INTRODUCTION TO INFORMATION TECHNOLOGY

COURSE CODE: B21CA01DC

Bachelor of Computer Application

Discipline Core Course

SREENARAYANAGURU OPEN UNIVERSITY

SREENARAYANAGURU OPEN UNIVERSITY

The State University for Education, Training and Research in Blended Format, Kerala

SREENARAYANAGURU OPEN UNIVERSITY

Vision

To increase access of potential learners of all categories to higher education, research and training, and ensure equity through delivery of high quality processes and outcomes fostering inclusive educational empowerment for social advancement.

Mission

To be benchmarked as a model for conservation and dissemination of knowledge and skill on blended and virtual mode in education, training and research for normal, continuing, and adult learners.

Pathway

Access and Quality define Equity.

Introduction to Information Technology

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Semester - I

Discipline Core Course
Undergraduate Programme
Bachelor of Computer Application
Self Learning Material

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MESSAGE FROM VICE CHANCELLOR

Dear

With immense joy and excitement, I extend my heartfelt greetings to all of you and warmly welcome you to Sreenarayanaguru Open University.

Established in September 2020 as a state-driven initiative, Sreenarayanaguru Open University is dedicated to advancing higher education through open and distance learning. Our vision is guided by the principle of "access and quality define equity," laying the foundation for a celebration of excellence in education. I am delighted to share that we are steadfast in our commitment to uphold the highest standards and refrain from compromising on the quality of education we offer. The university draws its inspiration from the legacy of Sreenarayana Guru, a revered figure in the Indian renaissance movement. His name serves as a constant reminder for us to prioritize quality in all our academic endeavors.

Sreenarayanaguru Open University operates within the practical framework of the widely recognized "blended format." Acknowledging the constraints faced by distance learners in accessing traditional classroom settings, we have curated a pedagogical approach centered on three main components: Self Learning Material, Classroom Counselling, and Virtual Modes. This comprehensive blend is poised to deliver dynamic learning and teaching experiences, maximizing engagement and effectiveness. Our unwavering commitment to quality ensures excellence across all aspects of our educational initiatives.

The university aims to offer you an engaging and stimulating educational environment that fosters active learning. The SLM is designed to offer a comprehensive and cohesive learning experience, fostering a deep interest in the study of technological advancements in IT. Careful consideration has been given to ensure a logical progression of topics, facilitating a clear understanding of the discipline's evolution. The curriculum is thoughtfully crafted to provide ample opportunities for students to navigate through the current trends in information technology. Furthermore, this course is designed to provide essential insights into computer hardware, software classification, and foundational HTML concepts crucial for web development.

We assure you that the university student support services will closely stay with you for the redressal of your grievances during your studentship. Feel free to write to us about anything that seems relevant regarding the academic programme.

Wish you the best.

Regards,

Dr. Jagathy Raj V. P. 24-04-2024

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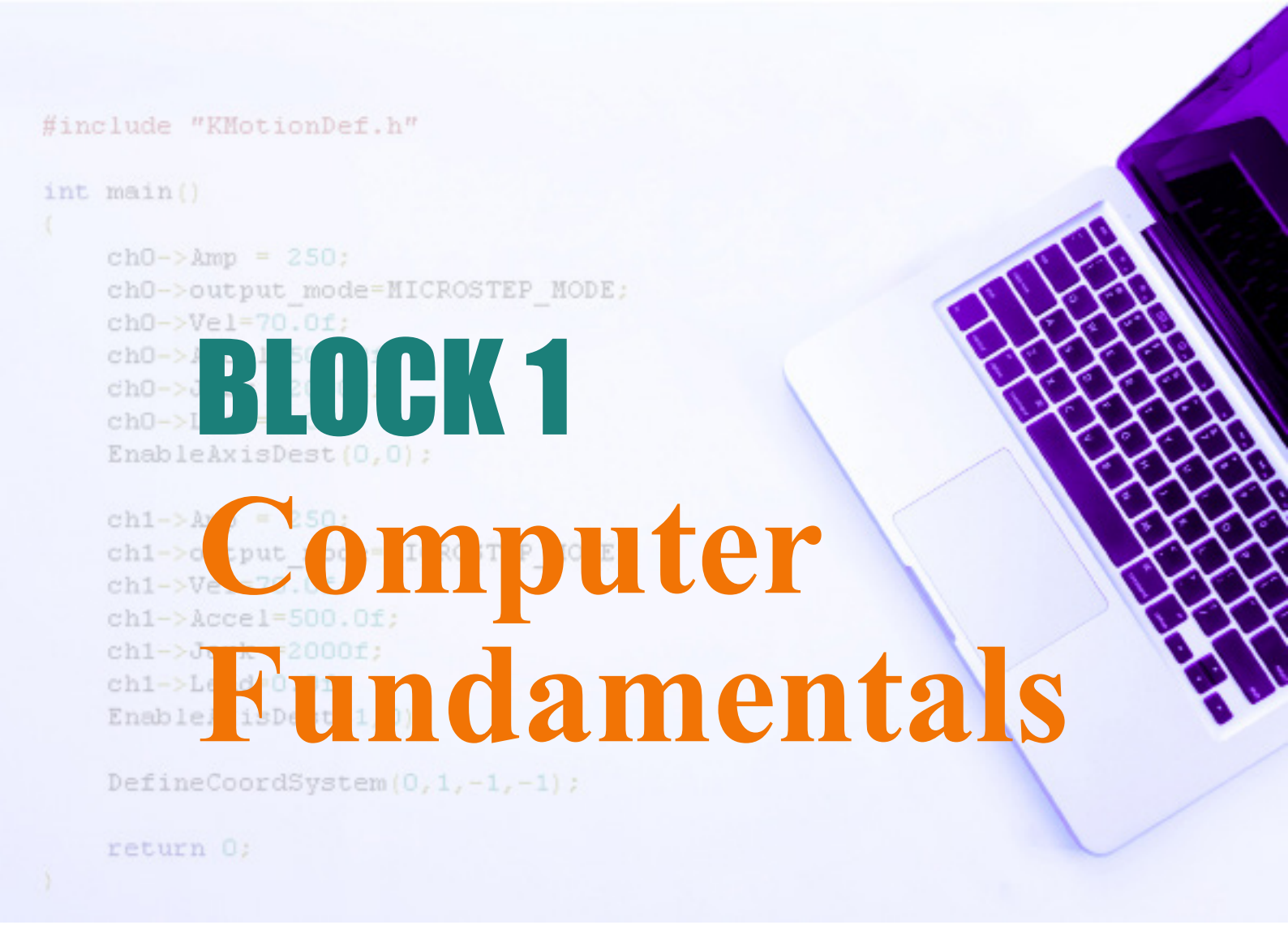


BLOCK 1

Computer Fundamentals

Basic Hardware Concepts

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- introduce the structure and function of computer systems.
- familiarize the various functional units and components of computers.
- recall the fundamental components that make up a computer's hardware and the role of each of these components

Prerequisites

What are your thoughts on devices like a ticket vending machine, ATM, smartphones and smartwatches? Have you ever noticed that these devices are an inevitable part of our modern life? These all are examples of computer devices used in our everyday life.

These are all examples of computers that surround us every day. The term computer comes from the word "compute." Computers are now everywhere, including our homes, educational institutions, hospitals, railway stations, airports, banks, and shopping malls. We can stream movies, listen to music, play video games, draw pictures, even make a birthday card for your friend and it can be used for solving complex scientific problems within seconds.

The computer is not only meant for entertainment purposes but to solve a number of complex problems with great accuracy and efficiency.

Have you ever thought about how people did calculations in ancient times when there were no machines to help?

In earlier times people used fingers and pebbles to do calculations. As civilizations made intellectual progress, our world expanded and we needed to move on from simple calculations to more complex ones. This led to the invention of calculators. Calculators helped them to do basic mathematical operations faster and reduced the time required.

Soon, humanity made inroads into new realms of knowledge. They needed a much more advanced calculator to assist them in their daily activities and this paved the way for the invention of computers. Hence, a computer is considered a super calculator. Alan Turing, a British mathematician, is considered as the father of modern digital computers.

In this unit we will go through the fundamental concepts of modern computers.

Key Concepts

Digital computer, Hardware, Software, Firmware, Liveware

Discussion

1.1.1 Functions of a Computer

A digital computer is an electronic device that accepts user input, processes it and generates the desired output. Now consider a toaster, if we put a piece of bread into the toaster and push the button, the bread will go inside the toaster and we get toasted bread. Here the input is the bread slice, the output is the toasted bread and the toaster machine is doing the processing. Imagine a computer in place of the toaster machine. If you give an input to the computer, it will produce the desired output.

Let us look at how your mother makes a glass of fruit juice for you.

Mother takes the fruit, slices it open and puts it in the juicer. \\ **Input**

When she presses the button of the juicer, the juicer processes it. \\ **Processing**

Finally, the juice will come out from the juicer. \\ **Output**

- In the above example, fruit is the input
- Juicer is the machine that is doing the processing.
- Juice is the output.

A computer has four functions:

1. Accept data (Input)
2. Process data (Processing)
3. Provide Response (Output)
4. Store information (Storage)

Input:

Input is the data entered into a computer using any input device. The input data are of different types like text input, images, sound, etc. For giving input to the computer we use devices like Keyboard, Mouse, Scanner, microphone, etc. In short, we can say that any data that we enter into a computer using the input devices constitute the input of the computer.

Processing:

Once input is received the next step is processing. In order to get an output, the computer needs to work on the input data. Processing is the operations performed on the data as per the given set of instructions. In the coming sections, we will learn the details of how the processing is done.

Output:

The information generated after processing is known as output or result. The output is made available to the users using the output devices like monitor and printer.

Storage:

You have been storing contact details in your mobile phone, right? Storing data and information is a major function of modern computers. We can save processed data for future use, or, the data can be sent to some other computer for processing. The devices used to store data are generally termed memory. In daily life, you might have used storage devices like CD, USB Storage etc.

1.1.2 Basic Concepts

- Hardware
- Software
- Firmware
- Liveware

Now we are going to discuss some of the key terminologies that you come across frequently when dealing with computers.

1.1.2.1 Hardware

All the physical and tangible parts of a computer system are called hardware. In other words all the components that we can see and touch come under the category of hardware. Keyboard, Mouse, Processor, Printer etc are examples of hardware components. There are electronic devices as well as mechanical and optical devices used as hardware components of a computer. The following Fig. 1.1.1. highlights the commonly used hardware components such as keyboard, mouse, system unit, monitor, speaker, microphone etc., of a computer.

Fig. 1.1.1 Computer System

1.1.2.2 Software

Do you know the fact that a computer cannot think independently or make any decision by itself? It needs instructions from the user telling what to do?

Instruction is the step-by-step procedure for doing a particular task. A set of

instructions for doing a particular task is called a program. A computer follows each instruction one by one. A set of programs that are bundled together is called software.

Operating systems like Windows, Linux, etc., are examples of software.

Consider a storybook. The cover, pages and the ink of the book constitute the hardware whereas the words, sentences, and storyline constitute the software. A computer without software is very much like having a book full of blank pages, you need the software to make a computer useful – just the same as you need the words and story to make a book meaningful.

1.1.2.3 Firmware

There are some programs which are essential for the computer to work. Such programs will be stored in a separate memory, which the user won't be able to modify or delete. Such programs are called firmware.

Have you ever noticed what happens immediately when you switch on a computer? The computer performs a self-test, to check whether all its hardware is connected and working. This test is called POST (Power-on self-test). This is done using a program called BIOS (Basic Input Output System), which is stored in the ROM chip is an example of firmware.

1.1.2.4 Liveware

The term, mostly used as a fancy term, is Liveware, which refers to the users, who are using computers in day to day activity.

1.1.3 Working of a Computer

All of us know how to operate a television for watching movies or other programmes. Let's check the operations.

- Switch on the TV.
- Connect the TV to antenna or set-top box (Input)
- Change the TV channel, adjust volume and other settings (Processing)
- The channel program appears on the screen (Output)

The TV with all its components constitutes the hardware and the channels constitute the software.

Similarly, the working of computers requires both Hardware and Software. The working principle can be well explained by the block diagram shown in Fig. 1.1.2.

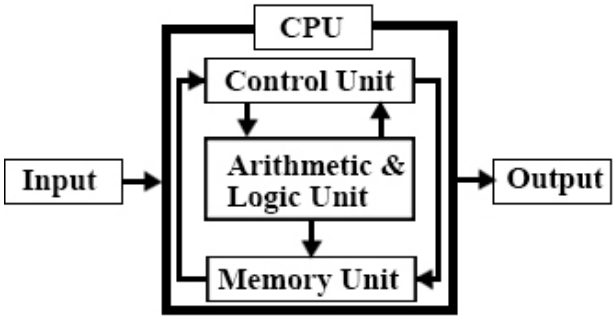


Fig. 1.1.2 Block diagram of a digital computer

The block diagram is having three Units namely

1. Input unit
2. Central Processing Unit (CPU) consisting of

   a. Control Unit (CU)

   b. Arithmetic and Logical Unit (ALU)

   c. Memory Unit
3. Output Unit

1.1.3.1 Input unit

The computer should have a system to receive information from the outside world. In order to accomplish this, an input unit is required. The input can be a single device, say, your keyboard, or a group of devices including keyboard, mouse, camera, microphone etc. Any input to the computer system is received through the input unit.

1.1.3.2 Central Processing Unit

Central processing unit is well thought-out as the brain of the computer. The input is processed by the central processing unit. The CPU is further divided into Control unit, Arithmetic logic unit and Memory unit. It is the central processing unit that does the processing.

Control Unit

The Control Unit is responsible for co-coordinating various operations using timing signals. Timing signals are those signals that control various operations. The order in which computer programs and instructions are executed is determined by the control unit. The control unit is responsible for controlling the overall operations. The CPU has a clock within it which produces the timing signals. On each pulse from the clock, the control unit generates signals to other units like ALU, memory unit etc.

Arithmetic and Logical Unit

Arithmetic and logic unit (ALU) is a digital circuit used to perform arithmetic operations such as simple addition, subtraction, multiplication, division and logical operations such as AND, OR, and NOT.

Memory Unit

Memory unit is used for storing the data and instructions during processing and for storing the result. The memory unit is acting as a medium for storage during processing as well as for storing the results for future use.

1.1.3.3 Output Unit

The processed data or the result in the desired form are made available to the user using the output unit

1.1.4 Von-Neumann Model

In 1945, John Von-Neumann proposed a computer architecture concept which is known as Von-Neumann Architecture. This architecture consists of control unit, ALU, registers, memory unit and input/ output unit. This design uses a stored program concept, where the data and programs are residing in the same memory.

1.1.5 Hardware Fundamentals

The major hardware components of a Computer are

- CPU(Processor)
- Motherboard
- Memory
- SMPS
- Hard disk drive
- Optical storage and drives
- Solid State Drive
- Registers

1.1.5.1 Processor

The processor is the main and most crucial hardware component of any computer system. It controls everything that the computer does. It provides commands and control sequences for all the activities that are taking place in a computer. Based upon the computational speed and efficiency processors are categorized into

different groups. A figure of processors is shown in Fig 1.1.3. Different categories of processors are used in computers and smartphones.

Examples of processors are Intel Core i7, Intel Core i5, AMD Athlon, AMD Phenom II, Qualcomm Snapdragon 888, AMD Ryzen 7, etc.

"The term processor is used interchangeably with the term central processing unit (CPU)."

Fig. 1.1.3 Processors

1.1.5.2 Motherboard

Motherboard is the main structure of the computer that holds everything together. Fig. 1.1.4. shows a typical motherboard that is used in a computer system.

Fig. 1.1.4 Motherboard

Motherboard is a printed circuit board that you can see when you open the computer cabinet.

It is considered the backbone of the computer.

The motherboard is acting as a single platform for connecting all the devices attached to the computer.

1.1.5.3 Memory

Memory is broadly classified into two, namely primary memory and secondary memory.

Primary Memory

Primary memory is accessed directly by the Central Processing Unit.

Primary memory is of two types:

- RAM
- ROM

a) RAM

Random Access Memory (RAM) is an example of primary memory. It is also called as internal or main memory. It is a faster volatile memory. Volatile memory is that, it holds the contents only as long as the computer is turned on. This type of memory has a number of storage locations (memory cells) with unique memory addresses. By using these addresses the memory locations inside RAM can be easily accessed for storing and retrieving contents. When the computer is rebooted, the operating system and other files must be reloaded into RAM (Fig. 1.1.5), usually from a secondary memory such as Hard disk or SSD.

Fig. 1.1.5 Random Access Memory

Memory Address

To locate the data or instructions in the main memory, the computer stores them in locations with addresses. Address is a unique number designates each memory

location. The address for each memory location is similar to the house number of a housing colony, by using the house number, it is very easy to identify the house in that colony. Similarly, memory location can be identified using memory address.

b) ROM

ROM is a type of primary memory which is non volatile. ROM stands for Read Only Memory. In the earlier days we could not alter the contents of ROM but nowadays erasable ROMs are available. The figure of a typical ROM is shown in Fig. 1.1.6. In the ROM, the Basic Input Output System (BIOS) is stored. ROM chips are also seen in other electronic items like washing machines and microwave ovens.

Fig. 1.1.6 Read Only Memory

The various types of ROM are

1. Programmable Read Only Memory (PROM)
2. Erasable Programmable Read Only Memory (EPROM)
3. Electrically Erasable Programmable Read Only Memory (EEPROM)

- Programmable Read Only Memory (PROM): You know this ROM cannot be modified or erased. Once content is added, it remains as such.
- Erasable Programmable Read Only Memory (EPROM):This ROM overcomes the limitations of PROM and ROM. The EPROM chip can be programmed again by erasing the information already in it. The content in EPROM can be removed by exposing it to ultraviolet rays.
- Electrically Erasable Programmable Read Only Memory (EEPROM): This ROM is almost similar to EPROM but it can be erased by applying electrical signals.

Secondary Memory

Secondary memory is a type of computer memory that is used to store data and programs permanently. Secondary memory is a non-volatile memory capable of retaining data and instructions even after power is turned off. Some examples of secondary memory include hard disk drives (HDDs), solid-state drives (SSDs), optical discs (such as CDs and DVDs), and flash memory (such as USB drives and memory cards). These storage devices provide a much larger capacity than primary memory and are typically used to store large amounts of data, such as operating systems, application programs, media files, and other types of digital content.

There is another classification for memory on the basis of retaining capacity:

a) Volatile memory

b) Non-volatile memory

a) Volatile memory: Volatile memory is a class of memory that retains its content only in the presence of power. When power is off the content gets erased. RAM is an example of volatile memory.

b) Non-volatile memory: Non-volatile memory is a class of memory where the saved contents remain as such even if

the power is off. ROM, Hard disk, CD, pendrive, etc., are examples of non-volatile memory.

Different types of secondary memories are:

i) Hard disk drive

Fig. 1.1.7 Hard disk drive

Hard disk drive abbreviated as HDD is a non volatile data storage device. The computer uses this as a permanent storage. This is also called secondary storage. Examples of data stored on a computer's hard drive include the operating system, installed software, and the user's personal files (shown in Fig. 1.1.7.)

ii) Optical storage and drives

Optical Storage refers to the use of optical technology to read and write data to a storage medium. The most common types of optical storage media include CDs (Compact Discs), DVDs (Digital Versatile Discs) and Blu-ray Discs. Optical drives, also known as Optical Disc Drives (ODD), are the hardware components used to read and write to optical disc. A typical DVD Drive is shown in figure 1.1.8.

Fig. 1.1.8 DVD Drive

Solid State Drive (SSD)

SSD are getting increased attention in the market due to its superior performance and reliability compared to HDDs. A Solid State Drive is a storage device used in computers and electronic devices to store data persistently. SSDs use a type of non-volatile memory called NAND flash memory. This technology allows SSDs to access data much faster than HDDs. SSDs are more resistant to physical shock and have lower power consumption compared to HDDs making them ideal for using laptops and other portable devices. However, SSDs typically have a higher post per gigabyte compared to HDDs, although prices have been decreasing steadily over the years.

1.1.5.4 Registers

Registers are small high speed storage area in CPU that holds data and instructions temporarily during processing. They are part of the processor rather than memory unit. CPU has several types of registers.

- General purpose register
- Special purpose register

Each serving specific functions in the execution of instructions.

1.1.5.5 SMPS

This unit can be compared to the heart of our body. The main duty of the heart is to pump blood to the whole part of our body so that the body can function well. Likewise the SMPS is providing energy and power to the computer system for its proper functioning.

Fig. 1.1.9 SMPS

SMPS stands for the switched mode power supply. A standard SMPS is shown in Fig. 1.1.9. It is a power supply unit (PSU). SMPS offers better efficiency compared to linear power supplies as it use switching transistors to swith input voltage ON and OFF at high frequencies. There by reducing heat losses.

Recap

- A computer is an electronic device that receives data, processes the data and then outputs the intended result.
- Hardware is made up of visible and touchable mechanical and electronic components.
- The software is made up of programs, an operating system, and data stored in memory and storage media.
- Input devices, output devices, memory, and the CPU are the four essential components of a computer.
- The input unit is where the computer system receives its input.
- The processing is done by the central processing unit, while the overall operations are controlled by the control unit.
- The memory unit serves as a storage medium for data during processing as well as for archiving the results for later use.
- The processed data or the results in the desired form are made available to the user using the output unit.
- Programs, the operating system, and data stored in memory and storage devices are all examples of software.
- The Von-Neumann architecture is made up of an ALU, a Control Unit, and a Memory Unit.
- The ALU, Control unit, Memory unit, and Input Output Unit make up the Von-Neumann architecture. This architecture employs the concept of a stored programme computer, in which data and programmes are kept in the same memory.
- An input device is a device that receives data or commands from the user. Output devices take data from the CPU and give it to the user in the format that the user wants.
- Computer Memory is the storage and is categorized into two

    1. Primary Memory
    2. Secondary memory

- Some of the fundamental hardware units are Processor, Motherboard, Memory, SMPS, HDD, SSD and DVD drive.
- In this unit we have discussed the fundamentals of a digital computer and its hardware. In the next unit we are going to discuss the different number systems used in computers along with the coding.

Objective Type Questions

1. What is a digital computer?
2. A computer requires both hardware and software for its proper functioning (True/False).
3. What exactly is software?
4. Provide a firmware example.
5. Which parts of the computer may people view and touch?
6. How many units are there in a computer system's block diagram?
7. During processing, which unit serves as a store medium?
8. What is the concept of a stored programme?
9. What is the function of the input system?
10. Which device gives the user the result or processed data?
11. Which part is considered as the brain of a computer?
12. What is secondary memory?
13. What is the expansion for the CPU?
14. Which part is considered the backbone of the computer?
15. Primary memory is volatile (True /False).
16. Give an example of primary memory.
17. What is the role of a control unit?
18. Which part is the power supply unit of the computer?
19. What type of storage device is a hard disk drive?
20. DVD is a secondary storage device (True/False).

Answers to Objective Type Questions

1. Digital Computer is an electronic device that takes input, processes it and produces the desired output.
2. True
3. A set of programs that are bundled together is called software.
4. BIOS
5. Hardware
6. 3
7. Memory
8. In a stored program concept the data and program reside in the same memory.

9. The Input to the computer system is received through the input unit.
10. Output
11. CPU (Processor)
12. Secondary memory is a non volatile memory.
13. Central processing unit
14. Motherboard
15. True
16. Random Access Memory (RAM)
17. The Control Unit is responsible for co-coordinating various operations using timing signals.
18. SMPS
19. Non volatile
20. True

Assignments

1. Differentiate RAM and ROM.
2. Distinguish between Primary and Secondary memory.
3. Why is the motherboard considered the backbone of computers?
4. What are the different types of ROM?
5. Write notes on hardware and software.
6. What is the relevance of BIOS in a computer system?
7. List and explain the functions of four essential components of a computer.
8. Explain the Von-Neumann model of computer architecture, highlighting its key features and components

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014

3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition.

Reference

1. https://nptel.ac.in/courses/106/103/106103068/
2. https://zbook.org/fundamentals-of-computers_MTQyMDk0.html
3. https://www.oreilly.com/library/view/introduction-to-information/9789332525146/
4. https://www.allabout-engineering.com/computer-organisation-by-hamacher/

Number Systems and Codings

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- identify and understand different number systems and codes.
- describe different number systems
- explain different number systems with examples.

Prerequisites

You are all familiar with computers and know that they are an inevitable part of our daily life. Everything around us makes use of computers. Many activities solve complex scientific problems, are using computers in one way or another. Do you ever think about the language of computers? Does the computer understand all languages?

No, The computer can only understand the language of numbers! So without any doubt we can say that modern technology surrounding us is entirely based on the "Number System". Machine language is the language of the hardware and has binary values 0 and 1.

Have you ever considered how the keys on your computer keyboard that are understood by humans are interpreted by the computer?

As the unit progresses you will get answers to the above mentioned questions. You're all familiar with the decimal number system, which you use all the time. However, the number system used in computers is distinct.

Let us recollect the number system that we have studied in our school classes.

A number system is a mathematical notation for representing numbers of a given group using symbols and digits in a consistent manner.

Natural numbers are those numbers that are used for counting and ordering. Examples are 1, 2, 3, 4, 5, 6, 7 etc.

Whole number is a collection of positive numbers and zero. Example: 0, 1, 2, 3, 4, 5, 6, 7 etc. An integer is a number that can be written without a fractional component. Example: 23, -2, 0, 1000 etc.

Rational number is a number that is expressed as the ratio of two integers, where the denominator is not equal to zero. Example: 10/2 (5.0), 0/1 (0.0), 13/5 (2.6), 22/7 (3.14).

Irrational numbers are those numbers that are not expressed as the ratio of integers. Examples: $\sqrt{5}$, $\sqrt{3}$ etc.

We are well familiar with the decimal number system. Let us analyze the number system scientifically. Why do we call it the decimal number system? Because the number system was developed based on "Deca", 10. We say 10 is the base of the number system, and hence, it is base-10 system.

We use 10 different symbols to represent numbers – 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. We call it digits. All other numbers are formed as combinations of these digits.

What is the largest number with 2 digits? It is 99.

We can write it as $10^2 - 1$.

We assign positional weightage to each digit position in a number. As you know, the position value of the right most digits is 1. Then it is in powers of 10 for next positions. Let us see an example.

Take the number 1743.

1	7	4	3
Thousand (10^3)	Hundred (10^2)	Ten (10^1)	One (10^0)

We can form other number systems like this, with other bases, say base-2, base-5, base-8 etc.

In this unit, we will familiarize the number systems used in Computers and programming.

Key Concepts

Signal, Binary signal, Number system, Digital codes, BCD, Gray code, Excess-3 code, ASCII

1.2.1 Number Systems

We know that the processor of a computer is an IC chip. The main memory devices are also using ICs. IC chips operate on different levels of voltage or current. An IC used in the computer works with voltage. Whatever be the information you need to process with IC, it shall be sent as a series of voltage signals. An IC can sense two states of voltage signals. One is the presence of a voltage and the other is the absence.

Let us represent the presence of a signal with 1 and the absence of a signal with 0. See, now the information sent to a computer can be seen as a series of 1s and 0s, right?

Now you may be clear why we are discussing number systems. We need a number system to describe the information in computers. How many symbols do we need in the system?

Only two, 0 and 1. Thus, we can use the base-2 number system to represent and describe machine level operations in a computer. The base-2 number system is popularly known as binary number system.

So, we say, binary numbers are the only symbols that a computer can understand. Binary number system defines its machine language.

Base or Radix: The number of different digits that can occur in each position in a number systems in defined as the base or radix of the number system.

1.2.1.1 Binary Number System

Binary number systems are base-2 number systems with two symbols to be used as digits- 0 and 1. A digit in the binary system- binary digit - is termed as a **bit**.

What is the smallest number in binary? Definitely it is 0.

Now, you start counting… next is 1, then.. There are no more single digits. What shall we do now?

Let us see what happens in the case of the decimal system, 9 is the largest single digit number.

After that, we will definitely move on to the next position and use two digit numbers, starting with 10. Similarly, in the case of binary also, after 1 being the largest single digit number, we have to move on to two digit numbers, with second position, 10, 11.

Move on to third position, use three digit numbers, like 100, 101, 110, 111.

Now you have got the concept of building numbers, haven't you?

See the table below, with binary equivalents for decimal numbers.

Table 1.2.1 Decimal to Binary

Numeric value	Decimal	Binary
0	0	0
1	1	1
2	2	10
3	3	11

4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	10	1010
11	11	1011
12	12	1100
13	13	1101
14	14	1110
15	15	1111
16	16	10000

Now let us familiarize ourselves with some common terminologies used with binary number systems.

Bit: Binary Digit

Nibble: A set of 4 bits together forms a nibble. E.g. 1010, 1101, 0110, 0000.

Byte: A group of 8 bits in a sequence. E.g. 10110101, 00101100, 11111111, 10101010.

MSB: Most Significant Bit, the digit with largest position value, the leftmost bit.

LSB: Least Significant Bit, the digit with smallest position value, the rightmost bit.

Advantages of Binary Number Systems

We have seen that the binary number system is the simplest, with only two digits to code all values (refer Fig 1.2.1(a) and 1.2.1(b)). This makes the arithmetic also very simple. We don't have to learn multiplication tables for all digits..! Multiplication in binary is very simple, since it reduces to multiplication by 0 or 1. You know multiplication by 0 results in zero and multiplication by 1 results in the original number itself.

When it comes to machines, we learnt that 1 represents the presence of a signal and 0 represents the absence. Now, the design of the chip becomes so easy that you don't have to design circuits for all complex levels of signals. Besides, the two-level signal handling helps to minimize the possibility of errors during operations.

- It has two distinct symbols 0 and 1.
- Binary number system is also a positional weighted system.
- Counting in binary is making use of two symbols; so its base or radix is 2.
- In binary the digit is called a Bit
- Binary numbers have a sequence of bits, either 0 or 1.
- The integer and fraction part are separated by a binary point.

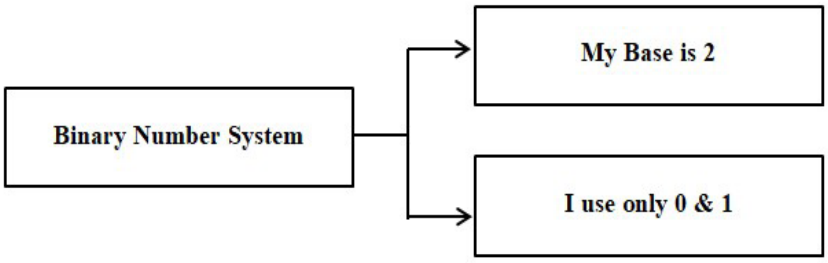


Fig. 1.2.1(a). Binary Number System

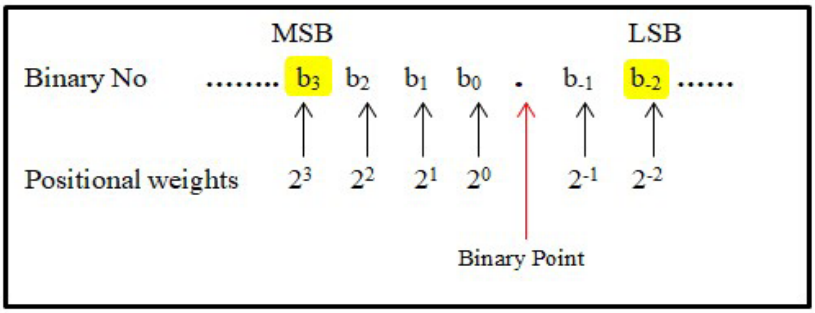


Fig. 1.2.1(b). Positional weight of Binary Number System

1.2.1.2 Decimal number system

- There are ten distinct or unique symbols in the decimal number system: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. (refer Fig 1.2.2(a) and 1.2.2(b))
- Counting in decimal makes use of ten symbols; so its base or radix is 10.
- Each and every symbol used in the number is called a Digit.
- In decimal number system any number (integer, fraction, or mixed) of any magnitude can be expressed using only these ten symbols.

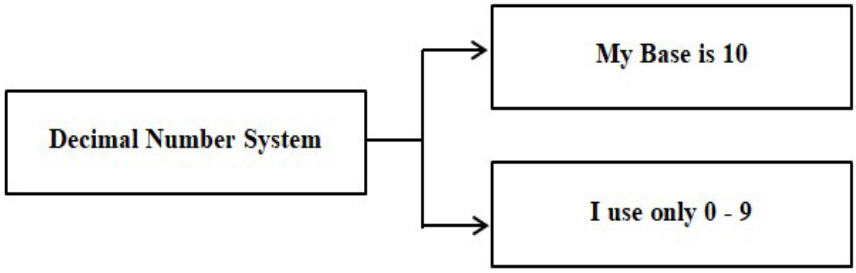


Fig. 1.2.2(a). Decimal Number System

MSD and LSD

The "Most Significant Digit" is the leftmost digit in any number representation that has the greatest positional weight out of all the digits present in that number.

The "Least Significant Digit" is the rightmost digit in any number representation that has the least positional weight out of all the digits present in that number.

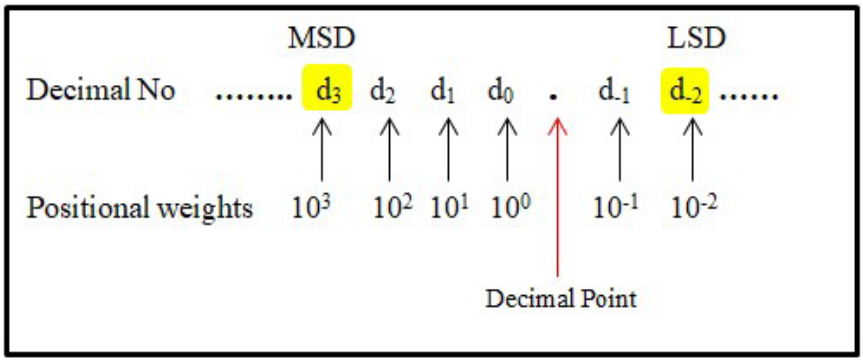


Fig. 1.2.2(b). Positional weight of Decimal Number System

1.2.1.3 Other Number Systems

We have seen the advantages of using binary numbers in the previous section. Did you feel any discomfort, or disadvantage of using binary numbers..? Let us see some binary numbers equivalent to decimal numbers in table 1.2.2:

What could you see from the table? Yes, we can see that the number of digits to encode a number is larger than that in our well-familiar decimal system. This causes a difficulty for programmers to represent data in binary numbers.

There are some other number systems that you may come across while learning computer

science. Though the binary number system is the only one used within the machine and memory, number systems like octal and hexadecimal, which helps to reduce the length of code, are used while describing programs and codes.

Table 1.2.2 Binary equivalent of decimal number

Decimal	Binary
7	111
10	1010
50	110010
101	1100101
1000	1111101000

Let us have a close look at each one

Octal Number system

- Octal number system contains 8 unique symbols 0, 1, 2, 3, 4, 5, 6, 7. (refer Fig 1.2.3(a) and 1.2.3(b))
- Counting in octal makes use of eight symbols; so its base or radix is 8.
- This is positional weighted.
- Octal is base 8 i.e. 2^3, a 3 bit group of binary numbers can be represented by an octal digit.
- Octal numbers are not directly understood by computers so we need octal to binary converters.

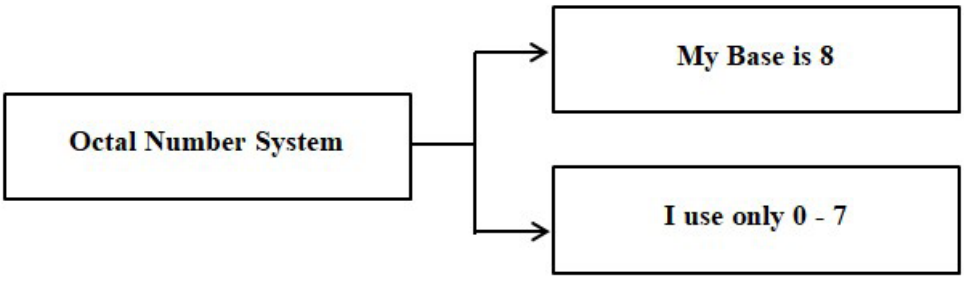


Fig. 1.2.3 (a). Octal Number System

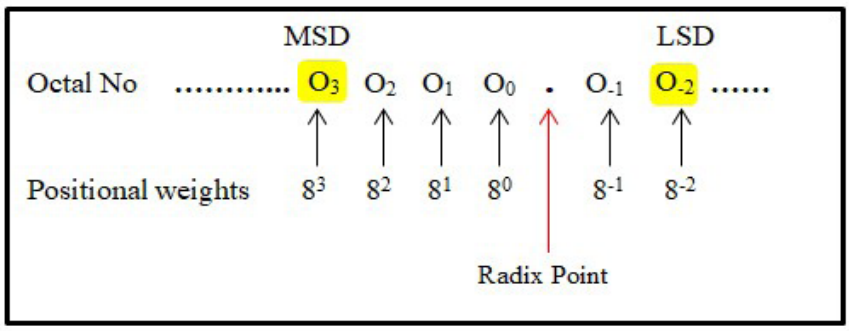


Fig. 1.2.3 (b). Positional weight of Octal Number System

Hexadecimal number System

- Binary numbers are long sometimes, it is easy for the machines but difficult for users to handle. The Hexadecimal number system is developed with this objective in mind and it represents binary numbers concisely.
- This is a positional weighted number system.
- This has 16 unique symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F. (refer Fig 1.2.4(a) and 1.2.4(b))
- Counting in Hex is making use of 16 symbols so its base or radix is 16.
- Hex is base 16 i.e. 2^4, every 4 bit group of binary can be represented by a hexadecimal digit.

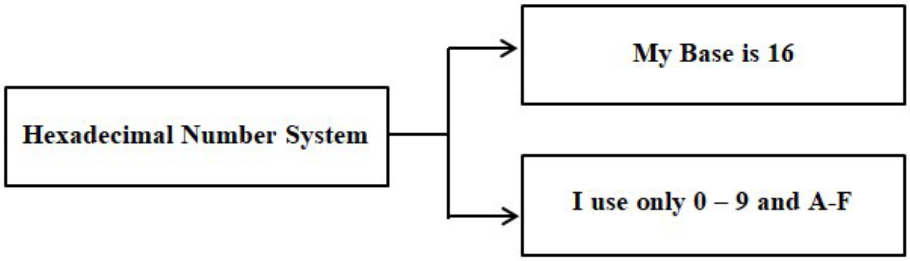


Fig. 1.2.4 (a). Hexadecimal Number System

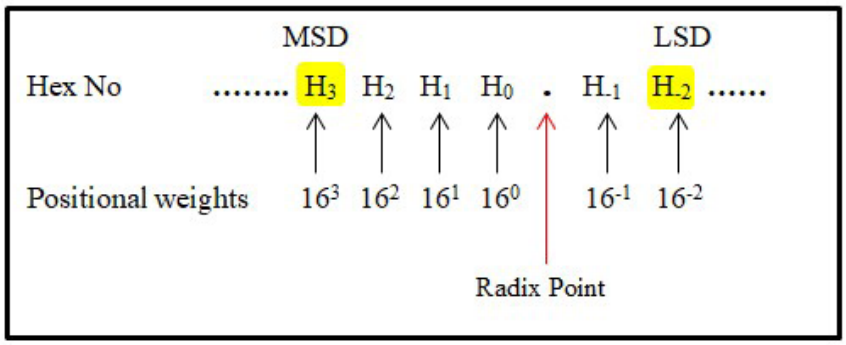


Fig. 1.2.4(b). Positional weight of Hexadecimal Number System

Table 1.1.2 Number System

Decimal No.	Binary No.	Hex No.
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Figure 1.2.5 shows different number systems and its base.

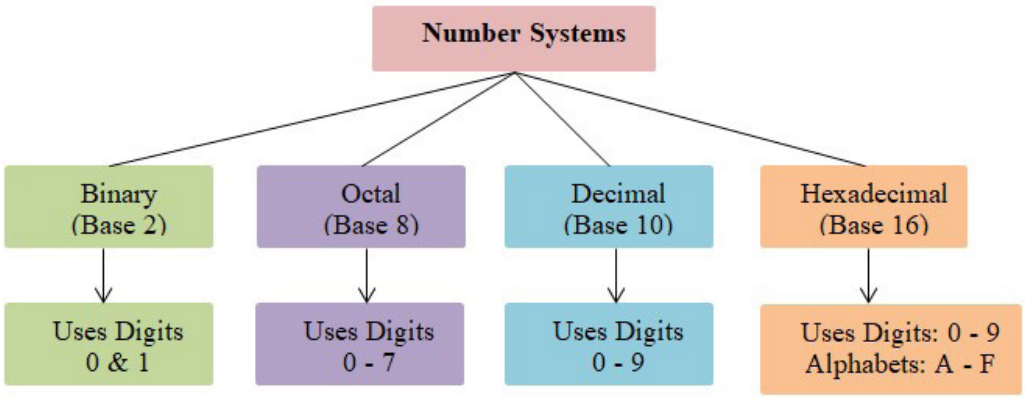


Fig. 1.2.5 Number System and Range

1.2.2 Digital Codes

Let us have a look at what happens when we press the key 'A' on the keyboard.

Once we press 'A' on the keyboard it is internally mapped to a decimal value 65(code value). This code value 65 is again converted to the equivalent binary value for the computers to understand. Here lies the relevance of digital codes. The process of using binary digits to represent letters, characters, and other symbols in a digital format is known as digital coding. The different digital codes are

- BCD
- Gray Code
- Excess -3
- ASCII Code

1.2.2.1 BCD

BCD stands for Binary-Coded Decimal. It's a binary encoding of decimal numbers in which each decimal digit is represented using 4 binary bits. In BCD, each decimal digit is encoded separately into its binary equivalent.

For example, the decimal number 123 would be represented in BCD as follows:

1	2	3
0001	0010	0011

BCD is commonly used in digital systems where decimal arithmetic is required, such as calculators, digital clocks, and electronic instrumentation. It allows for easy conversion between binary and decimal representations, simplifying arithmetic operations involving decimal numbers.

- Example: $(357)_{10}$ = 0011 0101 0111 (BCD representation).

1.2.2.2 Gray Code

A **Gray code**, named after Frank Gray, is a binary numeral system where two consecutive numbers differ in only one bit. This property makes Gray codes particularly useful in various applications, such as digital communications, error correction, and mechanical encoders, where it's essential to minimise errors when transitioning between consecutive values.

To generate the Gray code for a number,

1. We start by determining the number of bits needed to represent it.
2. Then, we begin with the code for 0, which is simply represented as 0000 in binary.
3. Subsequently, we modify this code by changing its most significant bit.
4. If altering this bit results in a code that has already been encountered, we proceed by adjusting the next significant bit.
5. Continue this process recursively until all unique codes are obtained.

Given below is the Gray code table for the numbers from 0 to 7 decimal digits.

Table 1.1.3 Gray code table for the numbers from 0 to 7 decimal digits

Decimal	Binary	Gray Code
0	000	000
1	001	001
2	010	011
3	011	010
4	100	110
5	101	111
6	110	101
7	111	100

You can see that in the Gray code sequence, consecutive numbers differ by only one bit, which makes it useful in various applications.

- Gray code doesn’t depend on the positional value of the digit.
- Gray codes are used in optical encoders.
- Used for error detection in communication systems.

1.2.2.3 Excess-3 Code

- Non weighted code used in expressing decimal numbers.
- Self complementary codes.
- Simplify arithmetic operations.
- This is obtained by adding 3 to each decimal digit and expresses each digit in four bit binary.

Represent 23 in Excess-3 code.

Add 3 to each digit of 23

```
   2   3  +
   3   3        \\ adding 3 to each digit
 ---------
   5   6
   ↓   ↓
 0101 0110
```

then write the corresponding 4 bit binary equivalent of each digit.

0101 0110 \\ representing each digit by 4 bit binary

So Excess -3 code representation of decimal 23 is 0101 0110

Table 1.1.4 Excess-3 code table for the numbers from 0 to 7 decimal digits

Decimal	Binary	Excess-3 Code
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010

EBCDIC (Extended Binary Coded Decimal Interchange Code) code is a 8-bit alphanumeric code developed by IBM, supports 256 symbols. It was mainly used in IBM mainframe computers.

1.2.2.4 ASCII Code

- ASCII is the short form of the American Standard Code for Information Interchange.
- 128 standard ASCII code available.
- Each ASCII code is represented by using a seven bit binary number.
- ASCII is a character encoding scheme that utilizes numeric code to represent character.
- Standard ASCII and Extended ASCII available.
- Standard ASCII is used for representing alphabets, numerals and punctuations in English.
- Extended ASCII is used for representing special characters.
- Uppercase and lowercase alphabets use different ASCII code
- Example A- 65, a- 97

Letter	ASCII
A	65
a	97

Recap

- The only language that is understood by the computer without any interpretation is the Machine language or binary language.
- A number system refers to a set of values used to represent quantity
- Gray Code encoding uses binary values to express sequential integers that differ only by one bit.
- Excess -3 codes are created by adding each decimal digit by three and then expressing each digit in four bits of binary.
- IBM developed the Extended Binary Coded Decimal Interchange Code, which is an 8-bit alphanumeric code that contains 256 symbols.
- ASCII (American Standard Code for Information Interchange) is a character encoding technique that uses numeric codes to represent characters.

Objective Type Questions

1. What is a digital signal?
2. Why is machine language used in a computer system?
3. How many symbols are used in a hexadecimal number system?
4. What is the radix of a binary number system?
5. What is a number system?
6. What is an ASCII code?
7. How many symbols are present in an octal number system?
8. What is a bit?
9. How many bits are combined to form a nibble?
10. How many bits are present in a byte?
11. Uppercase and lowercase alphabets use different ASCII codes (True/False).
12. What is the full form of BCD?
13. How do gray codes represent consecutive integers?
14. Why use extended ASCII?
15. How many symbols are present in Extended Binary Coded Decimal Interchange Code?

