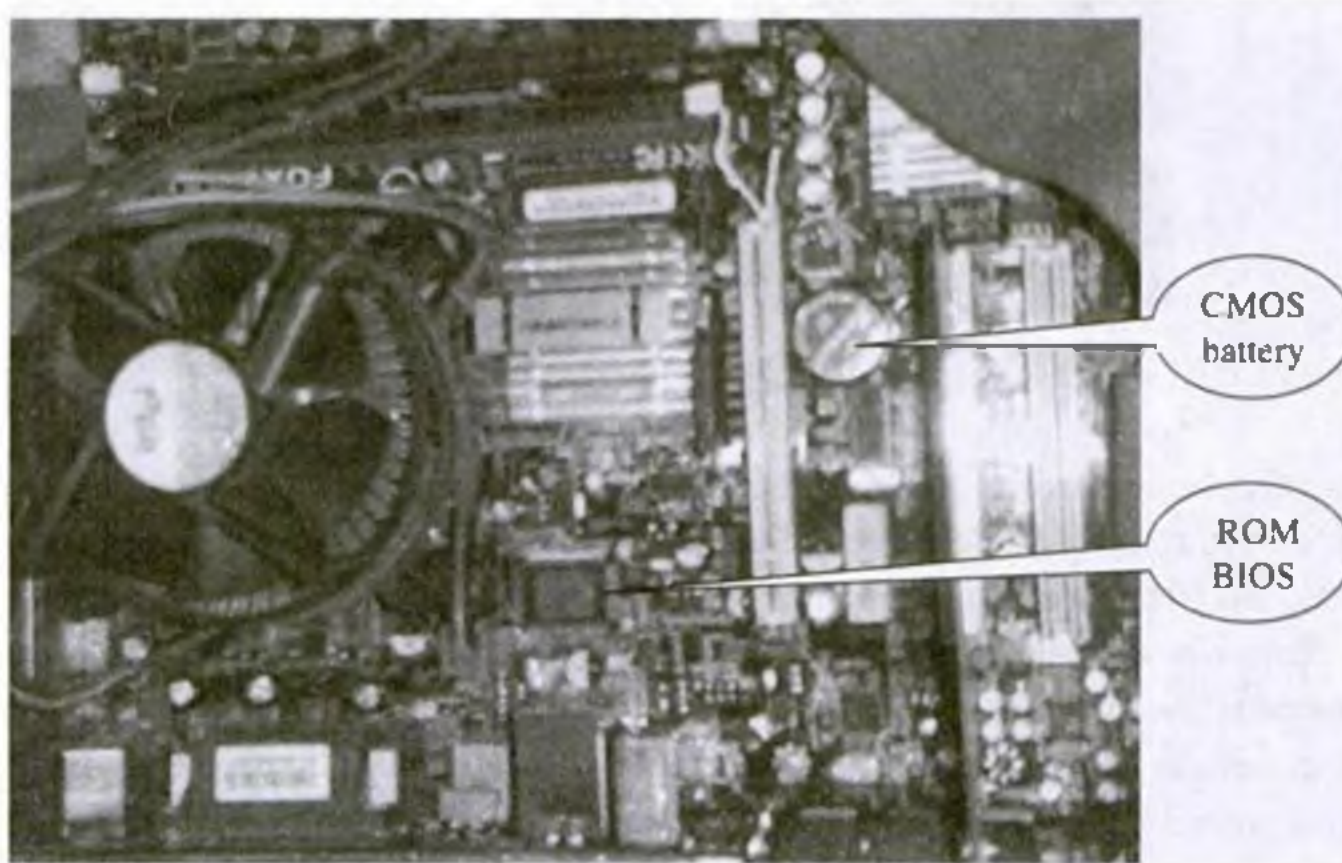


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- ⊙ The ROM memory chip (Figure 3.5) stores the *Basic Input Output System (BIOS)*. BIOS provides the processor with the information required to boot the system. It provides the system with the settings and resources that are available on the system. BIOS is a permanent part of the computer. It does not load from disk but instead is stored in a ROM memory chip. The program code in the BIOS differs from ordinary software since it acts as an integral part of the computer. When the computer is turned on, the BIOS does the following things—



**Figure 3.5** ROM BIOS and CMOS battery on a motherboard

- *Power On Self Test (POST)* is a program that runs automatically when the system is booted. BIOS performs the power-on self-test. It checks that the major hardware components are working properly.
  - BIOS setup program, which is a built-in utility in BIOS, lets the user set the many functions that control how the computer works. BIOS displays the system settings and finds the bootable devices. It loads the interrupt handlers and device drivers. It also initializes the registers.
  - *Bootstrap Loader* is a program whose purpose is to start the computer software for operation when the power is turned on. It loads the operating system into RAM and launches it. It generally seeks the operating system on the hard disk. The bootstrap loader resides in the ROM. The BIOS initiates the bootstrap sequence.
- ⊙ ROMs are of different kinds. They have evolved from the fixed read only memory to the ones that can be programmed and re-programmed. They vary in the number of re-writes and the method used for the re-writing. Programmable ROM (PROM), Erasable Programmable ROM (EPROM) and Electrically Erasable Programmable ROM (EEPROM) are some of the ROMs. All the different kinds of ROM retain their content when the power is turned off.
  - **PROM** can be programmed with a special tool, but after it has been programmed the contents cannot be changed. PROM memories have thousands of fuses (or diodes). High voltage (12 V) is applied to the fuses to be burnt. The burnt fuses correspond to 0 and the others to 1.
  - **EPROM** can be programmed in a similar way as PROM, but it can be erased by exposing it to ultra violet light and re-programmed. EPROM chips have to be removed from the computer for re-writing.



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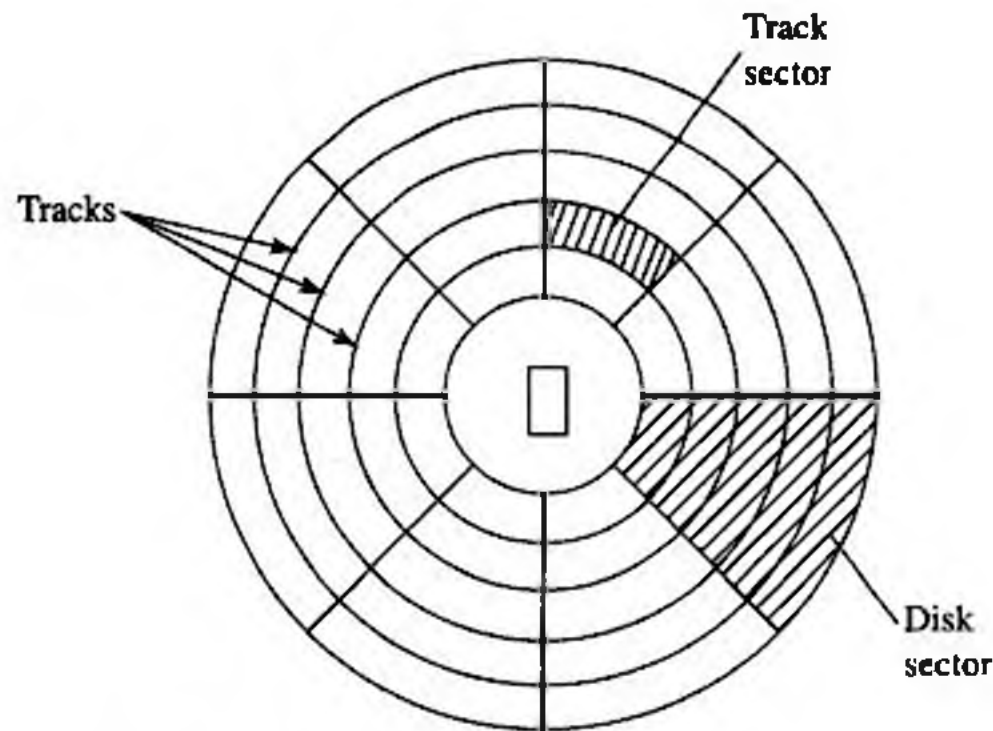