Answers to Objective Type Questions

1. A signal that represents data as a sequence of discrete values is referred to as a digital signal.
2. Machine language has 0 and 1 and is the only language that is understood by the computer.
3. 16 symbols
4. 2
5. A number system refers to a set of values used to represent quantity
6. ASCII code represents alphanumeric characters as seven-bit binary numbers.
7. 8
8. 0 and 1 represent bits.
9. 4
10. 8
11. True
12. Binary Coded Decimal

13. Gray code represents consecutive integers using binary numbers that differ only in one bit.
14. To represent special characters.
15. 256

Assignments

1. Why is hexadecimal code widely used in digital systems?
2. Distinguish between binary code and BCD.
3. Why is an excess-3 code called an unweighted code?
4. Describe the binary number system, including its representation, advantages and the concept of bits and bytes.
5. Explain octal number system and hexadecimal number system.
6. Explain why computers understand only the language of numbers and how the number system is fundamental to modern technology.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

Reference

1. http://www.inf.fu-berlin.de/lehre/WS00/19504-V/Chapter1.pdf
2. https://nptel.ac.in/courses/106/103/106103068/
3. https://www.youtube.com/watch?v=Me6n2RbiRhM
4. https://unacademy.com/lesson/overview-number-system/4TQ7DPDU

Input/Output Devices

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- introduce different types of input and output devices and their working
- identify several types of input and output devices and explain their functions.
- describe the characteristics of the input and output devices that most users encounter regularly.

Prerequisites

A computer is considered a dumb terminal if it has no interaction with the outside world. Can you imagine a computer that has no communication with the world outside? Definitely the answer is no. Then, how do computers interact with the outside world?

Input/output devices allow the computer to interact with the outside world. You are all familiar with using ATM machines. It is a machine that has input and output. Do you agree with that?

Let us check what the inputs to ATM are :

1. Smart card (ATM card)
2. Keyboard
3. Touch screen

Now what are the outputs from the ATM machine?

1. Cash dispensed by the ATM
2. Balance displayed on the screen.
3. The receipt that we got from the ATM.

From the above mentioned details it is clear that different types of input and outputs exist.

For providing different inputs we need input devices and for getting output from the machine output devices are also required.

Key Concepts

Input devices, Keyboard, Mouse, Output devices, Printer

In the previous units we discussed the digital computer, its different units along with the various number systems and coding. Now we are going to introduce you to input and output devices with their characteristics.

Do you have any idea as to what these input and output devices do? What type of input and output, these devices use? Ok, Let's have a quick recap on input and output.

Simply speaking input is something you give to the computer and output is something the computer give back to you after processing.

1. Role of Input/ Output Devices

- Input devices let the user give some information into the computer.
- Output devices let the computer provide some information back to you.

The role of an input device is to accept data and instruction from the user. Key board, mouse etc are examples of input devices.

Output devices are used to display or produce the desired result to the user. Monitors and printers are good examples of output devices.

1.3.1 Input Devices

Any devices that assist in the entry of data into the computer are known as input devices. In the ATM example given earlier, we mentioned smart card, keyboard and touch screen as the input devices. Similarly we are going to introduce some of the common input devices we use in a computer system.

Keyboard and mouse are the common input devices used in a computer system, other input devices are

- Light Pen
- Touch Screen
- Scanner
- OCR and MICR
- Barcode Reader
- Joy Stick

1.3.1.1 Keyboard

It is the most common input device used for entering data and instruction into the computer system. Keyboard is the standard input device we can see on all computers. This is a primary device for inputting data or instructions.

The layout of a keyboard is somewhat similar to the traditional typewriter of the type QWERTY. 101-keys QWERTY key-

board is most popular. QWERTY means the alphabet keys in the keyboard are arranged in that manner. The first character you can see on a standard keyboard is Q then W and so on.

Fig. 1.3.1 Keyboard

1.3.1.2 Mouse

Fig. 1.3.2 Mouse

Another commonly used input device is the mouse. Mouse controls the movement of the cursor or pointer on the display screen. Cursor means the small arrow that we see on the monitor screen while moving the mouse.

Mouse is a pointing device. The users can point on an object, drag and drop items using the mouse.

Types of Mouse

- Mechanical Mouse
- Optical Mouse
- Wireless Mouse

1.3.1.3 Touch Pad

This is a pointing device like a mouse that is used on some portable computers like laptops. It looks like a small touch sensitive pad. We can move the finger over the pad so that the cursor moves around the display screen.

Fig. 1.3.3 Touch pad

1.3.1.4 Graphic Tablet

This is an input device that is used to draw images and graphics. This can be used in the same way that a pencil and paper are used to draw pictures.

Fig. 1.3.4 Graphic Tablet

1.3.1.5 Gamepad

A gamepad, game controller or video game controller is a device designed to be connected to a computer or console gaming system.

Fig. 1.3.5 Gamepad

1.3.1.6 Scanner

A scanner is an input device; it can read texts and graphical illustrations printed on a paper and translate into a form that the computer can understand.

Fig. 1.3.6 Scanner

Two types of scanners

- Flatbed scanner
- Hand held scanners

1.3.1.7 Barcode Reader

A barcode reader is an input device that you can see in super markets and in textile showrooms. A barcode reader or scanner is a device that is capable of reading a barcode and printing out the details of the product.

Fig. 1.3.7 Barcode Reader

1.3.2 Output Devices

Output devices are used to communicate the processed information back to the user.

In our ATM example we have outputs like

- Cash dispensed by the ATM
- Balance or data displayed on the screen.
- Receipt of transaction.

We provide input data to the computer and give some instructions then the computer processes the data and outputs the result. This result is communicated to the users using output devices.

Output devices are broadly classified into two

- Soft copy output producing devices.
- Hard copy output producing devices.

Monitors, speakers are soft output devices whereas printers, plotters produce hard copy output.

Softcopy output is available only when the output device is turned on, and it can be edited and saved.

Hardcopy outputs are physical objects and are permanent, mean it cannot be edited later. The printout on a paper is a good example.

Types of Output

In a computer system we have different types of outputs. Some of them are:

- Text: Consists of characters or any other symbol that are used to create words, sentences, and paragraphs.
- Graphics: Digital representations of non text information such as drawings, charts, photographs, and animation.
- Tactile: For some blind people output such as raised line drawings may be useful.
- Audio: The output in sound format such as music, speech etc.

- Video: consists of images played back at speeds to give the appearance of full motion.

1.3.2.1 Monitor

One of the most common output device is the monitor. It is an electronic visual display and looks somewhat like our television. The monitor is used to display data and information. Monitors are available in various sizes with different technologies.

Older monitors were using CRT(Cathode Ray Tube) but they have been replaced by LCD, LED, OLED and Plasma monitors.

Modern monitors are typically a Thin Film Transistor Liquid Crystal Display (TFT-LCD) or a flat panel LED display.

Fig. 1.3.8. Monitor

1.3.2.2 Multimedia Speaker

This device is used for audio (sound) output. The speakers range in quality and price. It is used for various multimedia applications, including watching movies, playing video games, listening to music and more. Some computer speakers have equalisation features like bass and treble.

1.3.2.3 Printer

You've either seen or used printers for printing. Printer is an output device that gives hard copy output. Printers produce humanly readable representation of text/ graphics on paper or other similar media. Different types of printers are available and each printer has its own capabilities of printing. Some types of printers produce high quality print while others produce low quality print.

Printers are mainly categorised into two

1. Impact Printers
   a. Daisy wheel printer
   b. Dot matrix printer
2. Non-impact Printers
   a. Laser printer,
   b. Inkjet printer

Impact printers have a mechanism that touches the paper to create an image.

Non impact printer creates an image without touching the paper.

1.a Daisy Wheel Printer

Daisy wheel printer is the oldest type of printer. It produces letter quality print. This printer doesn't produce graphical output. This printer is very noisy and the number of copies printed per second is also low.

1.b Dot Matrix Printer

Dot matrix printer is another example of an impact printer. It is used in government offices and other places. The term dot matrix refers to the procedure of placing selected dots from a set of dots to create an image or a character. This is the cheapest and the most noisy printer and has a low print quality.

Two types of dot matrix printers are:

1. Serial dot-matrix printer
2. Line dot matrix printer

2.a Laser Printer

Fig. 1.3.9 Laser Printer

Laser Printer is a non impact printer. A laser beam projects an image of the page to be printed, through a rotating 6 sided mirror. Laser printers are sometimes known as page printers. These printers produce high quality text and graphics. The most important advantage of laser printers is their speed, printing precision and economy.

1.3.2.4 Plotters

A plotter is a special type of output device that produces hardcopies of graphs and designs on paper. Wide-format graphs or charts, such as building maps, engineering drawings, and large posters, are usually printed by a plotter. (refer 1.3.10)

Plotters are divided into two types:

- Drum Plotters
- Flatbed Plotters

Fig. 1.3.10 Plotter

Recap

- Input devices are used to give data to the computer.
- Typing something on the keyboard (Input) makes letters appear on the screen (Output).
- Moving a mouse/touch screen (Input) changes what appears on the screen (Output).
- Keyboard is the most common and standard input device we can see on almost all computers.
- Mouse and touchpad are pointing devices. The users can point on an object, drag and drop items using the mouse.
- A scanner is an input device; it can read texts and graphical illustrations printed on a paper and translate into a form that the computer can understand.
- A barcode reader or scanner is an input device that is capable of reading a barcode and printing out the details of the product.
- Output devices let the computer provide some information back to you.
- One of the most common output device is the monitor.
- Multimedia speaker is an output device that is used for audio (sound) output.

- Printer is an output device that produces humanly readable representations of text/graphics on paper or other similar Media.
- Printers are categorized into two, impact and non impact printers.
- Daisy wheel printer and Dot matrix printer are examples of impact printers.
- Laser printer is an example of a non impact printer.
- A plotter is a special type of output device that produces hardcopies of graphs and designs on paper

Objective Type Questions

1. Which is the most common input device for entering data and instructions into a computer?
2. A scanner is an input device (True/ False).
3. Name any two pointing devices.
4. What is a graphic tablet?
5. Which device is capable of reading a barcode and printing out the details of the product?
6. Which device is used for producing hardcopy output?
7. Which device is used for producing softcopy output?
8. Name any one non impact printer?
9. What is a light pen?
10. Which devices are known as peripheral devices?
11. What is OCR?
12. Which is the default pointing device of a laptop?
13. What is a plotter?
14. Which printer produces dots to create an image or a character?
15. Which device produces sound output?

Answers to Objective Type Questions

1. Keyboard
2. True
3. Mouse, touch pad

4. You can draw images and graphics using a Graphics tablet.
5. Barcode reader
6. Printer
7. Projector
8. Laser Printer
9. A device which is used to select and display objects on a computer screen
10. The I/O devices are sometimes called the peripheral devices because they surround the CPU and memory of the computer system
11. Input Device
12. Touch pad
13. A device that produces hardcopies of graphs and designs on paper.
14. Dot Matrix printer
15. Multimedia Speaker

Assignments

1. What are the roles of input output devices in a computer system?
2. Differentiate Impact and Non impact printers.
3. What are the different types of scanners?
4. Comment on hardcopy output and soft copy output.
5. Why do engineers and architects use a plotter?
6. Explain the different types of monitors currently available in market.
7. What are the benefits of laser printer?
8. Explain about different input and output devices used in medical fields.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

Reference

1. https://nptel.ac.in/courses/106/103/106103068/
2. https://www.youtube.com/watch?v=DuYF3uD9AYQ
3. https://www.youtube.com/watch?v=jx_dVfCnNWU

UNIT 4

Different Types of Computing Systems

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the evalution of the computers
- describe the characteristics of a computer
- list the types of computers based on operating principles
- list the types of computers based on its size and structure

Prerequisites

All of you are familiar with the device called television. Is the television set that you see today the same as the one you saw 10 years ago?

Definitely the answer is no and you have noticed a lot of change in the size, shape, structure, features and components used.

Have you ever thought about the reason for this change?

Fig 1.4.1 Different types of computers

Humans have progressed and as a result their needs also have increased. For fulfilling his needs man has continually devised improvements on gadgets like the television.

Similarly computers have advanced significantly over the decades. Computers are used

for a variety of purposes; there are many different types of computers. For example, intensive tasks necessitate powerful computers, while routine tasks can be completed on less powerful ones. Gamers use gaming computers with high-resolution graphics. Laptops are used because they are portable.

Years back computers were very large and slow. Gradually the computers became smaller and faster and as a result people can now use them anywhere as they require. Smart phones, smart watches, laptops etc are examples of computers that differ in size, computing power, characteristics and usage.

Key Concepts

Analog computer, Digital computer, Hybrid computer

Discussion

In the previous units we discussed the digital computer and its different units. Now we are going to introduce you to the different types of computers and their characteristics.

As we find televisions differing in size, model, picture clarity, and power usage, computers can also be categorized based on their characteristics, size, and usage.

1.4.1 Evolution of Computers

In the ancient times people used different devices and methods for performing the computing operations. But the methods used were not fast and accurate. This led to the invention of computers.

1.4.1.1 Abacus

When man began to count numbers many centuries ago, he thought of a device that could trace the numbers, and thus ABACUS was invented. Fig. 1.4.2 shows a typical abacus.

Fig. 1.4.2 Abacus

1.4.1.2 Napier's Bones

This device contains a group of rods made of bones as shown in fig. 1.4.3. It was invented by John Napier, a Scottish Mathematician and so the device was named as Napier's bones.

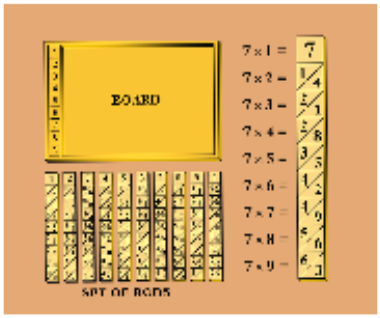


Fig. 1.4.3 Napier's Bones

1.4.1.3 Pascaline

The French mathematician Blaise Pascal created the calculating machine and is shown in fig. 1.4.4. It was the first device that could perform addition and subtraction of whole numbers.

Fig. 1.4.4 Pascaline

- Blaise Pascal invented the first mechanical adding machine in 1642.
- Baron Gottfried Wilhelm von Leibniz invented the first calculator for multiplication in 1671.
- Keyboard machines came into existence in the United States around 1880.
- Around 1880, Herman Hollerith presented the concept of punched cards that were extensively used as input media until late 1970s. The structure of a punched card is shown in fig. 1.4.5.

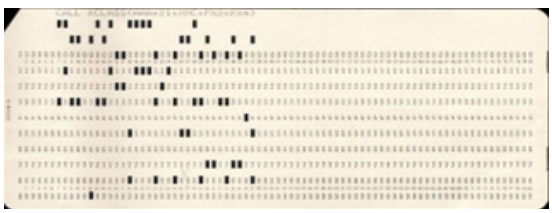


Fig. 1.4.5 Punched Cards

Charles Babbage is considered to be the father of computers. He designed the "Difference engine" in 1822. He designed a fully automatic analytical engine in 1842 for carrying out basic arithmetic functions. His efforts established a number of principles that are fundamental to the design of any digital computer.

1.4.1.4 Digital Era

With the digital era, the Binary system came into existence in the computer world. The binary system was suggested by the American Mathematician Claude Shannon.

The first electronic computer was built by Dr. John Vincent Atanasoff, a Physics Professor and Clifford Berry. The computer was named ABC (Atanasoff-Berry Computer). This computer used vacuum tubes for data storage. It was designed mainly for solving systems of simultaneous equations.

- In 1947, Transistors were introduced into computers. With the introduction of transistors, computations became simpler and faster
- In 1957, IBM developed FORTRAN.
- In 1959, Integrated Circuit(IC) came into existence which was later used in computers.
- In 1960, a Mainframe computer was designed which used IC for the first time.
- In 1970, a Memory chip with 1KB storage capacity was developed by Intel.
- In 1975, the first micro computer was developed by H. Edward Roberts(now the father of micro computer).
- In the 1980s and 1990s, many modifications and upgrades were done and the usage

of chips and various other stuff changed the computers completely.

1.4.2 Characteristics of a Computer

The basic characteristics of a computer are

- Automatic
- Speed
- Accuracy
- Diligence
- Versatility
- Power of Remembering
- No IQ
- No feeling
- Storage

Automatic

An automatic machine works by itself without human involvement. Computers are automatic because once started on a job, they carry out the job until it is finished.

Speed

A computer is a very fast device . It can complete the amount of work that a human can do in a year in a matter of seconds. The speeds of computers are calculated earlier in milliseconds and microseconds and nowadays in nanoseconds.

Accuracy

The computer's accuracy is extremely high, and each calculation is done with the same precision. The level of accuracy is determined by the computer's design. Computer errors are caused mainly by human errors and incorrect data.

Diligence

Tiredness, lack of attention, fatigue, and other issues are not present when using a computer. It is capable of working for hours without producing any errors. A computer can perform each calculation with the same accuracy even though millions of calculations are required. This capability allows it to outperform humans in routine tasks.

Versatility

It refers to the ability to perform a wide range of tasks. You can create payroll slips on your computer. You can use it for inventory management or preparing electric bills in the next moment.

Power of Remembering

A computer has the ability to store any amount of data or information. Any information can be stored and retrieved for as long as you need it, for as many years as you want.

NO IQ

A computer is a dumb machine that can't do anything unless the user tells it to. It follows the instructions at tremendous speed with accuracy.

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.

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

Classification of computers based on operating principle

Computers are categorized based upon

how they are operated or worked. This classification is based on the structure, speed and architecture of the computer.

There are three categories of computers:

1. Analog Computers
2. Digital Computers
3. Hybrid Computer

1.4.2.1 Analog Computers

An analog computer is a form of computer that uses continuous physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved. Analog computers provide continuous information. These computers represent physical quantities in the form of waves or continuous form.

Eg:Thermometer, Weight machine, Speedometer, Petrol pump indicator

1.4.2.2 Digital Computers

A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system. The outputs of digital computers possess more accuracy and precision than the analog computers. Digital computers are used in many areas of day-to-day life such as banking, insurance, education, marketing etc.

1.4.2.3 Hybrid Computers

The hybrid computers possess the qualities of both analog and digital computers. It has the speed of analog and accuracy of digital computers. Hybrid computers are used in hospitals to measure the heart beats of patients. The ICUs of hospitals utilize hybrid computers for different purposes.

1.4.3 Types of Computers

Computers are classified as

- Notebook computers
- Personal computers
- Workstations
- Mainframe computers
- Supercomputers
- Handheld computers
- Wearable computers

1.4.3.1 Notebook Computers

A notebook computer is a battery powered or AC powered personal computer. The size of it will fit a briefcase. The major advantage is its small size and can be transported easily. This can be used in temporary situations like aircraft, libraries, meetings, conferences etc effectively. Notebook PCs are also called Laptop computers, Refer to fig. 1.4.6. It has a keyboard, touchpad, screen and necessary ports. The processing capabilities of notebook pc's are almost the same as the processing capabilities of a personal computer. The main reason for this is that both are using almost the same type of processors.

Fig. 1.4.6 Notebook PC

1.4.3.2 Personal Computers

Fig. 1.4.7 Personal Computer

This is a general purpose non portable computer. The size of it fits a normal office table and can be used by a single person at a time (refer Fig 1.4.7).

As the name implies users use this for their personal use at workspace or at homes.

1.4.3.3 Workstation

A workstation is a powerful desktop computer and is used by professionals, engineers and architects to address their greater computing needs in terms of computing power, efficiency, storage and graphics than normal personal computers (refer 1.4.8).

Fig. 1.4.8 Work station

1.4.3.4 Mainframe Computers

This is a large, expensive computer having the capability to support hundreds to thousands of users simultaneously. If we look at the hierarchy we can see that a simple microprocessor (eg : watches) lies at the bottom and a super computer on the top. The main frames are just below the super computer (refer fig 1.4.9).

Fig. 1.4.9 Mainframe

1.4.3.5 Supercomputers

Super computers are the fastest computers possessing extremely large storage and computational power. This is many times faster compared to other computers. It can execute millions of instructions per second (MIPS). These types of computers are used for solving large scale numerical problems in engineering and scientific fields. One such usage is weather analysis.

IBM Deep Blue is an example of a Super-computer.

Fig. 1.4.10 Supercomputer

1.4.3.6 Handheld Computers

Another name of this computer is Personal Digital Assistant (PDA). Its size is small and can be held in your hands. It is capable of gaming, presentation and word processing.

- Tablet PC
- PDA
- Smartphone

Fig. 1.4.11 Handheld Computers

1.4.3.7 Wearable computers

The size of this computer is very small so that it can be worn on the body. It has a smaller processing power. It is used in the field of medicine. For example, pace makers correct the heart beats and insulin meter to find the levels of insulin in the blood.

Fig 1.4.12 Wearable Computers

Recap

- People used a variety of devices and methods to accomplish computing operations in the past. However, the methods used were not quick or precise. Computers were created as a result of this.
- Charles Babbage is generally regarded as the father of computers.
- Binary systems were first used in the early stages of the digital era.
- Automatic, Speed, Accuracy, Diligence, Versatility, Power of Remembering, No IQ, No Feeling, Storage are the basic properties of a computer.
- Computers are classified as Analog, Digital, or Hybrid based on their operating principles.
- Notebook computers, personal computers, workstations, mainframe computers, supercomputers, and handheld computers are the various sorts of computers.

Objective Type Questions

1. Which is the first mechanical adding machine invented by Blaise Pascal?
2. Which computers introduced IC for the first time?
3. Who is considered the father of computers?
4. Which concept is suggested by Shannon in the digital era?
5. What input media was used from 1880 to 1970?
6. Which computer operates on digital data?
7. Which computer can operate on batteries and hence are very popular with travelers?
8. What is an analog computer?
9. What is a hybrid computer?
10. Name any two analog computers?
11. Give an example of a supercomputer?
12. Which computers are used for solving complex applications such as global weather forecasting?
13. What is MIPS?
14. Pace makers belong to which category of computers?
15. Smartphone is a handheld computer (True/ False).

Answers to Objective Type Questions

1. Pascaline
2. Main Frame
3. Charles Babbage
4. Binary system
5. Punch card
6. Digital
7. Laptop
8. The computers which provide us with continuous information are called analog computers.
9. Hybrid computer is a combination of analog and digital computers.
10. Thermometer, Speedometer
11. IBM deep blue
12. Supercomputer

13. Million Instructions per second
14. Wearable computers
15. True

Assignments

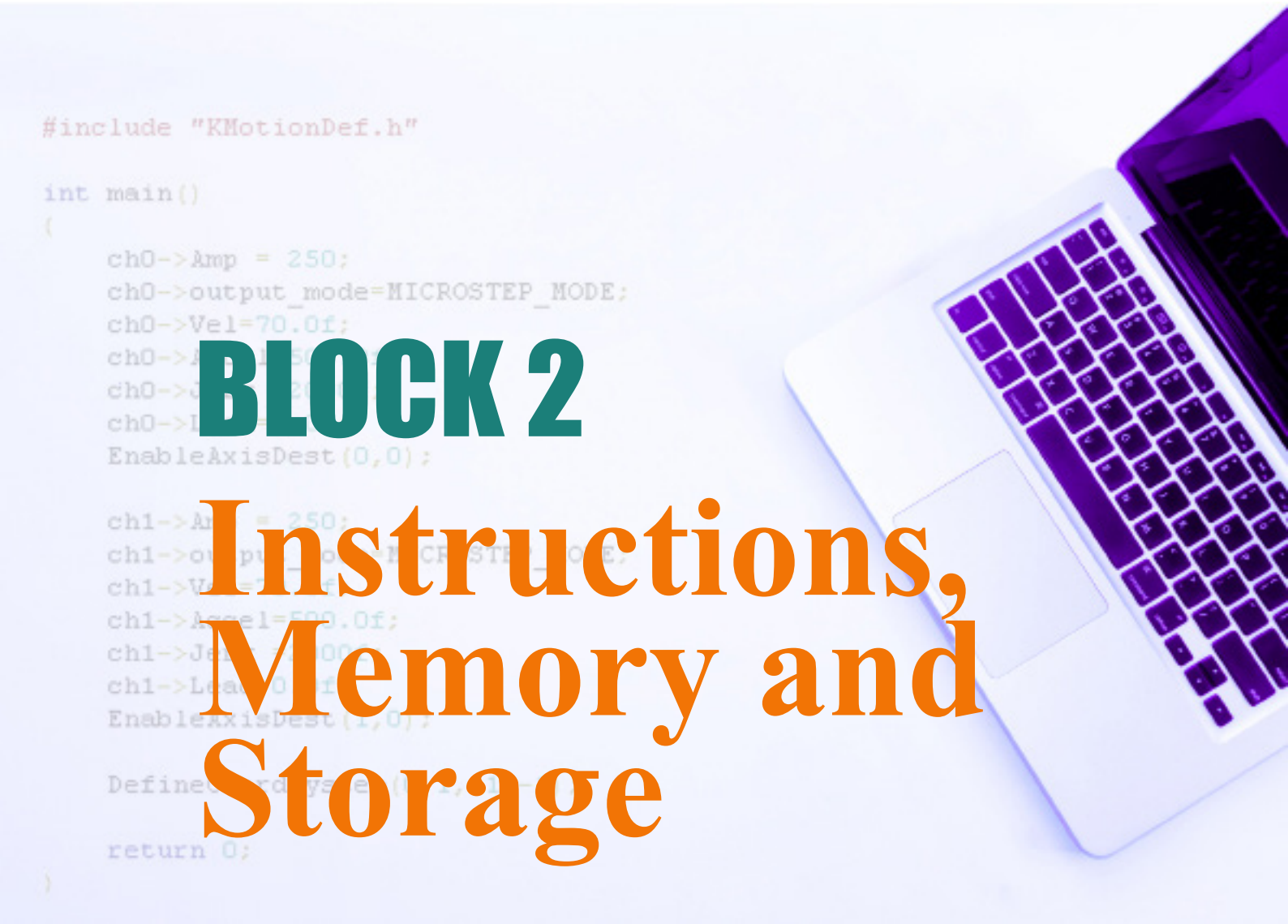
1. Do a case study on the evolution and generations of computers.
2. Comment on the relevance of computer systems in our day-to-day life.
3. Compare and contrast Laptop and desktop.
4. Explain why computers are considered automatic machines and discuss their ability to work without human intervention.
5. Describe the characteristics of a computer, including its automatic operation, speed, accuracy, diligence, versatility and storage capacity.
6. Who is credited with inventing the first mechanical adding machine, and what was its significance?

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014.
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill.
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014.
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition.

Reference

1. https://blog.udemy.com/categories-of-computer/
2. https://www.just.edu.jo/~mqais/CIS99/PDF/Ch.01_Introduction_%20to_computers.pdf
3. https://www.javatpoint.com/types-of-computer



BLOCK 2

Instructions, Memory and Storage

UNIT 1 Memory Representations and Hierarchy

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the concept of memory organization
- understand the concept of memory hierarchy
- explain the function of each element of a memory hierarchy

Prerequisites

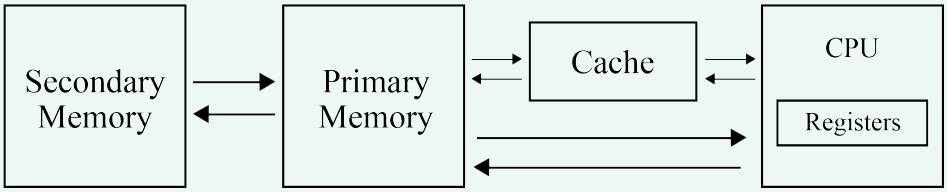


Fig 2.1.1 Different memories in a computer

Human memory is a term that you are all familiar with. You are able to remember something that happened in your school days.

What is actually happening here?

You are recollecting from the memory!

Since we stored that incident in our memory we are able to recollect it. So we can say that memory is a storehouse.

Now replace the computer memory in the place of the human memory. It also stores the information and later on allows recollecting it. It is clearly evident that computer memory is also a type of storage.

The computer's memory is mainly classified into two, primary memory and secondary memory. Primary memory is the memory that is directly accessed by the CPU. CPU

can access data from primary memory. RAM is used to store data and instructions that CPU needs to access quickly.

The secondary storage is non-volatile and permanent memory is used for long term data storage and have larger storage capacity. However, access to data in secondary memory is much slower compared to primary memory or permanent memory is called secondary memory, the CPU cannot get primary access to it, that is, the CPU needs the help of an interface to get data from it.

Did you ever imagine the structure of computer memory?

Doesn't have any similarity with the human brain?

In this unit we are going to familiarize you with memory, memory types, memory units and memory hierarchy.

Key Concepts

Memory, Primary memory, Secondary memory, Cache memory, Memory hierarchy

Discussion

2.1.1 Computer Memory

Computer memory is the storage space in a computer. In a computer the data and instructions are stored in memory.

Memory is the vital part of any computer system. It can store data temporarily or permanently.

Memory may be either volatile or non volatile. Volatile memory means its contents are erased when the systems power is turned off or interrupted. Non-volatile memory means it retains contents even after the power is turned off or interrupted.

2.1.1.1 Structure of Memory

Human memory is made up of a number of cells called neurons. The computer memories also have a cell like structure and it is made up of semiconducting materials.

Memory is physically organized as a large number of cells, each of which can store one bit of information.

A memory has a number of cells and each cell has an address (location). By using the address we can access the content in the memory. Refer fig. 2.1.2.

It is not practical to assign each cell an address and access the content of the memory. Logically bits are combined to form memory words and are assigned an address. These memory addresses are used to access data and instructions.

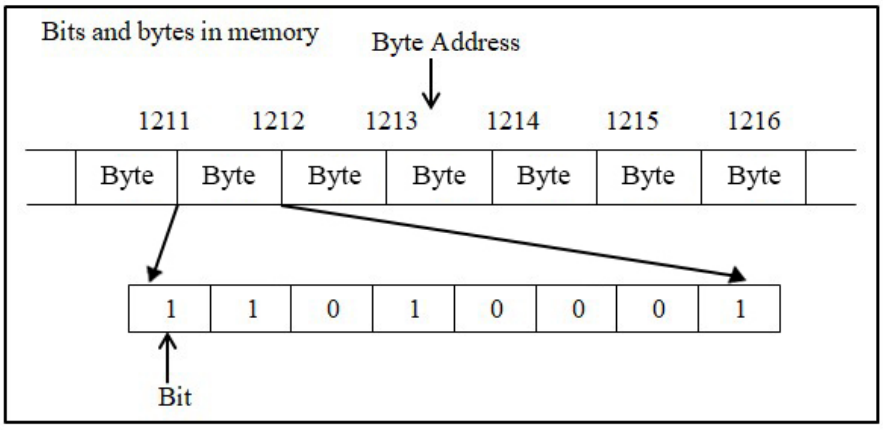


Fig 2.1.2 Structure of memory

A good analogy is a set of shelves, each with a unique name/number. And each shelf is big enough to store 'X' number of books. Look at the fig. 2.1.3.

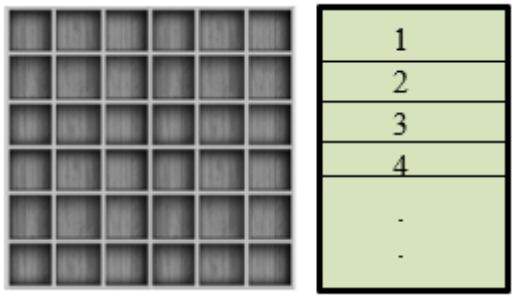


Fig 2.1.3 Analogy depicting memory cells and address

2.1.1.2 Units of memory

Table 2.1.1 Units of memory

(KB) Kilobyte	2^{10} = 1024 bytes
(MB) Megabyte	2^{20} = 1024 KB
(GB) Gigabyte	2^{30} = 1024 MB
(TB) Terabyte	2^{40} = 1024 GB
(PB) Petabyte	2^{50} = 1024 TB

- Kilo Byte (KB)
- Mega Byte (MB)
- Giga Byte (GB)
- Tera Byte (TB)
- Peta Byte (PB)

2.1.1.3 Operations in Memory

The two major operations in memory are

1. Read
2. Write

Consider a notebook, what are the two activities you can do in the book.

1. Read the content from the book.
2. Write some content on the book

Now imagine a memory in place of the book. Two operations: Read and Write.

Read: Fetching the content from the memory based on the address that is like reading content from the book.

Write: Storing something into the memory, that is like writing content to the book.

Access time: The amount of time it takes to access data from memory, either to read or write.

Memory is broadly classified into

- Primary Memory (Main Memory)
- Cache memory
- Secondary Memory

Suppose in your college, you have a department library and a central library.

Some books you refer to frequently, so you take those books from the department library and place them on the study table.

Your study table is like the cache memory because those things that are frequently required are placed in the cache.

Department library acts as the primary memory

Central library acts as the secondary memory.

What are the sizes of your table, department library and central library?

Size of the table is small and has limited capacity.

The department library is bigger than your table but smaller than the central library.

Likewise the size of the cache is small, primary memory has bigger capacity than cache, but smaller than secondary memory.

The largest storage area is the secondary storage.

On your table you have small drawers where you can store small writings. The registers are like those small drawers.

Registers: These are fast temporary storage cells that are available in CPU.

2.1.1.4 Primary Memory

- Primary memory is the memory that is directly accessed by the CPU.
- Primary memory is also called the main memory or working memory.
- Primary memory's capacity is limited.
- The main memory is made up of semiconducting material. This memory is not as fast as cache memory.
- A computer cannot run without a primary memory.
- This is faster than secondary memory.
- RAM (Random Access Memory) and ROM (Read Only Memory) are examples of primary memory.

RAM

Random Access Memory is a type of memory in which it is possible to randomly read or write the content to any location in the memory.

Another name of RAM is read/write memory.

It is a volatile memory, when power is off the content gets erased.

Types of RAM

- SRAM (Static Random Access Memory)
- DRAM (Dynamic Random Access Memory)

SRAM

SRAM stands for static random access memory. The term “static” refers to the fact that the memory’s contents are maintained as long as power is supplied. Data is lost however, when the power goes out due to the volatile nature.

SRAM chips use a matrix of 6-transistors

and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not be refreshed on a regular basis.

There is extra space in the matrix; hence SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher. SRAM is thus used as cache memory and has very fast access

Advantage: SRAM has low power consumption and faster access speeds.

Disadvantage: SRAM possesses less memory capacities and involves high costs of manufacturing.

DRAM

DRAM stands for dynamic random access memory.

DRAM, unlike SRAM, needs to be refreshed on a regular basis to keep the current data. This is accomplished by connecting the memory to a refresh circuit, which rewrites the data hundreds of times per second. DRAM is the most common form of device memory because it is inexpensive and compact. Memory cells, which are made up of one capacitor and one transistor, are used in all DRAMs.

Advantage: DRAM has low costs of manufacturing and greater memory capacities.

Disadvantage: DRAM has slow access speed and high power consumption.

2.1.1.5 Secondary Memory

Secondary memory is the memory that is not directly accessed by the CPU.

Secondary memory is a type of permanent storage. The primary memory is fast compared to the secondary memory.

The size of the primary memory is very limited, so additional storage is required and here comes the importance of secondary memory.

Another name of secondary memory is auxiliary memory. The operating speed of secondary memory is comparatively slower than primary memory.

The cost of secondary storage devices are low compared to that of primary memory.

Table 2.1.2 SRAM Vs DRAM

SRAM	DRAM
Transistors are used in SRAM.	Both transistors and capacitors are used in DRAM
Capacitors are not used hence no refreshing is required	To store information for a longer time, the contents of the capacitor needs to be refreshed periodically
SRAM is faster as compared to DRAM	DRAM provides slow access speeds
SRAM is expensive	DRAM is cheaper
SRAMs are low density devices	DRAMs are high density devices
Mainly used in cache memories	Used in main memories

Examples of secondary storage devices are hard disk, CD, DVD etc.

2.1.1.6 Cache Memory

In the above mentioned example your study table acts as the cache memory, the department library as the primary memory and central library as the secondary memory.

If you need to refer to some book, initially you look on the study table for that book.

If that book is available, ok you can refer and complete your task.

If the required book is not available what have you to do?

Go to the department library and take that book.

If the required book is not available in the department library then what to do?

You give a request for the book to the department library-in-charge. He contacts the central library and issues the book and places a copy in the department library and gives a copy to you.

This is what happens in the case of cache.

If the referred content is available, take it from the cache. If the required data is not available in the cache, fetch it from primary memory. Again if the required data is not available in the primary memory then take it from secondary and place it on primary and from there take a copy to cache memory.

- This is a very high speed semiconductor memory.
- It lies between the processor and the main memory.
- The most frequently used instructions and data are placed in the cache memory.
- Cache memory is faster than the main memory.
- When compared to main memory, it takes less time to access.
- There are three types of cache in modern computers: L1 cache, L2 cache and L3 Cache.
- L1 (L1 means Level1) cache is located in the processor chip whereas L2 and L3 cache are outside the processor.
- Since the cache memory is located inside or closer to the processor chip its size is very limited.
- It is very expensive also.

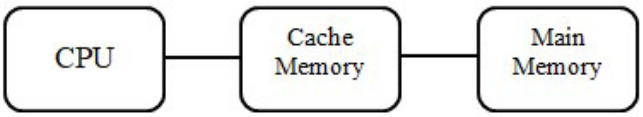


Fig 2.1.4 Cache Memory

Topics related to cache memory

- Cache hit
- Cache miss
- Miss penalty

Cache hit , Cache miss and Miss penalty

If the processor is fetching data or instruction during processing, it first looks whether the data or instruction is available in the cache memory. If the data is available in the cache, we call it a cache hit; otherwise we call it a cache miss.

When there is a “miss” in cache, the extra time needed to put the data into cache from Main memory is referred to as the “miss penalty.”

Connecting these three terms with our above mentioned example, you can see

if the required book is available on your study table then you say a hit occurs otherwise you say a miss.

Miss penalty is the time required to find the book from the central library and put it on the department library and from there take a copy to the table. This delay is similar to a missed penalty.

Once a cache miss occurs we need to bring the data to the cache from the main memory if it is not in main memory, it will fetch from primary memory to secondary memory.

The sequences of steps are as follows

A cache miss occurs.

The processor look on the main memory for the data, if it is available a copy of it is taken and placed in the cache

If the searched content is not available on the main memory then fetch the content from secondary memory and place a copy on main memory and from main memory place a copy to cache memory.

2.1.1.7 Memory Hierarchy

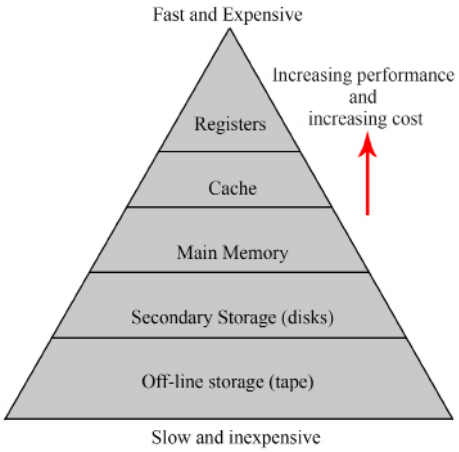


Fig 2.1.5 Memory Hierarchy

The computer memory is divided into different hierarchies based upon its use and speed. The processor can move from one level to the other based upon its requirements.

The memory organization of a system can be achieved through this memory hierarchy.

The different levels of memory is having different performance rate.

The different hierarchies are registers. Cache memory, Main memory, Secondary storage (disk). Offline storages (tape).

The top three are volatile whereas the bottom two are non volatile.

If we move from top to bottom of the hierarchy then the speed and cost decrease and the size increases.

The registers are the fastest one and the offline storage (tape storage) is the slowest one in the hierarchy.

Characteristics of Memory Hierarchy

1. Performance

Initially computers were designed without the memory hierarchy concepts, if the speed difference between the memory and the processor is increased then the performance gets decreased. But while incorporating this model the performance increases.

2. Ability

Storage ability of the memory hierarchy is the total amount of data the memory can store. If we move from top to bottom of the hierarchy, the capacity increases.

3. Access time

The top order memories have less access time.

If we move from top to bottom of the hierarchy, the access time increases.

4. Cost per bit

If we move from bottom to top, of the hierarchy the cost per bit increases.

In a nutshell we can say that in the memory hierarchy if we move from top to bottom the speed decreases and the storage size increases.

If we move from bottom to top the access time decreases and the cost per bit increases.

Recap

- Computer memory is the storage space in a computer, and it is physically organized as a large number of cells, each of which can hold one bit of data.
- Read and Write are the two most common memory operations.
- Primary memory, secondary memory, and cache memory are the three types of memory.
- Random Access Memory is a type of memory in which it is possible to randomly read or write the content to any location in the memory.
- SRAM stands for static random access memory. The term "static" refers to the fact that the memory's contents are maintained as long as power is supplied.
- DRAM stands for dynamic random access memory. DRAM, unlike SRAM, needs to be refreshed on a regular basis to keep the data current.
- The cache memory stores the most frequently used instructions and data, and it is faster than the main memory. It takes less time to access compared to main memory.
- Modern computers have three types of cache: L1 cache, L2 cache, and L3 cache.
- Based on its use and speed, computer memory is separated into several hierarchies. Depending on the processor's needs, it can go from one level to the next. This memory hierarchy can be used to organize the memory of a computer system.

Objective Type Questions

1. What is non volatile memory?
2. What is ROM?
3. Which is an example of secondary storage?

4. Random Access Memory of a computer is volatile (True/ false).
5. Which memory is the fastest means of memory access for the CPU?
6. What is the location of the internal registers of the CPU?
7. 1 KB is how many bytes?
8. What is RAM?
9. DRAM needs refreshing to retain the contents (True/ False).
10. Which name or number is used to identify storage location of devices?
11. What is primary memory?
12. How many bits of information can a memory cell can store?
13. In which type of memory the most frequently used instructions and data placed in a computer?
14. One GB is equal to _____ mega byte.
15. The size of cache memory is smaller than primary memory (True /False).

Answers to Objective Type Questions

1. Storage which stores or retains data after power off is called non volatile memory.
2. ROM is a permanent memory, which holds data and instructions for start-up the computer and does not erase data after power off.
3. Hard disk
4. True
5. Cache memory
6. Inside the processor chip.
7. 1024
8. Random Access Memory, is a type of memory in which it is possible to randomly read/write the content to any location in the memory.
9. True
10. Memory address
11. Main memory of a computer, CPU can only access data from primary memory while processing.
12. 1 bit
13. Cache memory
14. 1024 MB
15. True

Assignments

1. What is the relevance of cache memory?
2. Compare and contrast SRAM and DRAM.
3. Do a case study of registers and their relevance in computer performance.
4. Explain the units of memory measurement (KB, MB, GB, TB, PB) and their respective capacities in bytes.
5. Explain major operations in computer memory, including read and write processes and define access time.
6. Explain the concept of secondary memory and its role in providing additional storage capacity to the computer systems.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

Reference

1. https://www.tutorialspoint.com/computer_fundamental
2. https://www.elprocus.com/memory-hierarchy-in-computer-architecture/

Instruction Set and Instruction Cycle

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- identify the elements of instruction sets.
- understand the execution cycle of an instruction.
- understand the instruction set of RISC and CISC.

Prerequisites

All the physical and touchable parts of a computer system are called hardware. A set of programs that are bundled together is called software. A computer requires both hardware and software for its proper functioning.

Computers cannot work on their own. To command the computer, you have to speak to the computer in its language. Which language does the computer understand?

As we have already discussed, machine language is the only language that is directly understood by the computer. Is it easy to speak to computers using machine language?

The answer is no because machine language is difficult for us because it has only 0's and 1's.

Then how to interact with the computers?

Programming languages will help us in doing the task. In this unit we will introduce you to instructions and instruction sets.

Key Concepts

Instruction, Instruction Set, Instruction cycle, RISC, CISC

2.2.1 Instructions

To say something to the computer, you need to speak its language and the instructions are the words of a computer's language.

Instruction is one step in a program- a step by step procedure- for getting some specific task done by the computer.

Set of instructions for doing a particular task is called a Program.

Programs are bundled together to form software.

2.2.1.1 Instruction Set

Instructions are the words of a computer's language and the instruction set is basically its vocabulary. The entire group of instructions that a microprocessor supports is known as the instruction set. The instruction set architecture is the interface between the hardware and the software. Instruction set of the processor is the only way to interact with the hardware.

Consider an example; 8086 microprocessor has nearly 117 basic instructions .

Table 2.2.1: Sample Instruction Set

Sl No	Instruction Set	Remarks
1	ADD	Adding two numbers.
2	COMPARE	Compare two numbers
3	IN	Input information from a device, eg: Keyboard
4	LOAD	Load information from RAM to register
5	OUT	Output information to device. eg: Monitor
6	STORE	Store information from register to RAM
7	JUMP	Jump to designated RAM

2.2.1.2 General Instruction Format

Opcode-Field	Address-Field

Opcode field represents the operation that is to be performed and the address field represents the operands.

ADD A, B

ADD- Operator

A and B – Operands

Types of instruction

- One address instruction
- Two address Instruction
- Three address Instruction

2.2.2 Instruction Cycle

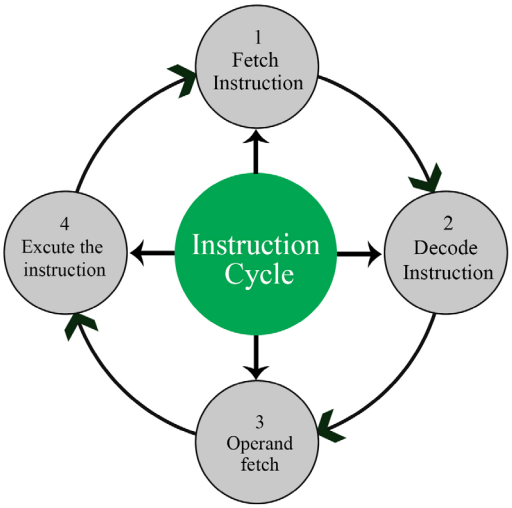


Fig 2.2.1 Instruction Cycle

A program residing in the memory has a sequence of instructions. The computer executes the program by going through a cycle for each instruction. The instruction cycle is further divided into a number of sub phases.

The phases are as follows

1. Instruction fetch
2. Instruction decode
3. Operand fetch, fetch values of operants based on memory address
4. Execution

Consider a program to add two numbers.

Steps:

For executing this program, first the computer needs to load it to the main memory.

Once the program is loaded, then the execution starts.

The processor takes the first instruction of the program; this step is known as instruction fetching.

Then the processor decodes the instruction.

Decoding of instruction means the processor identifies the operation to be performed and identifies the operands.