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**Figure 3.10** Tracks and sectors of a disk

- ⊙ Magnetic disk is inserted into a magnetic disk drive for access. The drive consists of a read/write head that is attached to a disk arm, which moves the head. The disk arm can move inward and outward on the disk.
- ⊙ During reading or writing to disk, the motor of disk drive moves the disk at high speed (60–150 times/sec.)
- ⊙ Accessing data on the disk requires the following—
  - The read/write head is positioned to the desired track where the data is to be read from or written to. The time taken to move the read/write head to the desired track is called the *seek time*.
  - Once the read/write head is at the right track, then the head waits for right sector to come under it (disk is moving at high speed). The time taken for desired sector of the track to come under read/write head is called the *latency time*.
  - Once the read/write head is positioned at the right track and sector, the data has to be written to disk or read from disk. The rate at which data is written to disk or read from disk is called *data transfer rate*.
  - The sum of seek time, latency time and time for data transfer is the *access time* of the disk.
- ⊙ The storage capacity of disk drive is measured in gigabytes (GB).
- ⊙ Large disk storage is created by stacking together multiple disks. A set of same tracks on all disks forms a *cylinder*. Each disk has its own read/write head which work in coordination.
- ⊙ A disk can also have tracks and sectors on both sides. Such a disk is called *double-sided disk*.

The features of magnetic disk are—

- ⊙ Cheap storage device
- ⊙ Can store a large amount of data
- ⊙ Easy to carry or transport
- ⊙ Suitable for frequently read/write data
- ⊙ Fast access device
- ⊙ More reliable storage device
- ⊙ To be prevented from dust, as the read/write head flies over the disk. Any dust particle in between can corrupt the disk.

Finding data on a magnetic disk is as follows—

- ⊙ In order to use a disk, it has to be formatted. Formatting includes assigning addresses to various locations on disk, assigning location of root directory and checking for defects on the surface of disk.
- ⊙ During formatting, the tracks and sectors of a disk are labeled, which provides an address to each location of the disk.
- ⊙ There are different methods to format a disk. File Allocation Table (FAT) is the commonly used logical format for disk formatting performed by Windows.
- ⊙ Four areas are created when a disk is formatted using FAT—
  - **Boot Sector** It contains the program that runs when the computer is started. The program checks if the disk has files required to run the operating system. It then transfers control to an operating system program which continues the startup process. Boot sector also contains information about the disk, like number of bytes per sector and number of sectors per track. This information is required by the operating system to access the data on the disk.
  - **File Allocation Table** It records the location of each file and status of each sector. While reading or writing to disk, operating system checks the FAT to find free area or locate where data is stored on disk, respectively.
  - **Root Directory** This is the main folder of disk. It contains other folders in it, creating a hierarchical system of folders. The root directory contains information about all folders on the disk.
  - **Data Area** The remaining area of the disk (after boot sector, FAT, root directory) is the data area. It stores the program files and data files that are stored on the disk.
- ⊙ The Windows XP and the Windows 2000 operating system use the New Technology File System (NTFS) 5 file system. The NTFS 5 file system offers better security and increased performance. It allows using of filenames that are more than eight characters long.
- ⊙ Floppy disk, hard disk and zip disk are the different types of magnetic disks.

### 3.10.1 Floppy Disk

- ⊙ Floppy disk (FD) is a flat, round, single disk made of Mylar plastic and enclosed in square plastic jacket (Figure 3.11).
- ⊙ Floppy Disk Drive (FDD) is the disk drive for floppy disk.
- ⊙ The floppy disk is inserted into the floppy disk drive to read or write data to it.
- ⊙ Floppy disk has a write-protect slide tab that prevents a user from writing to it.
- ⊙ A floppy disk may be single-sided or double-sided disk, i.e., data can be read and written on one and both sides of floppy disk, respectively.



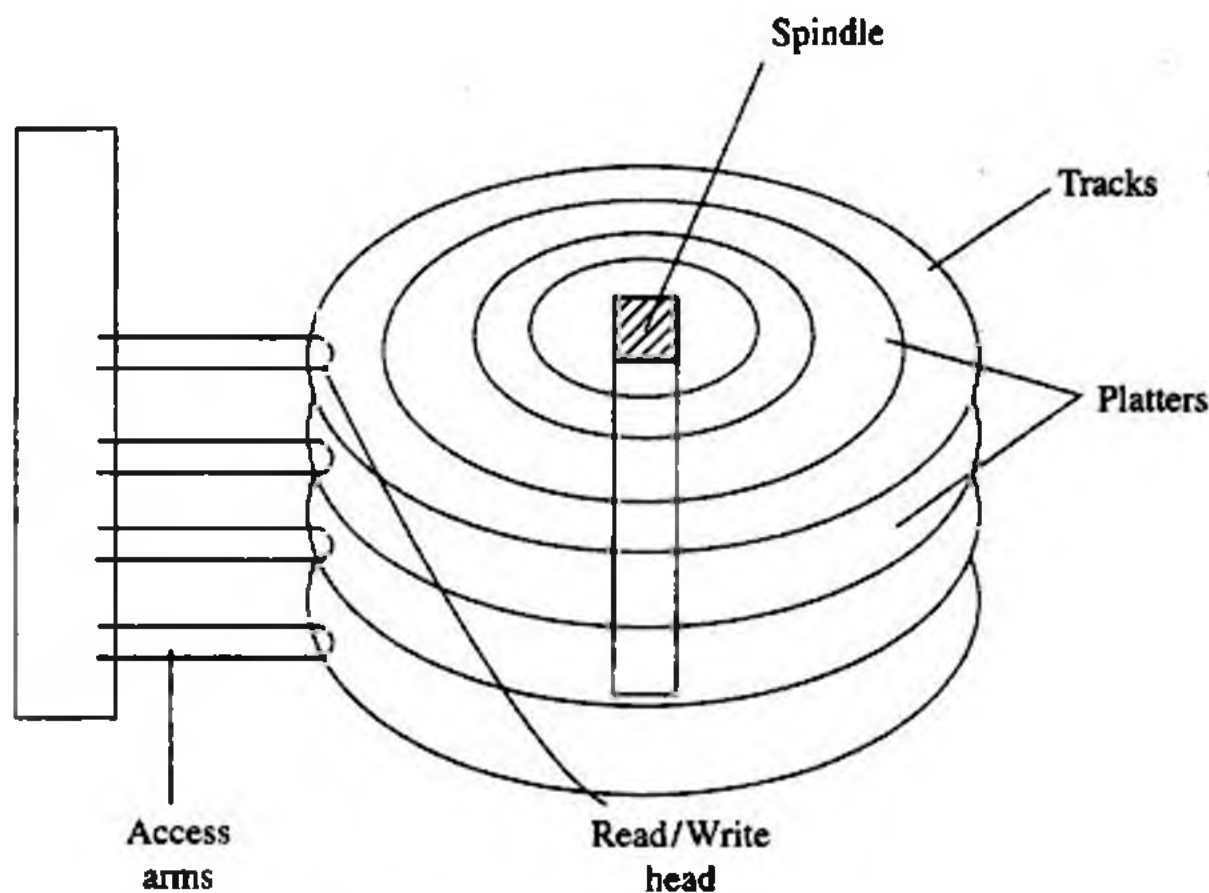
**Figure 3.11** Floppy disk

- ⊙ They are portable. They can be removed from the disk drive, carried or stored separately.
- ⊙ They are small and inexpensive.
- ⊙ Floppy disks are slower to access than hard disk. They have less storage capacity and are less expensive than hard disk.
- ⊙ They come in two basic sizes—5-¼ inch and 3-½ inch.

- ⊙ The 5-¼ inch disk came around 1987. It can store 360 KB to 1.2 MB of data.
- ⊙ The 3-½ inch disk has capacity of 400 KB to 1.44 MB. It usually contains 40 tracks and 18 sectors per track and can store 512 bytes per sector.

### 3.10.2 Hard Disk

- ⊙ A hard disk (HD) consists of one or more platters divided into concentric tracks and sectors. It is mounted on a central spindle, like a stack. It can be read by a read/write head that pivots across the rotating disks. The data is stored on the platters covered with magnetic coating (Figure 3.12).



**Figure 3.12** Parts of hard disk

- ⊙ Hard disk is a fixed disk. The disk is not removable from the drive, unlike floppy disk.
- ⊙ The hard disk and Hard Disk Drive (HDD) is a single unit.
- ⊙ Hard disk can store much more data than floppy disk. The data in hard disk are packed more closely (because fast spinning uses smaller magnetic charges) and they have multiple platters, with data being stored on both sides of each platter. Large capacity hard disks may have 12 or more platters.
- ⊙ Unlike floppy disk, the read/write head of hard disk does not touch the disk during accessing.
- ⊙ Hard disk can spin at the speed of up to 10,000 revolutions per minute and have an access time of 9–14 ms. It stores 512 bytes per sector but the number of sectors are more per track (54 or more) than floppy disk.
- ⊙ Nowadays, hard disks are available that can store up to 500 GB of data. Generally, PCs come with 160 GB hard disk.
- ⊙ Hard disk is the key secondary storage device of computer. The operating system is stored on the hard disk. The performance of computer like speed of computer boot up, loading of programs to



primary memory, loading of large files like images, video, audio etc., is also dependent on the hard disk.

- ⊙ Nowadays, *portable external hard disk drive* is available which can be attached to the USB drive of the computer. They come in the storage capacities of 80 GB to 500 GB.



**Figure 3.13** Zip disk

### 3.10.3 Zip Disk

- ⊙ They are high-capacity removable disk and drive.
- ⊙ They have the speed and capacity of hard disk and portability of floppy disk.
- ⊙ Zip disk are of the same size as floppy disk, i.e., 3-½ inch but have a much higher capacity than the floppy disk (Figure 3.13).
- ⊙ Zip disk and drive were made by Iomega Corp. It comes as a complete unit—disk, drive, connection cable, power cord and operating system. It can be connected to the computer system externally using a parallel chord or SCSI cable.
- ⊙ Their capacity ranges from 100 MB to 750 MB. They can be used to store large files, audio and video data.