After instruction decoding, operands are identified based on its address from memory. This phase is operand fetch. Finally perform the operation that is specified in the instruction. This is the execution phase.

Consider an instruction from a program for adding two numbers.

ADD A, B

Step 1: Load program to memory.

Step 2: Take the instruction ADD A, B \\ Instruction Fetch

Step3: Identify the Operation as addition and operands are A , B \\ Instruction Decode

Step 4: Fetch value of A and B from the memory \\ Operand Fetch

Step 5: Perform the addition operation i.e., A+B \\ Execution

Step 6: Store the result in A \\ Storing

2.2.3 Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer(CISC)

2.2.3.1. RISC

- RISC stands for the reduced instruction set computer.
- This is a microprocessor (processor) architecture that uses a basic simple set of instructions.
- Instructions are of the form LOAD for loading data and STORE for storing data.
- The hardware architecture is simple.
- The instruction execution time is improved by reducing the number of instructions.
- Instruction cycle has fetch, decode and execution phases.
- Examples of RISC processors are PowerPC, SUN's SPARC etc

Advantages of RISC

- The performance is improved by using simple instructions.
- Limited instruction set is used.
- Instruction takes a single clock cycle to get executed.

2.2.3.2 CISC

- The CISC Stands for Complex Instruction Set Computer
- It has a complex instruction set.
- CISC reduces the number of instructions in programs.
- The number of cycles per instruction increases.
- Instruction can be larger than a single word.
- Examples of CISC processors are VAX, AMD, Intel x 86 etc
- Advantages of CISC
- The code length is short and so memory requirement is reduced.
- A single instruction execution involves several low level sub tasks.
- It uses a smaller number of instructions to perform the same task as RISC.
- It takes very little RAM space to store the instructions on each CISC.

2.2.3.3 Comparison RISC and CISC

Table 1.3.1 : RISC Vs CISC

RISC	CISC
It is a Reduced Instruction Set Computer	It is a Complex Instruction Set Computer
RISC has simple decoding of instructions.	CISC has complex decoding of instructions.

It uses a limited number of instructions that requires less time to execute the instructions	It uses a large number of instructions that require more time to execute the instructions
It uses LOAD and STORE that are independent instructions in the register-to-register a program's interaction	It uses LOAD and STORE instruction in the memory-to-memory interaction of a program
The execution time of RISC is very short	The execution time of CISC is longer
RISC architecture can be used with high-end applications like telecommunication, image processing, video processing, etc	CISC architecture can be used with low-end applications like home automation, security systems, etc
It has fixed format instructions	It has variable format instructions

Recap

- A computer programme is a set of instructions for performing a certain activity
- Programs are bundled together to form software
- The entire group of instructions that a microprocessor supports is known as the instruction set.
- Processing or execution of instruction involves a sequence of steps namely Instruction fetch, Instruction decode, Operand fetch, Execution.
- RISC stands for the reduced instruction set computer. This is a microprocessor (processor) architecture that uses a basic simple set of instructions. Instructions are of the form LOAD for loading data and STORE for storing data.
- The CISC Stands for Complex Instruction Set Computer. CISC reduces the number of instructions in programs. The number of cycles per instruction increases.

Objective Type Questions

1. Where are the programs stored when they are not in the process of running or execution?
2. What is the use of main memory in program execution?
3. Which is the step during which a new instruction is read from the memory?
4. What is an instruction set?
5. What are the two fields in the general instruction format?
6. Which is the stage after instruction fetch in an instruction cycle?
7. Which microprocessor architecture has simple decoding of instructions?
8. Which is the only way used to interact with the hardware?
9. Execution time of RISC is short (True/False).
10. What are the operands in the instruction MUL X,Y?

Answers to Objective Type Questions

1. Secondary memory
2. Loading the program for execution
3. Instruction fetch
4. The entire group of instructions that a micro processor supports is known as the instruction set.
5. Opcode Field, Address Field
6. Instruction decode
7. RISC
8. Instruction set
9. True
10. X,Y

Assignments

1. Explain instruction execution cycle with a suitable example.
2. Compare and contrast RISC and CISC architecture.
3. Why is ISA important in a computer system?
4. Write notes on the instruction set of 8086.

5. What is the role of instructions in computer programming?
6. Differentiate between a program and an instruction set.
7. In what scenarios might a CISC architecture be advantageous?

Suggested Reading

1. https://nptel.ac.in/courses/106/103/106103068/
2. https://www.geeksforgeeks.org/computer-organization-risc-and-cisc/
3. http://www.c-jump.com/CIS77/CPU/InstrCycle/lecture.html

Reference

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

UNIT 3

Registers, Cache Memory and Virtual Memory

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the concepts of cache memory.
- familiarize with the concepts of Virtual memory.
- understand the relevance of cache memory and virtual memory.

Prerequisites

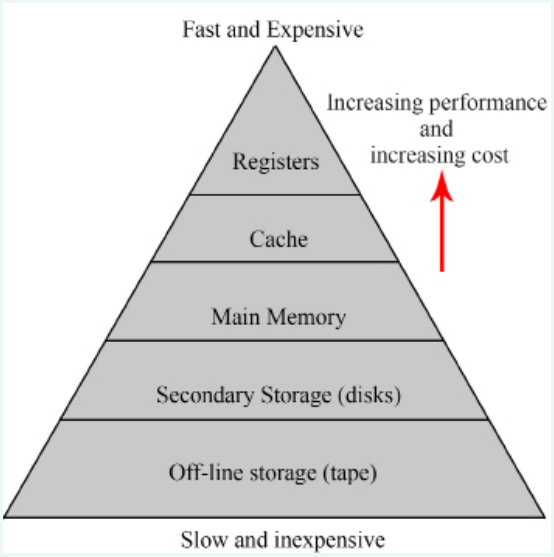


Fig. 2.3.1 Memory hierarchy

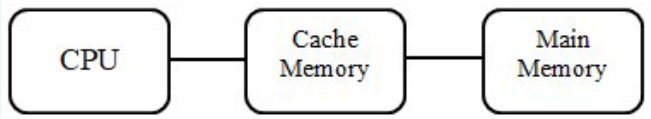


Fig. 2.3.2 Cache memory

Consider your college, where you have a department library and a central library.

Some books you refer too frequently, so you take those books from the department library and place them on the study table.

Your study table is like the cache memory, because those things that are frequently accessed are placed in the cache.

Department library acts as the primary memory.

Central library acts as the secondary memory.

What are the sizes of your table, department library and central library?

Size of the table is small and has limited capacity.

The department library is bigger than your table but smaller than the central library.

Likewise the size of the cache is small, primary memory has bigger capacity than cache.

The largest storage area is the secondary storage.

On your table you have small drawers where you can store small writings. The registers are like small drawers.

Key Concepts

Registers, Cache memory, Hit ratio, Virtual memory

Discussion

2.3.1 CPU Registers

Consider the previous example, where the study table has small drawers where we can store small notes. This is somewhat similar to our CPU registers. Registers are the fastest storage that can be seen on the processor of a computer system.

Registers are temporary storage. Some registers are internal (inside the processor) while others are external (outside the processor).

We can see registers on the top of the memory hierarchy.

Registers are accessed at a higher speed than the conventional memories.

Registers are the important components of a CPU. The different registers available are shown in Fig. 2.3.3.

The main aim of registers is the fast retrieval of data for execution by the processor.

Registers are classified into different types based on its purpose and functionality

2.3.1.1 General Types of Registers

- Data Register
- Address Register
- Status or flag register.

Data Register : This register holds the data for an operation.

Address Register : This register holds the address of data or instructions.

Status Register : This register indicates the current status of the processor or the result of an arithmetic operation.

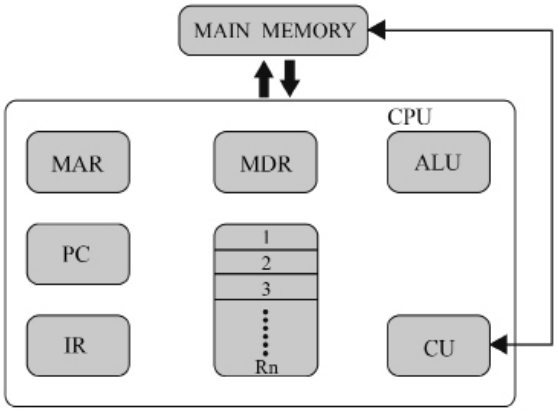


Fig. 2.3.3. Registers in CPU

2.3.1.2 Accumulator Register

Accumulator stores intermediate result after arithmetic and logical operations. The accumulator register holds the intermediate results of arithmetic and logical operations.

2.3.1.3 Memory Address Register (MAR)

This register holds the address of the memory location that is to be accessed.

2.3.1.4 Memory Data Register (MDR)

This register holds the data that is to be read or written to the memory location.

2.3.1.5 General Purpose Register

R0, R1, R2 to Rn-1 are the general purpose registers used. This will store temporary data during an operation. Many of the modern processors have more general purpose registers.

2.3.1.6 Program Counter (PC)

This register keeps track of the execution of the program. This register contains the memory address of the next instruction that is to be executed.

When the previous instruction has been successfully completed, PC points to the address of the next instruction to be fetched from main memory.

2.3.1.7 Instruction Register (IR)

The instruction which is about to be executed is stored in the IR. The instruction from the program counter (PC) is fetched and is stored in IR.

2.3.1.8 Condition Code Register

Condition code register contain flags to indicate the status of operations.

Flags are 1 bit register. They are either set to 0 or 1. Example; if the output of an operation is zero then the flag is set to 1, otherwise 0.

2.3.2 Cache Memory

It is a very high speed memory that lies just below the registers in the memory hierarchy.

The cache memory is acting as a fast storage between the processor and the main memory.

Frequently used instructions and data are placed inside the cache memory.

Cache is costlier than primary memory.

The size of the cache memory is smaller than the size of the primary memory.

Different levels of cache memory are available in the computer system.

Cache memory lies between the processor and the main memory.

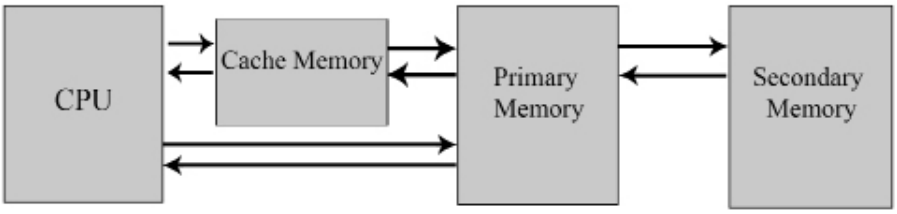


Fig.2.3.4 Cache Memory

Cache memory is very important because it improves the efficiency of data retrieval.

2.3.2.1 Types of Cache Memory

There are generally three categories or levels of cache.

- L1 cache
- L2 cache
- L3 cache

L1 Cache

- L1 cache is also known as the primary cache.
- This cache is extremely fast and the size is small.
- Normally L1 cache is embedded inside the processor chip as CPU cache.
- The size of the L1 cache depends on the CPU.

L2 Cache

- L2 cache is also known as the secondary cache.
- The size of the L2 cache is larger than the L1 cache.
- In most cases it resides outside the processor chip.

L3 Cache

- L3 Cache is developed to improve the performance of L1 and L2 cache.
- L1 and L2 are faster than L3 cache.
- L3 cache is located outside CPU cores
- Shared among all the CPU cores in a multi-core processor

The amount of time it takes to retrieve data from memory is referred to as "latency."

L1 cache has the lowest latency since it is closer to the processor and L3 cache has the highest latency.

2.3.2.2 Performance of Cache memory

When a processor has to read or write a location in main memory, it first searches in the cache for a corresponding entry.

A cache hit occurs when the processor finds that the memory location is in the cache, and data is read from the cache.

A cache miss occurs when the processor cannot find the required memory location in the cache and hence data cannot be found.

Hit ratio is the measure of the cache performance:

Hit ratio = hit / (hit + miss) = no. of hits/ total accesses

Advantages of cache memory

1. Cache is faster than main memory.

2. Access time is less compared to main memory
3. Data is stored for temporary purposes.
4. Cache stores programs that are executed in a short period of time.

Disadvantages of cache memory

1. Capacity is limited.
2. Cost is high.

2.3.3 Virtual Memory

A simple analogy for virtual memory that we see in our daily life.

Consider a smart television with the list of applications below (from some app store)

Fig 2.3.5 Applications

Now, the TV remote lets you navigate through the list of apps, by scrolling horizontally or vertically, and you can see a never ending list of them. But on this screen, at any given time you're seeing only a grid of 12 items, and you're made to believe that it can hold a higher number of entries. This is possible because viewing the next set of items comes at the cost of letting go of current items from the screen. So this is what's really happening in the case of a virtual memory. Your programs are made to believe that the platform they're running on (say, a computer) has more memory capacity than it actually does.

Virtual memory is an operating system feature that allows a device to compensate for physical memory shortages by moving data pages from random access memory to disk storage.

Virtual memory is a storage allocation scheme in which secondary memory can be addressed as though it were part of main memory.

Virtual memory is one of the most important concepts in computer architecture. It allows one to run large programs smoothly and effectively on the computer even if the computer is having a relatively small amount of RAM.

Address space can be considered as a range of valid addresses in memory that are available for a program or process.

The hardware addresses of physical memory are referred to as physical addresses.

Logical Address is the address that is generated by the processor.

In order to execute a program it is to be loaded into the main memory. Consider a large program. How to load it to the main memory? If the size of the main memory is small then the operating system will manage it by placing the required part of the program in the main memory and the rest is swapped between the main memory and the secondary memory. Now the user is having a feeling that he is using as much memory as required. This concept is referred to as virtual memory concept.

Virtual memory allows us to extend the use of physical memory by using a disk.

It provides memory protection

2.3.3.1 Virtual Memory Terminology

1. Virtual Address

Virtual Address is the address that is allocated to a virtual memory location so that it can be accessed as though it were in main memory.

2. Virtual Address Space

Virtual Address Space is the virtual storage that is assigned to a process. A program on execution is known as a process.

3. Real Address

Real address is the address of a storage location in main memory.

Recap

- Registers are the small and fastest storage mechanism that we can see on a processor.
- Address register, data register and status register are main three types of registers.
- Accumulator register holds the data taken from memory.
- Memory address register MAR holds address whereas, memory data register MDR holds data.
- There are 'n' general purpose registers.
- Program counter (PC), points to the next instruction that is to be executed.
- The instruction that is to be executed is stored in IR (Instruction Register).
- Flags are 1 bit registers.
- Cache memory is a very high speed memory that lies just below the registers in the memory hierarchy.
- Different levels of cache memory are available in the computer system.
- Hit ratio is the measure of the cache performance.
- Virtual memory is one of the most important concepts in computer architecture. It allows one to run smoothly and effectively large programs on the computer even if the computer is having a relatively small amount of RAM.

Objective Type Questions

1. What is a register?
2. Status register indicates the current status of the processor (True/False).
3. Which register points to the next instruction that is to be executed?
4. Which register holds intermediate results after ALU operations?
5. What is a flag?
6. Which is the high speed memory located between the main memory and the CPU?
7. What is cache hit?
8. Which metric is used to measure the performance of a cache memory?
9. Name any two operating systems.
10. Which part generates the Logical Address of the computer?
11. What is Virtual memory concept?
12. What is the address of a storage location in main memory?
13. What is a physical address?
14. What is a PC?
15. Which register holds the data that is to be read or written to the memory location?
16. Where is the instruction that is about to be executed stored?
17. What is the name of One bit registers that are used to indicate status?
18. What is a process?
19. How are we to calculate the Hit ratio?

Answers to Objective Type Questions

1. Registers are temporary storage that is seen on top of memory hierarchy
2. True
3. PC
4. Accumulator
5. Flag is a one bit register.
6. Cache memory
7. Whenever the data is found in the cache memory it is called a Cache hit
8. Hit ratio
9. Windows, Linux
10. Processor

11. Separation of user logical memory and physical memory is called Virtual Memory
12. Real address
13. The hardware addresses of physical memory are referred to as physical addresses.
14. Program counter
15. MDR
16. IR
17. Flag
18. A program on execution is called a Process.
19. Hit ratio = hit / (hit + miss) = no. of hits/total accesses

Assignments

1. What is the relevance of virtual memory in a computer system?
2. Point out the difference between logical and physical address.
3. Write notes on Cache hit, Cache miss and Miss penalty.
4. Comment on the different types of registers used in CPU.
5. What is general purpose registers?
6. Differenciate between L1, L2, and L3 cache memory, including cache hits and cache misses and hit ratio.
7. What is the role of accumulator register, and how is it used in arithmetic and logical operations.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition.

Reference

1. https://www.tutorialspoint.com/computer_fundamentals
2. https://nptel.ac.in/courses/106/103/106103068/
3. https://www.computerhope.com/jargon/s/secostor.htm

UNIT 4

Secondary Storage Devices

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the need for secondary storage devices.
- familiarise different types of secondary storage and describe their functional characteristics
- describe the common storage technologies like magnetic storage and optical storage.
- select suitable storage devices for a given application and justify the choice with the characteristics.

Prerequisites

Fig 2.4.1 Secondary Storage Devices

Consider the previous example of your college where you have a department library and central library.

Department library acts as the primary storage.

Central library acts as the secondary storage.

What are the sizes of the department library and central library?

The department library is smaller than the central library.

From this analogy we can infer that secondary storage has larger size and capacity.

Have you ever thought about the need of secondary storage?

Let us discuss secondary storage in detail in this unit.

Key Concepts

Secondary storage devices, Magnetic storage devices, optical storage devices

Discussion

2.4.1 Secondary Storage

As we have already pointed out, primary memory is very expensive and hence limited. Moreover it is volatile in nature. In order to store large amounts of data permanently, we need cheap and inexpensive storage mechanism; here comes the relevance of secondary storage.

Primary memory is volatile, but why do we still use it?

As the processor crunches through our data, it needs a place to store the intermediary result. Here comes the importance of primary storage. Another factor is its speed.

In this unit we are going to discuss the different types of secondary storage devices with their characteristics.

The most distinguishing characteristics of secondary storage are:

1. Non-volatile
2. Large size
3. Cheaper compared to primary memory.

Broadly speaking secondary storage devices are categorized into two

1. Fixed Devices
    - ♦ Hard disk drive
2. Removable Devices.
    - ♦ Pen drive

2.4.1.1 Magnetic Storage

The most common types of storage devices are magnetic storage devices.

In magnetic storage the data is stored on a magnetic medium.

Different types of magnetization patterns are used in the magnetic medium for

storage.

Sequential access devices: In these devices read and write takes place in a sequential (one after the other) manner.

Direct / Random access devices: Access any location at random.

Magnetic Tape

- This is an older type of Magnetic Storage Device, see fig. 2.4.2.
- One of the most popular sequential access storage systems.
- This is used for storing large amounts of data.

One of its most serious shortcomings of this type memory is that information on a tape can only be accessed in a sequential manner. This is okay if you want to listen to an entire music album in order, but computer systems often need non-sequential data access.

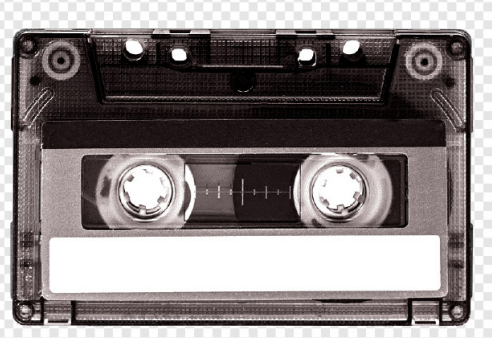


Fig 2.4.2 Magnetic Tape

Advantages

- Due to its high recording density, cost per bit is low.
- Portable, light weight and is removable.
- Stores large amounts of data.
- Modern magnetic tapes are packed in cassettes and in cartridges.
- Lots of businesses use magnetic Tape for backup.
- In a nutshell we can say that magnetic disk drives are near their limits, but magnetic tape technology continues to improve.

Magnetic Disk

The most common type of secondary storage is the magnetic disk.

This provides fast access and high storage at reasonable cost.

- A Magnetic Disk is a storage device that writes, rewrites, and accesses data using a magnetization mechanism.
- Magnetic disks are made up of metal or plastic disks that have an iron oxide recording material on both sides.
- Common examples of magnetic disks are Hard Disks, Zip Disks and Floppy Disks.

Types of Magnetic Disks

1. Hard Disk
2. Floppy Disk

Hard Disk

Hard Disk Drive (HDD) is the main data storage device in a computer

A typical hard disk is as shown in fig 2.4.3.

The speed of the hard disk is the speed at which content can be read or written on a hard disk.

The rotation speed of a hard disk ranges from 4500 to 7200 rpm (Revolution per minute).

Access time of the hard disk is measured

in milliseconds.

The storage capacity of a hard disk ranges from gigabytes to terabytes.

Fig 2.4.3 Hard Disk

Floppy Disk

This is one of the oldest types of portable storage devices, Refer to fig. 2.4.4.

Floppy Disk is used for transferring small files between computers.

A standard floppy disk can store 1.44Mb of data.

Nowadays floppy disk are not used.

Fig 2.4.4 Floppy Disk

2.4.2 Optical Disc

Optical disc can be considered as a storage medium from which data is read and to which it is written by lasers.

An Optical Disc can store large amounts of data.

The capacity of an optical disc is much higher than the floppies.

Common types of Optical Media

1. CD
2. DVD
3. BLU-RAY

2.4.2.1 Compact Disc (CD)

- James Russell invented the compact disc, which is a flat, circular optical storage medium.
- Philips factory in Germany produced the first CD on August 17, 1982.
- The format was designed to store and play only sound recordings at first, but it was later adapted to store and use data (CD-ROM).
- The data on a CD is written (burned) using a CD burner.
- Nero - is one of the most commonly used software for writing CDs.
- A standard CD can hold up to 650 megabytes of data. 700 MB of data can be stored on an 80-minute CD

CD -Types

CD-R (Recordable): Data is recorded on these discs only once and can't be erased.

CD-RW (Rewritable): The CD-RW is an erasable disc. We can write on it multiple times like a floppy or hard disks.

2.4.2.2 Digital Versatile Disc or Digital Video Disc (DVD)

A DVD or DVD-ROM is a disc capable of storing large amounts of data on one disc.

They are widely used for storing and viewing movies and other data.

DVD-R (Recordable): This is similar to CD-R, user can write on the disc only once but read it many times

DVD-RW (Rewritable): DVD-RW drives are the most popular writable DVD drives. We can erase and add new contents.

Categories of DVD based on Structure

- Single-sided, single-layer disc, capable of holding 4.7 GB.
- Single-sided, double-layer disc is capable of holding between 8.5 - 8.7 GB.
- Double-sided, single-layer disc is capable of holding 9.4 GB.
- Double-sided,Double-layer disc is capable of holding up to 17.08 GB.

2.4.2.3 Blu-Ray Disc (BD)

Blu-ray Disc (BD) is a digital optical disc data storage format.

This is the latest Video Disc.

It gets its name from a blue laser that is used to record and read discs.

Blue-Ray uses a blue laser and has a shorter wavelength.

Blu-ray is primarily for high-definition content and comes in single and dual layers.

All latest 3D movies are now only distributed on Blu-ray

Single layer blu-ray discs store up to 25 GB, that's 2 hours of hi-definition content or 13 hours of standard video.

Dual layer blu-ray discs store up to 50 GB, which is 4.5 hours of hi-definition video or 20 hours of standard video.

2.4.3 USB

USB stands for the Universal Serial Bus and is an industry standard.

Most of the computers provide at least two USB ports as minimum.

There are three main kinds of USB ports: Type A, Type B and Type C.

Port: In computer hardware, a port serves as an interface between the computer and other computers or peripheral devices.

The devices that connect to the USB port of the computer are known as USB devices. Examples are digital camera, smart phone, printer etc.

2.4.4 Pen drive

A pen drive is a small storage device shaped like a pen (refer fig. 2.4.5) that connects to a computer via a USB port and has built-in data storage.

Pen drives are used to store graphics, heavy documents, photos, music files and video clips.

Different capacity pen drives are available in market.

A pen drive is plugged into the USB port of the computer.

Fig 2.4.5 Pen Drive

Advantages of Pen Drive

- Resistant to scratches, dust and magnetic fields.
- Consumes less power compared to other devices.
- Pen Drives are Universal.
- Small Size for Easy Transport.
- Affordability

2.4.5 External Hard Disk

External hard disk is located outside the computer and is having its own enclosure.

They are portable storage devices.

External hard disks are connected to the USB ports of the computer.

Advantages

- High capacity (in Terabytes)
- For data backup, an external hard disk is one of the best options.
- Portable.
- Easy to use.

2.4.6 Memory Sticks

Memory sticks are one of the portable storage media and are shown in fig 2.4.6.

The memory stick can be easily removed and can be used in the personal computer.

This device was first introduced by Sony in their cameras and other digital photography equipment.

Fig 2.4.6 Memory Stick

Advantages

- Memory sticks can store a lot of information.
- They are incredibly compact, allowing the user to take them with them wherever they go.
- They are long-lasting due to the lack of moving parts.

2.4.7 Solid State Drives

SSDs are secondary storage devices that works faster, use less power and are more relaible than traditional hard drives. You can find them inside computer or as portable storage devices. They allow quick data access and are handy for saving file like photos or documents.

Recap

- Secondary storage is a type of low-cost storage used to permanently store vast amounts of data.
- Secondary storage is non-volatile, has a big capacity, and is less expensive than primary memory.
- Data is stored on a magnetic medium in magnetic storage. Types of Magnetic storage are Hard Disk, Floppy Disk etc.
- Optical disc is a storage medium from which data is read and to which it is written by lasers.
- Common types of Optical Media are CD, DVD and BLU-RAY.
- USB stands for the Universal Serial Bus and is an industry standard.

- A pen drive is a small storage device shaped like a pen that connects to a computer via a USB port .
- External hard disk is located outside the computer and has its own enclosure. They are portable storage devices.
- Memory sticks are one of the portable storage media. The memory stick can be easily removed and can be used in a personal computer
- This module gives a deep insight into secondary storage devices along with its characteristics and applications.

Objective Type Questions

1. Secondary storage is permanent storage. (True/False)
2. RAM is an example of Primary storage. (True/False)
3. Which medium is used by magnetic storage to store data?
4. Secondary storage is also called non volatile storage (True/False).
5. What are the two magnetic disks used in a computer?
6. Which are the two types of hard disks?
7. What is the capacity of a CD?
8. Which disc is good for storing videos?
9. What is USB?
10. How is digital information stored on the hard disk?
11. Pen drive is connected to the USB port of the computer(True/False).

Answers to Objective Type Questions

1. True
2. True
3. Magnetic
4. True
5. Hard Disk, Floppy Disk
6. Internal and External hard disk
7. 700 MB
8. Videos

9. Universal serial Bus
10. Magnetization
11. True

Assignments

1. Why do we need ports in a computer system?
2. Why is the floppy disk replaced by optical discs and other portable storage media? Justify your findings.
3. Why is magnetic tape still used by many companies for backup data?
4. Compare and contrast CD and DVD.
5. Write a note on Pen drive.
6. Describe the need for secondary storage despite the presence of primary memory?

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

Reference

1. https://www.tutorialspoint.com/computer_fundamentals
2. https://nptel.ac.in/courses/106/103/106103068/
3. https://www.computerhope.com/jargon/s/secostor.html

BLOCK 3

Software

System Boot up and Software Layers

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- describe the boot process.
- familiarise types of software
- identify the concept of files and folders in a computer system.
- understand the layered software architecture.

Prerequisites

For every work we perform in our life we need a very good script and step by step procedure. Similarly, for performing a specific task computers need instructions, data, programs and documentation.

Instruction: Instruction is a step-by-step procedure for doing some specific task on the computers.

Program: Set of instructions for doing a particular task is called a Program.

Hardware: All the physical touchable and seeing parts of a computer are named hardware.

Software: Programs are bundled together to form software.

The operating system acts as the interface between the user and the hardware. The most important software on the computer is the operating system. In the beginning, the users used DOS (disk operating system). In order to operate DOS, the users need to give commands. It is a purely command based OS.

Slowly Graphical User Interface (GUI) - based OS has evolved; this allows users to interact with computers using a mouse and other input tools.

Key Concepts

System software, Application software, Software layers, Files, Folders, Booting

Discussion

This unit highlights different types of software. The software architecture with different layers is also discussed. The concept of files and folders and the booting process are also mentioned.

3.1.1 Software

Software refers to a collection of computer programs, data, instructions, and associated documentation that enable a computer or other electronic device to perform specific tasks or functions. It is a set of instructions and data that tells a computer how to perform various operations, such as running applications, processing information, managing hardware components, and more.

Software is mainly classified into two

1. System Software
2. Application Software

3.1.1.1 System Software

System software is the software that helps to manage and control computer hardware and give essential instructions for other softwares for proper functioning of the computer. It is general-purpose software without which the system cannot run. System software ensures that hardware resources are utilised efficiently, provides an interface for users and applications, and maintains the overall functionality and stability of the computer system. Fig. 3.1.1 shows the interaction of software with hardware and user.

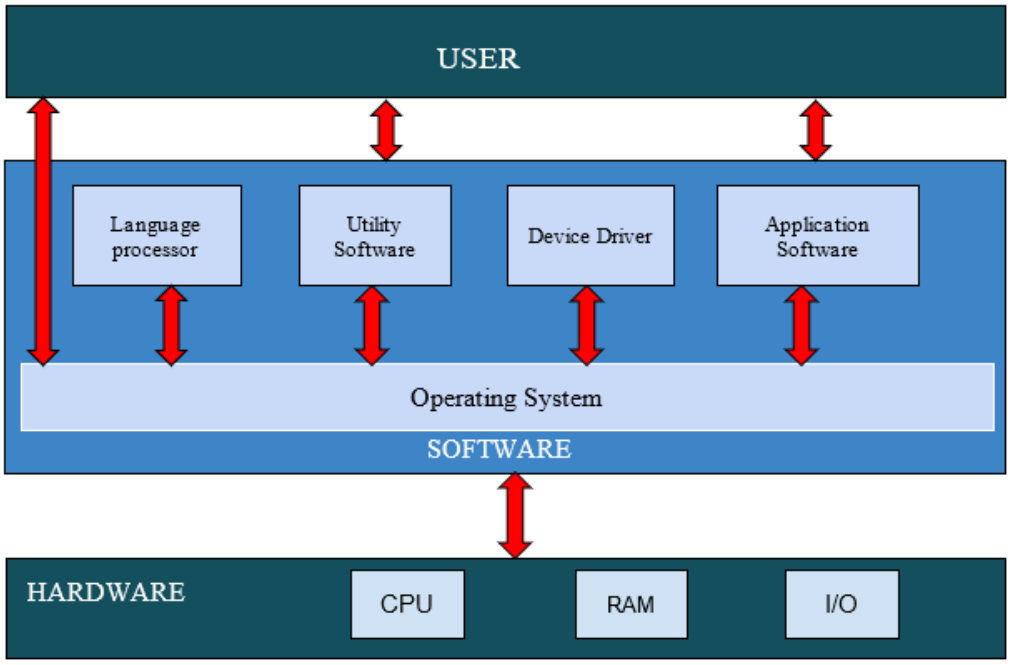


Fig 3.1.1 Software with user and hardware interface

Features of system software

- System software communicates directly with the hardware.
- The size of the system software is smaller.
- System software is very complex.
- High speed: allow high end application programs to run.
- Versatile: It can communicate with hardware and high end application programs.

Examples for system software are operating system, language processor, device drivers, utility software etc.

Operating System

The operating system is a core piece of system software that acts as an intermediary between users, applications, and hardware. Operating system is a software that helps computer hardware to work with another software and control and coordinate working of all hardwares. It is the first layer of software loaded into the computer memory when it starts up.

Functions of operating system are:

- Process Management
- Memory Management
- File System Management
- Device Management
- User Interface
- Security and Access Control
- Networking and Communication
- Error Handling and Logging
- Virtualization and Multitasking
- System Utilities
- Boot Process
- Time Management

Different types of operating systems exist, including

a) Single-User, Single-Tasking OS:

Supports a single user running one task at a time.

b) Multi-User OS: Supports multiple users simultaneously, each running their own tasks.

c) Single-User, Multi-Tasking OS: Allows a single user to run multiple tasks concurrently.

d) Real-Time OS: Designed for systems that require immediate response to events, such as embedded systems and industrial control systems.

Examples of popular operating systems include Microsoft Windows, macOS, Linux distributions (such as Ubuntu, CentOS, and Fedora), and various Unix-based systems.

Device Drivers

Device drivers are software components that allow the operating system to communicate with and control specific hardware devices such as printers, graphics cards, network adapters, and more. A driver acts as a translator between the device and the program that uses the device.

Language Processor

Language processors are software programmes that convert high level programming languages to machine code for computers to understand. Different language processors are assembler, compiler, interpreter.

Utility Software

Utility software is a set of programs which help users in system maintenance

tasks and in performing tasks of routine nature. Some of the utility software are Compression tools, Disk defragmenter, Backup software, Antivirus software etc.

3.1.1.2 Application Software

Software developed for specific applications is called application software. It includes general purpose software packages and specific purpose software. GIMP, Payroll System, Airline Reservation System, Tally, etc., are examples of application software.

a. General purpose software packages

General purpose software is used to perform operations in a particular application area. Such software is developed keeping in mind the various requirements of its users. General purpose software is classified as word processors, spreadsheet software, presentation software, database software and multimedia software.

b. Specific purpose software

Specific purpose software is a highly specialised software designed to handle particular tasks. These are tailor-made software to satisfy the needs of an organisation or institution. It is also known as customised software. Since customised software is developed for a single customer, it can accommodate that customer's particular preferences and expectations. Examples are Payroll System, Inventory Management System, Human Resource Management System.

Table 3.1.1 Comparison between System software and Application software

Sl No	System Software	Application Software
1	System Software is the type of software which acts as the interface between application software and the computer system.	Application Software is the type of software which designs according to users requirements. System software provides a platform for the application software to run.
2	System software are often written in low level languages. However, high level languages like C, Python, Java are also used nowadays.	High level language is used for the development of application software.
3	System software is used for operating computer hardware.	Application software is used by users to perform some specific task.

4	System software is installed on the computer when the operating system is installed	Application software is installed according to the user's requirements.
5	System software is specific to system hardware so less or no user interaction is available in the case of system software	On other hand in application software users can interact with it as the user interface is available in this case.
6	System software can run independently and provides a platform for application softwares to run	Application software can run only with the support of system software
7	A few examples of system software are operating systems, compilers, assemblers, debuggers, drivers, etc.	Examples of application software are word processors, web browsers, mediaplayers, etc

3.1.2 Files and Folders

Files and folders form the foundational framework within computer systems, facilitating the structured organisation and administration of digital data. They establish a systematic approach to store, retrieve, and oversee information on computers and other storage devices.

Let us consider your room; you have books, dress materials and other items. If you are putting all your items together, then how difficult is it to find an item? Moreover, the room looks disordered too.

What is the solution for this?

Order the items and store them in specific locations. Ok, let us have a close look.You bought a wardrobe and placed the items in an orderly manner in it. Here the items like books, dresses etc are similar to the files in the computer system and the wardrobe acts as the folder.

Inside the wardrobe, you can have one or more drawers which can store your certificates. These drawers inside the wardrobe correspond to the subdirectories in a computer system.

3.1.2.1 File

- A file is a digital container that stores data such as text, images, audio, video, programs, and more.
- Everything in the computer is stored as a file of one type or another.
- Files are represented by a name and an extension separated by a period.
- The extension helps the operating system to identify the type of files. E.g., "Notes. doc" (this means the name of the file is Notes and doc says it is a word document). Fig. 3.1.2 and Fig. 3.1.3 show the icons

of a word file and image file in a computer. “document.txt" - is a Text file and "Image.jpg" - is a JPEG image.

Fig. 3.1.2 A letter created in Microsoft Word is a file (document.txt)

Fig. 3.1.3 An image of you stored in the computer is another file (Image.jpg)

3.1.2.2 Folder

Fig. 3.1.4 A folder in computer

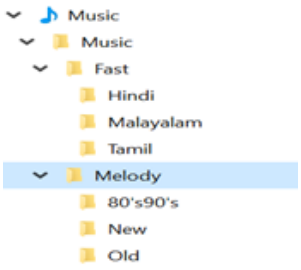


Fig. 3.1.5 Folders and subfolders

A folder is a container used to organise and group related files and other folders. Putting files in the folders helps to group them together and make them easy to find. Folders provide a systematic way to organise files. Folders are also called “directories.” Fig. 3.1.4 shows the icon of a folder in the computer. Folders can be nested within one another, creating a hierarchical structure.

If you want to store a music file, then you create a folder known as music. Inside it you can create other folders like melody, fast etc. These folders are called sub folders and the folder music is the main folder. Fig. 3.1.5 shows the image of a folder and subfolder in the computer.

Path

A file’s location in the folder hierarchy is represented by its path, which is typically written as a series of folder names separated by slashes.

e.g.,“C:\Users\Username\Documents\file.txt” on Windows

File System

A file system is the software component that manages how files and folders are stored and organised on a storage device.

e.g., a hard drive or SSD

File Operations

Users can perform various operations on files and folders, including creating, opening, editing, moving, copying, deleting, and renaming.

Permissions

Files and folders can have permission settings that determine who can access, modify, or delete them.

Metadata

Files often store additional information known as metadata, which can include details like the file’s size, creation date, modification date, and author. That is, ‘data about data’ is called metadata.

3.1.3 Booting

Now we are going to discuss the booting process. Before getting into the technical side we can compare it to warm up session before going with the exercise in the gymnasium. If you are ok with the warm-up and feel that the body is fit then proceed with the exercise. On the other hand, if we come up with any problem during warm-up what should we do? Rectify the problem and then continue with our exercises. This is what happens in the case of computers during booting.

Booting is a sequence of startup processes that starts the operating system of a computer when it is turned on. Booting is the initial set of operations, a computer performs when it is switched on. During the booting process, the system will check all the software and hardware that are installed/ attached to the system and also load the necessary files for running the system.

Types of Booting

There are mainly two types of booting

1. Warm booting
2. Cold booting

3.1.3.1 Warm booting

This is also known as soft reboot. It is the process of restarting a computer without interrupting the power.

3.1.3.2 Cold booting

This is also called hard booting.

This is the process of starting up the computer that is turned off.

In cold booting, we turn on the computer from an off state.

Boot Devices are those devices from which the operating system is loaded. In modern personal computers, the BIOS (Basic input output system) supports booting from various devices. Examples include hard disks, optical drives and USB.

3.1.4 POST (Power on self test)

POST stands for power on self-test. It is a test the computer will perform during the booting process. This test or process will ensure that all the hardware attached to the computer is working properly.

The POST process examines computer hardware such as RAM (random access memory), hard drives, CD-ROM drives, keyboards, and other components to ensure that they are all operational.

3.1.5 Software Layers

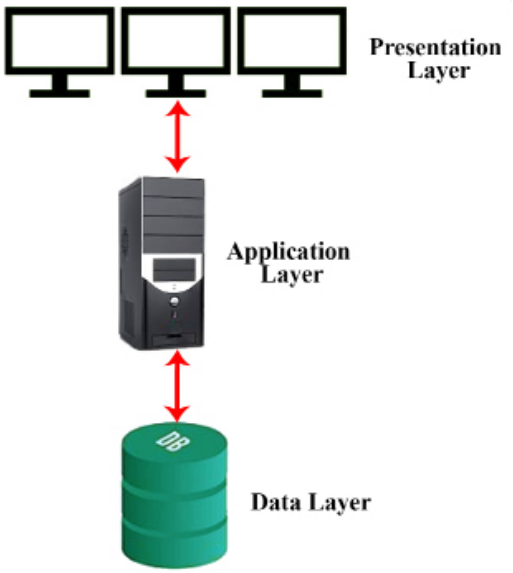


Fig. 3.1.6 Software Layers

The layers involved in any application listed below are shown in Fig 3.1.6

- Presentation layer
- Application layer (Business logic layer)

- Data layer

Presentation Layer

This is the topmost layer of an application.

This layer is also known as the client layer.

By using this layer the user is interacting with the application.

The main function of this layer is to pass the information from the user to the application layer. Consider an application that we are using regularly namely, Gmail.

In the login page of Gmail, end users could see text boxes and buttons to enter user id, password and to click on sign-in. This is the presentation layer.

Application layer

This layer acts as an intermediate between the presentation layer and the data layer.

This layer is also known as the business logic layer or logical layer.

This layer fulfils the detailed functions of processing.

As per the Gmail login page example, once a user clicks on the login button, the application layer interacts with the Database layer and sends the required information to the Presentation layer. The operations are all performed in this layer.

Data Layer

Data is stored in this layer. The application layer communicates with the data layer to retrieve data.

Software architecture is divided into different layers,

1. One tier
2. Two tier
3. Three tier

3.1.5.1 One tier architecture

In this architecture all the three layers such as the presentation, application and data layer are in a single software package. Best examples of one tier architecture software are MP3 and Microsoft office etc.

3.1.5.2 Two tier architecture

The two tier architecture consists of two parts as shown in Fig. 3.1.7.

1. Client tier
2. Data tier

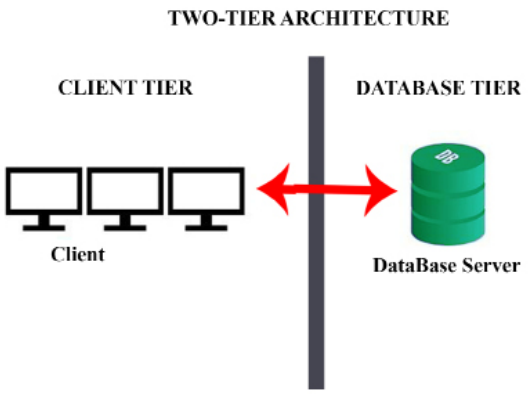


Fig. 3.1.7 Two Tier Architecture

Client system handles presentation and application layers whereas the server system handles the database layer.

This is a client server application.

Client system requests the server for services and the server system responds to the request of the client.

3.1.5.3 Three tier architecture

This architecture includes three parts as given below:

1. Client tier
2. Application tier
3. Data tier

Client system handles presentation layer, Application server handles Application layer and Server system handles Database layer. Fig. 3.1.8 shows three tier architecture.

Fig. 3.1.8 Three tier architecture

Recap

- Software is mainly classified into System Software and Application Software.
- Application Software is software that helps the user to perform a particular task.
- System software is a type of software program that manages the hardware and applications software on a computer.
- File is considered a storage unit in a computer.
- Folders provide a systematic way to organise files.
- Folders are also called "directories."
- Booting is a sequence of startup processes that start the operating system of a computer when the system is turned on.
- There are mainly two types of booting

  1. Warm booting

  2. Cold booting
- Software architecture is divided into three types, namely, One tier, Two-tier and Three tier
- The layers involved in any software application are the presentation layer, application layer (Business logic layer) and data layer.

Objective Type Questions

1. What are the two major classifications of software?
2. System software written in which language?
3. An example for utility software.
4. Files are considered storage units in a computer (True/False).
5. What is the other name of the folders?
6. Word processor belongs to which category of software?
7. What are different kinds of File operations?
8. What is called data about data?
9. Which software is responsible for memory management?
10. Name two digits used in machine languages?
11. Give an example of system software.
12. What is application software?
13. What is a folder?
14. What are the two components of a file?
15. What is booting?
16. Which layer acts as an intermediate between the presentation layer and the data layer?
17. What is the test the computer performs during the booting process?
18. Warm booting is also known as soft reboot (True/False).

Answers to Objective Type Questions

1. System software and application software
2. Machine language
3. Anti virus
4. True
5. Directories
6. Application software
7. Creating, opening, editing, moving, copying, deleting and renaming
8. Meta data
9. Operating system
10. 0 and 1
11. Operating system

12. Application software is designed to solve a specific problem or to do a specific task.
13. A folder is a collection of related files and subfolders.
14. Name, and an extension
15. The sequence of startup processes that starts the operating system of a computer when it is turned on is known as booting.
16. Application layer
17. POST
18. True

Assignments

1. Analyse the role of the system software in a computer system.
2. What are the advantages of files and folders in a computer system?
3. What is ROM POST?
4. Discuss software architecture.
5. What is the relevance of an application layer in a software?
6. Compare and contrast client and server.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014.
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill.
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014.
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition.

Reference

1. https://ecomputernotes.com/fundamental/disk-operating-system/what-is-booting-type-of-booting
2. https://squareboat.com/blog/different-types-of-software-with-examples

Popular Operating Systems

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the role of an operating system
- describe the basic functions, features and categories of the operating system
- list the common types of the operating systems
- identify Windows and Linux features
- understand mobile OS Android and iOS

Prerequisites

Consider a manager of a company. What does the manager do?

He manages the activities of the company. Similarly, the operating system plays the role of a manager in the computer system. This unit familiarises you with the popular operating systems. The operating systems Windows and Linux are highlighted.

Operating system acts as the interface between the user and the hardware. The most important software in the computer is the operating system. In the beginning, the users used DOS (disk operating system). In order to operate DOS, users need to give commands. It is a purely command-based OS. Graphical user interface-based OS has evolved; this allows users to interact with computers using a mouse and other input tools.

An introduction to mobile operating systems like Android and iOS is also given.

Key Concepts

Operating System, DOS, GUI, Client, Server

3.2.1 Operating Systems (OS)

As we have already stated, the role of an operating system is just like the role of a manager.

Its job is to make sure that all the programs in the computer are doing their jobs. So, Linux and Windows are just like different managers. They do the same thing, but have different styles of management.

The applications are like the workers who do the jobs and the managers who are incharge of keeping the work in line.

You, the computer user, are the owner of the company who directs the manager as to how to coordinate the workers. Sometimes, you need to fire a bad manager if things aren't working properly. However, some of the workers might not work well with the new manager.

An operating system is a collection of software that manages the computer's hardware and provides common services to the computer system.

It functions as an interface between the user and the computer hardware.

Every computer must have at least one operating system.

Commonly used operating systems are Windows, Linux, Android and Apple iOS.

Basic Functions of Operating System

- Memory Management
- Processor Management
- Device Management
- File Management

3.2.1.1 DOS (Disk Operating System)

DOS is a disk-based, single-user, single-task operating system. It is a simple command based operating system. Fig 3.2.1 shows Dos interface.