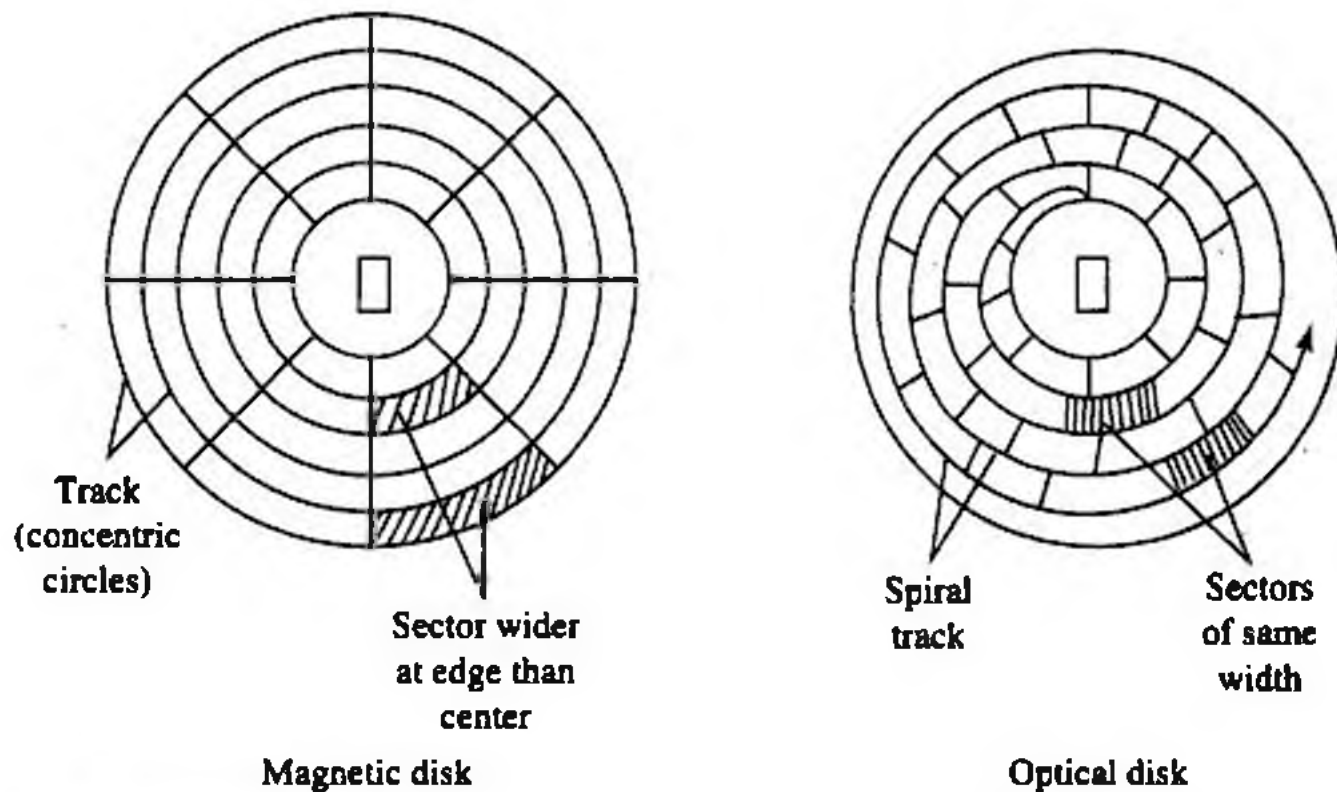
## 3.11 OPTICAL DISK

Optical disk (Figure 3.14) is a flat and circular disk which is coated with reflective plastic material that can be altered by laser light. Optical disk does not use magnetism. The bits 1 and 0 are stored as spots that are relatively bright and light, respectively.



**Figure 3.14** Optical disk

- ⊙ An optical disk consists of a single spiral track that starts from the edge to the centre of disk. Due to its spiral shape, it can access large amount of data sequentially, for example music and video. The random access on optical disk is slower than that of magnetic disk, due to its spiral shape.
- ⊙ The tracks on optical disk are further divided into sectors which are of same length. Thus, the sectors near the centre of disk wrap around the disk longer than the sectors on the edges of disk. Reading the disk thus requires spinning the disk faster when reading near the centre and slower when reading near the edge of disk. Optical disks are generally slower than hard disks. Figure 3.15 shows the tracks and sectors in a magnetic disk and optical disk.



**Figure 3.15** Sectors and track in magnetic disk and optical disk

- ⊙ Optical disks can store large amount of data, up to 6 GB, in a small space. Commonly used optical disks store 600–700 MB of data.
- ⊙ The access time for an optical disk ranges from 100 to 200 ms.
- ⊙ There are two most common categories of optical disks—read-only optical disks and recordable optical disks.

### 3.11.1 CD-ROM

- ⊙ Originally, Compact Disk (CD) was a popular medium for storing music. Now, it is used in computers to store data and is called Compact Disk-Read Only Memory (CD-ROM).
- ⊙ As the name suggests, CD-ROM (Figure 3.16) is an optical disk that can only be read and not written on. CD-ROM is written on by the manufacturer of the CD-ROM using the laser light.
- ⊙ A CD-ROM drive reads data from the compact disk. Data is stored as pits (depressions) and lands (flat area) on CD-ROM disk. When the laser light is focused on the disk, the pits scatter the light (interpreted as 0) and the lands reflect the light to a sensor (interpreted as 1).
- ⊙ As CD-ROM is read only, no changes can be made into the data contained in it.
- ⊙ Since there is no head touching the disk, but a laser light, CD-ROM does not get worn out easily.
- ⊙ The storage density of CD-ROM is very high and cost is low as compared to floppy disk and hard disk.
- ⊙ Access time of CD-ROM is less. CD-ROM drives can read data at 150Kbps. They come in multiples of this speed like—2x, 4x, 52x, 75x, etc.
- ⊙ It is a commonly used medium for distributing software and large data.

### 3.11.2 DVD-ROM

- ⊙ Digital Video Disk-Read Only Memory (DVD-ROM) is an optical storage device used to store digital video or computer data (Figure 3.17).
- ⊙ DVDs look like CDs, in shape and physical size.



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user, have slow access, store the data and instructions that are not currently being used by CPU, and are cheapest among all memory. Magnetic disk and optical disk are storage devices.

- ⊙ *Organization of memory* with respect to the CPU, is as follows—registers are placed inside CPU, cache memory is placed inside CPU, primary memory is placed next in the hierarchy, and secondary memory is the farthest from CPU.
- ⊙ *Registers* are very high-speed storage areas located inside the CPU. Registers are manipulated directly by the control unit of the CPU during instruction execution.
- ⊙ *Cache*, the fast memory, is placed between the CPU and the RAM. The contents from the RAM are stored in the cache.
- ⊙ *RAM* stores data and instructions during the operation of computer. RAM is a random access volatile memory having limited size due to its high cost. RAM affects the speed and power of the computer.
- ⊙ *RAM memory chips* are of two types—DRAM and SRAM. DRAM is used as main memory as it is small and cheap. SRAM chip is used in cache memory due to its high speed.
- ⊙ *ROM* is a non-volatile primary memory which stores the data needed for the start up of the computer. Instructions to initialize different devices attached to computer and the bootstrap loader are stored in ROM. PROM, EPROM and EEPROM are some of the ROMs.
- ⊙ *Flash memory* is a kind of semiconductor-based non-volatile, rewritable computer memory. It is used in

digital camera, mobile phone, printer, laptop computer, and MP3 players.

- ⊙ *Magnetic tapes* are inexpensive, can store a large amount of data, are easy to transport, are slow access device, and are suitable for back-up storage.
- ⊙ *Magnetic disks* are cheap storage device, can store a large amount of data, are easy to carry, are suitable for frequently read/write data and are fast access device. Access time of disk is the sum of seek time, latency time and time for data transfer.
- ⊙ *Floppy disk* is a flat, round, single disk enclosed in a jacket. It is portable, small, inexpensive and slower to access than hard disk. It comes in two basic sizes—5-¼ inch and 3-½ inch.
- ⊙ *Hard disk* is a fixed disk and can store much more data than floppy disk. Hard disk is the key secondary storage device of computer.
- ⊙ *Zip disk* have the speed and capacity of hard disk and portability of floppy disk.
- ⊙ *Optical disk* consists of a single spiral track that starts from the edge to the centre of disk. It can store large amount of data in small space.
- ⊙ *CD-ROM* is an optical disk that can only be read and not written on. It has high-storage density and is a low-cost device compared to floppy disk and hard disk.
- ⊙ *DVD-ROM* is a high-density optical storage device which stores data on both sides of the disk. It is used to store a full-length movie.
- ⊙ *Recordable optical disks* are CD-R, CD-RW and DVD-R.
- ⊙ *Computer uses its memory* from the time you switch on the computer till you switch it off.

## KEYWORDS

Access time 40	Compact Disk - Read Only Memory (CD-ROM) 53	Digital Video Disk-Recordable (DVD-R) 55
Basic Input Output System (BIOS) 45	Compact Disk-Recordable (CD-R) 55	Direct Access 46
Bit 40	Compact Disk-ReWritable (CD-RW) 55	Dual Inline Memory Module (DIMM) 44
Boot sector 50	Complementary Metal-Oxide Semiconductor (CMOS) 45	Dynamic RAM (DRAM) 43
Bootstrap loader 45	Data Transfer Rate 49	Electrically Erasable Programmable ROM (EEPROM) 45
Byte 40	Digital Video Disk-Read Only Memory (DVD-ROM) 53	Erasable Programmable ROM (EPROM) 45
Cache Hit 42		File Allocation Table (FAT) 50
Cache memory 42		
Cache Miss 42		
Compact Disk (CD) 53		



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# INPUT AND OUTPUT DEVICES

# 4

## Contents

- ⊙ Input-output unit—Input unit, output unit
- ⊙ Input devices—Human data entry devices, source data entry devices
- ⊙ Human data entry devices
  - Keyboard
  - Pointing devices—Mouse, trackball, joystick, digitizing tablet
  - Pick devices—Light pen, touch screen
- ⊙ Source data entry devices
  - Audio input device (microphone, sound card, speech recognition)
  - Video input device (video camera, digital camera)
  - Optical input devices—Scanner (hand held, flat bed), OCR, MICR, OMR, barcode reader
- ⊙ Output devices—Hard copy devices, soft copy devices
- ⊙ Hard copy devices
  - Printer—Impact printers (dot matrix, daisy wheel, drum), non-impact printers (ink-jet, laser)
  - Plotter—Drum plotter, flatbed plotter
  - Computer output on microfilm (microfiche)
- ⊙ Soft copy devices—Monitor, visual display terminal, video output, audio response (speakers, headphone)
- ⊙ I/O port—Parallel port, serial port, USB port, firewire port
- ⊙ Working of I/O system—I/O devices, device controller, device driver



## Why This Chapter

What is the use of the computer for us? We may want to process data, write project reports, listen to sound recordings, watch a movie and do many more things. But to do any of these things, we should be able to provide the data to the computer and also get the output from it. The input devices and output devices are used this purpose. The aim of this chapter is to introduce the different kinds of input and output devices.

## 4.1 INTRODUCTION

A computer interacts with the external environment via the input-output (I/O) devices attached to it. Input device is used for providing data and instructions to the computer. After processing the input data, computer provides output to the user via the output device. The I/O devices that are attached, externally, to the computer machine are also called *peripheral devices*. Different kinds of input and output devices are used for different kinds of input and output requirements. In this chapter, we shall discuss different kinds of input devices and output devices.





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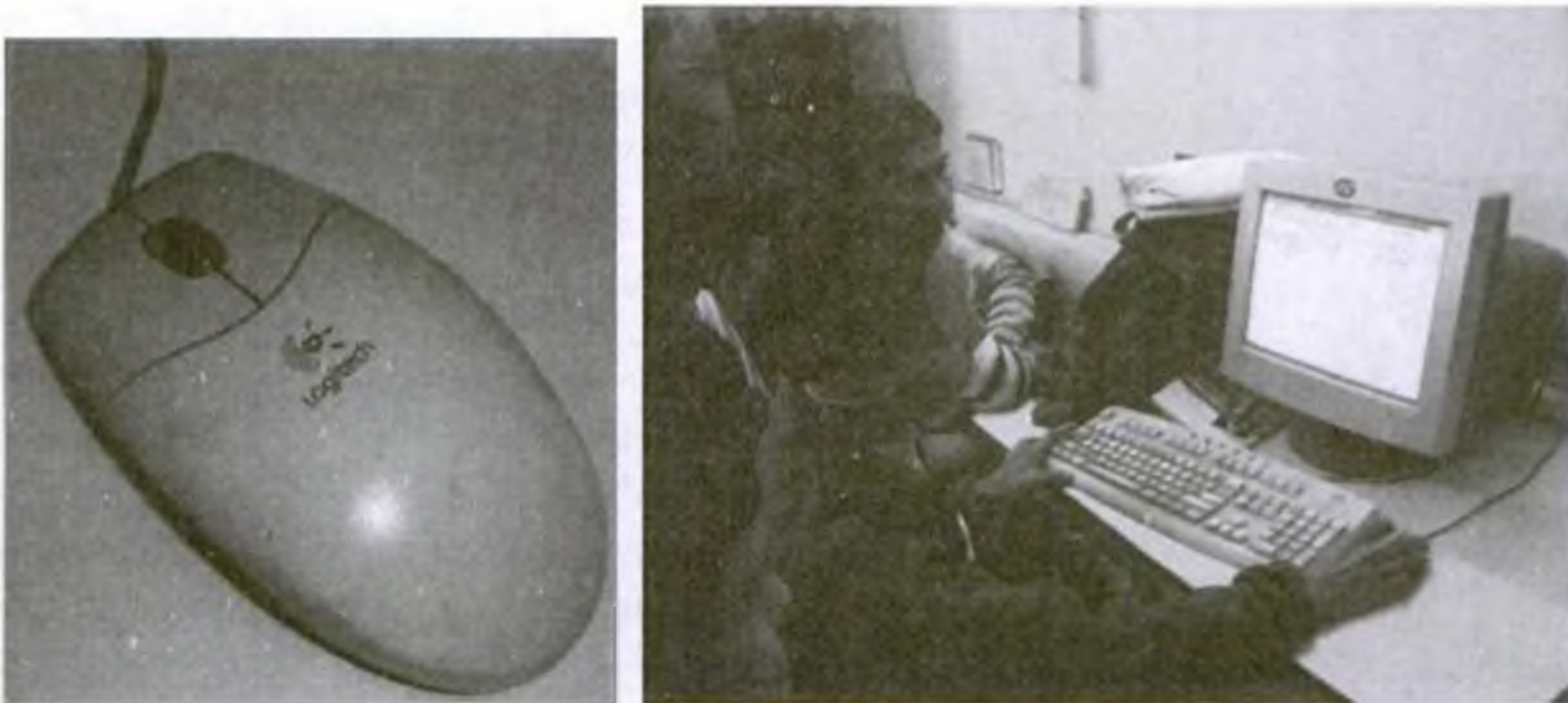
## 4.4.2 Pointing Devices

Pointing devices are used for providing the input to computer by moving the device to point to a location on computer monitor. The input data is not typed; instead, the data is entered by moving the pointing device. The cursor on the computer monitor moves with the moving pointing device. Operations like move, click and drag can be performed using the pointing devices. Mouse, trackball, joystick and digitizing tablet are some of the common pointing devices.

### 4.4.2.1 Mouse

**Features** It is the most common pointing input device. The data is entered by pointing the mouse to a location on the computer screen. The mouse may also be used to position the cursor on screen, move an object by dragging, or select an object by clicking. The key benefit of using a mouse is that the cursor moves with the mouse. So, the cursor can be positioned at any location on the screen by simply moving the mouse. Moreover, it provides an easy way to select and choose commands from menus, dialog boxes, icons, etc. Mouse is used extensively, while working with graphics elements such as line, curve, shapes, etc.

**Description** Mouse is a small hand-held device having two or three buttons on its upper side. In addition to the buttons, mouse also has a small wheel between the buttons. Figure 4.3 (i) shows a mouse. The wheel of the mouse is used for the up and down movement, for example, scrolling a long document. A mouse is classified as physical mouse or optical mouse.