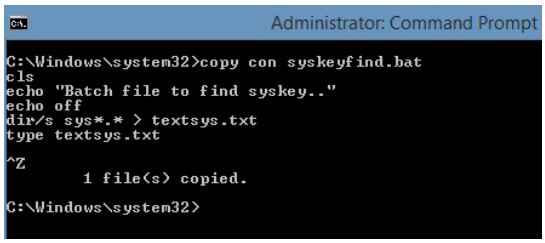


Fig. 3.2.1 Disk operating system

In the DOS operating system the user interacts with the system using commands. Whereas in a graphical user interface based OS (eg: Windows) the user interacts by using graphical icons. The user chooses an option usually by pointing a mouse or other pointing devices at an icon representing that option.

3.2.1.2 Server and Client Machine

- Both Server and Client are computers.
- The server has a higher configuration than that of the client.
- The client requests for services from the server.
- The server responds to the request of the client.

Restaurant service provides an analogy to help explain client/server computing. The customer (client) makes a series of requests for a specific set of services that may include an appetiser, beverage, main course and a dessert. These requests are all typically made to one person, the waiter (server). The services may actually be facilitated by a number of other people in the restaurant including the bus boy, bartender, and a variety of chefs. However, to the customer, these services are all provided by one person, the waiter. The customer doesn't want to know who performs what service. He would just like

to have a high quality meal delivered in a timely fashion. The client, in client/server computing, is much like the customer in a restaurant. The client requests a service, like running an application or accessing some information from a database. The server becomes responsible for performing the service and returning the information to the client in a timely manner. The server is like the waiter in a restaurant responsible for handling the client's requests and delivering the finished product to the client.

Open-source software is software whose source code is freely accessible and modifiable by everyone, while proprietary software is a software that is exclusively owned by the person or publisher who created it.

3.2.1.3 Types of Operating Systems

Operating systems are broadly classified into

1. Batch Operating System
2. Multitasking/Time Sharing OS
3. Multiprocessing OS
4. Real-Time OS
5. Distributed OS
6. Network OS
7. Mobile OS

3.2.1.3.1 Batch Operating System

Some computer processes are lengthy and time consuming. So jobs that demand similar needs are bundled together into a group and are executed at the same time.

In a batch operating system similar jobs are grouped together as batches.

In this operating system, the users do not directly interact with the computer system. The users can use any offline interface, such as a punch card to prepare their job, and submit it to the computer operator.

The major limitation of the system is the lack of interaction between the user and the job.

3.2.1.3.2 Multitasking/Time Sharing OS

In this type of operating system many users located at various terminals can use the system simultaneously.

Time-sharing refers to the use of a processor's time by multiple users at the same time.

Examples are UNIX, Multics .

Advantages of Time Sharing operating systems are

- Quick response.
- Avoids duplication of software.
- Reduces CPU idle time.

3.2.1.3.3 Multiprocessing OS

A multiprocessing operating system (OS) is one in which the computer's functions are managed by two or more central processing units (CPUs). Each central processing unit will have a copy of the operating system.

These operating systems communicate with one another for coordinating the operations.

Windows NT and Windows 2000 are examples of multiprocessing OS

3.2.1.3.4 Real Time OS

Real-time OS is used in a situation that uses real-time data. In this case, once the data arrives it should be executed and no delay is permitted.

If we want to process a large number of requests in a short time period, a real time operating system is the best choice.

For example, when we have to measure the temperature details of the petroleum industry it is to be carried out using real-time OS.

Delay in such situations invites a crisis. That is why in such environments we are supposed to resort to a real time operating system.

Military Software Systems and Space Software Systems are two other examples of Real time OS .

Real time operating systems are of two types:

1. Hard Real time OS
2. Soft Real time OS

Hard Real time OS: Time constraint is very important. Any delay can result in drastic consequences.

Soft Real-time OS: Time constraint is not that important, but it also deals with real-time data.

Advantages:

1. Maximum utilisation of devices and resources occurs.
2. System is almost error-free.

The major limitation of the system is that the algorithm used in real-time operating systems is very complex.

3.2.1.3.5 Distributed Operating System

Distributed systems use many processors located in different machines to provide very fast computation to the users. In a distributed operating system, we have different systems and each system has its own processor, main memory, secondary memory and resources.

These systems are connected to one another using a shared communication network. Each system can perform its task individually.

In distributed operating systems remote access is possible, which allows one user to access data from another system and operate with it. It also enables concurrent processing of tasks across different machines and provides fault tolerance, making it possible for the system to continue functioning even in the event of node failures. Distributed operating systems are widely used in applications such as cloud computing, big data processing, and high-performance computing.

Advantages:

1. Effective resource sharing: The load on the host computer gets distributed to other machines and hence the performance increases.

2. Concurrency: This means multiple task are executed simultaneously on different system nodes.

3. Scalability: Additional nodes can be added to the system.

4. Fault tolerance: This means that users can continue working with the system in case of hardware or software failure.

3.2.1.3.6 Network Operating System

Network operating systems run on server machines. The network operating system gives the server the capability to manage data and users.

Some examples of network operating systems include Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, and Novell NetWare.

Advantages

1. Centralised servers systems are highly stable.

2. Server Security is well managed.
3. Hardware and technology upgradation can be easily integrated into the system.

3.2.1.3.7 Mobile operating system

Mobile operating systems are those that are developed primarily for smartphones, tablets, and wearable devices.

Android and iOS are two of the most well-known mobile operating systems, but others include BlackBerry, Web, and watchOS.

3.2.1.4 Windows and Linux Operating systems

Linux and Windows are just like different managers. They do the same thing but have different styles of management.

Windows and Linux are the two commonly used GUI operating systems.

Windows is a licensed operating system and the source code is inaccessible.

Linux is an open source operating system.

Table 3.2.1. Linux Vs Windows

Sl No	Linux	Windows
1	Linux is an open source operating system	Windows is a licensed operating system
2	Linux is free of cost	Windows is costly
3	Its file name is case-sensitive	Its file name is case-insensitive
4	Linux is more efficient compared to windows	Windows is less efficient
5	Linux provides more security than windows	Windows provides less security than Linux

3.2.1.5 Android operating system

Google's Android is a commonly used mobile operating system.

Android is built on the Linux kernel and is primarily intended for touch screen devices like tablets and smartphones.

Android is partially open source.

The first version of android was launched in 2008.

It is the most used operating system overall.

3.2.1.6 iOS

- iOS is a mobile operating system which is developed by Apple Incorporation.
- Many Apple mobile devices,

such as the iPhone, iPod, and iPad, run on iOS.

3.2.2 Graphical User interface

In order to interact with the computer system, a user interface is required.

The Graphical User Interface (GUI) is a form of user interface that allows users to interact with electronic devices through graphical icons or visual indication representation. Fig 3.2.2 shows graphical user interface.

GUI offers a visual representation of the commands and functions of the operating system.

1. It is easier to use for beginners
2. Its ability to drag and drop, cut and paste will help for the easy exchange of information.
3. It allows users to try out various options easily.

Fig. 3.2.2 Graphical user interface

Recap

- Operating system is a collection of software that manages the computer's hardware and provides common services to the computer system.
- DOS is a disk-based, single-user, single-task operating system.
- The graphical user interface is a form of user interface that allows users to interact with electronic devices through graphical icons.
- In client server computing, the client requests and the server responds to the request from the client.
- Operating systems are broadly classified as Batch Operating System, Multitasking/Time Sharing OS, Multiprocessing OS, Real Time OS, Distributed OS, Network OS, and Mobile OS.
- Windows and Linux are the two commonly used GUI operating systems.
- Google's Android is a commonly used mobile operating system.
- iOS is a mobile operating system which is developed by Apple Incorporation.
- Operating system manages the overall operations in the computer. Two major operating systems are Windows and Linux.

- Our's is an era of smart phones, so an introduction to mobile operating systems is given in this module.
- System software and utility software are discussed in detail.
- A small glance on computer virus and protection is also given.

Objective Type Questions

1. Which is a collection of software that manages the computer's hardware and provides common services to the computer system?
2. What is the full form of DOS?
3. Give the names of two mobile operating systems.
4. Name a software system which is making use of real time operating systems?
5. Windows server 2008 is a network operating system (True/False).
6. Give an example of an open source operating system.
7. Which kernel is used in Android OS?
8. Which operating system is used in iPhone, iPod, and iPad?
9. Which computer requests for services from the server?
10. Which form of the user interface allows users to interact with electronic devices through graphical icons?

Answers to Objective Type Questions

1. Operating system
2. Disk operating system
3. Android, iOS
4. Space software systems
5. True
6. Linux
7. Linux Kernel
8. iOS
9. Client
10. Graphical user interface

Assignments

1. Analyze the role of the operating system in a computer system.
2. What are the advantages of GUI operating systems?
3. What do you prefer - Windows/ Linux operating system? Justify your answer.
4. Explain different types of system softwares.
5. Explain mobile operating systems widely used nowadays.
6. Compare and contrast the features of Windows and Linux operating systems.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGraw-Hill, 2014
5. Peter Norton, Introduction to Computers, McGraw-Hill, Seventh edition

References

1. https://afteracademy.com/blog/what-are-the-types-of-an-operating-system
2. https://www.edureka.co/blog/linux-vs-windows/

UNIT 3 System Software and Utilities

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand programming languages and their types.
- identify the role of compiler and Interpreter in programming languages.
- define the database with its functionality
- describe the role of utility programs.

Prerequisites

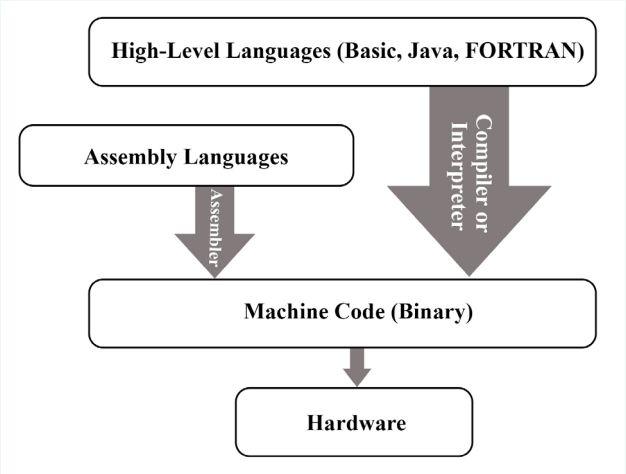


Fig. 3.3.1 Various types of programming languages

Picture your Department of Computer science in your mind.

This Department has a HOD and other teachers.

What are the roles of the HOD?

He will manage the department activities and provide a platform for teachers to work smoothly.

Here the Department is our computer system, HOD is the system software and teachers are the applications running on the computer. Technically speaking system software is used to manage the computer itself and it runs in the background, maintaining the basic functions of the computer. System software provides a platform for the application software to run on top.

Key Concepts

Programming languages, Compiler, Interpreter, Assembler, Utilities

Discussion

3.3.1 Programming Languages

As we know, to communicate with a person, we need a specific language, so too with computers; programmers also need a language called Programming language.

Programming languages are formal languages that are used by the programmers to communicate with the computer system.

3.3.1.1 Types of Programming Languages

1. High level language
2. Low level language
   - 2.1 Assembly Language
   - 2.2 Machine language

High Level Language

It is very easy for the programmers to write programs using high level languages.

Examples of high level languages are C, C++, Java, Python etc.

In high level languages we write the program using humanly readable languages.

Low Level Language

Low level languages are close-up to the

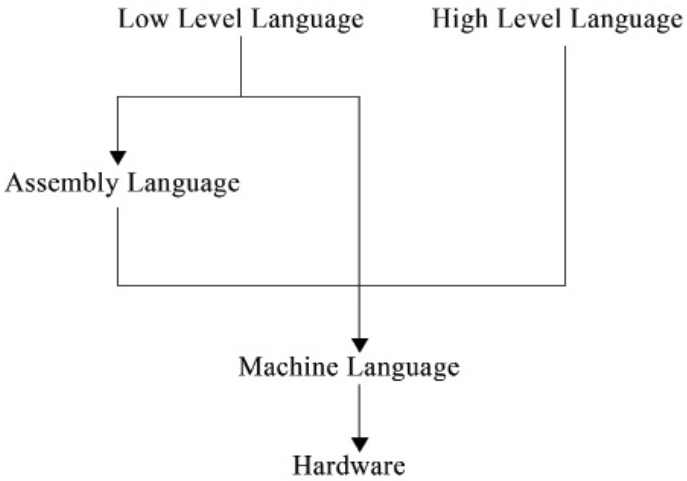


Fig. 3.3.1 Hierarchy of programming languages

hardware and machine code. They use binary, hexadecimal, and neumonics to directly manipulate the memory, registers and instructions of the processor.

Note:

System software consists of several programs which are responsible for controlling, integrating and managing the hardware components.

Table 3.3.1 Comparison of High level and Low level language

High Level Language	Low Level Language
It is a programmer friendly language	It is a machine friendly language
It is less memory efficient	It is highly memory efficient
It is easy to understand	It is tough to understand
It is simple to debug (correct if any errors)	It is comparatively complex to debug
It is simple to maintain	It is comparatively complex to maintain
It is portable	It is non-portable

Assembly Language

One example of such language is the assembly language that we are using. In this language we use some short codes called Mnemonics. Compared with machine language, assembly is more user friendly.

Machine Language

Computers can understand only machine language. If you are writing any program in a high level or assembly language you have to convert it to machine language. We need some converters for doing this task. Such converters are Compiler, Interpreter and assembler etc. Fig 3.3.2 shows the hierarchy of programming languages. Also Table 3.3.1 shows the comparison of High level and Low level language.

In a nutshell we can say that system software makes the computer functional. Examples are Language translators, Operating system etc.

Machine language is the only language the computer can understand. It is a binary that has only 0 and 1.

Writing a program in binary language is very tedious. So programmers prefer high level languages.

3.3.2 Language Translators

A computer can understand only binary language or the machine language. Writing programs using this language is very difficult and time consuming. So programmers use high level languages for developing programs.

Consider this scenario: the programs are in high level language and the computer understands only machine language. So a language translator is required.

What is the role of the language translator?

The language translator converts the programs in high level languages to machine understandable form. Compilers, interpreters, assemblers etc are examples of language translators.

3.3.2.1 Compiler

Converts the programs written in high level language to machine language. Fig. 3.3.2 shows the working of the compiler.

3.3.2.2 Interpreter

Converts the programs written in high level language to machine language line by line. The table 3.3.2 shows the features of Compiler and Interpreter.

3.3.2.3 Assembler

Converts the programs written in assembly language to machine language.

Fig. 3.3.2 Working of a compiler

Table 3.3.2 Compiler Vs Interpreter

Compiler	Interpreter
A compiler converts the entire program into machine code	Interpreter translates the program line by line
Compiler takes a large amount of time to analyse the entire source code but the overall execution time of the program is comparatively less	Interpreter takes less amount of time to analyse the source code but the overall execution time of the program is more
Debugging is comparatively hard	Debugging is easier
Intermediate object code is generated	No intermediate object code is generated
Examples: C, C++, Java	Examples: Python, Perl

The major differences between the compiler and interpreter are:

- Compiler converts the whole program to machine language.
- Interpreter converts the program to machine language line by line.
- Languages like C, C++ etc are using Compilers.
- Languages like PHP, Python etc are using interpreters.

3.3.3 Database

A database is a collection of information organised in such a way that a computer program can quickly select desired pieces of data.

Database is a systematic way of ordering and keeping data electronically.

Consider your kitchen. When you need to make a curry, you take coriander, cumin, turmeric, ginger, mustard, black pepper etc. from the spice rack. So the spice rack is like a database.

The concept of databases makes data management easier.

Let's take an example of an online telephone directory. It uses a database to store data of people, phone numbers, and other contact details.

Let's take a look at Facebook. It must be able to store, manipulate, and display information about members, their families, member events, messages, advertising, and much more.

The most promising features of databases are

1. Store large amounts of data
2. Easy to access
3. Easy to update
4. Accurate

3.3.3.1 DBMS

A database management system (DBMS) is a set of programs that enable users to access databases, manipulate data, report on data, and represent data.

Advantages

- A database management system (DBMS) can store and retrieve data in a number of ways.
- Database management system (DBMS) is an effective handler for balancing the needs of multiple applications that use the same data.
- Data administration processes that are consistent.
- Database management system (DBMS) employs a number of sophisticated functions to efficiently store and retrieve data.
- Provides Data Integrity and Security

3.3.4 Utility Software

These are software that assist the operating system to do some specialized task.

Utility software helps to analyse, configure and maintain a computer.

3.3.4.1 Utility Software Examples

The antivirus software that we use is one of the best examples of utility software.

Antivirus is a piece of software that helps the operating system in providing a virus-free environment for its users.

An antivirus programme searches the system for viruses and, if any are found, eliminates them by removing or isolating them.

It can detect a variety of viruses, including boot viruses, Trojans, worms, spyware, and more.

Backup software used to create copies of data and store them in a secure location.

Debuggers are used to test and "debug" other programs, mainly to solve programming errors.

Disk checkers can scan operating hard drives.

Disk cleaners can find files that are unnecessary for computer operation, and/or take up considerable amounts of space. Disk cleaner helps the user to decide what to delete when their hard disk is full.

Disk compression utilities can transparently compress/uncompress the contents of a disk, increasing the capacity of the disk.

Disk defragmenters can detect computer files whose contents are scattered across several locations on the hard disk, and rearranging the fragments to increase efficiency.

Recap

- Software is mainly classified into System Software and Application Software.
- Application Software is software that helps the user to perform a particular task.
- System software consists of several programs which are responsible for controlling, integrating and managing the hardware components.
- Programming languages are formal languages that are used by the programmers to communicate with the computer system.
- Compiler: Converts the whole program written in high level language to machine language.
- Interpreter: Converts the programs written in high level language to machine language line by line.
- Assembler**:** Converts the programs written in assembly language to machine language.
- A database, often abbreviated as DB, is a collection of information organised in such a way that a computer program can quickly select desired pieces of data.
- Utilities software is software that assists the operating system to do some specialised task.
- Utility software helps to analyse, configure and maintain a computer.
- Debuggers, Disk checkers and Disk cleaners are examples of utility software

Objective Type Questions

1. Which software provides a platform for application software to run on top?
2. Give an example of low level language?
3. What is the name of short codes used in assembly language?
4. High level languages are portable (True / False).
5. What is a programming language?
6. High level language is easily understood by the computer (True/ False).
7. Which is considered as the language of the computer?
8. Name any two language translator?
9. Which utility program converts assembly language to machine language?
10. What is a translator?
11. Name any two programming languages using compilers or translation?
12. Which language translator is used by python?
13. What is utility software?
14. Give examples of any two utility software?
15. What is the full form of DBMS?
16. Name any one antivirus program?

Answers to Objective Type Questions

1. System Software
2. Machine language
3. Mnemonics
4. True
5. Programming languages are used by the programmers to communicate with the computer system.
6. False
7. Machine Language
8. Compiler and interpreter.
9. Assembler
10. Translators convert high level language to machine language.
11. C, C++

12. Interpreter
13. Application software that assists the operating system to do some specialised task is called Utility software.
14. Disk Checker, Disk Cleaner
15. Database management system.
16. Avira

Assignments

1. Compare and contrast Compiler and interpreter.
2. Distinguish between high level language and machine language.
3. What is the role of a database in a software system?
4. Write a short note on assembler.
5. Comment on the features of the database.
6. Explain different language processors.

Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.
2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

Reference

1. https://www.geeksforgeeks.org/utility-software/
2. https://ftms.edu.my/v2/wp-content/uploads/2019/02/PROG0101_CH02.pdf
3. https://www.youtube.com/watch?v=qcEBXrqFLe8

Application Software

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand different types of application software.
- describe the generic features of Word Processor, Spreadsheet and Presentation software.
- identify the general features of Latex software.
- understand computer Viruses and computer protection.

Prerequisites

Consider a marketing executive. He needs to prepare a monthly plan for his activities, create an account for his sales, and also need to present his targets and achievements at the end of the month to his boss.

How does the executive do all these tasks?

First, he writes his monthly plan in his diary. Prepare a ledger for his accounts on paper.

Prepare a list of his achievements and make a presentation on the overhead projector.

What a time consuming process!!!

With the advancements in computer technology, he can easily prepare his monthly plan using Microsoft word. Prepare his accounts using spreadsheets (Excel). Creates his presentation using presentation software like Microsoft presentation.

How easily the marketing executive is doing his jobs now.

Here the software Microsoft office helps him in doing all his activities. This sort of software that is meant for doing a particular purpose or task is called application software.

Key Concepts

Application software, Word processor, Spreadsheets, Presentation software, Computer Virus

Discussion

In this unit we are going to introduce the various application software that we are all using in our daily activities like word processor, spreadsheets and presentation software. The scientific documentation tool Latex with its features is also highlighted. In this unit an introduction to computer viruses and modes of protection is also given.

3.4.1 Application Software

Application software is a computer program that helps users to do some specific task. This type of software is intended for a particular purpose. One of the well known examples of application software is the Microsoft office package.

Application software is also known as end user program.

Application software takes the user input and completes the task for the users. This type of software can perform simple as well as complex tasks.

3.4.1.1 Types of application software

1. Word processing software
2. Spreadsheet
3. Presentation software
4. Multimedia software
5. Database software
6. Simulation software

Word Processing software

This software is used for creating, manipulating and storing text documents.

This is also known as word processor.

Commonly used word processors are Microsoft word, Word pad, Google Doc etc.

Generic features :

Ability to:

- Create word documents, save and edit documents.
- Format text properties like font, alignment, font colour, background colour, etc.
- Check spelling and grammar.
- Add images.
- Add header and footer, set page margins and insert watermarks.

Word processing software will format and beautify the word documents. We can create text, faxes and documents using word processing software. Fig 3.4.1 shows a text created using a word processor.

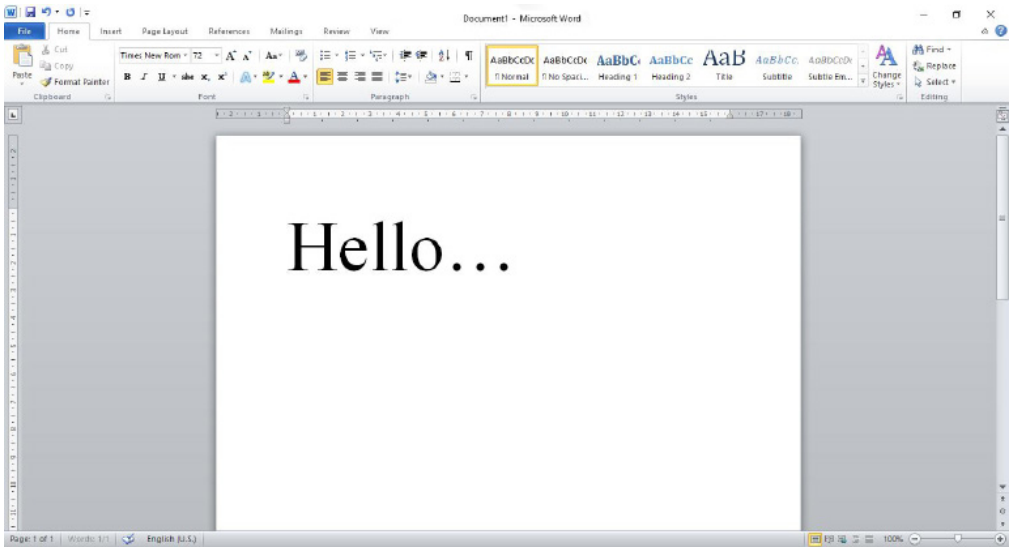


Fig. 3.4.1. Word Processor (Microsoft Word)

Spreadsheet

This type of software is used for performing, calculations. It contains rows and columns. We call each unit a cell. It is a computerised accounting tool.

Commonly used spreadsheets are Microsoft Excel, Google Sheets etc.

We can assign data value as text, date, time and number etc on the cell. Different operations like arithmetic, logical and text operations are possible. Data can be represented graphically using this. One of the well known examples is the Microsoft Excel. Fig 3.4.2 is an example for excel sheets.

List of activities that can be performed with the help of Spreadsheets are:

- Simple calculations like addition, average, counting, etc.
- Preparing charts and graphs on a group of related data.
- Data entry
- Data formatting
- Cell formatting
- Calculations based on logical comparisons

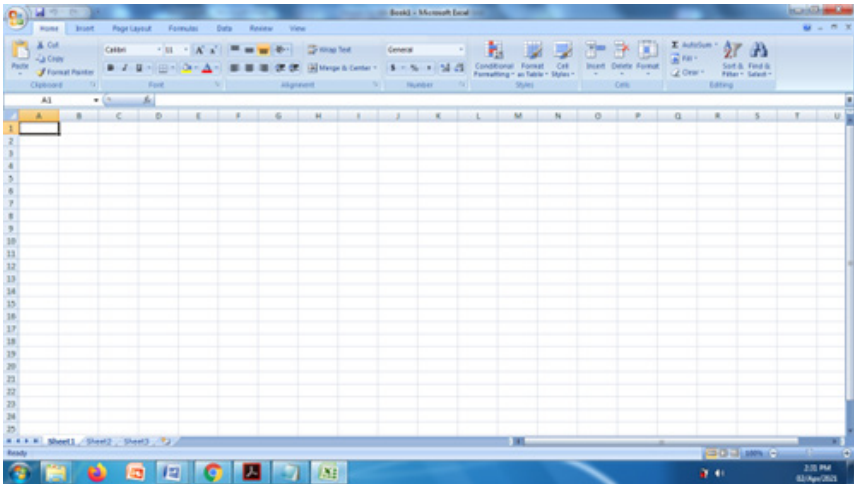


Fig. 3.4.2 SpreadSheet (Microsoft Excel)

3.4.1.1.3 Presentation Tool

The user may use a presentation tool to display information that has been broken down into small chunks and organized on pages called slides.

A presentation is a collection of slides that conveys a concept or an idea to an audience.

Presentation software makes it easier for the presenter to present their ideas and visual information.

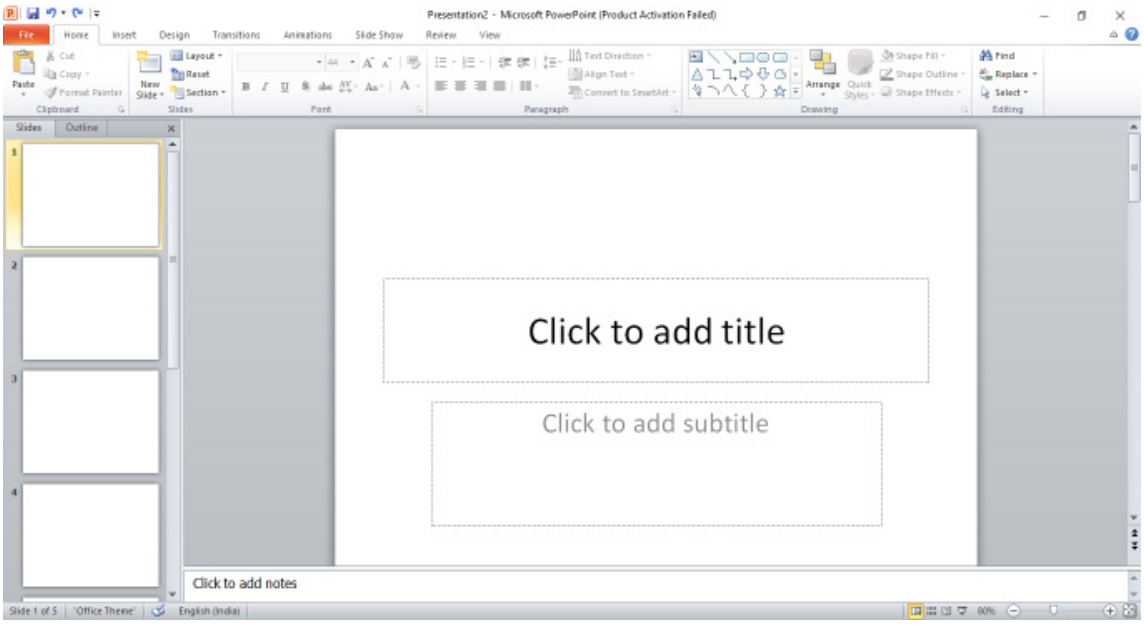


Fig 3.4.3 Presentation tool (Microsoft Powerpoint)

We can add text, graphics, video and images etc. to slides to make them more informative.

Some common presentation tools include MS-PowerPoint, Open Office Impress, Lotus Freelance etc.

Microsoft PowerPoint is a commonly used presentation tool. Fig 3.4.3 shows a presentation using Microsoft powerpoint.

3.4.1.1.4 Latex

This is a document preparation system. It provides designs for high-quality scientific and technical documentation. Latex is a free software.

Features of Latex

- Typesetting journal articles, technical reports, books, and slide presentations.
- Control over large documents containing sectioning, cross-references, tables and figures.
- Typesetting of complex mathematical formulas.
- Advanced typesetting of mathematics with AMS-LaTeX.
- Automatic generation of bibliographies and indexes.
- Multilingual typesetting.
- Inclusion of artwork, and spot colour.
- Using PostScript or Metafont fonts.

One of the most important reasons why people use LATEX is that it separates the content of the document from the style.

This means that once you have written the content of your document, we can change its appearance with ease. Similarly, you can create one style of document which can be used to standardise the appearance of many different documents.

3.4.2 Computer Virus and Protection

3.4.2.1 Computer Virus

A computer virus is a malicious code or program that is written to change the way a computer works and is intended to spread from one computer to another. Viruses usually damage the device or it steals data from it.

There are different ways by which the virus enters the computer like:

1. Sharing files, music and photo with others etc.
2. Visiting an infected webpage.
3. Opening spam email or other attachments.

Once a computer is infected by the virus, the following problems arise:

1. Slow performance
2. Frequent computer crashes
3. Data loss and corruption
4. Identity Theft
5. Inconsistent computer behaviour

Different types of viruses

1. Worms
2. Trojan
3. Ransomware etc.

3.4.2.2 Computer Protection

- Use an antivirus program and firewall.
- Antivirus is utility software that protects the computer from viruses.
- Firewall is a network security device that filters the incoming and outgoing network traffic based on the organisation's security policy.
- Update the antivirus and firewall frequently.
- Update the Operating system regularly.
- Increase browser security.
- Download contents from trusted sites only.

Recap

- Application software is a computer program that helps users to do some specific task. This type of software is intended for a particular purpose.
- Different types of application software are:

  a. Word Processing Software

  b. Spreadsheet

  c. Presentation software

  d. Multimedia software

  e. Database software

  f. Simulation software
- Word processor software is used for creating, manipulating and storing text documents.
- Spreadsheets are used for performing calculations. It contains rows and columns, we call each unit a cell.
- Presentation tools help the users to display information that has been broken down into small chunks and organised on pages called slides.
- Latex is a document preparation software. It provides designs for high quality scientific and technical documentation. Latex is a free software.
- A computer virus is a malicious code or program that is written to change the way a computer works and is intended to spread from one computer to another.
- Viruses usually damage the device or it steals data from it.

Objective Type Questions

1. What is the other name of an application software?
2. Which software is used for creating, manipulating and storing text documents?
3. Give an example of spreadsheet software?
4. Which software is used for creating presentations?
5. Latex is a Document Preparation System (True/False).
6. What is a computer virus?

7. Which type of network security device filters the incoming and outgoing network traffic based on the organisation's security policy?
8. A presentation is a collection of slides that convey a concept or an idea to an audience (True/False).
9. Spreadsheets are used for performing calculations (True/False).

Answers to Objective Type Questions

1. End user program
2. Word processor/Microsoft word/Wordpad/Google docx
3. Google sheet/Microsoft Excel
4. Presentation software/MS Powerpoint/Open office
5. True
6. Computer virus is a malicious code or program that is written to change the way a computer works.
7. Firewall
8. True
9. True

Assignments

1. What are the features of a spreadsheet?
2. Why is latex used for scientific writing?
3. Write notes on presentation software.
4. How can you improve the protection of your computer from viruses?
5. Comment on the types of computer viruses.

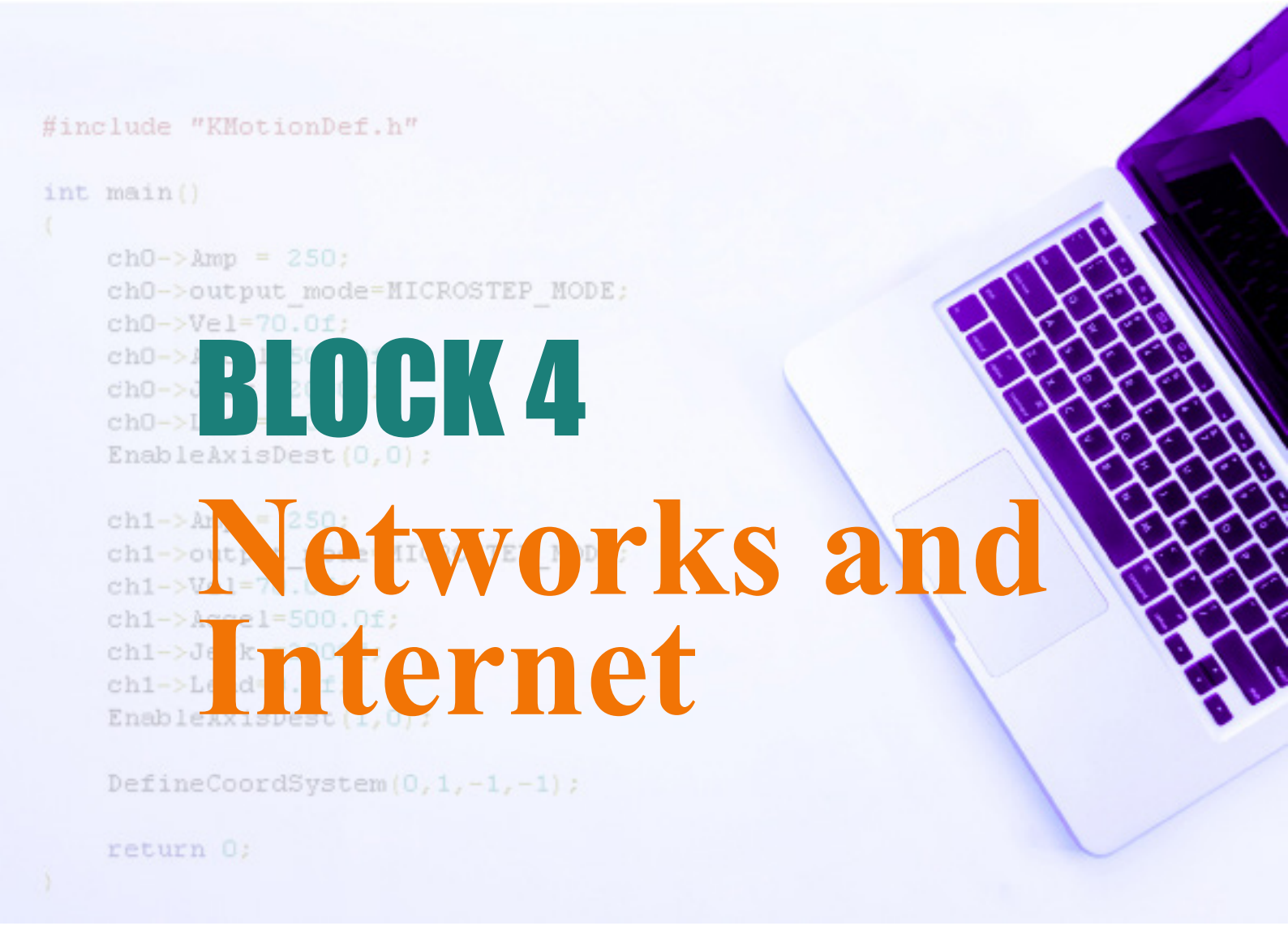
Suggested Reading

1. Introduction to Information Technology, 2nd Edition, ITL Education Solutions Limited, Pearson.

2. John D.Carpinelli, Computer systems Organization & Architecture, Pearson Education. E.Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014.
3. Carl Hamacher, Vranesic, Zaky, Computer Organization 4th Edition, McGraw-Hill.
4. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014.
5. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition.

Reference

1. https://en.wikibooks.org/wiki/Introduction_to_Computer_Information_Systems/Application_Software
2. https://www.quickbase.com/articles/application-software-basics#



BLOCK 4

Networks and Internet

Basic Concepts and Devices

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the basic concepts of computer networks
- study various types of computer networks
- understand the basic concepts of networking devices
- learn various types of networking topologies
- study on Network operating Systems

Prerequisites

We learned about the fundamentals of computers, memory, and software in the previous units. In this unit, we can have a look at how computers communicate with one another and work together.

Communication refers to how the transfer of information takes place from one point to another. Accordingly, a communication process involves a sender, a receiver, and a transmission medium. A simple communication model is given in Fig. 4.1.1.

Fig 4.1.1 Communication Model

As shown in the above figure, the **sender** initiates a message or will be the source of the message that sends the information to the receiver through a proper transmission medium.

Next, we can see what a **transmission medium** is**?** We shall study it through a simple example. Suppose you want to send birthday wishes to your friend. What will you do? You can choose different options like sending a letter by post, using a telephone or mobile. While sending a letter by post, the medium used is the postal department. If you use the telephone, the medium is a telephone line or if you use a mobile, the medium is air. There are two types of transmission medium as shown in Fig. 4.1.2.

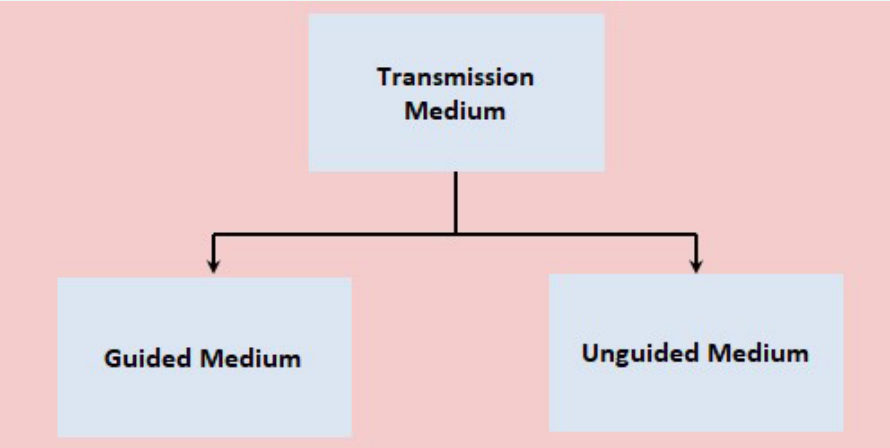


Fig 4.1.2 Types of the Transmission Medium

In the above figure, the guided medium is the physical medium through which the signals are transmitted. Here, the message is guided through a physical channel. Examples are copper cables or optical cables.

An unguided medium uses the transmission of signals without using any physical medium. Therefore it is known as wireless transmission. Examples are Radio waves, microwaves, infrared, etc.

Finally, the **receiver**, accepts the information from the sender through a proper transmission medium as shown above. The receiver is also called the destination of the message.

Key Concepts

Network types, Networking Devices, Network Topologies, Network operating System

Discussion

4.1.1 Basic Concepts of Computer Networks

You might have seen a group of computers in railway stations, banks, schools, etc. Do you know what those groups of computers are called?

Before answering the above question, try to imagine a family of 4 members; father, mother, and two children as shown in Fig. 4.1.3.

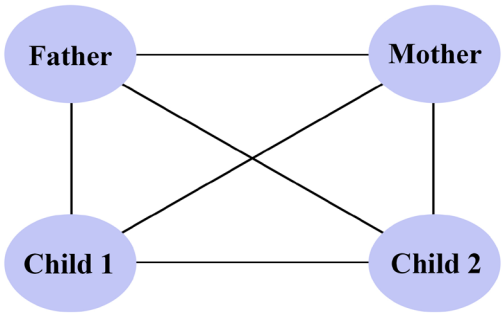


Fig. 4.1.3 Example of a family network

As you can see in the figure 4.1.3, the father communicates with the mother and two children. Likewise, the mother communicates with the father and two children, and so on. You can see that everyone in the family network can share their resources and information. Thus, they form a family network. Consider another example as in Fig. 4.1.4 where the family network communicates with other networks.

As shown in Fig 4.1.4, the family network communicates with the outside world. The members of the family can share their information with other networks such as school, workplace, store, and restaurant. Thus it forms a larger network. From the above two examples, you can understand the concept of a small network as well as a large network involving human interactions.

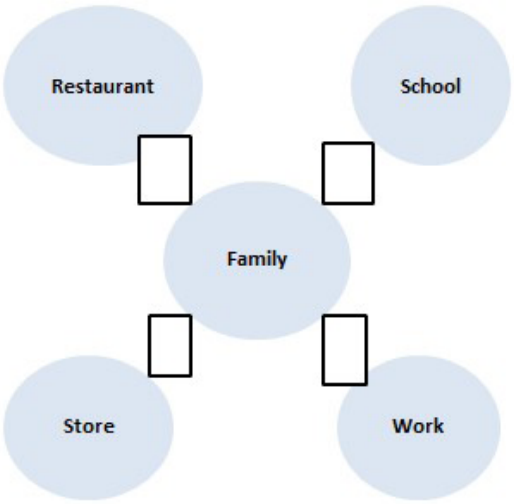


Fig 4.1.4. Example of a family network communicates with other networks

Likewise, a group of computers and networking devices connected or linked to one other is called a **computer network**. Using a computer network, we can communicate, and share resources, data, and applications between computers.

4.1.1.1.Need for Computer Networks

You just imagine working with individual computers that are not connected together.

In a single computer, we have to separately connect devices such as a printer, scanner, modem; as well as the installation of costly software. Here, arises the benefit for you of using a computer network. That means that we need only one set of devices connected to one another and can easily share data with all the computers in the network.

The general advantages of computer networks can be listed as follows:

- **File-Sharing:** If you are connected to a network, you can send your files to other users. Similarly, you can request files from other computers. That is we can upload data from our computer to other computer and also can download data from other computer to our computer.
- **Hardware sharing:** Suppose you are working in an office, and the computers in the office are networked. There can be one printer connected to one of the computers. This one printer can be shared among the users. Whenever anyone in the office wants to get a print out, just give the print command from their computer so that the printer connected to the computer network initiates printing.
- **Application sharing:** A computer network can be used to share programs and applications. An application installed in one computer can be used in another one connected to the network, provided the former shall permit accessing it.
- **User communication:** Different users connected in the network can communicate using messaging.You might be familiar with SMS services over mobile phones, messaging applications like Whatsapp, Twitter, etc.

4.1.1.2 Model and Working

A basic model of the computer network is shown in Fig 4.1.5.

We can see a server, two Personal Computers (PC), a network switch, and a printer in Fig. 4.1.5. Remember that the device that is connected to a network is commonly called a **node**.

The **server** or host computer may be a computer or system that provides necessary data, services, resources, or programs to other computers (clients) connected to the network. If a client requests data or services to a server, the server receives the request and sends the necessary data or provides the services asked for.

A **network switch** helps you to connect and communicate with all the devices in the network through its ports. Its foremost purpose is to send, receive or forward data across the network.

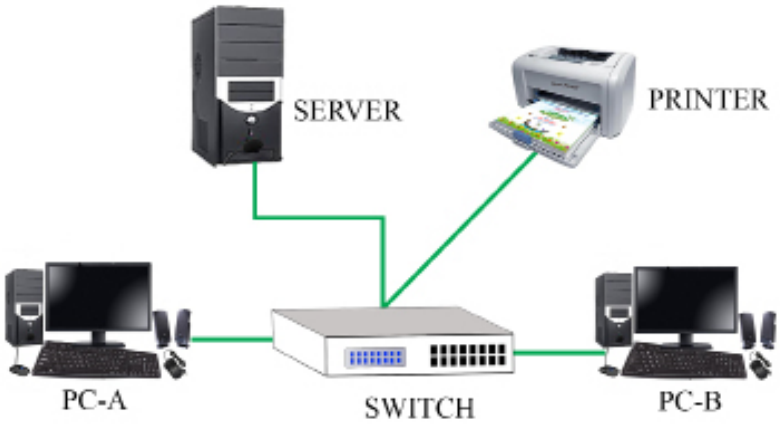


Fig 4.1.5 Basic Computer Network

A **printe**r is a hardware device used for printing files and documents in a network.

Working of a computer network

As shown in the above figure 4.1.5, the switch connects all the devices in the network. If you want to take a printout using the PC-A, you have to follow the steps below:

Step 1: PC-A sends a request to the switch and the switch acknowledges the request to PC-A.

Step 2: Switch sends a request to the printer and the printer acknowledges the request to the switch.

Step 3: Connection is established between PC-A and printer through the switch.

Step4: Printer prints the required document.

Similarly, if you want to take a print out from PC-B, all the above steps should be followed. Thus it is possible that the two computers share a common printer.

4.1.2 Types of Computer Networks

In the earlier sections, we discussed the concepts of computer networks. Next, we shall focus on the different types of computer networks.

You might have seen a group of computers in a DTP centre or a computer classroom. Have you noticed how the computers are networked together?

The computers are arranged in different ways to meet the requirements of the DTP centre and those of a computer classroom.

Now, we shall look into the various types of computer networks.

There are various types of networks used for different purposes and by different types of people and organisations. They are designed to operate as per the network requirements, service type, and network coverage area. They are classified as given below in Fig 4.1.6.

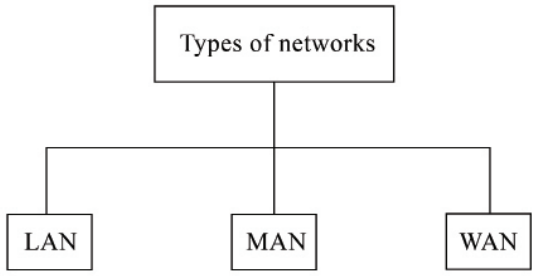


Fig 4.1.6 Types of Computer Networks

4.1.2.1 Local Area Network (LAN)

Consider a large hospital with various departments. The doctors in each department can communicate with other departments with the help of their personal computers. They can share information within their department and with other departments. But, it is limited to that hospital.

Similarly, LAN is a computer network limited to a small geographical area. This area may be one building or one campus within a few kilometres. It is one of the most frequently and commonly used networks.