**Figure 4.3** (i) Mouse, (ii) A user working with a mouse

**Physical Mouse** has a rubber ball on the bottom side that protrudes when the mouse is moved. It requires a smooth, dust free surface, such as a mouse pad, on which it is rolled.

**Optical Mouse** uses a Light Emitting Diode (LED) and a sensor to detect the movement of mouse. Optical mouse requires an opaque flat surface underneath it. Optical mouse was introduced by Microsoft in 1999. Optical mouse is better than physical mouse as there is no moving part that can cause wear and tear, and dirt cannot get inside it. A user is working with an optical mouse in Figure 4.3 (ii).

**Working** In a *physical mouse*, rollers and sensors are used to sense the direction and rate of movement of mouse. When the ball of mouse moves, the rollers sense the horizontal and vertical movement and



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generally used in applications like Automated Teller Machine (ATM), public information computers like hospitals, airline reservation, railway reservation, supermarkets, etc. (Figure 4.8).

**Description** Touch screen consists of a clear glass panel that is placed over the view area of computer screen. In addition to the glass panel with sensors, it has a device driver, and a controller that translates the information captured by the glass panel sensors to a form that the computer can understand.

**Working** Touch screens have an infrared beam that criss-cross the surface of screen. When a fingertip is touched on the screen, the beam is broken, and the location is recorded. Some touch screens have ultrasonic acoustic waves that cross the surface of screen. When a fingertip is touched on the screen, the wave is interrupted, and the location is recorded. The recorded location is sent to the computer via the controller of touch screen, in a form that the computer can understand.

## 4.5 SOURCE DATA ENTRY DEVICES

Source data entry devices are used for audio input, video input and to enter the source document directly to the computer. Source data entry devices do not require data to be typed-in, keyed-in or pointed to a particular location.

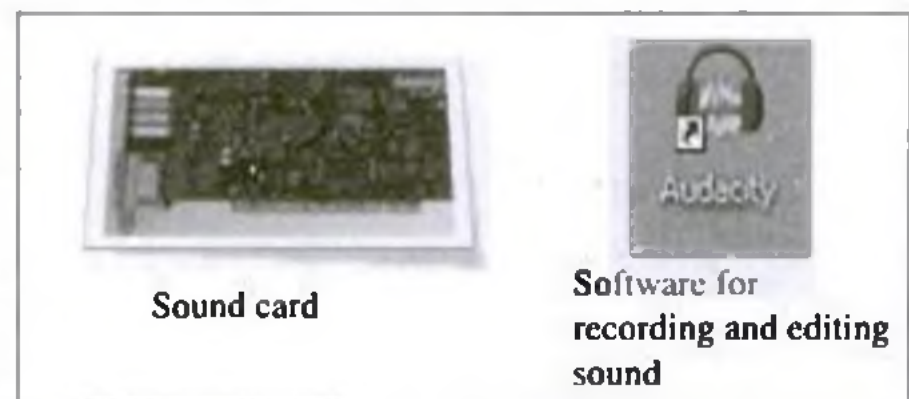
### 4.5.1 Audio Input Device

Audio input can be provided to the computer using human voice or speech. Audio input to the computer can be used for different purposes. It can be used for making telephone calls, for audio and video conferencing over Internet, to record voice, to create audio files and embed these files to be sent over e-mail, or, to translate spoken words into text, etc.

Audio input devices like a *microphone* is used to input a person's voice into the computer. A *sound card* (Figure 4.9 (i)) translates analog audio signals from microphone into digital codes that the computer can store and process. Sound card also translates back the digital sound into analog signals that can be sent to the speakers. Translating spoken words into text is also known as *speech recognition* or *voice recognition*. The audio input along with the software for voice recognition forms the speech recognition system or voice recognition system.

The computer can be operated using voice commands. The user can dictate the commands to the computer, instead of typing them. The computer has to be trained to recognize the voice of user using the speech patterns and pronunciation of words. The system thus adapts to the voice of user.

Speech recognition systems are costly and difficult to develop. They are generally used by people who have difficulty in typing, people with disabilities or by corporate world for dictation. Audio input can be recorded on an mp3 recorder and provided as an input to computer. Open source software like Audacity is used for recording and editing of audio files (Figure 4.9 (ii)).



**Figure 4.9** (i) Sound card, (ii) Audacity software

### 4.5.2 Video Input Device

Video input is provided to the computer using *video camera* and *digital camera* (Figure 4.10). Video camera can capture full motion video images. The images are digitized and can be compressed and stored in the computer disk. Webcam is a common video camera device. It is placed on the computer above the screen to capture the images of the user who is working on the computer. A video capture card allows the user to connect video devices like camcorders to the computer.



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(sharpness and clarity of print) of the printer is determined by the resolution of the printer. Resolution is measured in dots per inch (dpi). Printers with a high resolution (more dpi) provide better quality output. Different kinds of printers are available for different types of applications. Printers are classified into two categories—impact printer and non-impact printer.

**Impact printers** use the typewriter approach of physically striking a typeface against the paper and inked ribbon. Impact printers can print a character or an entire line at a time. Impact printers are low-cost printers useful for bulk printing. Dot matrix printers, daisy wheel printers and drum printers are examples of impact printers.

- ① **Dot Matrix Printers** (Figure 4.17) print one character at a time. The speed of dot matrix printer lies between 200 and 600 characters per second (cps) and their resolution ranges from 72 to 360 dpi. Dot matrix printers normally come in two sizes—80 column printer and 132 column printer. Dot matrix printers can print alphanumeric characters, special characters, charts and graphs. They can print only in black and white. Some dot matrix printers can print in both directions - left to right and right to left. Dot matrix printers are commonly used for printing in applications like payroll and accounting.

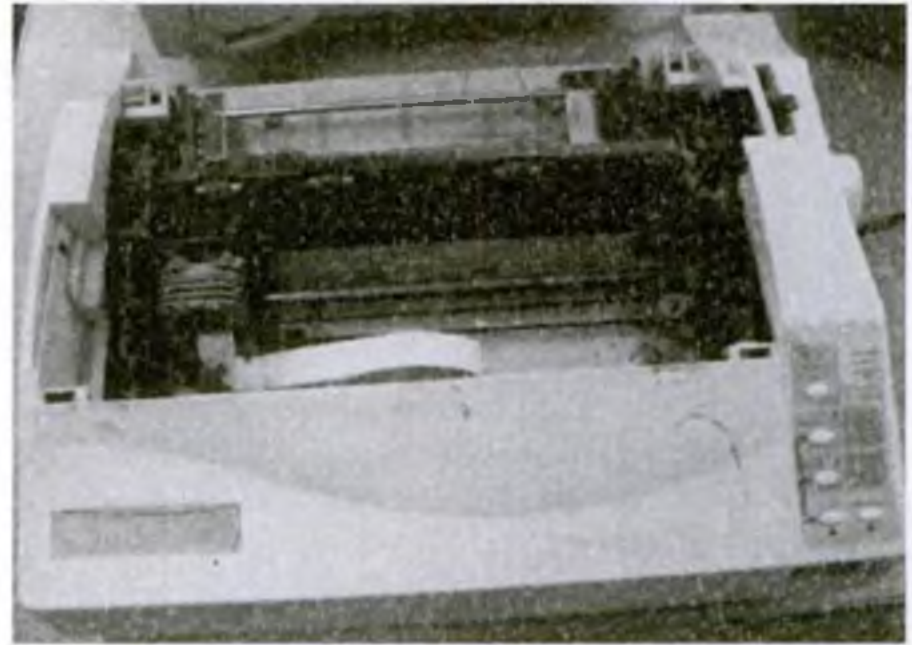


Figure 4.17 Dot matrix printer

- ① **Daisy Wheel Printers** (Figure 4.18) print one character at a time. They produce letter quality document which is better than a document printed by a dot matrix printer. The speed of daisy wheel printers is about 100 cps. The print head of the printer is like a daisy flower, hence the name. These printers are slow, can only print text (not graphics), and are costly in comparison to dot matrix printers. Daisy wheel printers are used where high quality printing is needed and no graphics is needed.



Figure 4.18 Daisy wheel for printers

- ① **Drum Printers** are line printers. They are expensive and faster than character printers but produce a low quality output. They can print 200–2500 lines per minute. Drum printers are generally used for voluminous print outputs.

**Non-Impact Printers** do not hit or impact a ribbon to print. They use electro-static chemicals and ink-jet technologies. Non-impact printers are faster and quieter than impact printers. They produce high quality output and can be used for printing text and graphics both in black and white, and color. Ink-jet printers and laser printers are non-impact printers.

- ① **Ink-jet Printers** spray ink drops directly on the paper like a jet (Figure 4.19 (i)). Their resolution is more than 500 dpi. They produce high quality graphics and text. Ink-jet printers are commonly found in homes and offices.
- ① **Laser Printers** (Figure 4.19 (ii)) provide highest quality of text and graphics printing. Laser printers process and store the entire page before printing and are also known as *page printers*. The laser printer can print 5-24 pages of text per minute and their resolution ranges from 400 to



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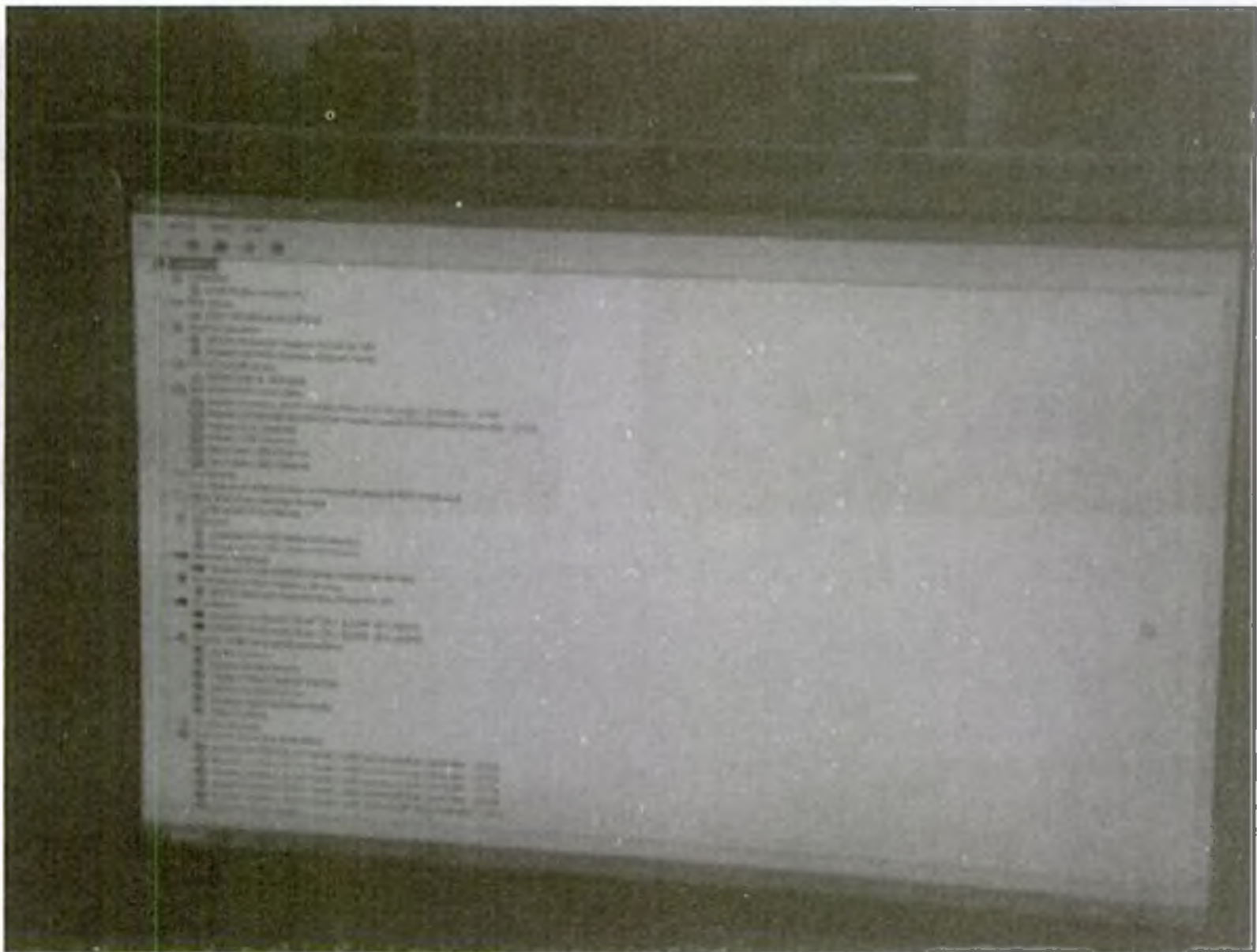




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**Figure 4.23** LCD monitor



**Figure 4.24** A user viewing the output on a LCD monitor



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35. Name three optical scanner devices.
36. Why is a scanner used?
37. Describe hand-held scanners and flat-bed scanners.
38. What is the purpose of OCR software in optical character recognition?
39. An application where MICR is commonly used is \_\_\_\_\_.
40. Name an application of OMR.
41. How does optical character reader recognize characters?
42. How does magnetic ink character reader recognize the magnetic characters?
43. How does optical mark reader recognize marks?
44. What is the use of barcode reader?

#### Section 4.6–4.6.1.1

45. Dot Matrix printers come in two sizes—\_\_\_\_\_ column printer and \_\_\_\_\_ column printer.
46. The sharpness and clarity of print of the printer is determined by the \_\_\_\_\_ of printer.
47. Resolution of printer is measured in \_\_\_\_\_.
48. Describe a dot-matrix printer.
49. Describe a daisywheel printer.
50. Dot matrix and daisy wheel printers are character printer but drum printer is a \_\_\_\_\_ printer and laser printer is a \_\_\_\_\_ printer.
51. Describe non-impact printers.