4.1.2.2 Metropolitan Area Network (MAN)

Metropolitan Area Network is a type of computer network that spans over a metropolitan area, that is a city. A cable TV connection network is an example of MAN.

4.1.2.3 Wide Area Network (WAN)

You have been introduced to LAN networks. Now, we have to focus on Wide Area Network (WAN).

Let us take the same example of the hospital above. In this case, the network covers a group of hospitals within the country as well as outside the country. The doctors can share their information within and outside the country. Therefore, it covers a large geographical area.

Correspondingly, WAN is a wireless network used to communicate with one another irrespective of the distance that separates them. They also facilitate communication and the sharing of information across devices from anywhere in the world.

4.1.3 Networking Devices

In the previous section, you should have understood the concept of computer networks. Now, we shall move on to networking devices.

You might have seen computer networks in hospitals, banks, schools, railway stations, etc. Consider any one of those networks above.

Apart from the computer systems, we can see hardware devices called networking devices which are used to interconnect computers. They are also called networking hardware or networking equipment. Do you know how these networking devices can be useful?

It can be very useful in data transfer and communication. It can also be used to connect computers, printers, fax machines, and other electronic devices to a network.

The different types of networking devices are shown below:

- Hub
- Switch
- Router
- Repeater
- Bridge

4.1.3.1 Network Hub

Suppose you want to send an anniversary card to your uncle. You can use ordinary postal services in a post office. The post office will deliver the letter to the addressee or any other person available at that address. The limitation is that anybody can see the card. In this example, the post office is the same as that of the hub.

A hub is a multiple-port network device

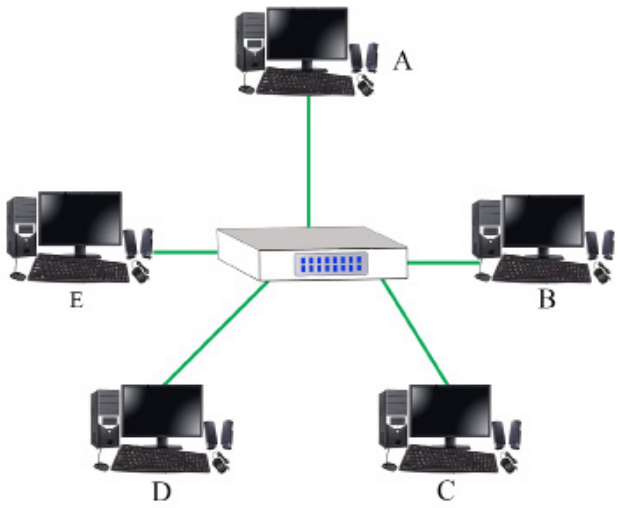


Fig.4.1.7 Working of network hub

used to connect multiple computers or other network devices. In a hub, the data is transferred in the form of packets. Whenever the data transfer is done from a device to a network hub, the data is transmitted to all the connected ports as shown in Fig 4.1.7.

Fig. 4.1.7 consists of five computers (nodes-A to E) connected with a common hub. Assume you want to transfer data from A to C through the hub. The hub receives the data in all the ports from A and transfers it to C. The disadvantage is that unwanted ports also get the data.

Therefore, the communication is not secure.

4.1.3.2 Network Switch

The working of a network switch is similar to a hub.

The main difference is that the hub is used for forwarding the data, but the switch filters and forwards the data in the form of packets. So it deals in an intelligent way of data transmission.

Assume, you want to send an anniversary card to your uncle using a registered post. The post office will deliver the card only to the specified addressee.In this example, the post office can be considered a switch. A typical network switch is given in Fig 4.1.8.

As you can see in the figure 4.1.8, it consists of five computers (nodes-A to E) connected to a common switch. If you want to transfer data from A to C through the switch. The switch receives the data in the designated port only from A and transfers it to C. The advantage is that the unwanted ports will not get the data. Therefore, the communication is secure. Nowadays, switches are being used everywhere in the place of the hub.

4.1.3.3 Network Router

You have already learned about the difference between hub and switch. Now, we shall discuss network routers.

Consider two classes- Class A for boys and Class B for girls. The boys in Class A can form a network, as well as the girls in Class B. The two classes have a common class teacher who is in control of both the classes. Suppose a boy in Class A wants to discuss the annual day celebrations with a girl in Class B. As the class teacher is

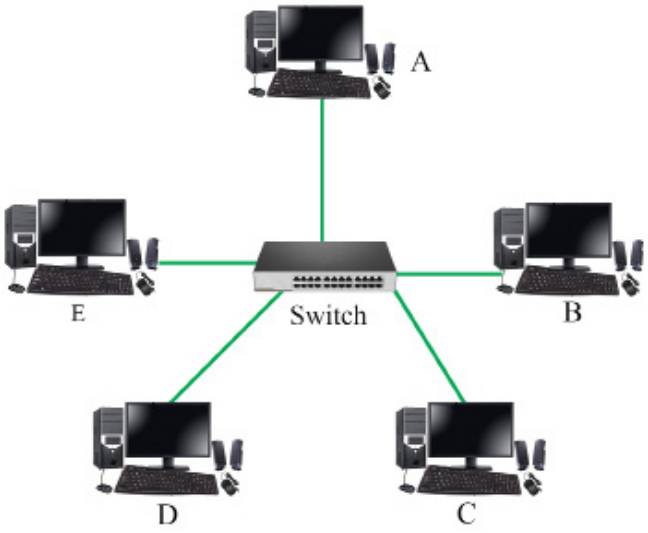


Fig. 4.1.8 Working of network switch

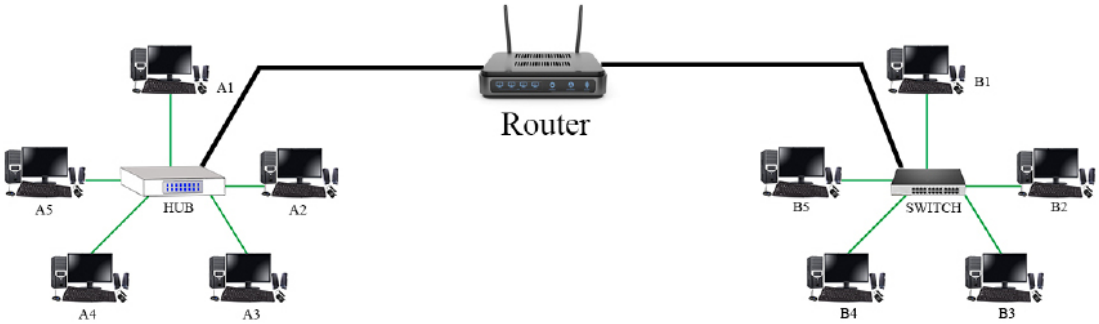


Fig. 4.1.9 Working of Router

in control of both the classes, the boy in Class A first communicates with the class teacher. If the teacher gives permission, he will be able to discuss with the girl of class B, otherwise, he won't be. In this analogy, the class teacher acts as a router.

The network router in a computer network is a networking device mainly used for connecting two individual networks. It is responsible for receiving, analysing, and forwarding data among the connected computer networks. When the data reaches the router, first of all, the router checks the destination address, then chooses the optimal route, and finally, transfers data along this route. Fig 4.1.9 shows how the router transmits data from one network to another. Here A represents one network and B represents another.

As you can see in the figure, network A consists of 5 computers (nodes-A1 to A5) and network B also has 5 computers (nodes-B1 to B5). Assume that you want to transfer data from A5 to B2. We can see that A5 is a network node connected using a hub and B2 a network node connected using a switch. At first, node A1 sends the data to the hub, the hub forwards the data to the router, the router then forwards the data to the switch, and finally, the switch transmits the data to the B2 node.

4.1.3.4 Network Repeater

Consider you and your family are travelling by car from Trivandrum to Ernakulam. While travelling, you notice that the fuel is running out and the vehicle is going to stop. What will you do?

You will find a petrol pump, fuel up and continue your journey. This is what happens in a repeater, which means a repeater is similar to a petrol pump.

As shown in Fig. 4.1.10, there are four computers(nodes) in the network separated by a repeater. If node A wants to transmit data to node D and the signal weakens while transferring the data, the repeater strengthens the data and then retransmits

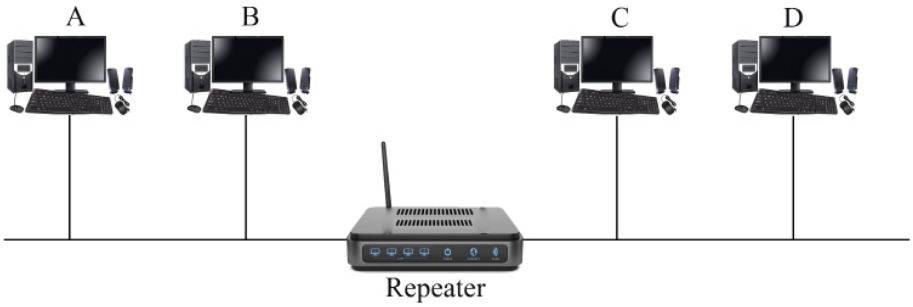


Fig. 4.1.10 Working of Repeater

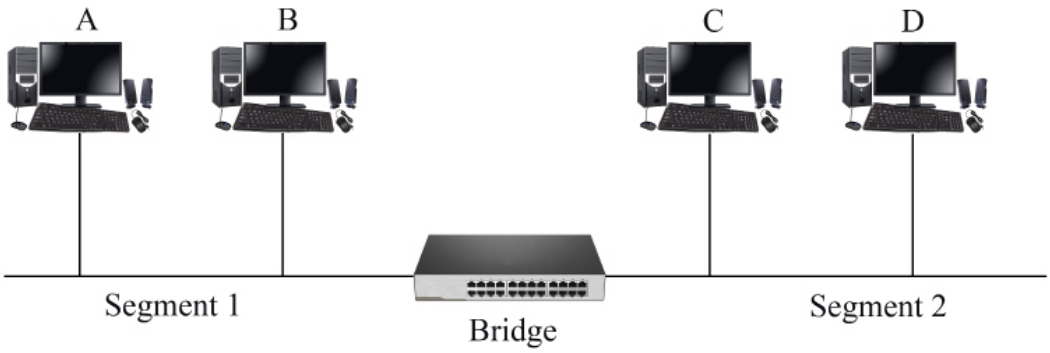


Fig 4.1.11 Working of Bridge

it to the destination node.

4.1.3.5 Bridge

A network bridge is a networking device that divides network traffic into segments. It connects two or more LANs for sharing the information. A typical bridge is shown in Fig 4.1.11. Its main function includes filtering, forwarding, and blocking data.

As shown in the figure above, the LAN is divided into two segments. The first segment consists of two computers (nodes-A, B), and the second segment consists of nodes-C, D respectively. The two segments are separated using a network bridge. If you want to send data from node A to node D, the bridge checks the address of node D as well as the segment of node D. After that, the bridge forwards the data to node D and thus reduces the traffic.

4.1.4 Workstation

In the previous section, you were introduced to various networking devices. In this section, we shall know the concept of the workstation.

It is a computer dedicated to a user or group of users involved in business or professional work. It includes one or more high-resolution displays and a faster processor than that of a personal computer. As the workstation has additional random access memory (RAM), drives, and drive capacity, it is capable of performing multitasks. In addition, the workstation is capable of sharing resources with client computers and network servers.

4.1.5 Topologies

Having discussed the concepts of different

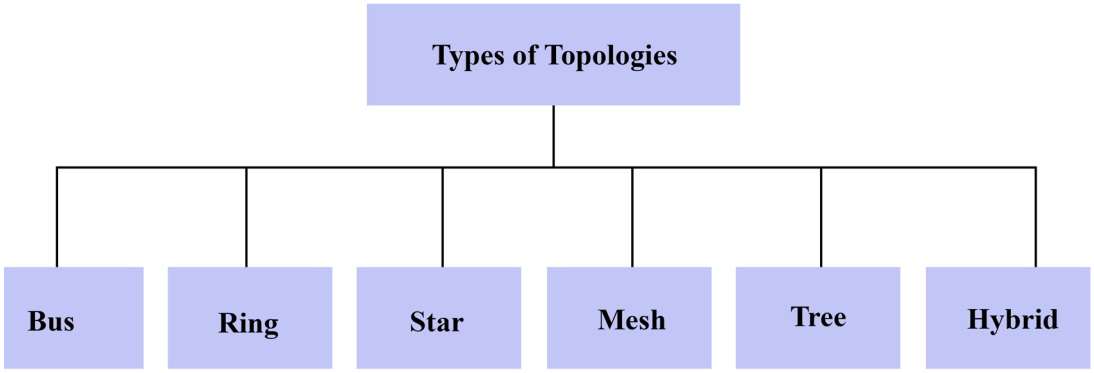


Fig 4.1.12 Types of Topologies

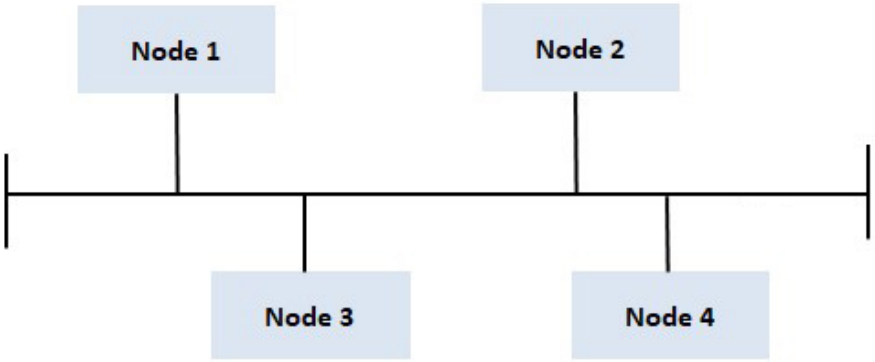


Fig 4.1.13 Bus Topology

types of networks and workstations, we shall now move on to network topologies.

The term topology refers to the way computers in a network are connected. It explains how a network is physically connected and the logical flow of information in the network. The different topologies are shown in Fig 4.1.12.

4.1.5.1 Bus Topology

In a bus topology, the nodes in a network are connected through a single cable known as the backbone cable as given in Fig 4.1.13. We call this main cable a bus.

The figure 4.1.13 consists of four nodes (1 to 4) connected to a common bus cable. If you want to send data from node 1 to node 4, you can send it with the help of the common bus.

4.1.5.2 Ring Topology

In a ring topology, all computers are connected using a cable that loops in a ring or circle. A ring topology is a circle that has no start and no end terminators.
In this topology, each device is connected with the two devices on either side. The ring topology is shown in Fig 4.1.14.

In a ring topology, data is sent in one direction using a token system. As you can see in the figure above, there are 4 nodes connected with a cable. Suppose, you want to send data from node 1 to node 4. Node 1 can transmit data only when the token is available with node 1. The data packet travels through node 1, node 2, node 3, and finally reaches node 4.

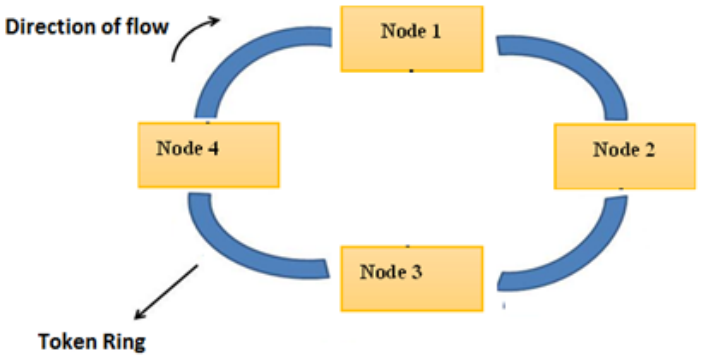


Fig 4.1.14 Ring Topology

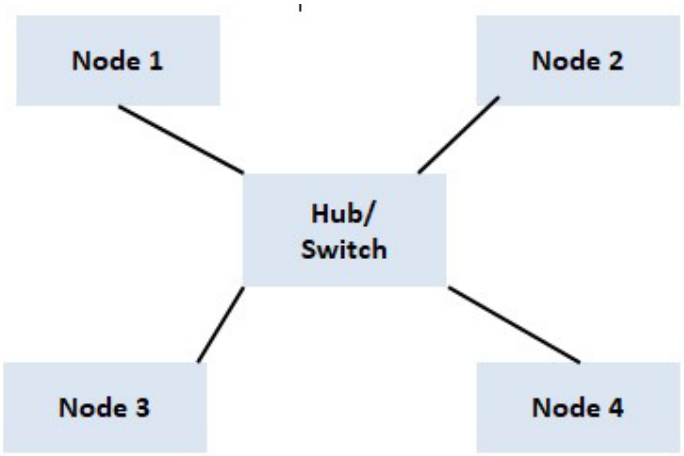


Fig 4.1.15 Star Topology

4.1.5.3 Star Topology

In star topology, each device in the network is connected to a central device called the hub. The star topology does not allow direct communication between devices; a device has to communicate through the hub. The star topology as shown in Fig 4.1.15. You may review the role of the hub we discussed in networking devices.

If you want to send data from node 1 to node 3, it goes first from node 1 to the hub or switch and then the hub transmits that data to node 3.

4.1.5.4 Mesh Topology

A mesh topology is a network setup in which we can connect each device to all the devices in the network. Therefore, the data transfer easily takes place even if one of the connections goes down. The mesh topology is given in Fig 4.1.16.

As you can see there are 4 nodes connected back to back so that data can be transferred from one node to any other node. If you want to send data from node 2 to node 3, you can send data directly to node 3 or you can use node 2 to node 1 and then node 3 or node 2 to node 4 and then to node 3. If we have 'n' nodes, then number of edges in a mesh topology is equal to n(n-1)/2.

4.1.5.5 Tree Topology

The tree topology is a network topology in which the devices are organized in the form of a tree structure with branches.

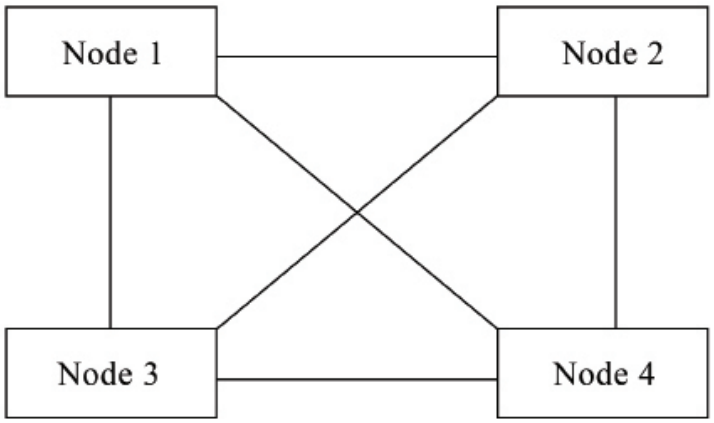


Fig 4.1.16 Mesh Topology

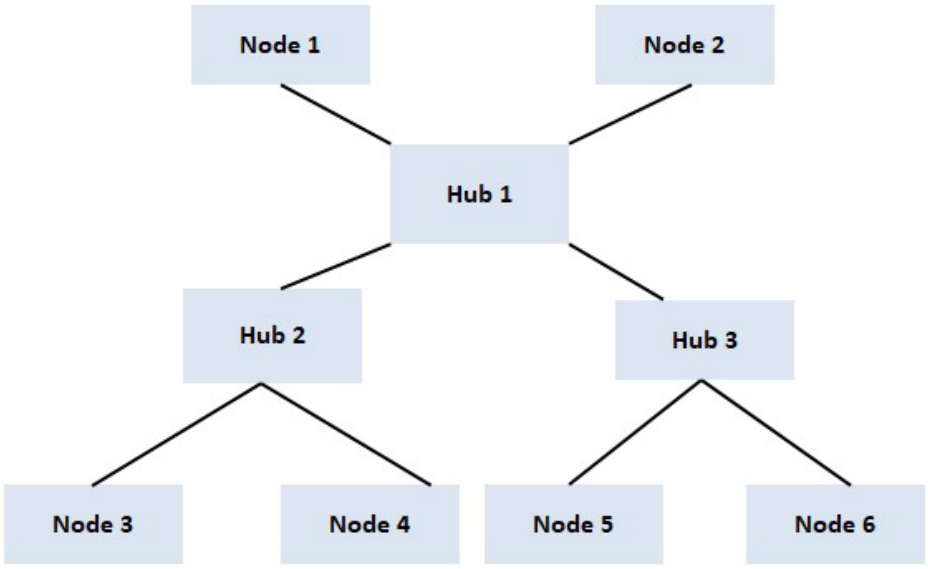


Fig 4.1.17 Tree Topology

Here, all the nodes are directly or indirectly connected to the main bus cable. It is a combination of Bus and Star topology where the whole network is divided into segments. The structure of the tree topology is given in Fig. 4.1.17. It consists of six nodes (1 to 6) and three hubs (1 to 3).

Assume you want to transmit data from node 1 to node 6 in the above figure. Here, Node 1 first transmits the data to hub 1, then to hub 3, and finally to node 6 to complete the data transfer. Similarly, if node 2 wants to transmit data to node 3, node 2 sends the data to hub 1, then to hub 2, and finally to node 3.

4.1.5.6 Hybrid Topology

Hybrid topology is a type of network topology that uses two or more different network topologies. These topologies can include a mix of bus topology, mesh topology, ring topology, star topology, and tree topology. The choice to use a hybrid topology over a standard topology depends on the needs of a business, school, or user. The hybrid topology is given in Fig 4.1.18.

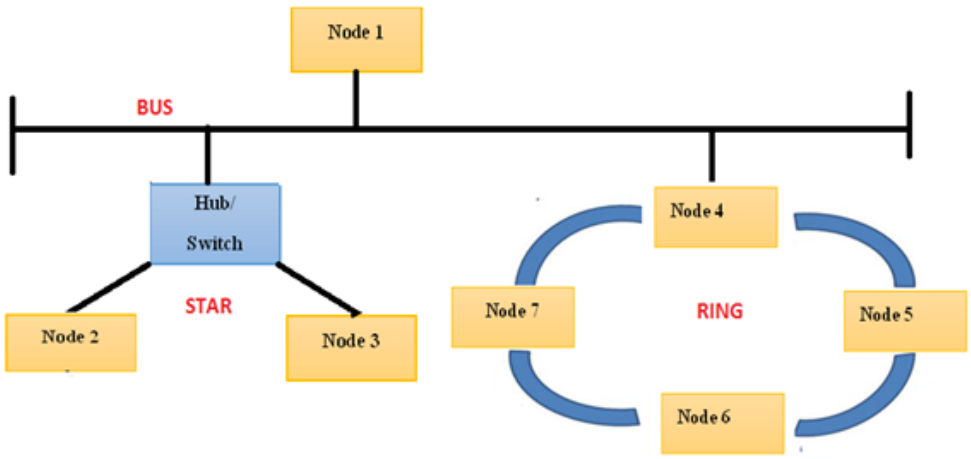


Fig 4.1.18 Hybrid Topology

As you can see, three topologies such as Bus, Star and Ring are combined to form a hybrid topology. In this hybrid topology consist of, bus topology has one node (node 1), Star has 2 nodes (node 2 and 3), and Ring has 4 nodes (nodes 4, 5, 6, and 7).

Suppose you want to transmit data from node 1 to node 2. What will happen?.

Node 1 first transmits the data to the hub of the star topology and then the hub transmits the data to node 2.

Now, consider the data transfer from node 1 to node 6. Here node 1 uses bus topology and node 6 uses ring topology. First of all, node 1 transfers the data to node 4, then to node 5, and finally to node 6 while it receives the token.

4.1.6 Network Operating Systems (NOS)

You might be familiar with the word operating systems in computers like Windows, Linux, etc. In this section, we discuss what a Network Operating System is?

From the name itself, you can assume that it is an operating system for the networks. Unlike operating system in a single computer, network operating system (NOS) coordinate the communication activities of multiple computers across a network to keep the network running smoothly. The two major types of network operating systems are:

- Peer-to-Peer
- Client/Server

4.1.6.1 Peer-to-Peer

Peer-to-peer type of network operating system helps you share resources and files of your computer as well as to access files and resources on other computers. However, this type does not possess a file server or a centralized management system. In a peer-to-peer NOS, all computers are considered equal and have the same capabilities to use the resources available on the network. They are mainly designed for small to medium local area networks.

4.1.6.2 Client/Server

Client/server type of network operating system helps you to centralize the functions over the network and has one or more dedicated file servers. The file servers allow you to access resources as well as providing security in the network. In addition, this NOS allows you to integrate all the devices and share the same resources with multiple users irrespective of their location.

Recap

- Communication transfers information from one place to another
- Transmission medium may be guided or unguided
- A computer network connects computers and network devices
- A computer network shares resources, data, applications etc.
- A server provides data, services, resources, or programs to other computers
- LAN is limited within a small geographical area
- WAN - used without geographic limitations
- Network devices are called networking hardware or networking equipment
- Network hub connects multiple devices without intelligence
- Network switch connects multiple devices with intelligence
- Network router transfers data in packets
- Repeaters regenerate the signal across the same network
- Bridge divides a network into segments.
- Workstation has multitasking capability
- **Topology** describes physical connection and logical flow of information in the network.
- **Bus** topology uses a single cable called bus.
- **Ring** topology connects computers in a ring or circle.
- **Star** topology communicates through the hub or switch.
- **Mesh** topology interconnects all the devices with one another.
- **Tree topology** connects devices like tree branches.
- **Hybrid topology** uses combination of different topologies.
- **NOS** manages the networking services

Objective Type Questions

1. What type of transmission medium uses a physical channel?
2. What is the technology used in an unguided medium of transmission?
3. What is a group of computers and networking devices called?
4. What type of device is a printer?
5. Which type of network is limited to a building?
6. What is the expansion of WAN?
7. Which is the network that has no geographical limitation?
8. Which networking device is used as an intelligent multiple-port device?
9. Which networking device can be used for connecting two individual networks?
10. Which is the networking device used to strengthen the signal for transmission?
11. Which is the networking device that divides network traffic into segments?
12. Which has high-resolution displays and a faster processor than a personal computer?
13. What gives the logical flow of information in the network?
14. Which topology connects all the nodes in a network through a single cable?
15. Which topology uses a token system?
16. Which topology connects all nodes to a central connection point?
17. Which topology forms when you combine bus and star topologies?
18. What is the name of the operating system that coordinates multiple computers across a network?

Answers to Objective Type Questions

1. Guided
2. Wireless
3. Computer networks
4. Hardware
5. LAN
6. Wide Area Network
7. WAN
8. Switch
9. Router
10. Repeater
11. Bridge
12. Workstation

13. Topology
14. Bus
15. Ring
16. Star
17. Tree
18. Network operating system

Assignments

1. Prepare a note on the different types of transmission media with examples.
2. Prepare a note on the evolution of computer networks.
3. Discuss in detail about the token system in a ring topology.
4. Explain Network Operating System (NOS).
5. Describe the concept of a computer network using the analogy of a family network.
6. What distinguishes WAN, MAN and LAN and how it is used in practical scenario?

Suggested Reading

1. Peterson, Larry L., and Bruce S. Davie. Computer networks: a systems approach. Elsevier, 2007.
2. Forouzan, Behrouz A., and Firouz Mosharraf. "Computer networks: a top-down approach." (No Title) (2012).
3. "Computer Networking" by James F Kurose and Keith W Ross.
4. "Fundamentals Of Computer Networks" by Sudakshina Kundu.

Reference

1. William Stallings, "Data and Computer Communication" Pearson Education, 8th edition.
2. Andrew S Tanenbaum,"Computer Networks" Pearson Education, 3rd edition.
3. B. A. Forouzan - Data communication and Networking, Fourth edition, TMH
4. Cryptography and Network Security Principles and Practices, William Stallings, Fifth Edition
5. Douglas E. Comer, Computer Networks and Internets.

UNIT 2

World Wide Web and Search Engines

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- learn the history and the concepts of the Internet
- understand the concept of the world wide web
- get understanding on website, web page, and Uniform Resource Locator
- get an idea about the concept of browsers and search engines
- understand the tips used while searching the Internet

Prerequisites

In the previous unit, we discussed Computer networks, types, network devices, and topologies. In this unit, we focus on the concepts of the Internet, the World Wide Web, and Search Engines.

Consider a network consisting of five computers (nodes) and a common switch shown in Fig. 4.2.1.

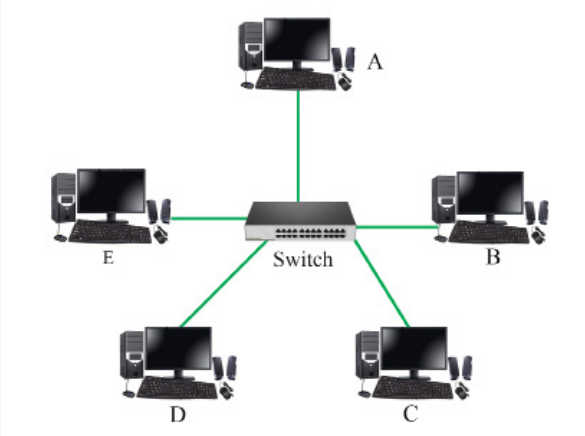


Fig. 4.2.1 Computer Network

As you can see in the figure above, all the nodes are connected to a common switch. The working of the diagram is as explained below.

Suppose node A wants to share a file with node C. At first, node A sends a request to the switch, the switch acknowledges the request and sends another request to node C to check whether node C is busy or not. After that, node C acknowledges the request, and then a connection is established. Finally, node C receives the file from node A through the switch. This is just an example of how computers communicate inside a room or a part of the building.

Now, try to think of communication of computers with the outside world such as another state, country or any part of the world. i.e., how the devices communicate with the outside world.

It is possible only with the help of the Internet. We are all familiar with the term Internet, and definitely, you might have used the Internet for one or other purpose in your daily life. You may be using Google or Yahoo to search for something on the Internet. You can also send messages through WhatsApp, Facebook, or paying your semester fees or monthly telephone bill online etc. Thus the Internet helps you in many ways to perform your daily tasks.

Key Concepts

Internet, World Wide Web, Website, Browser, URL, Search engine

Discussion

4.2.1 History of the Internet

The Internet is an inevitable facility in our daily lives today. Can you imagine a world without the Internet? In today's world it is just unimaginable.

Suppose you want to send a document to your friend residing in another country. What is your first and easiest option? You will use your smartphone, tablet, or computer to send the document as an email.

Do you know how it is possible? It is possible because of the Internet. Likewise, different online activities can be done with the help of the Internet. Before explaining the Internet concept, we should have a look at the history of the Internet.

Do you know that it was in 1958, that the Advanced Research Projects Agency (ARPA) led to the creation of the Internet? At that time, it was used for defense applications in the United States with the help of physical cables.

It was in 1962, J.C.R. Licklider has recommended connecting computers with an active communications network in the incident of a nuclear attack. This

communication network came to be called the ARPA Network, or ARPANET.

It was in 1965, that packet switching was introduced for data transmission. The Stanford University Network was the institution that used the first local area network for connecting distant workstations. In 1981, the ARPANET was extended to national computer science researchers.

Later, in 1983, ARPANET adopted the transmission control protocol (TCP) and accelerated the spread of internetworking technology for public research. The ARPANET technology not only expanded to the university campuses across the US but also acted as Internet Service Providers to support commerce and industry.

In 1985, the National Science Foundation Network (NSFNET) was used for connecting university computer science departments across the U.S. The NSFNET became a linked resource for the supercomputing centers across the U.S to connect researchers to regional networks. Eventually, NSFNET took the role of Internet provider across the US, and thus ARPANET gradually phased out by 1990.

In 1989, there was a dramatic change in Internet communications. Tim Berners-Lee of the European Council for Nuclear Research (CERN) has founded the hypertext transfer protocol (http), which has since been used as standardisation in different computer platforms and has the ability to access the same internet sites. For this reason, Tim Berners-Lee is called the father of the world wide web (www).

In 1993, the Mosaic web browser was created at the National Center for Supercomputing Applications (NCSA). It is regarded as a key development that emerged from the NSFNET. In the long run, the NSFNET modified its acceptable use policy for commercial use and was decommissioned in 1995. Soon, the Internet provider model was created and the commercial side of the Internet was developed.

4.2.2 Internet

You learned the history of the Internet in the previous section. Now, it is time to learn the concepts of the Internet.

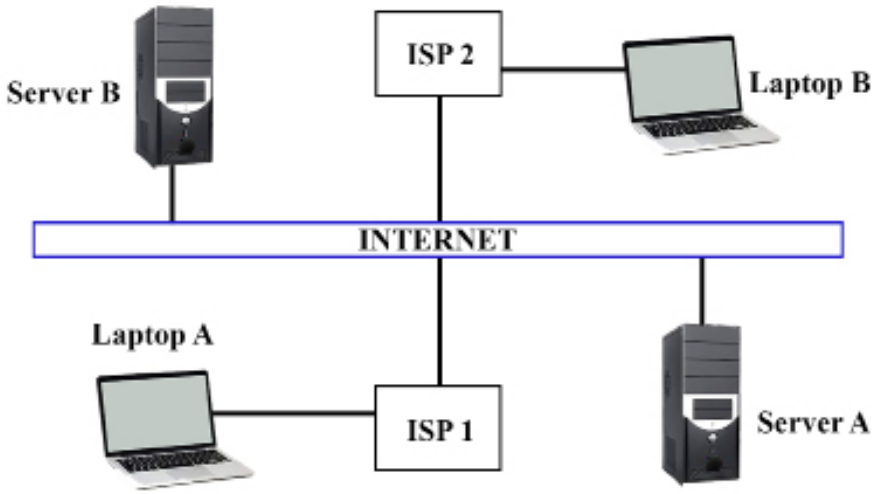


Fig 4.2.2 Working of Internet

Imagine that you are in your home country and your friend is in another country. You are using Gmail and your friend is using Yahoo mail. You want to send an important document related to a visa to your friend using the Internet using email. What will you do?

You just open the Gmail browser on your computer or smartphone, and upload the necessary document and send it as an email to your friend who is using Yahoo Mail. Your friend opens his Yahoo mail browser, checks the mail, and downloads the document. Although Gmail and Yahoo mail use different servers, they are interconnected with each other using the Internet for sending the email.

Have you ever thought of the different components involved in sending the email?

They Include hardware, software, and Internet Service Providers (ISPs). Internet Service Providers (ISPs) is a company offering Internet access to users for the transfer of data and communication across the world. Examples of ISPs are MTNL, BSNL. Airtel, Reliance Jio, etc.

Consider another situation. Suppose you want to buy a smartphone from amazon using the Internet.

First, you should open the browser on your computer, then type the address www.amazon.com. The Internet Service Provider (ISP) will then connect to the amazon web server, collect the required web pages and send them to your computer. You can select the required smartphone from the website and confirm the purchase.

Now, we can define the Internet. The Internet is a global network connection of millions of computers around the world for sharing resources and for communicating with one another. It results from a mass of computers, network devices, and wireless/cabling technologies that allow digital information to travel around the world. The working of the Internet can be explained with the help of Fig. 4.2.2. The main devices include two laptops, 2 servers, two ISPs, and the Internet.

Assume that laptop A wants to send a file using email to laptop B with the help of the Internet. From the figure, you can see that the laptops are not directly connected to the Internet. For sending the email, laptop A first sends a request to the ISP1, the ISP1 then connects to the email server A. After that laptop A can upload the file and send it using email.Similarly, while opening the email from laptop B, it sends a request to ISP2 and ISP2 connects to server B and retrieves the information from server B since servers A and B are connected using the Internet. Finally, laptop B can download the file from the email.

4.2.3 World Wide Web (WWW)

In the previous sections, you learned the history and working of the Internet. Now, we can learn about the World Wide Web (WWW).

We are all frequently using various activities like checking the weather, ordering food, chatting with friends, playing games, transferring money, etc. Thus, a lot of activities can be done with the help of the Internet.

Imagine that you have an encyclopaedia in your hand which contains information about all the subjects on different pages.

What will you do inorder to find information about computer science?

You will turn over the pages to get into the topic. The page you find contains text, images, etc. This is what happens when you try to access www using the Internet. Therefore we can compare WWW with the encyclopaedia and web page that you search and find the pages in the encyclopaedia.

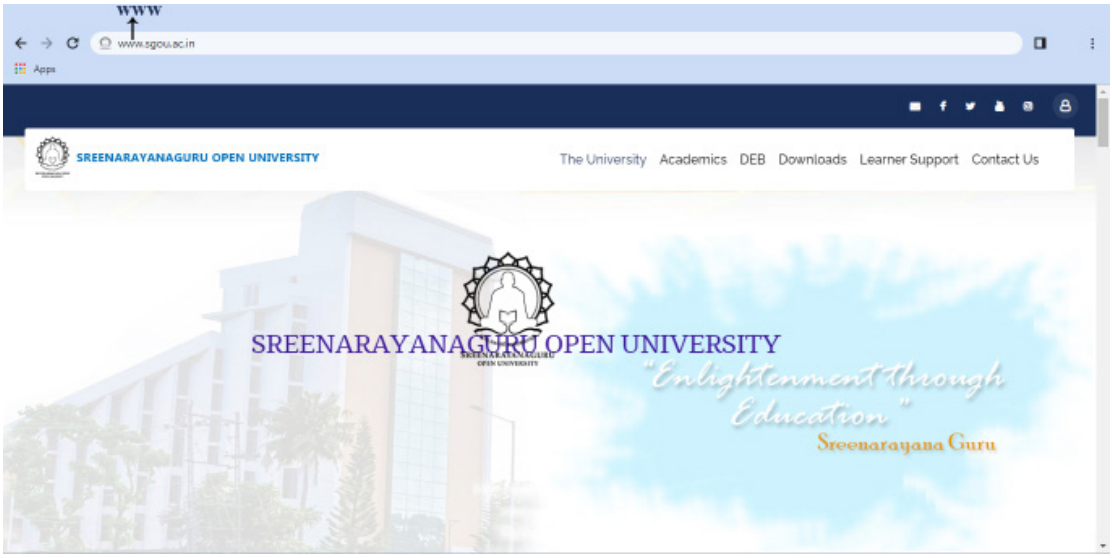


Fig 4.2.3 Sample Web Page

Do you know which is the most common information system accessed by the Internet?

The answer is the World Wide Web.

How can we define WWW?

It is a vast collection of information linked to each other around the world on web pages. A web page is defined as a single document or a solitary page of any website. A web page consists of information such as text, audio, video, animations, hyperlinks, etc which can be accessed using the Internet. A sample web page is shown in Fig 4.2.3.

As you can see the page is accessed using the Internet by typing the address www.sgou.ac.in in the web browser. We can see text, images, hyperlinks, etc. on the webpage. A web page is created using three components. They are:

- HyperText Markup Language (HTML)- describes the structure of a web page
- Cascading Style Sheets (CSS) – used for designing purposes
- Javascript - adds interactivity to your web page

4.2.4 Websites

Having learned about a web page, you must be more interested to know about the website. A website is a collection of web pages made available online and identified with a common domain name by an individual, business organization, educational institution, government, etc. The website is published on a web server.

Do you know, what is a web server?

A web server is a server that is used to run and display a website. The main objective of the web server is to store, process, and deliver web pages to the users. If a web server is used internally and is not visible

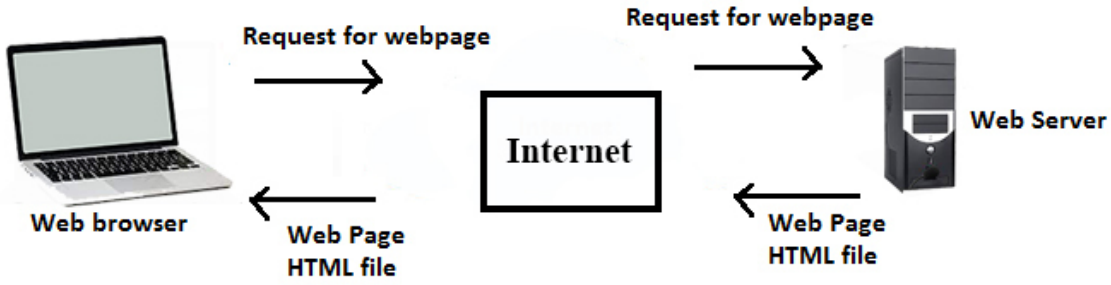


Fig 4.2.4 Working of Website

to the public, then it is called an Intranet Server. You are familiar with the website www.amazon.com. This website contains many web pages displaying information on phones, dressing materials, grocery items, etc. They also have a web server for storing the contents.

Are you aware of the types of websites?

There are mainly two types:

- Static Website
- Dynamic Website

a. Static Website

It is a website containing web pages with fixed content and displays the same information to every user. The contents or the page design may not change frequently.

b. Dynamic Website

It is a website that changes web pages every time, while it is viewed. Each time you open the web page, the contents may get modified. More than that, the content that the website presents to you may be different from that presented to your friend..!. The working of websites is displayed in Fig 4.2.4.

The figure 4.2.4 contains a web browser, Internet, and web server. The operation is explained with the following steps.

Step 1: The Web browser sends a request for the required web page on the Internet

Step 2: The Internet acknowledges, and sends a request to the web server

Step 3: The Web server acknowledges the request and sends an HTML page to the Internet

Step 4: Finally, the required web page is received by the web browser or client

4.2.5 Uniform Resource Locator (URL)

You have learned about web pages and websites. Now, we can move on to the next topic, URL?

URL is a web address that allows you to find a specific web page or file across the Internet. The URL must be unique as your home address and point to only one place. As you know, a postal address enables the mail to reach its destination. Likewise, URL allows your browser to find a specific web page or file across the Internet. Consider an example of a URL as given below in Fig 4.2.5.

We shall next discuss the different parts of the URL one by one as given in the figure.

a. https - Set of rules that the browser and the computer use to communicate with each other over the Internet

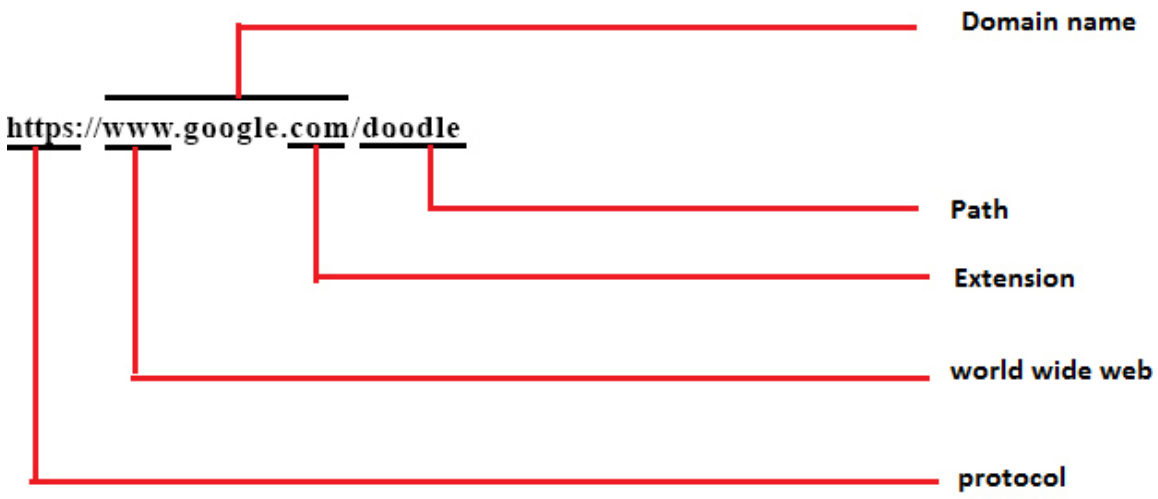


Fig 4.2.5 Example of URL

b. WWW -World Wide Web

c. www.google.com -It is called the domain name. It is a unique name that is registered to one owner and points to the root directory on a website's host computer

d. .com - It represents the extension and gives the information about the website owner (other extensions are .gov, .co.uk, etc.)

e. doodle - It represents the specific page of the website

4.2.6 Browsers

In the previous section, you should have understood the meaning of the URL. In this section, we can have a look at the web browsers.

You are very familiar with the term browser because most of us are regularly using the Internet for many online activities. Suppose, you want to access a website for sending an email using Gmail, online shopping using Flipkart, amazon etc. You would require a web browser to access those activities.

Therefore, a web browser is a software that helps you to access and view websites. Examples of browsers are Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari, etc. You can understand some common features

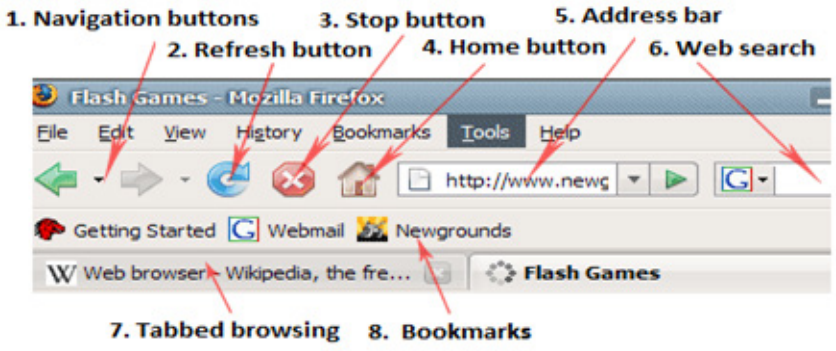


Fig 4.2.6 Sample of Mozilla Firefox Internet Browser

of Internet browsers with the help of Fig. 4.2.6 given below.

As you can see navigation buttons are used to go back and forward while browsing. A small down arrow near the navigation buttons helps you to find a quick list of back or forward web pages available.

The refresh button helps you to reload the web page of the web browser and the Stop button helps you to cancel the web browser's communication with a server and to stop page loading.

The home button loads the predefined home page. You can select any page as the browser's home by clicking on the tools menu and selecting options.

The address bar is used to enter website and page names. Address bar works as a dropdown menu showing all previously visited sites.

Another feature of the browser is the web search tool that allows you to choose your favourite search engine.

With tabbed browsing, you may allow the opening of many websites on a single web browser's window.

The final feature that we have to discuss is the Bookmark buttons. A bookmark is a feature that helps you to save a website's URL address for future reference.

4.2.7 Search Engines

You learned the concepts of browsers in the previous section. In this section, we can know about search engines.

Today, you are familiar with many search engines (Google, Yahoo, Bing, etc) because you regularly search for different topics on the Internet.

Do you know what a search engine is?