#### Section 4.6.1.2–4.6.2.4

52. What is the use of a plotter?
53. Plotters are of two kinds—\_\_\_\_\_plotter and \_\_\_\_\_plotter.
54. Name two applications where plotters are used.
55. Define a microfilm.
56. When do we use a microfilm?
57. Give a description of the monitor.
58. Define the resolution of the screen.
59. Define the refresh rate of the screen.
60. Define the dot pitch of the screen.
61. The common resolution of computer screen is \_\_\_\_\_ and \_\_\_\_\_.

62. Describe the three factors on which the clarity of image on the computer screen depends.
63. Name the three factors on which the clarity of image on the computer screen depends.
64. Name some color adapters.
65. What is a visual display terminal?
66. Why are screen image projectors used?
67. Describe how the audio response system works.
68. Name two applications of audio response system.

#### Section 4.7–4.8

69. Name the different types of I/O ports.
70. Name at least one device each that can be connected to the serial port, parallel port, USB port, MIDI port and firewire.
71. Explain the working of the I/O system.
72. What is the purpose of ports, buses and controllers in the I/O system?
73. What is a device driver?
74. What is the use of the device driver?
75. Is device controller a hardware or software?
76. Is device driver a hardware or software?

#### Extra Questions

77. Give full form of the following abbreviations

- |            |            |           |
|------------|------------|-----------|
| (i) I/O    | (ii) LED   | (iii) CAD |
| (iv) ATM   | (v) MICR   | (vi) OMR  |
| (vii) OCR  | (viii) dpi | (ix) cps  |
| (x) CAM    | (xi) COM   | (xii) CRT |
| (xiii) LCD | (xiv) VDT  | (xv) USB  |
| (xvi) MIDI |            |           |

78. Write short notes on

- |                        |                           |
|------------------------|---------------------------|
| (a) Input-iutput unit  | (b) Input Unit            |
| (c) Output unit        | (d) Keyboard              |
| (e) Mouse              | (f) Trackball             |
| (g) Joystick           | (h) Digitizing tablet     |
| (i) Light pen          | (j) Touch screen          |
| (k) Input devices      | (l) Audio input device    |
| (m) Video input device | (n) Optical input devices |
| (o) Scanner            | (p) MICR                  |
| (q) OMR                | (r) OCR                   |
| (s) Printer            | (t) Impact printers       |



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- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	$10^3$	$10^2$	$10^1$	$10^0$		$10^{-1}$	$10^{-2}$	$10^{-3}$
Quantity:	1000	100	10	1		1/10	1/100	1/1000

### 5.2.2 Binary Number System

- ⊙ The binary number system consists of two digits—0 and 1.
- ⊙ All binary numbers are formed using combination of 0 and 1. For example, 1001, 11000011 and 10110101.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	$2^3$	$2^2$	$2^1$	$2^0$		$2^{-1}$	$2^{-2}$	$2^{-3}$
Quantity:	8	4	2	1		1/2	1/4	1/8

### 5.2.3 Octal Number System

- ⊙ The octal number system consists of eight digits—0 to 7.
- ⊙ All octal numbers are represented using these eight digits. For example, 273, 103, 2375, etc.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	$8^3$	$8^2$	$8^1$	$8^0$		$8^{-1}$	$8^{-2}$	$8^{-3}$
Quantity:	512	64	8	1		1/8	1/64	1/512

### 5.2.4 Hexadecimal Number System

- ⊙ The hexadecimal number system consists of sixteen digits—0 to 9, A, B, C, D, E, F, where (A is for 10, B is for 11, C-12, D-13, E-14, F-15).
- ⊙ All hexadecimal numbers are represented using these 16 digits. For example, 3FA, 87B, 113, etc.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	$16^3$	$16^2$	$16^1$	$16^0$		$16^{-1}$	$16^{-2}$	$16^{-3}$
Quantity:	4096	256	16	1		1/16	1/256	1/4096

Table 5.1 summarizes the base, digits and largest digit for the above discussed number systems. Table 5.2 shows the binary, octal and hexadecimal equivalents of the decimal numbers 0–16.

	Base	Digits	Largest Digit
Decimal	10	0–9	9
Binary	2	0, 1	1
Octal	8	0–7	7
Hexadecimal	16	0–9, A, B, C, D, E, F	F (15)

**Table 5.1** Summary of number system



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- (3) Record the non-fractional part of the resulting number.
- (4) Repeat the above steps at least four times.
- (5) Write the digits in the non-fractional part starting from *upwards to downwards*.

**Example 5:** Convert 0.2345 from Base 10 to Base 2.

0.2345

x 2

0.4690

x 2

.4690

x 2

0.9380

x 2

.9380

x 2

1.8760

x 2

.8760

x 2

1.7520

x 2

.7520

x 2

1.5040

x 2

.5040

x 2

1.0080

The binary equivalent of  $(0.2345)_{10}$  is  $(0.001111)_2$

**Example 5a:** Convert 0.865 from Base 10 to Base 2, 8 and 16.

0.865

x 2

1.730

x 2

1.460

x 2

0.920

x 2

1.840

x 2

1.680

x 2

1.360

0.865

x 8

6.920

x 8

7.360

x 8

2.880

x 8

7.040

The octal equivalent of  $(0.865)_{10}$  is  $(.6727)_8$

0.865

x 16

5190

865 x

13.840

x 16

5040

840 x

13.440

x 16

2640

440 x

7.040

The binary equivalent of  $(.865)_{10}$  is  $(.110111)_2$

The number 13 in hexadecimal is D.

The hexadecimal equivalent of  $(0.865)_{10}$  is  $(.DD7)_{16}$



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# Computer Fundamentals

Anita Goel

Any undergraduate course, irrespective of the streams—commerce, humanities, management, science or engineering—cannot be completed without a basic understanding of computers. This book has been written keeping in mind the requirements of this vast audience. The language used in the book is lucid, simple and reader-friendly so that a novice can easily comprehend underlying concepts in computing. Logical organization of the chapters, step-by-step presentation of the concepts, illustrations, flow charts, photographs (both color and black-and-white) and chapter-end exercises makes the book a perfect choice for an introductory course.



## CONTEMPORARY IN COVERAGE

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- Flash, SIMM and DIMM Memory
- Wireless Networking
- Notebook, Netbook and Smartphones
- Aspect Oriented Programming (AOP)
- Digital Signature and Biometrics



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Anita Goel is Associate Professor, Department of Computer Science, Dyal Singh College, University of Delhi. She has teaching experience of over two decades. She is guiding several students for their doctoral studies, and has several national and international research publications to her credit. She has been appointed as Fellow for Computer Science, Institute of Life Long Learning (ILL), at the University of Delhi.

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