Consider the library as a search engine, the librarian as the browser, and yourself as the user. Suppose you need a calculus book. What will you do?

You will first meet the librarian and he searches the name of the required book on his computer with library software. After finding the book using the library

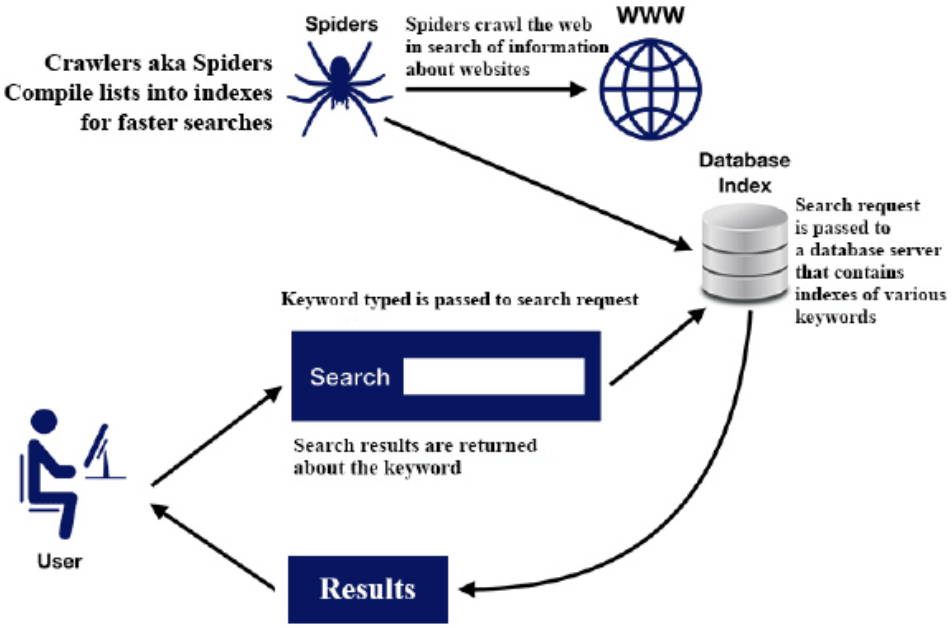


Fig. 4.2.7 Operational Diagram of Search Engines

software, he navigates you to the book you need.

Similarly, the search engine is a software that is accessed on the Internet and searches a database of information according to the query of the user. It provides a list of results that best matches the topic you have searched. The working of the search engine is given in Fig 4.2.7.

As shown in the Fig. 4.2.7., the search engine (Google) looks for the keyword in the index for a predefined database. The search engine does not go directly to the web to search for the keyword. After that, it uses a web crawler or web spider software to search for the information in the database. Once the web crawler finds the page, the search engine shows the relevant web pages or websites. The retrieved web pages include the title of the page, size of text portion, images, videos, etc.

A web crawler is a computer program that automatically searches documents on the Web in a systematic manner. It helps you to provide quick searches by indexing the downloaded pages.

Consider the example of a librarian in a large library. The librarian has to arrange the books in a systematic order so that he can index the books according to the subject and retrieve the book whenever required. Similarly, the web crawler uses an algorithm to index the downloaded pages so that it can provide a fast search.

4.2.8 Internet Searching Tips

Almost all of you search for different things on the Internet. Do you know, there are some search tips that we can use while searching to get the relevant information you want. They are described below:

a. Keywords

If you are searching on the Internet, you have to list the keywords that describe your topic. Also, you have to list the keyword as specific as possible.

For example, if you want to search the term lotus on the Internet. You know that lotus is a flower. Therefore, do not use the flower as the search term instead of the lotus.

b. Use quotation marks for exact phrases

If you want to search for a phrase, you can use the exact phrase in quotation marks so that you will get the appropriate result.

Imagine, if you want to search for the phrase Maruti Car Service, you should give the phrase in quotation marks- “Maruti Car Service”. This will result in web pages where that phrase appears. You will get fewer sites if you do not use quotation marks.

c. Boolean searching

In this method, you have to use the ‘+’ sign (include the word) and the ‘–‘ sign (exclude the word) to narrow down your search. While searching,you should not use a space between the ‘+’ and ‘–‘ signs and the search term.

Consider the above phrase Maruti Car Service, you should give the phrase like “Maruti Car Service”+Kerala-jobs. This will result in web pages where Maruti car service is available in Kerala, and exclude the Maruti car service jobs.

d. Advanced search option in Google

This is another search option available in Google in which you can use the Advanced Search button at bottom of Google. It

will refine your search by date, country, amount, language, or other criteria.

e. Browser History

You can use this method to find web pages you may have used previously or terminated.

f. Searching the web page using Ctrl+F

This technique is used when you have found a web page that seems to be useful. Here, you have to use the CTRL+F function to open the FIND box. After that, you have to type the word or phrase you are looking for and then press ENTER

Recap

- Internet was launched for defence applications in the United States
- ARPA - Advanced Research Projects Agency
- NSFNET - National Science Foundation Network
- Father of World Wide Web - Tim Berners Lee
- Mosaic - web browser
- NSFNET - Decommissioned in 1995
- Internet Connects millions of computers around the world.
- WWW – Collection of information linked on web pages.
- Web page - Single document of website.
- Website - Collection of web pages.
- Web server run and display a website.
- URL - Uniform Resource Locator
- Browser is used to access and view websites
- Examples of browsers: Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari, etc.
- A search engine searches databases in the Internet
- Examples of search engines: Google, Yahoo, Bing, etc
- Searching tips: use keywords, phrases, signs, function, etc

Objective Type Questions

1. What was the year in which the Internet was launched?
2. When was the transmission control protocol adopted by ARPANET?
3. In which year NSFNET launched?
4. Who is the father of www?
5. What is the name of the web browser created in 1993?
6. Which language describes the structure of a web page?
7. Where is the website published?
8. What is a vast collection of information linked to each other on web pages called?
9. Which website contains fixed content web pages?
10. Which is identified with a common domain name?
11. What is the unique address to find a specific web page or file across the Internet called?
12. What is the unique name registered to one owner on a website's host computer?
13. What is the name of the application used for accessing websites?
14. Which is the software used for searching databases on the Internet?
15. What is an application used by the search engine to search information in the database?
16. Which search uses '+' and '-' signs?

Answers to Objective Type Questions

1. 1958
2. 1983
3. NSFNET
4. Tim Berners-Lee
5. Mosaic
6. HTML
7. web server
8. www
9. static
10. Website

11. URL
12. Domain Name
13. Browser
14. Search Engine
15. Web Crawler
16. Boolean

Assignments

1. Prepare a note on the evolution of the Internet.
2. Prepare a note on Internet Service providers.
3. Write the steps needed in searching the term Indian railways using a search engine.
4. Write the steps required to transfer money using Internet banking.
5. Discuss the different browsers and search engines.
6. Explain structure of a URL

Suggested Reading

1. Peterson, Larry L., and Bruce S. Davie. Computer networks: a systems approach. Elsevier, 2007.
2. Forouzan, Behrouz A., and Firouz Mosharraf. “Computer networks: a top-down approach.” (No Title) (2012).
3. "Computer Networking" by James F Kurose and Keith W Ross.
4. "Fundamentals Of Computer Networks" by Sudakshina Kundu.

Reference

1. William Stallings, “Data and Computer Communication” Pearson Education, 8th edition.
2. Andrew S Tanenbaum,“Computer Networks” Pearson Education, 3rd edition.
3. B. A. Forouzan - Data communication and Networking, Fourth edition, TMH
4. Cryptography and Network Security Principles and Practices, William Stallings, Fifth Edition
5. Douglas E. Comer, Computer Networks and Internets.

Internet Connectivity

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- know the concept of Internet Service Providers
- learn about Dial-up Connection and Cable modem connection
- get an idea on Wireless Local Loop
- understand about Digital Subscriber Line
- acquire knowledge on Leased line
- obtain a deep understanding of Broadband.

Prerequisites

From the previous units, you might get an idea about computer networks, the Internet, WWW, and search engines. In this unit, we shall discuss Internet Service Providers and various types of Internet connections.

Do you know how the Internet is connected to your computers, laptop, and Personal Digital Assistant (PDA) devices like smartphones, tablets, etc.? If you connect your PDA devices to the power supply, you cannot get Internet connectivity. You must use some networking devices and also the help of an Internet Service Provider (ISP) to get an Internet connection.

Suppose, you want to chat using WhatsApp with your friend on your mobile. Have you thought about how it is possible? It is possible only because of the Internet. When you open WhatsApp on your mobile, you must have an Internet connection which is provided by your ISP. The ISP sends a request to the WhatsApp server, then the server sends the data to your friend's ISP, and finally to the friend's mobile.

Before proceeding to different connection types, you must recall the concepts of wired and wireless connections. A wired connection means the connection is done using any physical means like cables (copper, coaxial and optical fibre). But in the case of wire-

less connection, there are no physical cables required. It is done with the help of radio waves. The network of wired and wireless connections using a router is shown in Fig 4.3.1.

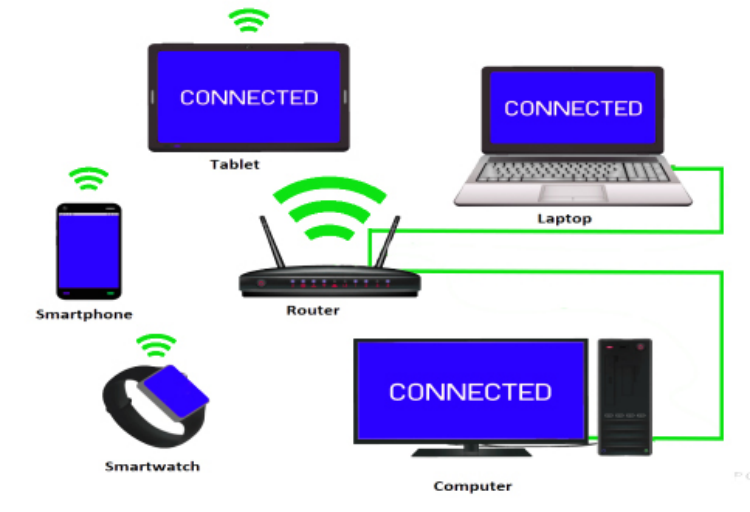


Fig. 4.3.1 Wired and Wireless Connection

As you can find in the above figure (Fig 4.3.1.), laptops and computers are connected using cables. On the other side, a tablet, a smartphone, and a smartwatch have been connected without wires. If the devices shown above want to communicate with the outside world, they should have a wireless connection, preferably an internet connection. Otherwise, it is not possible. The following sections deal with ISP and the different types of Internet connections used for providing Internet to your home or the outside world.

Key Concepts

Digital Internet Service Providers, Dial-up Connection, Cable modem, Wireless Local Loop, Digital Subscriber Line, Leased line, Broadband, Computer, Hardware, Software, Firmware, Liveware

4.3.1 Internet Service Providers (ISPs)

You learned the concepts of the Internet in the previous unit. But, do you know who provides the Internet service to your home or office? The answer is Internet Service Provider (ISP).

Assume, your father is out of the country and you are in your hometown. You need to send an email to your father. What happens when you send the email? Your email goes from your computer to the ISP computers or servers, where it is sent along to its destination through other servers on the network. The ISP is the link between your computer and all the other servers on the Internet. You may feel like talking to your father directly through email.

Internet Service Provider is a company offering Internet access to users for data transfer. It helps you to access the Internet. In other words, if you can have a new computer with a built-in modem, but without a subscription with an ISP, you cannot access the Internet. An ISP is your gateway to the Internet and you can do everything online like sending emails, do shopping, research, and more. Some of you are already aware of the Internet Service Providers in India such as BSNL, Airtel, Reliance Jio, Vodafone-Idea, etc.

Do you know what the different services offered by ISPs are? They are as follows:

- Internet Access
- Domain name registration
- Web hosting
- Usenet

4.3.1.1 Internet Access

You are very familiar with the term, Internet Access. Do you know what exactly it is? It is the practice of connecting to the Internet using PDA devices by users or organisations. It helps you go online for different activities. You have to subscribe to the ISP connection to use the Internet. The speed of the connection may vary according to the subscription plan you have chosen.

4.3.1.2 Domain Name Registration

Next, we can proceed to Domain name registration. It is the act of reserving a name on the Internet for a certain period, usually for one year. You can use the domain as long as you renew it; otherwise you will lose it.i.e, You cannot purchase a domain for a lifetime. It is a requisite for a website, email, or other web services. Whenever you register a domain name, the information about the owner is publicly available. The price for a domain name registration varies on its extension (.com, .gov, .co.in, .co.uk, etc). An example is www.amazon.com

4.3.1.3 Web Hosting

It is another service offered by the ISPs. You might have seen a lot of websites on the Internet. What do you see on the websites? You can see various files like pictures, audio, video, etc. on the web pages.

Have you ever thought about where the files you see on the Internet are stored? The files are stored in web servers through a web hosting provider. The Web host allocates you a rent space on a web server for a website to store its file. Every website you visit is provided with a web server to see the content online.

4.3.1.4 Usenet

Finally, we shall discuss about Usenet. It is a collection of online discussions that are organized into newsgroups. Here the users can create their discussion topics and also provide forums for questions and answers and file sharing.

4.3.2 Internet Connection types

You studied the concepts of Internet service providers in the previous section. Now, we shall see the ways the ISPs give connection to your home or organization. There are various types of connection as given below.

- Dial-up Connection
- Cable modem
- Wireless Local Loop
- Digital Subscriber Line
- Leased line
- Broadband

4.3.2.1 Dial-up Connection

Imagine, you are in India and your friend is in Australia. You want to send an engagement photo to your friend using the dial-up connection. First, you have to upload the photo using your email from the computer drive and send it to your friend. The friend can download the photo from his email and save it to any drive on his computer. This is done with the help of a dial-up connection.

You should have seen landline telephone lines in your home or office. A dial-up connection is one in which two or more communication devices use a Public Switched Telephone Network (PSTN) or landline to connect with an Internet Service Provider (ISP).

Do you know PSTN uses circuit switching? Circuit Switching is a connection-oriented network that establishes a dedicated communication path between the sender and the receiver in the physical form. Many remote areas in our country depend on dial-up connections because broadband and cable are rare in those areas. A dial-up connection setup is shown in Fig 4.3.2.

As shown in Fig. 4.3.2, it consists of two personal computers (A and B), two modems, two telephone lines, and an Internet Cloud. Consider node A wants to send data to node B using a dial-up connection. At first, node A sends the data in the digital format to the modem, the modem; converts the digital data to the analog format and sends the data to the Internet Service Provider using telephone lines. With the help of the Internet, data is again sent to the Internet Service provider on the receiving side, and then to the modem as analog data. The modem converts the analog data into digital format and finally sends it to node B.

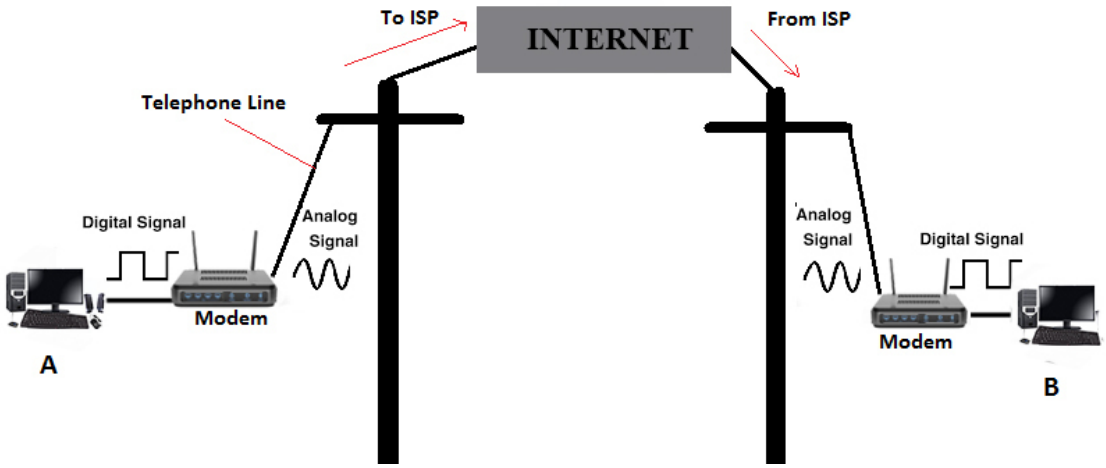


Fig 4.3.2 Dial-up Connection

4.3.2.2 Cable Modem

Next, we proceed to the Internet connection using a Cable Modem. These ISPs are cable TV operators. Fig 4.3.3 shows the Internet connectivity using Cable Modem.

As you can see, the figure consists of a cable outlet, cable splitter, cable modem, set-top box, computer, and television. Here the Internet is provided by the cable TV operator using coaxial cable or optical fiber cable to the cable outlet in your home or office. The output from the cable outlet

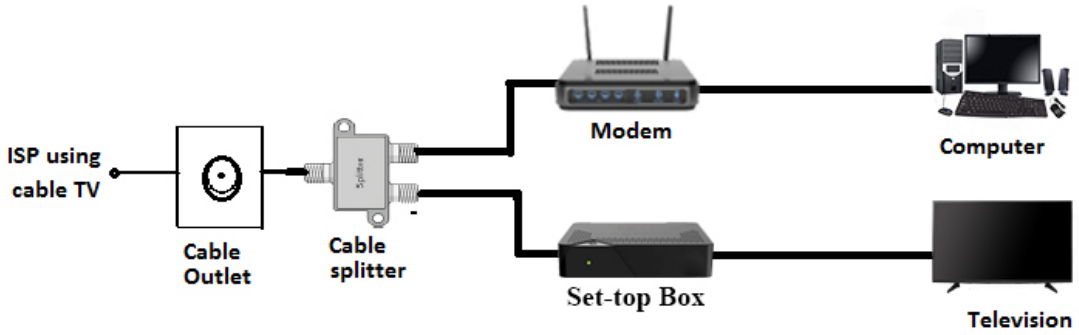
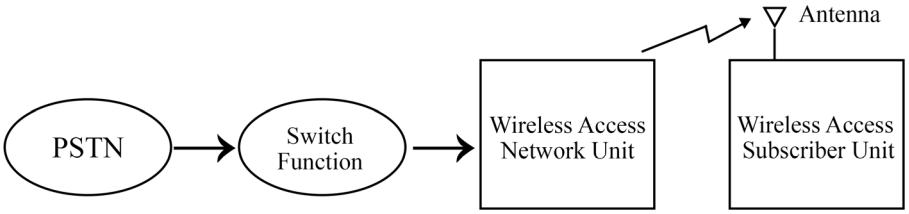


Fig 4.3.3 Cable TV Connection



4.3.4 WLL Connection diagram

is split into two separate connections using the cable splitter. One connection is given to the modem for Internet access by the computer and the other is given to the set-top box for watching TV programs.

4.3.2.3 Wireless Local Loop (WLL)

You have already learned about the dial-up connection. It is set up with the nearest telephone exchange through telephone lines (copper cables). So the connection is wired or fixed.

Now, let us see what WLL is? Unlike dial-up connection, WLL connects the subscriber to the nearest exchange through a radio link instead of telephone lines. Therefore, the connection is wireless. The WLL setup is shown in Fig 4.3.4.

The main components of the figure include Public Switched Telephone Network (PSTN), Switch Function, Wireless Access Network Unit (WANU), and Wireless Access Subscriber Unit (WASU). PSTN is a circuit-switched network, which is a collection of the world's interconnected circuit-switched telephone networks. The Switch Function is used for switching the PSTN among various WANU. It is present at the local exchange office. The main functions of WANU includes Authentication, Operation & Maintenance, Routing, Transceiving voice, and data. All local WASU is connected to WANU wirelessly through an antenna as you can see in the above figure 4.3.4. WASU, present at the house of the subscriber, connects the subscriber to WANU to provide Internet access.

4.3.2.4 Broadband Connection

You are familiar with the term Broadband connection. Do you have any idea about it? It is the transmission of wide bandwidth data over a high-speed Internet connection. Bandwidth is the maximum amount of data transmitted over an Internet connection in a given amount of time. It is the volume of information that can be sent over a connection in a measured amount of time calculated in megabits per second (Mbps). According to the Federal Communications Commission(FCC), the definition of broadband Internet is a minimum of 25 Mbps download and 3 Mbps upload speeds.

Do you know the various types of technologies used by Broadband to provide high-speed Internet? They are fibre optics, wireless, cable (already discussed), DSL, and satellite. We shall study them one by one.

Fibre Optics

We can move on to the first type of broadband connection, Fibre Optics.

You might have heard about Fibre optic technology from your cable TV operator or ISP and you have an interest in knowing, what Fibre optic technology is? It is a technology in which the electrical signals that carry the information are converted to light (information). It then sends the light through transparent glass fibres about the diameter of human hair. The fibre technology transmits data at speeds greater than Digital Subscriber Line (DSL) or cable modem speeds, typically by tens or even hundreds of Mbps. Fig. 4.3.5 shows the structure of an Optical fibre. It consists of an outer jacket, strength member, coating, cladding, and core.

As you can see, the outer jacket and strength member protect the fibre from mechanical and environmental stresses. Cladding is the outer part of the optical fibre that helps in reducing the scattering of light. It helps the light signals to retain inside the glass core and prevents the attenuation of light from the core to the outside. Cladding is bound in another outside layer called the coating. It helps to deliver extra protection to the core and cladding. Next, we can move on to the last and most important part of the fibre which is called glass Core. It is the innermost portion of the fiber optic cable which is used to transmit light. The higher the diameter of the core, the more the light that can be transmitted over it.

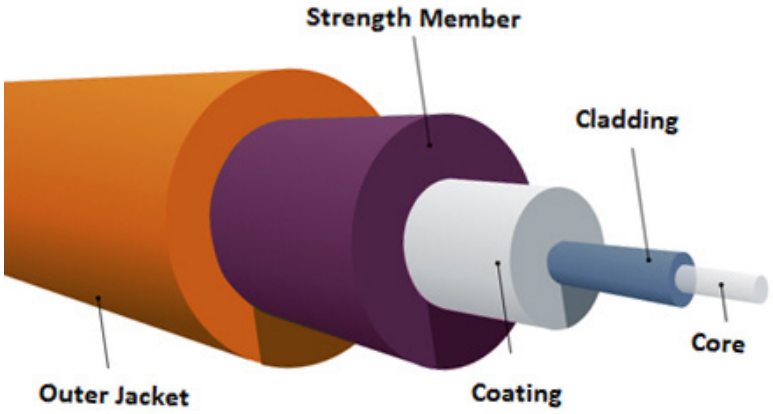


Fig 4.3.5 Optical Fibre Structure

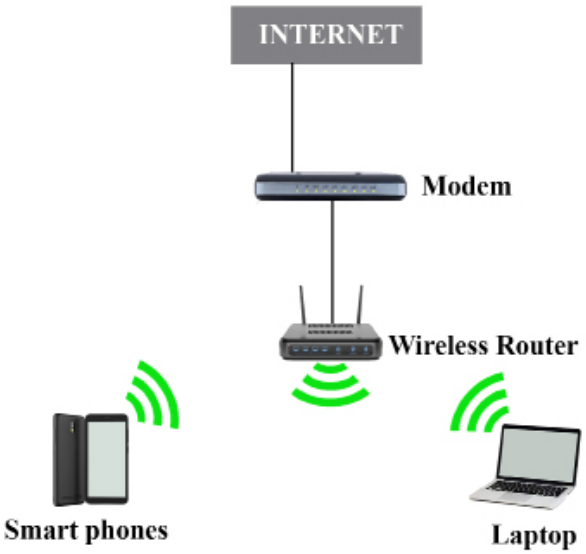


Fig 4.3.6 Wi-Fi Connection Setup

Wireless Broadband

In the previous section, you learned fibre optics. Now, we can study Wireless broadband. It is a technology in which the user connects to the Internet using a radio link between the customer's location and the ISP. A radio link is a link used by radio frequency bands to connect to the Internet at a high speed.

Do you know where this technology was commonly used? It was previously used in remote or sparsely populated areas where DSL or cable modem service would be too costly to provide. Now, it is widely used everywhere as technology has advanced significantly. Wireless broadband Internet access services allow consumers to access the Internet from a fixed point and this often requires a direct line-of-sight between the wireless transmitter and the receiver.

You might be familiar with the terms Wi-Fi or WiMAX. Do you have any idea about the terms?

First, we shall look at Wi-Fi (Wireless Fidility). Suppose, you want to access www.amazon.com on your smartphone using Wi-Fi. For that, you have to turn on your Wi-Fi option on your smartphone. Then type the router password and after that connection is established with the router. Finally, you can access the required website wirelessly.

Wi-Fi stands for wireless fidelity. It is a wireless networking technology that helps you to interface computers, laptops, smartphones, wearables, printers, and video cameras with the Internet. It also helps you to exchange information or between devices and for creating a network. The wireless connection setup is shown in Fig. 4.3.6. The main devices include a modem, wireless router, laptop, and smartphone.

Internet connectivity is established through a wireless router with the help of a modem. When you need to access the Internet using Wi-Fi, you have to check whether the modem is connected to the Internet. The output from the modem is then connected to the wireless router and finally, the router allows your Wi-Fi-compatible devices to interface with the Internet. Next, let us see what WiMAX is?

WiMAX is an abbreviation for Worldwide Interoperability for Microwave Access. The operation of WiMAX is somewhat similar to WiFi, but at more speeds, distances, and numbers of users. WiMAX allows you to serve over areas where wired connections cannot reach.

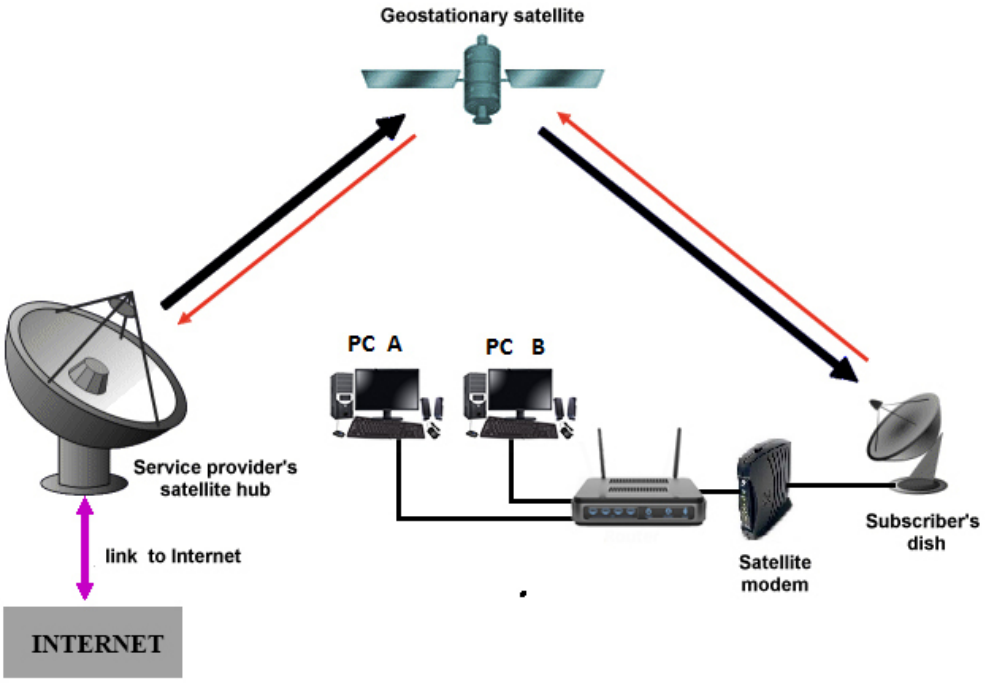


Fig. 4.3.7 Internet Connection using Satellite

Satellite

You might be familiar with the launching of satellites by the Indian Space Research Organisation (ISRO). The different applications of satellites include the study of earth, moon, mars, weather reports, links for telephone and television, providing Internet connection, etc.

Would you like to know how the satellite provides Internet Connection? You can obtain satellite Internet through a satellite Internet connection provider. Once you approach them for service, you'll receive the satellite dish and the modem on payment of their fees or charges. The main feature of the Satellite Internet service is that it uses geostationary satellites, rather than telephone lines to deliver an Internet signal directly to the customer.

Fig 4.3.7 shows the Internet connection using Satellite. It consists of a Geostationary satellite, two dishes (one at the service provider's hub and the other at the subscriber's side), two personal computers (PC A and PC B), a router, and a satellite modem.

We shall examine the working of the above facility. Suppose you want to access a webpage using PC A. A request is sent from PC A to the satellite through the router, modem, and the subscriber's dish. After receiving the request or signal, the satellite transmits the signal to the service provider's satellite hub. The hub sends the request to the web server where the user has requested the webpage. The web server

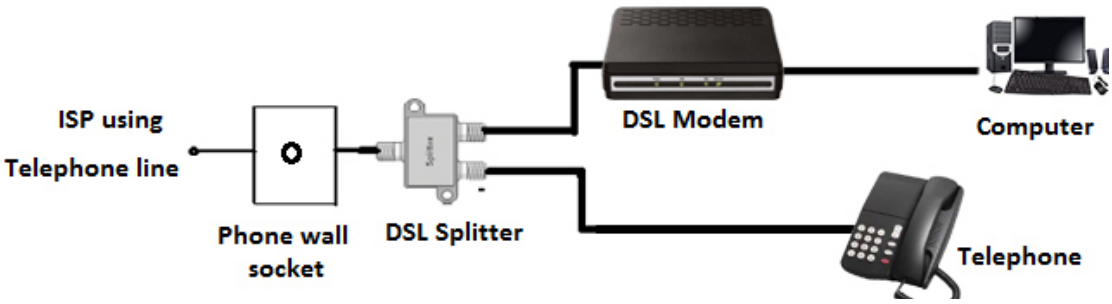


Fig. 4.3.8 DSL connection Setup

sends the required webpage to the satellite hub, then to the satellite, and finally the loaded page to PC A through the modem and the router.

Broadband over Powerline (BPL)

Is it possible to provide an Internet connection using electrical lines?

Yes, it is possible to use broadband over powerline. It is the method of providing the Internet using the electrical network. It is an emerging technology that is available in very limited areas. It has substantial potential because power lines are already installed everywhere. Thus it helps to avoid the requirement of building new broadband facilities for individual customers.

Digital Subscriber Line (DSL)

Have you ever heard of Digital Subscriber Line (DSL)?

It is a type of Internet connection that uses your telephone line to transfer data and connect you to the Internet. There are mainly two forms of DSL connections - symmetric and asymmetric.

Symmetric offers equal upload and download speeds, while asymmetric offers higher download speeds and slower upload speeds. DSL can provide you with a dedicated and continuous connection for accessing the Internet. An interesting fact is that DSL operates on different frequencies for telephone and the Internet. Therefore, it is possible to use the telephone and the Internet at the same time, without interruptions. Fig. 4.3.8 shows the connection setup of a DSL. It consists of a Phone wall socket, DSL splitter, DSL modem, computer, and telephone.

As you can see in the diagram, ISP provides the Internet with the help of telephone lines. At your home or office, you can set up the connection with the phone wall socket. From the socket, the signal from the ISP is given to the DSL splitter where the signal is split up into different frequencies. One frequency is for using the telephone and the other for accessing the Internet. Accordingly, voice calls and the Internet can be accessed simultaneously

4.3.3 Leased Line Connection

We can move on to the last topic of this unit, Leased Line.

Just imagine a metal pipe. What are the different uses of that pipe? It is used to carry different things such as water, gas, sewage, etc. The leased line is somewhat similar to the metal pipe. It carries different types of data traffic such as Internet traffic, phone calls, etc.

Now, let us define a leased line. It is a dedicated, fixed-bandwidth, and symmetric data connection. It allows a reliable, high-quality Internet connection with assured upload and download speed.

Do you know what a leased line is used for? It is used for linking locations or computers and servers in different offices. For example, if you have two office locations and you want to link the two locations, you can use a leased line for linking those locations with the Internet. You can also provide a reserved bandwidth of your need and for your use. Unlike ordinary Internet connections, the bandwidth of the leased line does not fall at peak times, when you and other customers are using the same ISP at the same time.

Recap

- Internet Service Provider is a company offering Internet access.
- ISP provides data transfer across the world.
- ISP is the gateway to the Internet.
- Internet access- connects devices with the Internet.
- Domain Name Registration- reserving a name on the Internet.
- Web hosting allocates space on a web server.
- Usenet- Collection of online discussion groups.
- Dial-up connection uses circuit switching
- Cable modem uses cable splitter
- WLL connects the subscriber to the nearest exchange using a radio link.
- WANU stands for Wireless Access Network Unit
- WASU means Wireless Access Subscriber Unit
- Broadband uses wide bandwidth data
- Fibre Optics technology uses light for data transmission
- Wireless Broadband uses radio link for Internet Connection
- WiFi- Wireless technology is used for small distances
- WiMAX- Wireless technology is used for longer distances
- Satellite Internet uses geostationary satellites

- BPL provides Internet connection using power lines
- DSL uses symmetric and asymmetric connections
- Leased line uses dedicated, fixed-bandwidth, symmetric data connection

Objective Type Questions

1. Who provides the Internet service to the home or office?
2. What is the practice of connecting devices to the Internet?
3. What is the act of reserving a name on the Internet?
4. What helps the users to allocate space on a web server?
5. What is a collection of online discussions groups called?
6. What type of switching is used in dial-up connection?
7. Which switching establishes a dedicated communication path?
8. How to split the signals in a cable TV connection?
9. Which connection uses a radio link between the subscriber and the nearest exchange?
10. Which part in WLL is used for authentication?
11. What is the transmission of wide bandwidth data over high-speed Internet called?
12. Name the technology that uses light for data transmission.
13. How does the optical fiber reduce the scattering of light?
14. Which part of the fiber optic transmits light?
15. What is the link used by radio frequency bands for Internet connection?
16. What type of satellite is used in satellite connection?.
17. Which is the Internet connection method that uses an electrical network?
18. Which DSL offers equal upload and download speeds?

Answers to Objective Type Questions

1. ISP
2. Internet access

3. Domain Name Registration
4. Web hosting
5. Usenet
6. Circuit Switching
7. Circuit Switching
8. Cable splitter
9. WLL
10. WANU
11. Broadband
12. Fibre Optics
13. Cladding
14. Core
15. Radio link
16. Geostationary
17. BPL
18. Symmetric

Assignments

1. Write the steps for creating a dial-up connection on a personal computer.
2. Discuss the different versions of DSL.
3. Prepare a note for providing Internet connection using Dish TV.
4. Define Internet Service Provider (ISP) and explain its role in providing internet access to users.
5. What is a domain name registration? Discuss its significance and the process involved.
6. Define Wi-Fi and WiMAX, and explain their role in providing wireless internet access.

Suggested Reading

1. James, K. L. (2010). The Internet: a user's guide. PHI Learning Pvt. Ltd..
2. Akujuobi, C. M., & Sadiku, M. N. (2007). Introduction to broadband communication systems. CRC Press.
3. B. A. Forouzan - Data communication and Networking, Fourth edition-, TMH
4. Andrew S Tanenbaum - Computer Networks ,Fourth Edition, Prentice Hall of India.
5. Cryptography and Network Security Principles and Practices, William Stallings, Fifth Edition
6. Computer networks / Andrew S. Tanenbaum, David J. Wetherall. Fifth Edition

Reference

1. Whittaker, Jason. The Internet: The Basics. United Kingdom: Routledge, 2002.
2. Bangia, Ramesh. Internet & Web Design. India: Firewall Media, 2006
3. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014.
4. Andrew S Tanenbaum - Computer Networks, Fourth Edition, Prentice Hall of India.

Electronic Mail Systems

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- understand the concept of Electronic mail
- get an idea of email software features
- learn the characteristics of web-based systems
- study the benefits of web-based systems

Prerequisites

In the previous units, you studied the concepts of computer networks, the Internet, search engines, and types of Internet connections. Now, it is time to study the concepts of electronic mail (email or e-mail), web-based systems, and the basics of Hypertext Markup Language (HTML).

We can recall the basic concepts of Networks and the Internet that you have already studied. As you know, communication between computers is very important to send data from one user to another. In this scenario, a Computer Network allows you to communicate with another computer and share its resources, data, and applications. When it comes to a global network connection of millions of computers around the world for sharing resources and communication, the Internet is very essential. Fig. 4.4.1 shows how the devices are connected as a network using the Internet to communicate to the outside world at large.

As you can see in Fig. 4.4.1, there are many devices connected using the Internet as a network. The devices include printers, laptops, computers, a server, a tablet, a smart-phone, a switch, a modem, and a wireless router. Note that some of the devices are connected directly and some in an indirect manner. The direct connection is done with the help of a switch and the indirect one with the support of a wireless router. It means that we can communicate to the outside world using wired or wireless methods with the support of the Internet.

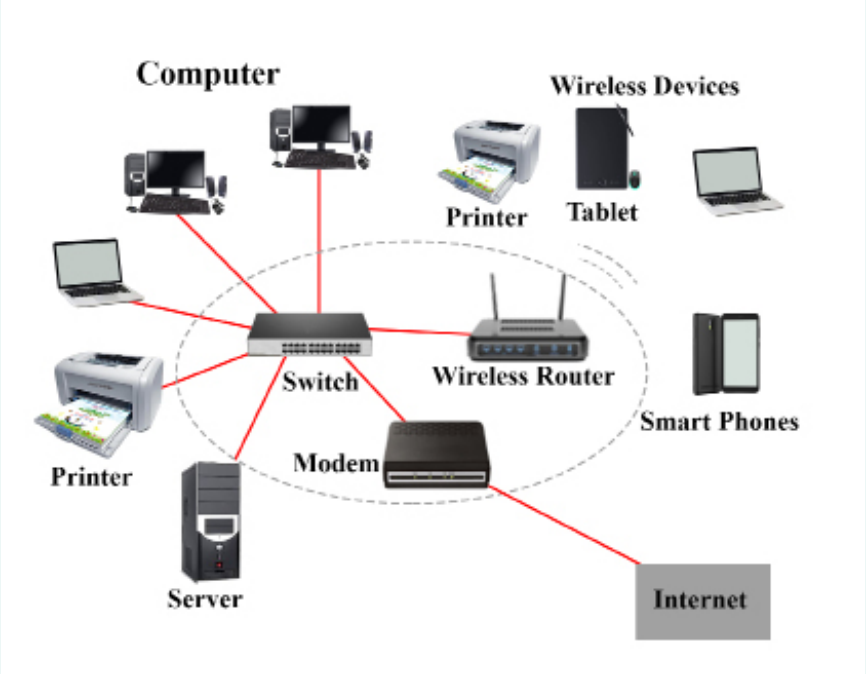


Fig 4.4.1 Internet

Key Concepts

Email, Email Software Features, Web-Based Systems, Web Pages, HTML

4.4.1 Electronic Mail (e-mail)

Almost everyone sends e-mail using the Internet from our computers or smartphones for different purposes. Some of you may send email for personal use, and some others for official and educational purposes.

Imagine, you are residing in Thiruvananthapuram. You want to post a letter using ordinary mail to your friend who is residing in New Delhi. You will write the complete source address and destination address with Pincode before posting the letter at the post office. Finally, the letter will be delivered to the destination address. The same thing happens when you send an email using the Internet also. You should type the source and the destination address to deliver the message promptly.

Do you know, what exactly is an e-mail? An email is the transmission of messages from one computer to another computer or group of computers with the help of the Internet. It is one of the most frequently used services on the Internet.

Would you like to know what the different types of messages are that can be sent using email? You can send messages that may contain text, images, audio, or other attachments. Usually, you can send the file that is stored on your computer as an attachment to another individual or group. The person who is sending the email is called the sender and the person who

receives the email is called the recipient. You must keep in mind that the sender and the recipient should have proper email addresses, otherwise the message cannot be delivered.

4.4.1.1 Email Address

Next, you should learn what an email address is. If you are using email, you should be assigned a unique name for your email account. This is known as an email address. It has two parts, one part is the username and the other part is the domain name. It is generally of the form username@domainname.

For example, sachin@gmail.com is an e-mail address where sachin is the username and gmail.com is the domain name. The username and the domain name are usually separated by @ (at the rate) symbol. You must note that email addresses are not case sensitive and spaces are not allowed.

4.4.1.2 Email Systems

Next, we can talk about email systems and their components. They are the systems responsible for the successful transmission of email messages from one user to another or a group. The basic components of an email system are given below:

- User Agent
- Message Transfer Agent
- Mail Box
- Spool file

User Agent (UA) is a program that helps you send and receive emails. It accepts a variety of commands for composing, receiving, and replying to messages. Message Transfer Agent (MTA) helps you to transfer email from one system to another. If you want to send an email, a system must have client MTA and system MTA. It transfers mail to the mailboxes of recipients if they are connected to the same machine. It delivers the mail to peer MTA if the destination mailbox is in another machine.

Mailbox is a file on the local hard drive of your computer to collect emails. The emails that you have delivered are normally present in this file. It helps you to read or delete according to the requirement. The spool file is the file that contains emails that are to be sent. User Agent adds outgoing mails in this file. MTA helps to extract the pending mail from the spool file for their delivery.

Now, we can discuss the different services provided by the email system.Various services include Composition, Transfer, Reporting, Displaying, and Disposition.

Composition refers to the process that creates messages and answers. Transfer means the procedure of sending the email from the sender to the recipient. Reporting helps you to confirm the delivery of emails. It helps you to check whether your email is delivered, lost, or rejected. Displaying refers to the presentation of an email in a particular format that is understood by the user. Disposition is mostly concerned with the recipient after receiving the email such as whether to save the email, delete before reading or delete after reading.

4.4.2 Email Software Features

Having learned the concepts of email and email systems, it is time to study the features of email software. The various features include:

- Sending email
- Receive
- Filter
- Attach
- Forward

- Copy
- Blind copy

4.4.2.1 Sending email

Suppose, you are in India and five of your friends are in different countries. You want to invite them to your sister's marriage scheduled at the end of the next month. What will you do? You can use your yahoo mail as shown in Fig. 4.4.2 and type all your friends email addresses together to send the invitation quickly and easily.

As you can see, the email contains From address, To address, Subject, and the Body of the message. For sending an email, you should follow the different steps given below.

- Open the browser on your computer and log in with your webmail address and password.
- Click 'New' or 'Compose'.
- Enter the recipient(s) email address(es) in the 'To' field.
- Write the subject in the 'Subject' field.
- Write the message in the space below the Message field.
- Click 'Send' to send the email.

4.4.2.2 Receiving Email

You can normally have two types of email. One is called email clients (eg: Microsoft Outlook) and the other is called webmail (eg: Gmail, yahoo mail). While using an email client, you can manually check emails by clicking 'Send and Receive'.

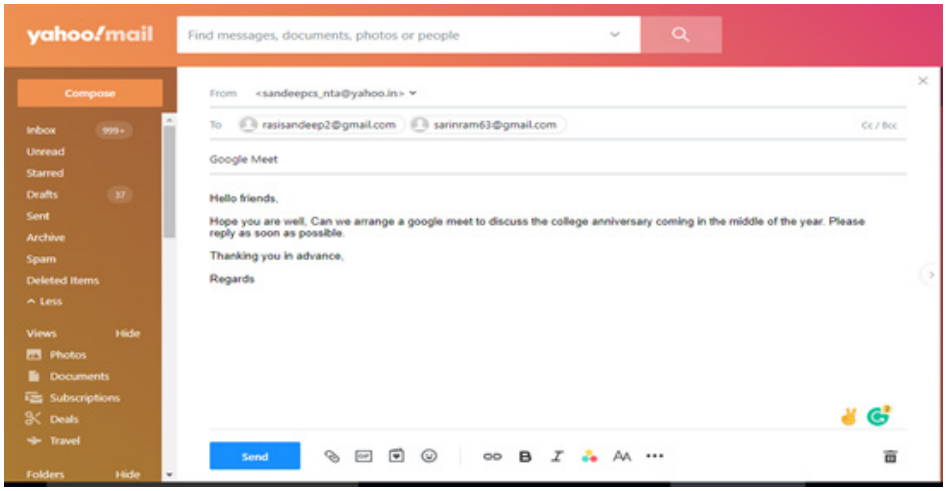


Fig. 4.4.2 Sample Document for Sending an Email

When you are using webmail, you can check the email by refreshing the page. In email clients, attachments are downloaded automatically but in webmail, you should have to choose to download attachments. An email client is a program that exists on your computer for sending or receiving emails.

4.4.2.3 Email filtering

Is it possible to filter email messages? Yes, it is possible to filter messages using an email filter.

Suppose, you are receiving too many anonymous emails in your inbox. How to avoid this? One option is that you can unsubscribe the unwanted email or the

other option is to block the sender. When you block a sender, their messages will go to your spam folder. It helps you manage and organize the flow of incoming email messages. You should know that an email filter works when an email is received at the email server. The email server forwards and stores each email based on the filter(s) applied.

For example, if you mark any email address as “work”, it will automatically transfer the email into the "work" folder. Similarly, for non-configured email addresses, the email program uses its default email filtering capabilities. That means it sends the email to the primary inbox. If the email filter finds any suspicious emails, they will be sent to the junk or spam folder. Besides the above, email filtering helps you to block unwanted or potentially malicious code or links that redirect the user to suspicious websites. It also prevents emails that seek entry into the system to get access to sensitive data.

4.4.2.4 Attaching files

In this section, you can learn how to attach a file when sending an email.

To better understand the concept, an example is given below that tells how to attach files using yahoo mail.

Consider, you are a class teacher of a school and the school has been on vacation for two months. During this period, you are appointed as the convenor of an online seminar on disaster management. Now, you want to send the brochure of the online seminar to your students. How can you send the brochure? You can send the brochure as an email attachment to the students as shown in the Fig. 4.4.3.

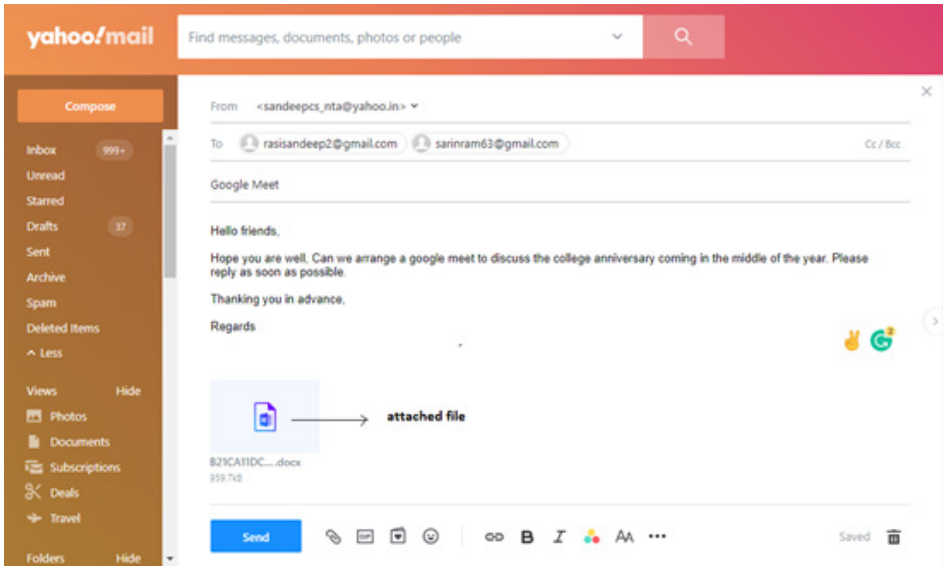


Fig. 4.4.3 Sample document for Attaching a File using Yahoo Mail

The above figure shows how a file is attached using yahoo mail. For this, you have to fill in the fields like from address, recipient's address, subject, the body of the message and finally, attach the files and click send. The steps followed for attaching a file are given below:

a) Open your browser and type yahoo mail

b) Enter your username and password

c) Start a new message and select Attach Files

d) Select Choose File

e) Locate and highlight the file you want to attach, then select Open

f) Select Attach Files

g) Finish composing your message and send the email.

4.4.2.5 Forwarding files using email

different steps given below to forward an email using yahoo mail.

a. Open your browser and type yahoo mail

b. Enter your username and password

c. Select the file you want to forward

d. Type the destination address

e.Send the email using the forward symbol

4.4.2.6 Copy files using email

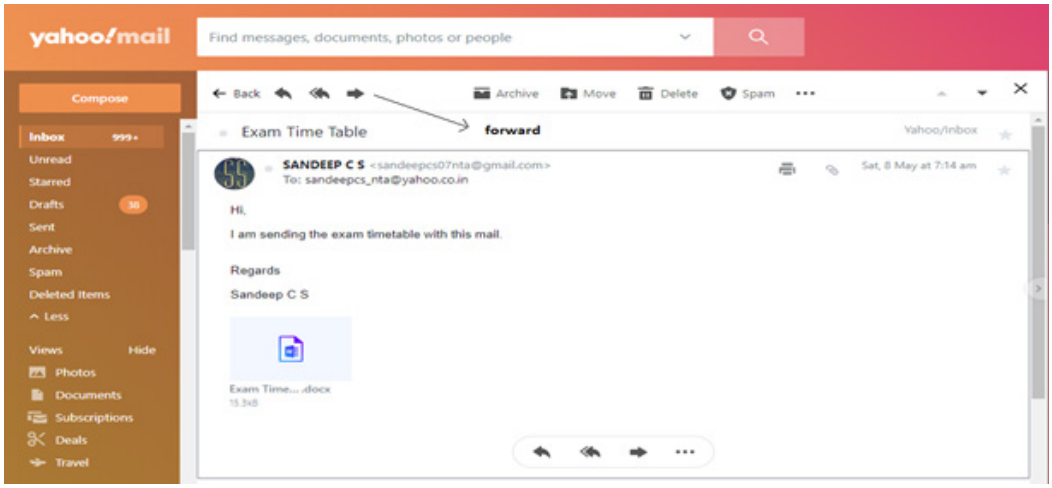


Fig. 4.4.4 Sample Document for Forwarding a File using Yahoo Mail

Imagine, you are the manager of a company. You have got an email from your boss about the promotion of two employees working under your department. Is it possible to forward the mail received? Yes, you can forward the mail using the forward tab as shown in Fig. 4.4.4.

The above figure shows how you can forward a mail using the forward symbol using yahoo mail. First, you have to select the message in the inbox and forward the selected message using the forward tab. Forwarding a file means you need not compose the email, you can forward the email to the destination address using the forward symbol. You might use the

Suppose, you want to send CC to rohit@example.com and james@example.com. You can type their addresses on the CC field of an email, both Rohit and James will know about the people in the CC list. Suppose, if you want to send BCC to rohit@example.com and james@example.com. You can type their addresses on the BCC field of an email, neither Rohit nor James will know that the other received the email.

There are two fields for copying files one is Carbon Copy (CC) and the other is Blind Carbon Copy (BCC). CC and BCC are both ways of sending copies of an email to added addresses using the “To" field.

CC is similar to placing a sheet of carbon paper between two pieces of paper. The pressure from writing on the first piece of paper will push the ink from the carbon paper down onto the second piece of paper, producing an additional copy of the document. Likewise, CC is a method of sending extra copies of an email to other people. If you place additional addresses on the CC field, the CC list is visible to all other recipients. Next, we can focus on BCC. In the case of CC, each recipient is aware of each other about the received email. But in BCC, no one but the sender can see the list of BCC recipients.

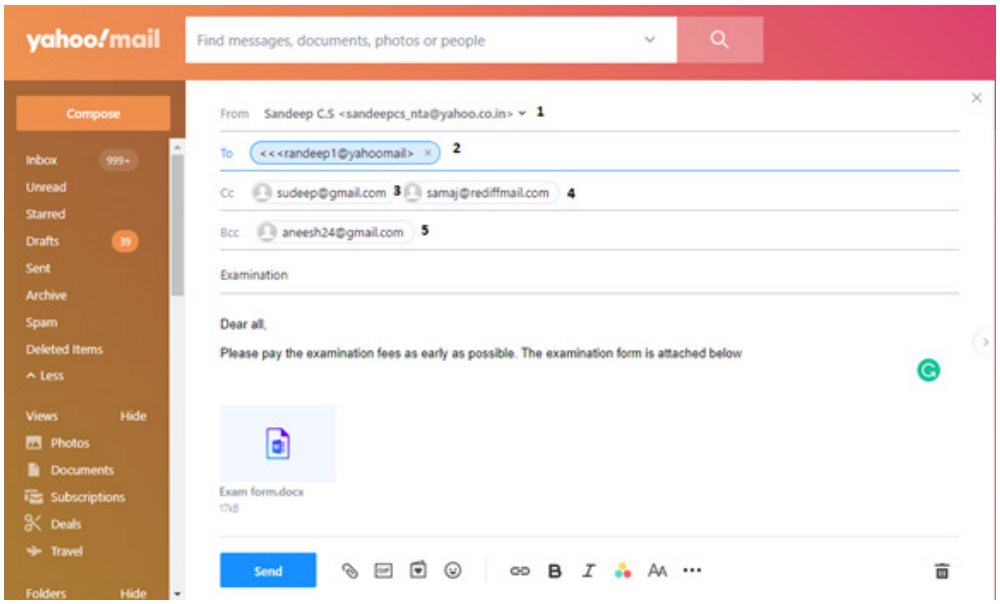


Fig. 4.4.5 CC and BCC

Fig. 4.4.5 shows CC and BCC using yahoo mail. As you can see in the figure, each address is denoted with a number. 1 stands for the source address, 2 stands for the destination address, 3 and 4 denote CC and 5 for BCC. Here, 3, 4, and 5 receive the copies of mail. CC recipients know each other, however BCC recipients will not know about other in the BCC mail list.

4.4.3 Web-Based Systems

Assume that you are the head of the Computer Science Department of a college. You want to arrange an online meeting immediately with the staff in the department through a web application. What do you do? You can arrange a meeting with Google meet or Zoom meeting to solve the problem because both are web-based applications and very easy to handle.

Now, you must be keen to study about Web-Based Systems. It is a system that utilizes web applications to accomplish different tasks using the Internet. A web-based application is a computer program which you can utilize web browsers and web technology to perform tasks with the help of the Internet. Examples of Web applications include online forms, shopping carts, word processors, spreadsheets, video and photo editing, Google Applications, Microsoft 365, etc.

The Web applications are usually coded with the help of JavaScript and HTML. These languages depend on the web browser to make the applications executable. The web applications may be dynamic or static. The dynamic applica-

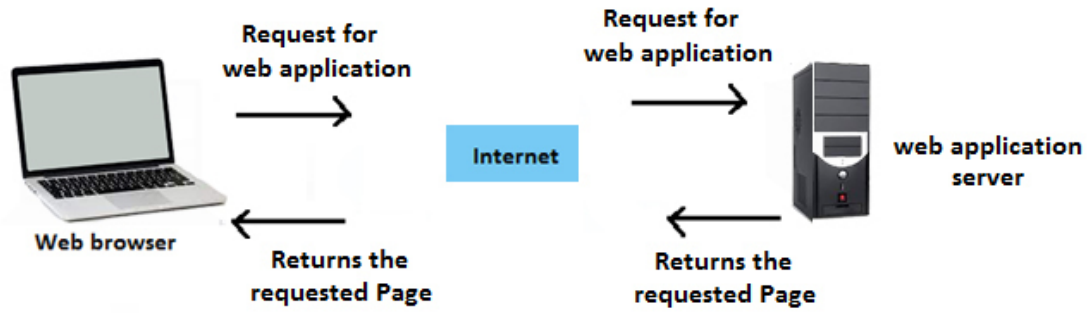


Fig. 4.4.6 Working of Web-Based Application

tions require server-side processing and no such processing is required at the server in static applications. The web application involves a web server that receives requests from the client, an application server to accomplish the requested tasks, and a database to store the information. The working of the web-based application is shown in Fig. 4.4.6.

We can explain its working through simple steps as given below:

a. The web browser requests for the required web application to the Internet.

b. The Internet forwards this request to the appropriate web application server

c. Web application server generates the results of the requested data

d. The web application server returns the requested page to the web browser using the Internet

e. The requested information will appear on the user's display

4.4.3.1 Benefits of a web application

If you are doing a business or running an organization, you need web-based applications to run the business very smoothly. You must know the different benefits of web applications as given below.

- Data Recovery
- Better Security
- Competitive Edge
- Improved Efficiency
- Greater Visibility
- 24/7 Accessibility

By data recovery, you can speedily recover data whenever your data is lost while using web applications. Another benefit of web applications is that it provides better security to the users. This helps to gain better customer loyalty for your business. With the help of a competitive edge with constant improvement, you can keep the customers engaged and involved with your company. The use of web-based applications leads to improved efficiency and helps you to perform better in business.

The other benefit of web applications is that it helps you reorganize your business with greater accuracy. By integrating all data into one place, your business can benefit from higher visibility. The last benefit you have at hand is 24/7 accessibility. Here, the customers can access applications at any time using an Internet connection.

4.4.3.2 Characteristics which can integrate into web application

Now that you have learned the benefits of web applications, it is time to study the features that you must have in your web applications.

- Mobile Interface
- Social Integration
- Analytics
- Live Chat
- Web Payments

The most important feature of the web application is that it should use a mobile interface. It helps the user to use the application on desktop as well as smartphones and tablets.

Another feature of the web application is Social Integration. Suppose, you are trying to complete the registration process as a new user to an application. What happens if the registration process is time-consuming? You are right! You would be disappointed or frustrated. What is the solution? You should consider using social media platforms to streamline the registration process. Social integration allows you to enter into a social media account very quickly.

Next, we can discuss Analytics, one of the best features of the web application. With the help of integrated analytics, you can get critical insights into user activity patterns and the total performance of your web application. Therefore, you can now keep the progress of all such data and enhance your web applications for advanced engagement and better conversion.

Another feature to look out for in any business is Live Chat. This is a better way to connect with customers to understand their problems and give solutions to those problems.

Web Payment or online payment is a feature you must incorporate into your web application. It is useful to the customers to pay for products or services more easily. You should combine shipping, billing information, and payment methods into one step.

4.4.4 Web pages

You might have seen encyclopedias in libraries. An encyclopedia contains information on various subjects all around the globe. These subjects are printed on different pages. Each page is a mixture of texts, figures, etc. You should understand that the web pages are similar to pages in an encyclopedia that are stored in web servers.

Web page is a document used for displaying texts, figures, audio, video, animations, links, etc., on the web browser. We can access the web pages using the Internet. You may link a collection of web pages on a web server and can be called a website. Each web page has a unique Uniform Resource Locator (URL) associated with it.

Now, we can talk about the two main classifications of web pages- Static and Dynamic web pages.

You must understand that the former one consists of stationary web pages loaded on the client's browser as exactly they are stored on the web server. They are created using HyperText Markup Language (HTML). The latter one that we have to discuss is the dynamic web page that shows different bits of information at different times. You should keep in mind that the portion of a dynamic web page can be changed without loading the entire web page. They can be created using HTML, JavaScript, etc.

4.4.4.1 Types of webpages

Suppose, you are running an Institution and you need a website. You should include the different types of pages as given below. You can also follow these pages to create a website for your institution.

Now, we shall discuss the basic types of web pages that you can see on websites. They are:

- Home Page
- Feed Page
- Menu Page
- Search Page
- About Page
- Registration Page
- 404 Page
- Portfolio Page
- Product Page

The first page you have to study is the Home Page. It is one of the most strategic pages of any website. It is called home, as it is typically a starting point where you can get an introduction to the website and choose the direction of your further journey around it.

The second type of page you have to focus on is the Feed Page. It is normally found on websites and its function is to update content. For example, in the case of a social networking site, the feed will often show the updates from the following users or pages.

Next, we can move on to the Menu Page. This page is typically about navigation goalmouths. When you go to a restaurant, you can see a menu which contains the list of food items that you can order. Similarly, the menu page presents a sort of list giving access to different content categories and interaction zones.

Now, we can move on to the Search Page. This page consists of internal search results that you can jump directly to the webpage you want after typing the item in the search field.

The fifth type of page that we are going to discuss is the About Page. It allows you to get information about the company, product, or person behind the website. It is essential for branding and also acts as a shortcut to tell the audience about the benefits of what they can find on the website.

Next, we can see the details regarding the Registration Page. It allows you to create and log into personalized accounts. You should have noticed these types of pages on Facebook, Twitter, email, WhatsApp, etc.

The seventh type of page you have to get an idea of the 404 Page. It tells you that the requested web pages are not found or have any errors. For example, when you click a link of the web page that has been deleted, dead, or broken, the web server sends the 404 web pages to inform you that the content cannot be found.

The Portfolio Page is a usual web page whose objective is professional presentation, creating visual content such as animations, designs, art, videos, or physical goods. For example, you can see hand-made stuff, clothing, exclusive decor, etc in shopping sites.

The final page in this topic is the Product Page. It is one of the essential pages that you can watch on e-commerce websites. This page provides you with all the information about the product such as details, photos, reviews, and ratings from previous buyers, add the product to cart or wish list option. A sample web page of an institution is given in Fig. 4.4.7.

The above figure consists of text, images, links to different pages and websites, etc. You can see different tabs and links such as home page, about page, search page, Facebook, Twitter, Youtube, etc. You may also see different tabs like Home, About, Administration, Academics, Placements, Contact, Search, etc. By clicking those tabs, you can visit the different pages on the website to get the information you want.

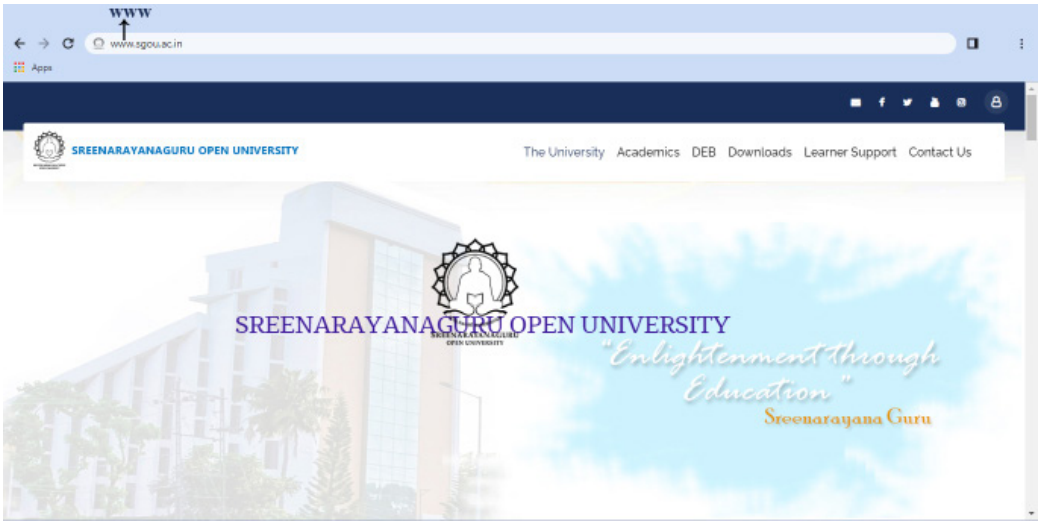


Fig. 4.4.7 Sample Web Page

Recap

- Email transfers messages between computers
- Email needs sender and recipient's addresses
- Email address has username and domain name
- User Agent helps to send and receive emails
- MTA helps to transfer email from one system to another
- Mailbox located on local hard drive collects emails
- Spool file contains emails that are to be sent
- Email messages require sender and recipient's addresses
- Two types of email - email clients, webmail
- Email filtering helps to avoid unwanted emails

- Forwarding and attaching files can be done using email
- CC and BCC help to copy files using email
- Web-Based Systems utilizes web applications to accomplish tasks
- Web applications are usually coded with JavaScript and HTML

Objective Type Questions

1. What helps in the working of e-mail?
2. What are the two parts in an email address?
3. What is the program that helps to send and receive emails?
4. What helps you to transfer email from one system to another?
5. Which is a file on the hard drive to collect emails?
6. What refers to the process of creating messages?
7. What are the two types of email?
8. What helps to avoid unwanted emails?
9. How can we copy files using email?
10. Which is the program that helps the web browser to perform tasks using Internet?
11. How can we code web applications?.
12. What helps to use the application on desktop as well as mobile phones?

Answers to Objective Type Questions

1. Internet
2. Username, Domain name
3. User Agent
4. MTA
5. Mailbox
6. Composition
7. Email clients, webmail
8. Email filtering
9. CC, BCC

10. Web application
11. JavaScript, HTML
12. Mobile Interface

Assignments

1. Prepare a note on the web applications provided by Google.
2. Write notes on any three webmail emails.
3. Open a shopping website in your browser and make notes on the type of web pages seen in the website.
4. Describe the components of an email system and their functions.
5. Differentiate between statis and dynamic webpages. Provide examples of each type.
6. Define web based systems and explain their role in accomplishing tasks using the internet.

Suggested Reading

1. Rhoton, J. (1999). Programmer's guide to internet mail: SMTP, POP, IMAP, and LDAP. Digital Press.
2. Jamsa, Kris. Introduction to web development using HTML 5. Jones & Bartlett Publishers, 2013.

Reference

1. Michael Sampson, in Encyclopedia of Information Systems, 2003
2. Jose Stigliano, Marco Bruni, in Encyclopedia of Information Systems, 2003
3. Peggy Barker, in Clinician's Guide to Assistive Technology, 2002
4. P.K. McBride, Nat McBride, HTML 4.0 Made Simple, 2001

BLOCK 5

Hypertext Markup Language

UNIT 1

HTML: Basic Tags and Divisions

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- learn the structure of HTML documents
- get aware of the different types of documents in HTML
- study the rules in HTML
- study the concept of HTML tags
- learn about Head tags and Body tags
- acquire knowledge on Division and Center tags of HTML

Prerequisites

Almost all of you access different websites for your daily activities with the help of the Internet. Can you explain what a website is? A website is a collection of web pages that can be accessed using the Internet. For the creation of any web page, we need the support of Hyper Text Markup Language (HTML). HTML is a combination of Hypertext and Markup Language.

Hypertext is the text which contains links to other texts or documents that can be displayed on a computer. In a Markup Language, you can use tags to define elements within a document. Apart from the typical programming language, it uses standard words to create the HTML document.

What are the different types of information that you can see on a webpage? You can see text, graphics, links between pages, etc. They are designed with the help of HTML and other software like Cascading Style Sheets (CSS), Javascript, etc. CSS is used to describe the presentation or format the layout of Web pages. It includes changing the text styles, font size, table size, etc. Javascript allows you to make the web pages interactive. We can recall the different versions of HTML as shown in Fig 5.1.1.

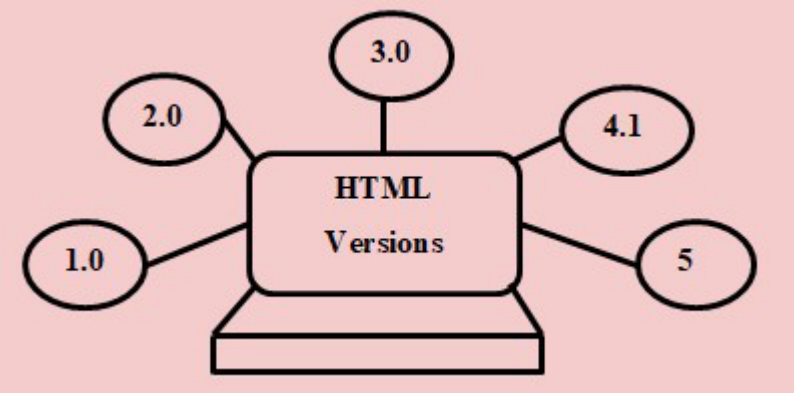


Fig. 5.1.1 Versions of HTML

As shown in Fig 5.1.1 above, different versions of HTML have evolved since it was invented in 1991 by Tim Berners-Lee. In the beginning, HTML version 1.0 supported only the basic text controls and images. It did not provide support for tables, fonts, etc. After that, HTML version 2.0 was developed to maintain common rules and regulations across different browsers with text boxes, buttons, etc.

With version 3.0 of HTML, HTML tags were further improved and supported the CSS to style HTML elements. HTML 4.1 extended the support of cascading styling sheets. That means, an external CSS file could be developed, and this external styling file could be included in HTML. HTML5 is the latest version of HTML that provides you with the support of video streaming, location support, etc

Key Concepts

HTML tags, Head tags, Body tags, Heading tag, Division Tag, Center Tag

Discussion

You must have seen books written in Malayalam, Hindi, English, and other languages. These languages help you to understand the content written in those books.

Likewise, HyperText Markup Language (HTML) is a language used for the designing of web pages. HTML helps you to read and understand the contents of the web page. You should keep in mind that HTML is an amalgamation of Hypertext and Markup language. Hypertext provides you with the link for connecting the web pages and the markup language is used to define the text document within the tag. Both hypertext and markup language define the structure of web pages. Each HTML file is just a plain-text file, but with a .html file extension and is made up of many HTML tags as well as the content for a web page. The HTML tags are the

hidden keywords that define how your web browser must format and display the content.

5.1.1 HTML as Structured Language

In the previous section, you have learned what HTML is and what its different versions are. In this section, we can learn why HTML is called a structured language.

Imagine, you are a story writer going to write a book of 100 stories. First, you have to decide a common language (English) for writing the book. After that, you can use language for writing stories one by one and finally complete the book. Each page of the book consists of texts, images, etc.

Likewise, HTML is a language similar to the English language for creating web pages; each webpage is similar to the page of the book, and the website is similar to the final book. Texts, images, etc in a book are compared to texts, images, etc on each web page. HTML is called structured language because it defines the structure of web pages. These web pages are required to construct a website. It consists of a series of elements that helps the browser to display the content.

5.1.1.1 HTML Element

An HTML element normally has an opening tag, some content, and a closing tag.

Do you know what is an HTML tag? An HTML tag is a set of characters constituting a formatted command for the creation of a Web page. These tags play a significant part in the formation of an HTML Document. You should keep in mind that the HTML predefined tags support the browser to display a particular content properly.

5.1.1.2 Syntax of HTML Element

Suppose, you want to write a sentence in English. You cannot write a sentence with some English words. You have to arrange the words in a well-defined format so that the sentence is free from verbal and grammatical errors.

Similarly, in HTML documents, the elements should follow a syntax. It is the arrangement of elements and attributes to create well-formed documents. Attributes are usually used to define the additional characteristics or properties of the HTML elements like width, height, etc of an image. Attributes are always specified in the start tag (or opening tag) and usually consist of name or value pairs like name="value". Attribute values should always be enclosed in quotation marks. The general syntax of the HTML element is given by

<tagname> Content </tagname>

In the above syntax, <tagname> is the opening tag and </tagname> is the closing tag. The HTML tags are mainly classified into two types. One is called Paired Tag and the other is called Singular Tag. The paired tags come with both opening(< >) and closing(</ >) tags. But in the case of singular tags, closing tags are not required. Some HTML elements have no content. They are called empty elements and have no end tag.

Consider an example of paired tags, <h1>My First Heading</h1>. In this example, <h1> is the opening tag and </h1> is the closing tag, where <h1> defines the most important heading. Consider an example of a singular tag, <br>. Here it has only the opening tag, but no closing

tag. Here <br> element produces a line break in the text.

5.1.1.3 Structure of HTML document

We have learned what is a structured language and what is an HTML element. Now, we shall discuss the basic structure of an HTML page.

Imagine, you want to build a new house on a five-cent plot. For this, you need a structure or plan of the house to complete the building within the five-cent plot. In the structure, you can see rooms, floors, walls, etc. Likewise, in the case of HTML documents, there should be a defined structure to create a webpage. The structure consists of different HTML elements similar to the rooms, floors, walls, etc., of the building. The basic structure of an HTML document is shown in Fig 5.1.2.

```
<!DOCTYPE html>
    <html>

        <head>
            <title> Title here </title>
        </head>

        <body>
            Web page content goes here.
        </body>

    </html>
```

Fig. 5.1.2 Basic structure of HTML document

As you can see in the structure above, it consists of different elements such as DOCTYPE declaration, HTML, head, title, and body elements.

The DOCTYPE declaration is specified in the first line of each web document. It tells the web browser in which version of HTML the page is designed. Next is the HTML element which tells the browser the page is structured in HTML. Also, it is the root element of the HTML document. The third element is the head element which gives information about the “behind the scenes” elements of a web document. Therefore, the elements that are written within the head are not visible on the front end of a webpage.

The fourth element we have to study is the title element. It specifies a title for the HTML document. It also tells the browser what text will be shown in the web browser’s title bar. The last element in the structure is the body element. It helps you to display the actual content such as text, images, videos, links, etc., on your web page. It defines the document's body and is a container for all the visible contents, such as headings, paragraphs, images, hyperlinks, tables, lists, etc.

5.1.1.4 Saving the HTML Document

Imagine, you are preparing a leave letter using Microsoft word. How will you save the

document? You can save the document using the extension .doc or .docx. Similarly, in the case of an HTML document, you can save the document in the .html or .htm extension.

Would you like to know how to save the HTML document? Before saving the document, you can create the HTML document using a text editor such as Notepad or TextEdit. After that, you can save the text file using the .html or .htm extension. Once you save an HTML document, it can be opened as a web page in the browser. You can view them using Google Chrome, Safari, Mozilla Firefox, etc. The browser reads the HTML file and renders its content to Internet Users. If you want to create a simple web document using notepad, you can follow the HTML document example given below.

Example of an HTML document

```
<!DOCTYPE html>
<html>
<head>
<title> Web Page</title>
</head>
<body>
<h1>Distance Learning Computer Science </h1>
<p>A portal for Students</p>
</body>
</html>
```

Output:

Distance Learning Computer Science

A portal for Students

Description:

After saving the document as a.html file, you can display the output in your browser.
In this example, ***h*** represents the heading and ***p*** *denotes* the paragraph.

5.1.2 HTML Document Types

In the previous section, you learned the structure of HTML. In this section, we can study the different types of HTML documents. HTML documents are classified into three main categories. They are

- Transitional
- Strict
- Frameset

5.1.2.1 Transitional Document

First, we can go through the transitional type of HTML document. It is the most used type of HTML document having a flexible syntax. It has been used without syntax restrictions for many years, and the browsers support a 'best effort' tactic to read the tags. The 'Best effort' concept means that the browsers do not report the HTML errors, but they simply display what they can. If there is any misspelling in the tags, the browsers do not correct errors and display the content anyway.

5.1.2.2 Strict Document

It is the second type of HTML document you should learn while creating an HTML document. When you are using this type of document, it returns the rules into HTML and makes it more reliable. For example, if you use opening tags for all HTML elements, closing tags are also required for all opened tags. This type of HTML documents are significant on mobile phones, where the processing power is restricted compared to computers. It also helps you to load the web pages more rapidly.

5.1.2.3 Frameset Document

A frameset document allows you to create a mosaic of HTML documents in which multiple documents can be connected to a single screen. This method is frequently used for creating a menu system. For example, if you click on a menu item on the left side of the screen, only the right side of the screen reloads. The menu stays in place.

5.1.3 Rules of HTML

Suppose you want to solve y=2*3+(5-1)/2. What is the procedure for solving the problem? You have to apply the BODMAS rule to solve the question. BODMAS means Bracket of, Division, Multiplication, Addition, and Subtraction. So, you have to solve according to the BODMAS rule. The steps are given below.

Step 1: (5-1)=4 (bracket)

Step 2: 4/2=2 (division)

Step 3: 2*3=6 (multiplication)

Step 4: 6+2=8 (addition)

Final answer=8

Likewise, in HTML we have to follow certain rules, otherwise, the document will not be displayed or produce errors.

Before you begin to design a web page, you have to keep in mind the basic HTML rules. All you need is to decide what to do on a page layout. To do this, you have to take a piece of paper and a pencil and start sketching the design or layout that is needed for the web pages. This helps to rearrange the designs according to your vision without using HTML tags. Once you have settled on the type of web page you want, you can start creating pages with HTML tags. The tags help to include text, images, and links to other pages and tell the web browser how to display them. For example, if you want an image to show up on the right side of the page, a certain word to appear bold, or another word to link to an outside resource, you can use the HTML tags to do it.

As you are moving to design a web page using HTML tags, you should remember some important rules for coding with HTML tags. They are given below.

a. The first thing you have to keep in mind is that HTML tags are always surrounded by angle brackets (less than or greater than symbols)

Example:<head>

b. The second rule is that most tags work like a light switch. That means, the opening tag makes the action on, and the closing tag makes it off. Also, there are some exceptions.

For example, the <BR> tag creates a blank line and doesn't have an "off switch."

c. The next rule is that the closing tag always uses a forward slash (/). For example, if you want to make the text bold, you can use <B>. If you want to terminate the bold option and return to regular text, you can use </B>.

d. Tags can be embedded, so when you start a tag within another tag, you have to close that inner tag before closing the outer tag. Therefore, the page will not display properly when the tags are not closed correctly.

Consider the example below:

<HEAD><TITLE> Your text </HEAD></TITLE>

In the example, the closing tags are not in proper order. First, you have to close the inner tag TITLE and then the HEAD tag. We can correct the order as given below.

<HEAD><TITLE>Your text </TITLE></HEAD>.

e. You should learn that many tags have optional attributes. These attributes use values to modify the tag's behavior. For example, take the <P> (paragraph) tag. ALIGN attribute is associated with the <P> tag. The default alignment of <p> is left. You can align <p> as center by using <P ALIGN=CENTER>.

Apart from the above, you have to remember the following things also. You have studied the different versions of HTML. When new versions evolve, some of the tags

may be unused and some new tags or features will be introduced. Accordingly, the older browsers often do not support the newest tags. When a browser cannot understand a tag, it normally ignores both the tag and the material the tag affects. So, the newest elements will appear to viewers with newer browsers without causing problems for viewers using older browsers, who will only see material their browsers recognize.

5.1.4 HTML Tags

We have already learned that HTML tags are like keywords that help web browsers to format and display the content. With the help of tags, a web browser can distinguish between HTML content and simple content. HTML tags have three main parts: an opening tag, content, and closing tag. But some HTML tags have no closing tags. When a web browser reads an HTML document, it reads from top to bottom as well as from left to right. HTML tags are always used to create HTML documents and render their properties.

5.1.5 Head Tags

Regarding the concept of HTML tags, you might have an interest in knowing the different types of HTML tags. This section deals in detail with the head tag.

The head tag contains the metadata information. Metadata includes information regarding the document title, character set, styles, links, scripts, etc. You should know that the metadata is not displayed to the user on the web page. It provides technical information to the browsers and search engines about the web page. The Syntax of the head tag is given by

<head> content </head>

where <head> represents the opening and </head> represents the closing head tags.

5.1.5.1 Elements of Head Tag

After learning the head tag, you must have interest in knowing the elements of the head tag. The head tag includes the following elements:

- Title tag
- Style tag
- Base tag
- Link tag
- Meta

a.Title Tag

What is a title tag? It describes the title of an HTML document. Sometimes, the title tag may confuse you with the h1 tag, but they are different. The h1 tag specifies the title of page content, whereas the title tag represents the title of the entire HTML content. It is usually displayed at the top of the browser window. You should note that there is only one <title> element in an HTML document located inside the <head> section.

Tips for Creating Titles

You should remember some tips while creating the title of your web document. They are specified below.

- You can use a descriptive phrase instead of using one or two words.
- Try to avoid special characters (#, $, ^, *, &, etc.), as they are displayed by the browsers differently.
- Avoid using the list of words as a title and make sure that the title is unique.

The Syntax of the title tag is given by

<title> content </title>

where<title>represents the opening and </title>denotes the closing title tags. An example of how to use the title tag in an HTML document is given below:

Example of the HTML <title> tag

```
<!DOCTYPE html>
<html>
<head>
<title>learn HTML, CSS, JavaScript.</title>
</head>
<body>
<p>The main content of the page.</p>
</body>
</html>
```

Output:

The main content of the page.

(How to save the file and produce the result is already explained in the structure of the HTML document section)

Description:

In the above example title tag is represented with opening and closing tags as given below.

<title>learn HTML, CSS, PHP, JavaScript.</title>

The content ‘learn HTML, CSS, PHP, JavaScript’ will be displayed only at the top of the browser window.

b. Style Tag

Before moving to the style tag, you should recall the concept of Cascading Style Sheets (CSS). CSS is mainly used for the styling of web documents. You should also understand that CSS and HTML are two fundamental technologies for building web pages. As you know that HTML provides the structure of the page, CSS is used to format the layout of Web pages. They can be used to define text styles, table sizes, and other aspects of Web pages.

Now, we can focus on “style tag”. It is generally used to style HTML documents with CSS. The style tag defines how elements should be displayed in browsers. The information that is included in the style tag is mainly used for browsers and placed inside the <head> element. You should note that it is possible to use more than one <style> element on one page.

The Syntax of the style tag is given by:

<style> </style>

where<style>represents the opening and </style>represents the closing style tags. An example showing the use of style tag in an HTML document is given below:

Example of the HTML <style> tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
h1 {
color: #1c87c9
}
p {
color: #8ebf42;
}
</style>
</head>
```

```
<body>

<h1>Text heading SGOU.</h1>

<p>First paragraph sgou.</p>

</body>

</html>
```

Output:

Text heading SGOU.

First paragraph sgou.

Description:

In the above example style tag is represented by opening and closing tags. In between the style tags, you can see the color information of h1 (heading) and p (paragraph) which is displayed at the output.

c. Base Tag

Next, we shall talk about the base tag. It defines an absolute or base Uniform Resource Locator (URL) in the HTML document. This tag also determines how the links in the current document should be opened in a new window or the current window. If the HTML document does not contain any <base> element, the default URL is used. You should remember that there will be only one base tag that can be used on the web page, and it should be placed in the <head> element.

The Syntax of the base tag is given by

<base>

The base tag is an empty tag, so no closing tag is required. The HTML <a> element (or anchor element), with its href attribute, creates a hyperlink to web pages. An example showing the use of base tag in an HTML document is given below:

Example of the HTML <base> tag:

```
<!DOCTYPE html>

<html>

<head>

<title>HTML base tag</title>

<base href="https://www.htmlexample.com/" target="_blank">

</head>
```

```
<body>

<a href="/css3-maker/border-radius">Try CSS Maker Tool</a>

</body>

</html>
```

Output:

Try CSS Maker Tool

Description:

In this example, the base tag defines the base URL - "https://www.htmlexample.com/", and the relative link "/css3-maker/border-radius" as a starting point.

d. Link Tag

The next<head>element that you have to study is the link tag. It defines the relationship between the current HTML document and the external resource. It is generally used to link to the external CSS. An HTML document can have several <link> elements for loading different types of scripts or pages. All these <link> elements should be placed in the <head> section of the document. A script is a program that helps you to add interactivity to your website. For example, a script could generate a pop-up alert box message, or provide a drop-down menu.

The Syntax of the link tag is given by

<link>

The link tag is empty, so no closing tag is required. You should note that the rel is an attribute of link tag that defines the connection between a linked resource and the current document. An example showing how to use the link tag in an HTML document is given below:

Example of the HTML <link> tag:

```
<!DOCTYPE html>

<html>

<head>

<link rel="stylesheet" type="text/css" href="style.css">

</head>

<body>

<h1>The presence of the header is determined by the CSS styles indicated in the external file.</h1>
```

```
<p>The presence of the paragraph is determined by the CSS styles indicated in the external file.</p>

</body>

</html>
```

Output:

The presence of the header is determined by the CSS styles indicated in the external file.

The presence of the paragraph is determined by the CSS styles indicated in the external file.

e. Meta Tag

From the above examples of the <head> element, you have got an idea to write an HTML document. Now, it is time to learn about the meta tag. It provides additional information about HTML documents. The <head> of a page consists of <meta> elements that may contain different attributes. The metadata specifies the page description, keywords, author of the document, etc. It is generally used by browsers, search engines, and other web services, and is not displayed on the web page.

A web document can contain more than one meta tag, but the physical appearance of the document is not affected by it.

The metatag is placed in the head tag and the syntax is given by:

<meta>

The meta tag is an empty tag, so no closing tag is required. We can look into different examples to understand the concept of meta tags.

For example, you can define the keyword for the search engines as

<meta name=”keywords” content=”HTML, CSS, XML, XHTML, JavaScript”>

Another example of how to define the website description using meta tag is given by

<meta name=”description” content=”Tutorials on HTML, CSS and PHP”>

Another example of setting the viewport to make the website look good on all devices is given by

<meta name=”viewport” content=”width=device-width, initial-scale=1.0”>

5.1.6 Body Tag

After discussing the head tags, we shall now focus on the body tag. This tag is mainly used for defining the content of a web page like text, images, links, etc. The body tag

is placed inside the <html> element, after the <head> element. In an HTML document, we can use only one body tag.

The Syntax of the body tag is given by

<body> content </body>

where <body> represents the opening and </body> represents the closing body tags. You can write the content in between the opening and closing tags. The usage of body tag in an HTML document is given as an example below:

Example of the HTML <body> tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<p>Content of the document</p>
</body>
</html>
```

Output:

Content of the document

5.1.7 Headings tag

You have seen different types of headings on a page or section of the book. Likewise, in an HTML document, there are different types of headings to structure the content of the web page. These headings are helpful to search engines to understand and index the structure of the web page.

Do you know,there are mainly six levels of headings in HTML. They are <h1>, <h2>, <h3>, <h4>, <h5>, and <h6>. The <h1> - <h6> tags are used to mark headings according to their importance. The <h1> tag stands for the most important heading of the web page and the <h6> stands for the least important and smallest one. An example of the usage of heading tags in an HTML document is given below:

Example of <h1> - <h6> html heading tags:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<h1>This is heading 1</h1>
<h2>This is heading 2</h2>
<h3>This is heading 3</h3>
<h4>This is heading 4</h4>
<h5>This is heading 5</h5>
<h6>This is heading 6</h6>
</body>
</html>
```

Output:

This is heading 1

This is heading 2

This is heading 3

This is heading 4

This is heading 5

This is heading 6

5.1.8 Division Tag

The division tag or is like an empty container that helps you to define a division or a section. It does not affect the content or layout of the HTML document and is

generally used to group HTML elements to be styled with CSS. In the meantime is a block-level element, a line break should be placed before and after the division tag. It also helps you to place any HTML element within a division tag, including another . The division tag cannot be inside <p> element, because the paragraph will be broken at the point where the division tag is entered.

The Syntax of the division tag is given by

** content **

Where represents the opening and represents the closing division tags. You can write the content in between the opening and closing tags. An example showing how to use the division tag in an HTML document is given below:

Example of the HTML tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Division Tag</title>
</head>
<body>
<h1> Division Tag </h1>
<div>
<p>We use division tag
</p>
<p>It is an HTML tag
</p>
</div>
</body>
</html>
```

Output:

Division Tag

We use division tag

It is an HTML tag

5.1.9 Center Tags

We shall now move on to the final topic of this unit, the center tag. This tag helps you to align the content such as text, graphic elements, tables, etc, to the center.

The syntax of the center tag is given by

** content **

Where represents the opening and represents the closing center tags. You can write the content in between the opening and closing tags. An example of the usage of centertag in an HTML document is given below

Example of the HTML tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<p>This text is aligned to the left.</p>
<center>And this one is placed in the center.</center>
</body>
</html>
```

Output:

This text is aligned to the left.

And this one is placed in the center.

Recap

- HTML - Combination of Hypertext and Markup Language
- Hypertext contains links to other texts or documents
- Markup Language uses tags to define elements within a document
- CSS describes presentation or format of the layout of Web pages
- Javascript makes interactive web pages
- HTML5 - the latest version of HTML
- HTML defines the structure of web pages
- Attributes define the additional characteristics or properties of the HTML
- Paired tags come with opening and closing tags.
- Singular tags have no closing tags
- Empty elements - HTML elements having no content
- DOCTYPE declaration is the first line of HTML document
- HTML element – the root of HTML document
- head element gives info on “behind the scenes” elements
- title element specifies the title for the HTML document
- body element - last element in the HTML structure
- HTML documents created using Notepad and TextEdit.
- HTML documents use .html or .htm extension.
- Transitional Document - most used type of HTML document with a flexible syntax
- Strict Document returns the rules into HTML
- Frameset Document - creates a mosaic of HTML documents
- HTML tags - always surrounded by angle brackets
-
 element creates a blank line
- Closing tag always uses a forward slash (/)
- head tag contains the metadata information
- h1 tag specifies title of page content

- title tag represents title of entire HTML content
- style tag used to style HTML documents with CSS
- base tag defines absolute or base URL
- link tag links to external CSS
- Script - program that adds interactivity to the website
- meta tag provides additional information about HTML documents
- body tag defines the content of web page
- HTML document uses only one body tag
- <h1> element - most important heading of web page
- <h6> element - least important heading of web page
- division tag defines division or section
- division tag does not affect the content or layout of the HTML document
- division tag - used to group HTML elements to be styled with CSS
- division tag cannot be inside <p>element
- center tag aligns the content to center

Objective Type Questions

1. What is the combination of Hypertext and Markup Language called?
2. Which contains links to other texts or documents?
3. Which software tool is used for formatting the layout of Web pages?
4. How can we make interactive web pages?
5. Which is the latest version of HTML?
6. What defines the structure of web pages?
7. Which gives additional characteristics or properties to the HTML document?
8. What are the elements in HTML having no content called?
9. Which declaration is specified in the first line of the HTML document?
10. Which element is the root of an HTML document?
11. How can we get information on the "behind the scenes" of HTML documents?

12. What helps to display the actual content on the web page?
13. How can we save an HTML document?
14. What type of HTML document has a flexible syntax?
15. Which HTML document returns the rules into HTML?
16. How will you create multiple HTML documents on a single screen?
17. How are the HTML tags surrounded with?
18. What helps to create a blank line in the HTML document?
19. Which tag contains the metadata information?
20. Which tag specifies the title of page content?
21. Which tag represents the title of the entire HTML content?
22. How many <title> elements are located inside the <head> section of the HTML document?
23. How can we define a base URL?
24. Name the program that helps to add interactivity to the website?
25. Which tag defines the content of the web page?
26. How many body tags are used in the HTML document?
27. How many levels of headings are there in HTML?
28. Which HTML element represents the most important heading of a web page?
29. Which tag defines the section of a web page?
30. How to group HTML elements to be styled with CSS?
31. How can we align the content to the center?

Answers to Objective Type Questions

1. Hyper Text Markup Language
2. Hypertext
3. CSS
4. Using Javascript
5. HTML5
6. HTML
7. Attributes
8. Empty elements
9. DOCTYPE
10. HTML element

11. head element
12. body element
13. .html/.htm
14. Transitional
15. Strict
16. Frameset document
17. Angle brackets
18.
 element
19. head
20. h1
21. title
22. one
23. <base> element
24. Script
25. body
26. one
27. 6
28. <h1>
29. division
30. element
31. element

Assignments

1. Prepare a note on the different versions of HTML.
2. Write notes on the attributes related to the HTML tags that you have studied in this unit
3. Write a note on designing a webpage using HTML tags that you have studied in this unit.
4. Compare and contrast the three main catagories of HTML documents: Transitional, Strict, and Frameset. Explain the use cases for each type with examples.
5. Design a one page resume or CV website showcasing your education, work experience, skills and accomplishments.
6. Explain link tag in HTML.

Suggested Reading

1. P.K. McBride, Nat McBride, HTML 4.0 Made Simple, Made Simple Publishers, 2001st edition.
2. Thomas A Powell,The Complete Reference HTML & XHTML, McGraw Hill Publishers,4thEdition.
3. Steven A. Gabarro, "Introduction to HTML," in Web Application Design and Implementation: Apache 2, PHP5, MySQL, JavaScript, and Linux/ UNIX ,Wiley-IEEE Press, 2007.
4. B. Douglas Blansit,An Introduction to Cascading Style Sheets (CSS), Journal of Electronic Resources in Medical Libraries, 2008.

Reference

1. For the live demo to understand basic HTML tags, use the link: https://www.w3schools.com/tags/ref_byfunc.asp
2. For the live demo to understand the division tag, use the link: https://www.geeksforgeeks.org/div-tag-html/
3. For the live demo to understand the center tag, use the link: https://www.tutorialspoint.com/html/html_center_tag.htm

UNIT 2 Managing List and Table

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- study the concept of list tags in HTML
- get knowledge on ordered and unordered lists
- acquire knowledge on the use of tables in HTML
- study the table tags used in HTML
- obtain the awareness of frames in HTML

Prerequisites

In the previous unit, we learned the concepts of Hypertext Markup Language (HTML), the structure of an HTML document, the different document types in HTML, the rules in HTML as well as the syntax of HTML tags. In this section, we study HTML lists and Tables. We have already learned that HTML is a structured language that defines the structure of web pages. These web pages are very essential to construct a website. Therefore, we have to use different HTML tags to structure as well as to create the web document. These tags also support the browser to display a particular content properly.

As you know, every HTML element has a proper syntax. The general syntax of an HTML document is given by:

<tagname> Content </tagname>

In the above syntax, <tagname> is the opening tag and </tagname> is the closing tag. You must note that some HTML tags have no closing tag. Now, we can recall the structure of an HTML document given in Fig 5.2.1.

As you can find in the structure, it consists of different elements such as DOCTYPE declaration, HTML, head, title, and body elements. The DOCTYPE declaration is specified on the first line of each web document. This helps the web browser to understand in which version of HTML the page is written. After the DOCTYPE declaration, there

comes the HTML element, which is the root element of an HTML document. It conveys to the browser that the page is structured in HTML.

```
<!DOCTYPE html>
    <html>

        <head>
            <title> Title here </title>
        </head>

        <body>
            Web page content goes here.
        </body>

    </html>
```

Fig. 5.2.1 The basic structure of HTML document

Next, you can see the head element, which gives information about the "behind the scenes" elements of a web document. After the head element, you can see the title element that gives a title for the HTML document. It also tells the browser what text will be shown in the web browser's title bar. The last element in the structure is the body element. It helps you to display the actual content such as text, images, videos, links, etc. on your web page. It also defines the body of the document as well as a container for all the perceptible contents like headings, paragraphs, images, hyperlinks, tables, lists, etc.

Key Concepts

HTML List, Ordered List, Unordered List, HTML Tables, HTML Frames

Discussion

5.2.1 HTML Lists

This section deals with the study of HTML lists. Lists are used in HTML to present the information in a well-defined manner. Also, the lists may assist you to introduce the information more semantically.

Consider a real-life example. Suppose you are the coordinator of an arts festival in a college. In the festival, there may be different competitions in dance, music, painting, etc. So, you have to list or arrange the programs like a well-defined manner for the smooth conduct of the festival. The list used in this example is similar to the HTML list.

Now, we can have a look at the types of HTML list. There are mainly three types of lists as given below. Each of them is defined with the help of different tags and each one has a specific purpose and sense.

- Unordered list
- Ordered list
- Description list

5.2.1.1 HTML Unordered Lists

The HTML unordered lists help you to group the items that have no numerical order. That means, when you change the order of list items, the meaning will not change.

Consider the same example of the arts festival above. There are different participants in each competition. You can list the names of the participants in any order. It does not affect their participation in the program. This is similar to the unordered list in HTML.

Do you know how to create an unordered list? An unordered list can be created with the use of an ul tag. The ul tag comes in pairs. The Syntax is given by

** content **

Where <ul> denotes the opening tag and represents the closing tag. An important point you should note is that each element of an unordered list is declared inside the ul tag.

Now, let us see, what is a li tag? The HTML li tag is used to represent an item in a list. It must be confined to a parental element such as an ordered list, an unordered list, or a menu. In the case of menus and unordered lists, items are usually displayed using bullet points. But in ordered lists, they are usually displayed with an ascending counter on the left, such as a number or letter. The li tag comes in pairs and the syntax is given by

** content **

Where <li> denotes the opening tag and represents the closing tag. An example showing the usage of ul tag and li tag is given below:

Example of the HTML <ul> tag for creating an unordered list:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<h1>An unordered list:</h1>
<ul>
```

Neil Amstrong

Maxwell

Albert Einstein

Issac Newton

</body>

</html>

Output:

An unordered list:

- Neil Amstrong
- Maxwell
- Albert Einstein
- Issac Newton

5.2.1.2 HTML Ordered Lists

From the previous section, you should have got an idea of the modality of using unordered lists. Now, we can learn about the HTML ordered lists. It is mainly used for listing the items that are marked with numbers. That means you can list the items in an ordered form starting with numbers 1, 2, 3, …

Consider the same example of an arts festival given in the previous section. As there are different participants in each competition, you can list the names of the participants in order with numbers starting 1, 2, 3, …. This is similar to the ordered list in HTML.

Do you know how to start an ordered list? An ordered list can be started with the help of an ol tag. The ol tag comes in pairs and the syntax of ol tag is given by:

** content
**

where
denotes the opening tag and
represents the closing tag. Similar to the unordered list, each item in the ordered list starts with the help of ol opening and closing tags. An example of an HTML document using ol tag is given below:

Example of the HTML <ol> tag for creating an ordered list:

<!DOCTYPE html>

<html>

```
<head>
<title>Title of the document</title>
</head>
<body>
<h1>An ordered list:</h1>
<ol>
<li>Neil Amstrong</li>
<li>Maxwell</li>
<li>Albert Einstein</li>
<li>Issac Newton</li>
</ol>
</body>
</html>
```

Output:

An ordered list:

1. Neil Amstrong
2. Maxwell
3. Albert Einstein
4. Issac Newton

5.2.1.3 HTML Description Lists

You should have understood the concepts of unordered and ordered lists from the above sections. Now, one more type of HTML list you have to study, is the HTML description list. The description list helps you arrange terms or names with a description as they are arranged in a dictionary.

Suppose you are searching the meaning of the words database, algorithm, broadband, and command using a dictionary. You get a description of all the words that you search and can understand the meaning of each word. This is similar to the description list in HTML.

Are you interested in creating a description list? You can create a description list using

the dl tag. This tag also comes in pairs and the syntax of dl tag is given by

<dl> content</dl>

Where <dl> denotes the opening tag and </dl> represents the closing tag. While using a description list, you can use HTML dt tag for a term in the description list and HTML dd tag for the description of that term in the description list.

a. HTML dt tag

The HTML dt tag helps you to represent a term in the list of descriptions. You can use dt tag with the HTML dd tag and dl tag. You must keep in mind that in the description list, there should be at least one dt tag that is followed by at least one dd tag.

The syntax of dt tag is given by

<dt> content</dt>

Where <dt> denotes the opening tag and </dt> represents the closing tag.

b. HTML dd tag

The second tag associated with the dl tag is the HTML dd tag. You can use the dd tag together with the dl tag and dt tag to create a definition list. The dd tag holds the description of the term, which is defined by the dt tag. You should note that there should be a minimum one dt tag followed by one dd tag for each group.

The syntax of ddtag is given by

<dd> content</dd>

Where <dd> denotes the opening tag and </dd> represents the closing tag.

We can see an example showing the usage of dd tag given below:

Example of the HTML <dl> tag for creating a description list:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<h1>Description list:</h1>
<dl>
<dt>Abert Einstein</dt>
```

```
<dd>- Scientist</dd>
<dt>Sachin</dt>
<dd>- Cricketer</dd>
<dt>Mohan Lal</dt>
<dd>- Actor</dd>
</dl>
</body>
</html>
```

Output:

Description list:

Abert Einstein

- Scientist

Sachin

- Cricketer

Mohan Lal

- Actor

5.2.2 HTML Tables

In the previous section, you learned the use of lists in an HTML document. In this section, we have a look at the HTML tables.

You might have used Microsoft Word for creating documents. What will you do if you want to draw a table in the document? You can use the insert tab to create a table with the required rows and tables.

In an HTML document also, you can create tables with the HTML table tags. The HTML tables help you to create rows and columns on a web page. In HTML, you can create tables using the table tag in combination with the tr, td, and th tags. The syntax of the table tag is given by

<table> content</table>

Where <table> denotes the opening tag and </table> represents the closing tag. Now, we can move on to tr, td, and th tags.

a. HTML tr tag

The tr tag is an HTML tag that allows you to specify a row in an HTML table. The cells inside the tr tag can be defined with td and th tags. You should note that the tr tag is declared inside the table tag. The Syntax of tr tag is given by

<tr> content</tr>

Where <tr> denotes the opening tag and </tr> represents the closing tag.

b. HTML td tag

The td tag helps you to specify a standard data cell in an HTML table. It can be used as a child element of the tr tag which defines a row in a table. The td tag can contain text, images, etc., in the standard data cell. The content inside the cell is aligned to the left by default. The syntax of td tag is given by

<td> content</td>

Where <td> denotes the opening tag and </td> represents the closing tag.

c. HTML th tag

The th tag allows you to specify a header cell in an HTML table. It must be used as a child element of tr tag which is declared in the table tag. The th tag can contain text, images, etc., that can be used in the body of the HTML document. The size of the table is automatically adjusted based on the size of its content. Both the td and th tags support the colspan attribute for additional control over cells as to how they span across or fit into columns. You can use the rowspan attribute on cells if you require more than one row. The syntax of th tag is given by

<th> content</th>

Where <th> denotes the opening tag and </th> represents the closing tag. An example of, how to use th tag is given below:

Example of the HTML <tr> tag

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
table {
width: 80%;
margin: 30px auto;
```

```
border-collapse: collapse;
        }
th,
td {
padding: 10px;
border: 1px solid #666;
        }
</style>
</head>
<body>
<table>
<tr>
<th>Month</th>
<th>Date</th>
</tr>
<tr>
<td>April</td>
<td>10.04.2021</td>
</tr>
<tr>
<td>May </td>
<td>02.05.2021</td>
</tr>
</table>
</body>
</html>
```

Output:

Month	Date
April	10.04.2021
May	02.05.2021

Description:

From the output, you can see that a table is created with two columns: month and date

5.2.3 HTML Frames

We have already studied HTML lists and tables. Now, we are going to the final section of this unit, which is called HTML frames. An HTML frame tag defines a window or a frame. By using the frame tag you can load more than one web page. For this operation, you can use the src attribute to define the address of the web page and the URL of the external source. The frame tag is empty, so no closing tag is required. Therefore the Syntax is given by :

<frame>

Do you know that the frame tag is used with the <frameset> element? This helps you to divide the window into frames. If you need to use frames in a browser, you can use the frameset tag. It helps you to express the structure of a frame in the browser, where you can load another web page. The horizontal frame is defined by the rows attribute of the frame tag and for defining vertical frames, cols attribute is used. The frameset tag comes in pairs. Therefore, the content is written in between the opening and closing frameset tags. The syntax of frameset tag is given by

<frameset> content</frameset>

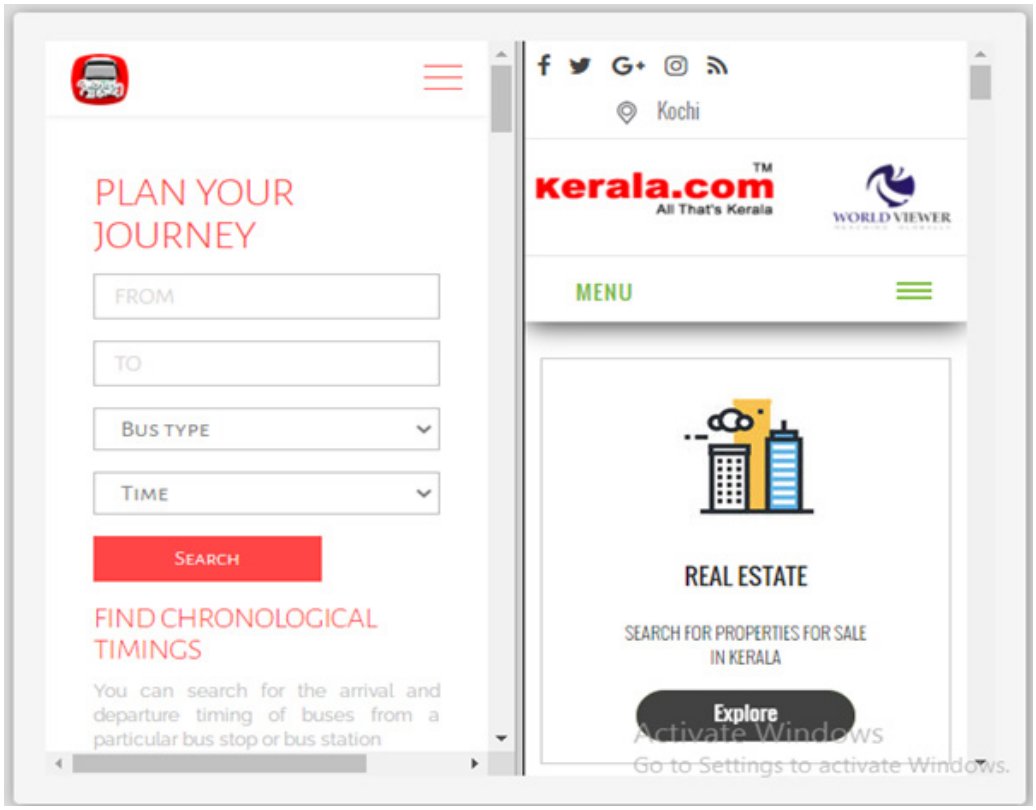
Where <frameset> denotes the opening tag and </frameset> represents the closing tag. The frameset tag can contain one or more frame tags. It is allowed to nest one frameset tag in another if it is necessary to divide the windows into smaller ones. An example of the usage of frame tag is given below:

Example of the HTML <frame> tag:

```
<!DOCTYPE html>

<html>

<head>

<title>Title of the document</title>

</head>
```

```
<frameset cols="50%,50%">
<frame src="https://www.aanavandi.com">
<frame src="https://www.kerala.com">
</frameset>
</html>
```

Output:



Description:

From the output, you can see two frames can be nested using the ***frameset*** tag and ***frame*** tag.

Recap

- HTML lists present information in a well-formed manner
- HTML lists introduce information semantically
- HTML unordered list groups the items having no numerical order and are shown in bullets
- Unordered list is created with ul tag
- Each element in unordered list is declared inside the ul tag
- HTML li tag represents an item in a list
- HTML ordered list groups the items marked with numbers
- Ordered list starts with ol tag
- Description list is created using dl tag
- HTML dt tag represents a term in the list of descriptions
- Description list contains at least one dt tag
- dd tag holds a description of the term defined by dt tag
- th tag specifies header cell in HTML table
- HTML frame tag defines specific window or frame
- Frame tag helps to load more number of web pages
- <frameset> element divide the window into frames

Objective Type Questions

1. What helps to present the HTML document in a well-formed manner?
2. How do the HTML lists introduce information?
3. Which HTML list groups the items that have no numerical order?
4. How can we create an unordered list?
5. How to represent an item in a list?
6. How can we group the items marked with numbers?
7. Which tag is used for starting an ordered list?
8. How can we arrange terms with a description?
9. Which HTML tag is used for representing a term in the list of descriptions?
10. How can we create tables in the HTML document?

11. Which tag specifies a row in an HTML table?
12. Which tag specifies a standard data cell in an HTML table?
13. Which HTML tag defines a specific window?
14. How to divide a window into frames in an HTML document?

Answers to Objective Type Questions

1. HTML lists
2. Semantically
3. Unordered, ul
4. ul tag
5. li tag
6. Ordered list, ol
7. ol
8. Description list, dl
9. dt
10. HTML table tags
11. tr
12. td
13. frame
14. <frameset>element

Assignments

1. Prepare an HTML document to list your ten friends.
2. Prepare a note on the attributes used in HTML lists and Tables.
3. Prepare an HTML document to construct a table with ten rows and five columns.
4. Prepare an HTML document to incorporate four frames in the document.
5. Investigate the concept of description list in HTML. How are description list structured, and what do the <dl>, <dt> and <dd> tags play in creating them?
6. Design and develop a simple website that displays a catagorised list of various types of fruits and vegetables. The website should provide information about each item such as item name, image and a brief description.

Suggested Reading

1. P.K. McBride, Nat McBride, HTML 4.0 Made Simple, Made Simple Publishers, 2001st edition.
2. Thomas A Powell, The Complete Reference HTML & XHTML, McGraw Hill Publishers,4thEdition.
3. Steven A. Gabarro, "Introduction to HTML," in Web Application Design and Implementation: Apache 2, PHP5, MySQL, JavaScript, and Linux/ UNIX ,Wiley-IEEE Press, 2007.
4. B. Douglas Blansit, An Introduction to Cascading Style Sheets (CSS), Journal of Electronic Resources in Medical Libraries, 2008.

Reference

1. For the live demo to understand the HTML list tags, use the link: https://www.w3schools.com/html/html_lists.asp
2. For the live demo to understand the HTML tables, use the link:https://www.tutorialspoint.com/html/html_tables.htm
3. For the live demo to understand the HTML frames, use the link: https://www.javatpoint.com/html-frame-tag

Presenting Multimedia

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- study the HTML Image tags
- obtain knowledge on colors, color names, and color values in HTML
- study the concepts of HTML audio element
- study the concepts of HTMLvideo element
- acquire knowledge on HTML plug-ins

Prerequisites

You have already learned the concepts of HTML tags, HTML lists, tables, and frames in the previous unit. In this unit, you have to concentrate on the concepts of presenting multimedia in HTML. Do you know which was the first and foremost mass communication medium? The answer is the newspaper. It provides different information in the form of text, images etc. Afterward, radio and television emerged to present audio and visual representation. Then comes the computer that provides different information such as text, audio, video, etc., in the digital format.

Now, we can define Multimedia. Multimedia is an interactive mass communication medium that allows you to present information powerfully to users in the digital format. Fig. 5.3.1 shows the types of information that constitute multimedia.

The figure 5.3.1 shows the multimedia and various elements. As you can see text, image or graphics, audio, video, and animation are the different elements of multimedia. The text includes characters, words, sentences, phrases, paragraphs, etc. You must have seen images or graphics in black and white as well as color. It comes in different file formats such as Joint Photographic Experts Group (JPEG), Portable Network Graphics (PNG), Tagged Image File Format (TIFF), Bitmap File Format (BMP), Graphics Interchange Formats (GIF), etc.

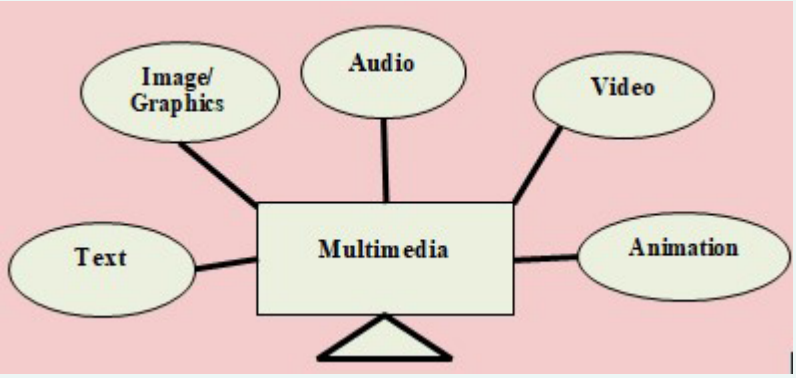


Fig. 5.3.1. Multimedia and Elements

Multimedia audio includes speech, music, and other sound effects. It comes in different formats like Waveform Audio File Format (WAV), Audio Interchange File Format (AIFF), Moving Pictures Expert Group-1 Audio Layer III (MP3), Advanced Audio Coding (AAC), etc. You have seen videos or moving pictures on television and computers. The multimedia video formats include MPEG-4 Part 14 (MP4), Windows Media Video (WMV), Audio Video Interleave (AVI), etc. Multimedia animation includes design, drawing, and preparation of photographic sequences as you see in cartoons and gaming.

Now, we can have a look at the different applications of multimedia. The main application includes educational purposes, business activities, advertising, banking, entertainment, etc. With the help of HTML, you can create multimedia content on a web page. In this unit, how to present multimedia content using HTML has been explained.

Key Concepts

Image tags, HTML Colors, Marquee tag, HTML audio, HTML video

Discussion

5.3.1 HTML Image Tag

Now that you are familiar with the basic concepts of multimedia, we can focus on the HTML image tag. The image tag or <img> is used to insert or embed an image into an HTML document. You should know that the image itself is not inserted directly into the document. It is done with the help of the browser that inserts an HTML image from the source specified in the image tag. Would you like to know the two required attributes of an image tag? They are src and alt attributes. The src attribute is used to show the image source and the alt attribute defines an alternate text for the image that is not displayed on the browser. The image tag is empty, which means that the closing tag is

not necessary. It is important to specify the width and height of an image. If width and height are not specified, the page might flicker while the image loads.

The syntax of the image tag is given by :

<img>

An example showing the operation of HTML image is given below:

Example of the HTML <img> tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<h1>Photo</h1>
<p>This is the photo of a child</p>
<img src=”/uploads/media/default/abc.jpeg”
alt= "Baby Photo" width=”200” height=”185”/>
</body>
</html>
```

Output:

Photo

This is the photo of a child

5.3.2 HTML colors

In the previous section, we dealt with the HTML image tag. In this section, we shall focus on the HTML colors. In an HTML document, you can change the color of the text, background, borders, etc, using the following three ways:

- Hexadecimal(Hex)color codes
- HTML color names
- RedGreenBlue (RGB) values.

5.3.2.1 Hex Color Codes

Hexadecimal is a number system that uses numbers from 0, 1, 2, 3,….., 13, 14, 15. So there are 16 numbers in this system and the base is 16. While representing a hexadecimal number, you can use numbers from 0 to 9 and letters from (10 to15). i.e, 10=A, 11=B, 12=C, 13=D, 14=E and 15=F .

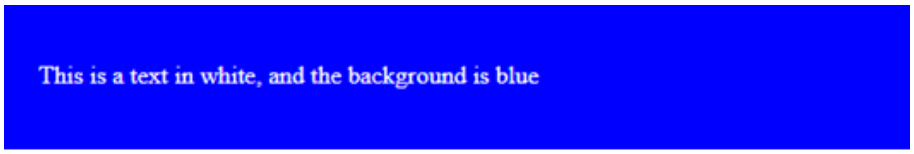
A hexadecimal (hex) color code is represented by using three separate values. That means it helps you to define the levels of the constituent colors. You can specify the constituent colors with a hex notation for a mixture of Red, Green, and Blue color values. In an HTML document, Hex values are usually written as a six-digit number, starting with a # sign. Also, the letters used in a hexadecimal digit are not case sensitive. You can specify the white color with #FFFFFF or #ffffff. An example to understand the usage of hex values is given below:

Example of the background-color property used with the “hex” value:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
div {
background-color: #1c87c9;
color: #ffffff;
padding: 22px;
    }
```

```
</style>
</head>
<body>
<div>
<p>This is a text in white, and the background is blue</p>  //refer E- version
</div>
</body>
</html>
```

Output:



5.3.2.2 HTML Color Names

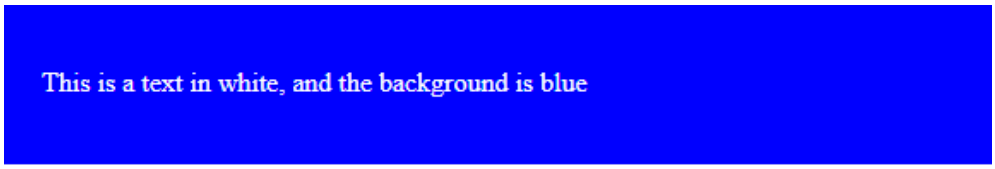
You learned the hex color code in the previous example. You can also use the HTML color name to color the elements in an HTML document. That means you can use the name of the color (blue, red, etc) instead of Hex code. An example showing the color name in an HTML document is given below:

Example of the color property used with the “color name” value:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
div {
background-color: blue;
color: white;
```

```
padding: 22px;
        }
</style>
</head>
<body>
<div>
<p>This is a text in white, and the background is blue</p>      //refer E- version
</div>
</body>
</html>
```

Output:



5.3.2.3 RGB Color Values

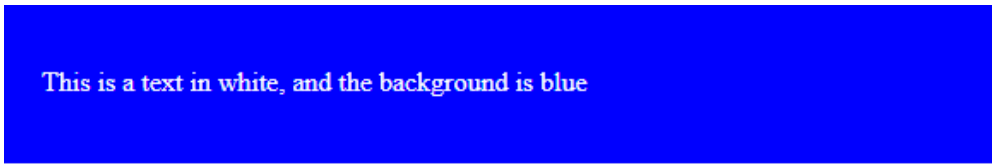
Since we have learned how to color the elements in an HTML document, we can discuss another method of colouring using the RGB Color Values. In this method, you can add color to the text element using the style attribute in which the color property is the values of Red, Green, and Blue. An example showing the usage of RGB values in an HTML document is given below:

Example of the background-color property used with the “RGB” value:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
```

```
div {
background-color:rgb(25,25,112);
color: rgb(255,255,255);
padding: 22px;
    }
</style>
</head>
<body>
<div>
<p>This is a text in white, and the background is blue</p>
</div>
<p style="color:rgb(25,25,112);"> This is a text in blue</p>    //refer E- version
</body>
</html>
```

Output:



This is a text in blue

Color Values

In the previous examples, you used hex values and RGB values of gray, white and blue. In this section, we are going to discuss some color values in both Hex and RGB. Table 5.3.1.shows the different colors, their Hex values, and RGB values

Table 5.3.1. Hex and RGB values of different colors (refer E-content)

Colour	Color Name	Hex Value	RGB Value
	Black	#000000	rgb(0,0,0)
	White	#FFFFFF	rgb(255,255,255)
	Red	#FF0000	rgb(255,0,0)
	Cyan	#00FFFF	rgb(0,255,255)
	Blue	#0000FF	rgb(0,0,255)
	Magenta	#FF00FF	rgb(255,0,255)

Table 5.3.1 shows some of the commonly used colors used in an HTML document. You can see that the hex value of black color is #000000 and that of white is #FFFFFF. #000000 represents the minimum Hex value and the maximum Hex value is #FFFFFF. All other colors come in between the lowest and highest values as you can see in the table.

Now, we can discuss the RGB values. The RGB value of black is rgb(0,0,0) and that of white is rgb(255,255,255). From this, you must understand that black color has the minimum RGB values and white color has the maximum RGB values. i.e, the values of RGB vary from 0 to 255.

5.3.3 HTML Marquee Tag

Would you like to know how to scroll a text or an image in an HTML document or webpage? It is done with the help of the HTML marquee tag. By using this tag, you can scroll the text or image horizontally or vertically on the web page. That means you can scroll from either left to right or vice versa, or top to bottom or vice versa. The syntax of marquee tag is given by:

<marquee> content </marquee>

The ***marquee*** tag contains opening and closing tags**.** The content is written between the opening and closing tags. An example of the usage of HTML <marquee> tag is given below:

Example of using HTML <marquee> tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
```

```
<style>
marquee{
font-size: 30px;
font-weight: 800;
color: #8ebf42;
font-family: sans-serif;
    }
</style>
</head>
<body>
<marquee>A scrolling text created with Marquee element.</marquee>
</body>
</html>
```

Output :

A scrolling text created with Marquee element.

5.3.4 HTML Multimedia

Multimedia refers to the eye-catching and interactive manner of information with the combination of text, sound, music, images, records, videos, films, animations, etc. It comes in different formats. On a web page, you can see the different types of multimedia contents.

Multimedia Tags

How can you add multimedia contents to your webpage? HTML helps you to add different multimedia contents on the web page using multimedia tags. These tags include:

- audio tag
- video tag
- embed tag
- object tag

5.3.4.1 HTML Audio Tag

The HTML audio tag is used to embed or play an audio file on a web page.While using the audio tag, the source tag or the src attribute is used to indicate the URL of the source. The controls attribute allows you to add audio controls like play, pause, and volume. The supported audio formats in HTML are MP3, WAV, etc. You should know that the text between the audio tags will be displayed only to the browsers that do not support the <audio> element. As the audio tag comes in pairs (closing and opening tags), the syntax of the audio tag is given by:

<audio> content </audio>

The HTML source tag is used to define multiple media resources in different formats: video, audio, or image. The browser can choose the format which it supports and play audio and video files without any difficulty. The source tag can be used multiple times in one document to indicate the alternative audio/video files and images of numerous formats. If the source tag is included in the audio tag or video tag, it should be placed before the audio tag and after the media files. Since the source tag is empty, the syntax is given by

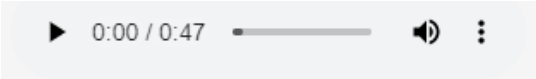
<source>

An example to explain the operation of audio tag is given below:

Example of the HTML <audio> tag:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<audio controls>
<source src="/build/audios/jingle_bells.mp3" type="audio/mpeg">
</audio>
<p>Click the play button</p>
</body>
</html>
```

Output:



Click the play button

5.3.4.2 HTML Video Tag

The HTML video tag is used to embed or display a video on a web page or in an HTML document. The video format supported by the browsers includes MP4/MPEG 4, WebM, etc. If the web browser do not support the video formats, you should provide multiple video formats for correct rendering. A path to the video file can be given inside the source tag or src attribute. You can also include an alternate text in the video tag if the displayed video format is not supported by the browser. The syntax of video tag is given by

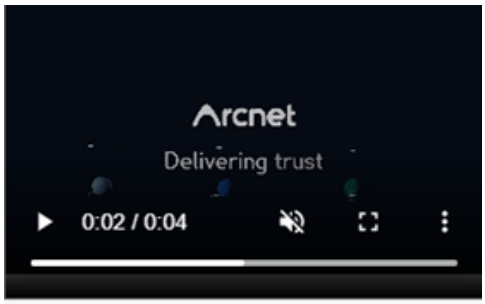
<video> content </video>

Where <video> denotes the opening tag and </video> represents the closing tag. The controls attribute allows you to add video controls like play, pause, and volume. The mute attribute mutes the video. The width and height attributes are used to set the height and width, otherwise, the page might flicker while the video loads. The below example shows the usage of the video tag in an HTML document.

Example of the HTML <video> tag with the controls, mute and src attributes:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
video{
width: 300px;
height: 200px;
border: 1px solid #666;
    }
```

```
</style>
</head>
<body>
<video controls muted src="/build/videos/arcnet.io(7-sec).mp4">
<track default kind="subtitles" srclang="en" src="/build/videos/arcnet.io(4-sec).mp4"/>
</video>
<p>Click the play button</p>
</body>
</html>
```



Click the play button

5.3.4.3 HTML Embed Tag

The embed tag is used as a container for external applications, multimedia and interactive content that the browser cannot recognize. Therefore, you must have external plug-ins or special programs for displaying the content properly. The presentation of the embedded content depends on the file type, the attributes of the embed tag, and the plugins installed in the browser. Since no closing tag required in the embed tag, the syntax is given by

<embed>

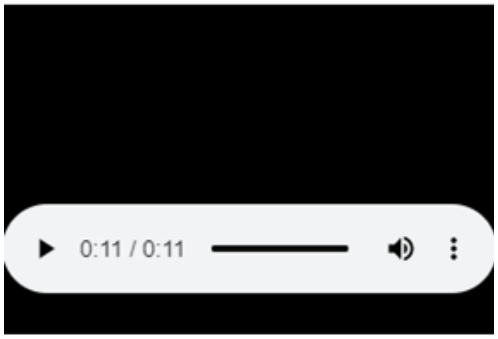
The example below shows the use of embed tag for placing an audio:

Example of the HTML <embed> tag for placing an audio:

```
<!DOCTYPE html>
<html>
```

```
<head>
<title>Title of the document</title>
</head>
<body>
<embed type="audio/mpeg" src="/build/audios/audio.mp3" width="300"
height="200">
</body>
</html>
```

Output:



5.3.4.4 HTML Object Tag

The object tag helps you to specify an embedded object within the HTML document. It is generally used for embedding multimedia contents as well as to embed another HTML document into the web page. You can also include alternative text in the object tag if the browser does not recognize it. The syntax of the object tag is given by

<object> content </object>

The object tag comes in pairs. The content is written between opening <object> and closing </object> tags. The object tag can also be used as a child element of <body> element. The usage of object tag is given below:

Example of the HTML <object> tag:

```
<!DOCTYPE html>
<html>
```

```
<head>
<title>Title of the webpage</title>
</head>
<body>
<p>Steve Jobs' Stanford Commencement Address - YouTube</p>
<object width="320" height="240" data="https://www.youtube.com/embed/bZNEB_o3Hzw?ecver=2">
</object>
</body>
</html>
```

Output:

Recap

- Multimedia is an interactive mass communication medium
- Various file formats are there for image, audio and video.
- image tag inserts image into HTML document
- src attribute specifies the URL
- alt attribute defines an alternate text on the browser
- Hex color code defines the levels of constituent colors

- Hex values are written as six-digit number
- HTML color name helps to color the elements
- style attribute add color to the text element
- minimum Hex value - #000000
- maximum Hex value - #FFFFFF
- minimum RGB value - rgb(0,0,0)
- maximum RGB value - rgb(255,255,255).
- marquee tag scroll text or image in HTML document
- HTML audio tag embed or play an audio file on a web page
- Examples of HTML supported audio formats - MP3, WAV
- Examples of HTML supported video formats - MP4/MPEG 4, WebM
- HTML source tag defines multiple media resources in different formats
- HTML video tag embeds or displays a video on a web page
- embed tag is used as a container for external applications
- object tag specifies embedded object within the HTML document

Objective Type Questions

1. What is an interactive mass communication medium called?
2. Which tag helps to insert an image into the HTML document?
3. Which attribute specifies the URL of the source?
4. Which helps to define an alternate text on an unsupported browser?
5. How can we define the levels of constituent colors?
6. How many digits are required to represent a hex value?
7. Which symbol is used with hex values?
8. How to add color to the text element?
9. What is the hex value of Red?
10. What is the RGB value of magenta?
11. Which is the minimum Hex value?

12. Which is the maximum RGB value?
13. Which tag helps to scroll a text or an image in an HTML document?
14. Which tag helps to play an audio file on an HTML document?
15. How can we define multiple media resources in different formats?
16. Which tag helps to display a video file on a web page?
17. Which is the tag used as a container for external applications?
18. Which tag specify embedded object within the HTML document
19. How can we add controls like play, pause, and volume in an HTML document?

Answers to Objective Type Questions

1. Multimedia
2. <img>
3. src
4. alt attribute
5. Hex color code
6. 6
7. #
8. style attribute
9. #FF0000
10. rgb(255,0,255)
11. #000000
12. rgb(255, 255, 255)
13. marquee
14. audio
15. <source> element
16. video
17. embed
18. object
19. control attribute

Assignments

1. Define multimedia and list its various elements.
2. Explain the purpose of the HTML <img> tag and mention its two required attributes.
3. Describe three different ways to specify colors in an HTML document.
4. What is a hexadecimal (hex) color code? Provide an example.
5. How do HTML color names work? Give an example.
6. Explain the concept of RGB color values and provide an example.
7. Provide the hexadecimal and RGB values for the colors black, white, red, cyan, blue, and magenta.
8. What is the HTML <marquee> tag used for? Give an example.
9. Explain how to add multimedia content to a webpage using HTML.
10. Describe the purpose of the HTML <audio> tag and mention its key attributes.
11. How does the HTML <video> tag work? Discuss its attributes.
12. What is the purpose of the HTML <embed> tag? Provide an example of its usage.

Suggested Reading

1. P.K. McBride, Nat McBride, HTML 4.0 Made Simple, Made Simple Publishers, 2001st edition.
2. Thomas A Powell, The Complete Reference HTML & XHTML, McGraw Hill Publishers,4thEdition.
3. Steven A. Gabarro, "Introduction to HTML," in Web Application Design and Implementation: Apache 2, PHP5, MySQL, JavaScript, and Linux/ UNIX ,Wiley-IEEE Press, 2007.
4. B. Douglas Blansit, An Introduction to Cascading Style Sheets (CSS), Journal of Electronic Resources in Medical Libraries, 2008.

Reference

1. For the live demo to understand the HTML image tags, use the link: https://www.w3schools.com/tags/tag_img.asp
2. To understand about the different HTML colours, use the link:https://www.computerhope.com/htmcolor.htm
3. For the live demo to understand the HTML audio and video tags use the link: https://www.tutorialspoint.com/html5/html5_audio_video.htm

UNIT 4

Linking in HTML

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- study the concepts of HTML links
- get knowledge on the HTML anchor tags
- obtain insights into the concepts of internal linking in HTML
- acquire the concepts of external linking in HTML
- learn how to create a website

Prerequisites

In the previous unit, you learned the concepts of image tags, colors in HTML, audio tags, video tags, embed tags, object tags. You also learned how to present multimedia contents in an HTML document. In this unit, we are focusing on internal linking, external linking, and how to create a website.

Do you know the meaning of a link? A link is a connection between two things, especially when one affects the other. When we were kids, our grandparents told stories. They had start with "Once upon a time, there was a king named Asoka." We would ask, "Who is the king?" They had explain a bit about him. This helped us understand. Then, they had continue the story. This inspired us to do the same on our website. We will use links in our story. Users can click to learn more before continuing. It's like how our grandparents helped us understand the king better. Now, we can talk about the internal and external links on a web page as shown in Fig. 5.4.1.

The above figure shows the sample web-page of www.keralatourism.org. As you can see Experience Kerala, Where to go, Where to stay, etc., are internal links. These links help you to navigate to different pages on the same website. In the case of an external link, you can see logos of Youtube, Facebook, Twitter, etc. By clicking on those logos, you will be navigated to external links. In the succeeding sections, we can study in detail about the HTML links.

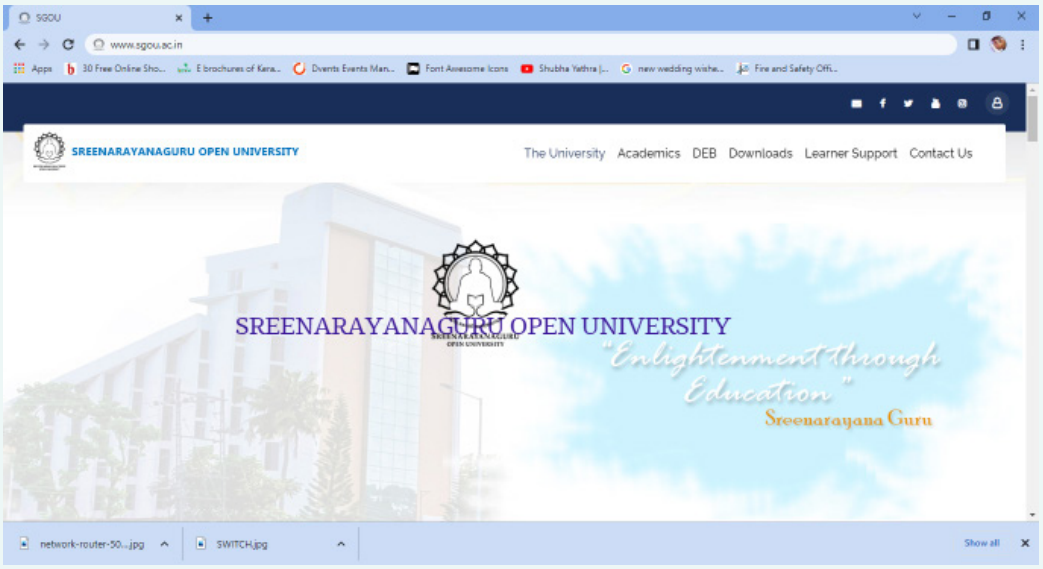


Fig.5.4.1 Sample webpage

Key Concepts

HTML links, Anchor tag, Internal linking, External linking, Bootstrap

Discussion

5.4.1 HTML Links

You have already learned the meaning of the link in the previous section. In this section, we can discuss the concept of HTML links.

Suppose, you want to travel from one place to another through a bridge. Here, the bridge is the link that connects both places. Similarly, in an HTML document, a link or hyperlink connects one web page to another.

An HTML link normally has two ends such as anchor and direction. An anchor is a text that marks the beginning and the end of a hypertext link.You should know that the link starts at the "source" anchor and ends at the "destination" anchor. This link may be an HTML document, image, video, audio, or an element within an HTML document.On a web page, you can see different types of links that allow you to enter into other pages or to a particular part of the page itself.

Do you know that hyperlinks are normally applied to a text, image, or any HTML element? There are some default colors related to the hyperlinks as given below:

- Unvisited links - underlined and blue
- Visited links - underlined and purple
- Active link - underlined and red

5.4.2 HTML Anchor Tag

You have got an idea about HTML links. Do you know how these links are created? These links are created using anchor tags <a>. The anchor tag is an HTML tag that is used to insert hyperlinks to other pages, or any part of the same page. Since the anchor tag comes in pairs, it has both opening and closing tags. Therefore, the syntax is given by :

**<a> content **

where <a> represents the starting link and represents the closing link.You must note that to create a hyperlink, you have to use the combination of anchor tag and the href attribute which represents the URL. An example of the HTML anchor tag with the href attribute is given below:

Example of the HTMLanchor (<a>) tag with the href attribute:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
</head>
<body>
<a href="https://www.flipkart.com/">flipkart.com</a>
</body>
</html>
```

Output:

flipkart.com

Description:

By clicking on the hyperlink, you will be redirected to the home page of the Flipkart website. We can see another example of the anchor tag to create a linked image. This can be done with the help of image tag and the href attribute.

Example of the HTML anchor (<a>) tag for creating a linked image:

```
<!DOCTYPE html>
<html>
<head>
<title>Title of the document</title>
<style>
img {
height: 90vh;
    }
</style>
</head>
<body>
<a href="https://en.wikipedia.org/wiki/France">
<imgsrc="https://images.unsplash.com/photo-1549144511-f099e773c147?ix-lib=rb-1.2.1&ixid=eyJhcHBfaWQiOjEyMDd9&w=1000&q=80" alt="France">
</a>
</body>
</html>
```

Output:

Description:

By clicking the image above, you are redirected to “https://en.wikipedia.org/wiki/France”

5.4.3 Internal Linking in HTML

In the above section, you have understood the usage of anchor tags. This section discusses the HTML internal links. As you know, internal links are those which are linked within the same web page. The link may be an absolute path or a relative path. The absolute path relates to the original URL of the webpage and the relative path relates to the path of the page.

Do you know how we can create an HTML internal link? To create an internal link, you have to use the hash symbol (#) and assign an id that represents the required section of the page. When you click on an internal link, you will be automatically scrolled to the mentioned section on the link and display it on your browser. An example showing how to create an internal link is shown below:

Example of Internal Linking:

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
<a href=”#lesson1”>Lesson.1</a><br />
<a href=”#lesson2”>Lesson.2</a><br />
<br />
<a id=”lesson1”>Introduction of Lesson.1</a>
<p>This is sub-topic.1</p>
<br />
<a id=”lesson2”>Introduction of Lesson.2</a>
<p>This is sub-topic.1</p>
<br />
<br />
```

```
</body>
</html>
```

Output:

Lesson.1
Lesson.2

Introduction of Lesson.1

This is sub-topic.1

Introduction of Lesson.2

This is sub-topic.1

Description:

In this example, two links are created on the same page, by clicking the links, the page scrolls to the particular section. The space in the document is created using the <br /> tag

5.4.4 External Linking in HTML

The concept of internal linking has already been studied previously and you have got an idea about it. In this section, we can study about external linking in HTML.

The external HTML links are those links that are connected to other external web pages. This link may be an absolute path or a relative link path. Here, an anchor tag is used as a referred link to another web page. This helps to browse different webpages on the Internet. As you know, in the case of internal linking, the hash symbol (#) with an id is used. But in the case of external linking, no such elements are used. The example below shows the concept of using HTML external links.

Example of External Linking:

```
<html>
<head>
</head>
<body>
<a href="../tutorial.php">HTML</a>
<br />
<br />
```

```
<a href="../../css/tutorial.php">CSS</a>

<br />

<br />

<a href="../../javascript/tutorial.php">Java Script</a>

<br />

</body>

</html>
```

Output:

HTML

CSS

Java Script

Description:

In this example, you can see three links. By clicking the links, you are redirected to the external webpages.

5.4.5 Creating a Website

In this unit, you have already learned about HTML links, anchor tags, internal and external linking in HTML. Now, it is time to focus on the steps for creating a website.

Before going to create a website, you must remember the concepts of HTML and CSS. As you know, HTML defines the structure and contents of the web document; and CSS defines the styling or presentation of a web page. The combined usage of HTML and CSS helps you to design and create the final web page. As you know, a web page is a single HTML document of the website. All the individual web pages are used for creating a website.

In addition to the above, you should also keep in mind some important points before you get started on creating a website with HTML and CSS. They are given below:

- First of all, you need a web hosting service by which you can create a space in the web server for the website.
- The next thing you need is a unique domain name that identifies your website on the web. For example, www.websites.org.

After completing the above procedures, you can move on to the steps for creating a website using HTML and CSS.

Steps for Creating a Website

a. Study the basics of HTML

b. Learn the HTML document structure

c. Saving the HTML document

d. Learn how to select the CSS selectors

e. Merging the CSS documents

f. Installation of Bootstrap Software

g. Pick a design

h. Customize your website with HTML and CSS

i. Add content and images

j. Fine-tune colors and fonts

k. Create additional pages

5.4.5.1 Study the basics of HTML

This is the first step for the creation of a website. In this step, you have to recall the concepts of HTML tags that you have studied in the previous units. You must note that every HTML element has syntax. The general syntax of the HTML element is given by:

<tagname> Content </tagname>

Where <tagname> is the opening tag and </tagname> is the closing tag. The content is written in between the tags. For example, headings tags is given by <h1>content</h1>

Some common HTML tags are given as in table 5.4.1:

Table 5.4.1 HTML Tags

HTML tags	Description
content	Italicize the content
* content *	paragraph of text
* content *	Unordered list

Likewise, in the table above, there are different HTML tags for different purposes to create a web document.

5.4.5.2 Learn the HTML Document Structure

This is the second step in which you have to know the structure of the HTML document. Fig. 5.4.2. Below shows the basic structure of an HTML page.

```
<!DOCTYPE html>
    <html>

        <head>
            <title> Title here </title>
        </head>

        <body>
            Web page content goes here.
        </body>

    </html>
```

As you can see in the structure above, it consists of different elements such as DOCTYPE declaration, HTML, head, title, and body elements.

The DOCTYPE declaration is specified on the first line of each web document. The HTML element is the root element of the HTML document. The head element gives information about the "behind the scenes" elements of a web document. The title element defines a title for the HTML document and the body element helps you to display the actual content such as text, images, videos, links, etc. on your web page.

5.4.5.3 Saving the HTML Document

You can create an HTML document using a text editor such as Notepad and TextEdit and save the text file using .html or .htm. Once you have saved an HTML document, it can be opened as a webpage in the browser. You can view them using Google Chrome, Safari, Mozilla Firefox, etc. The steps used for saving an HTML document in notepad is given below:

Step 1: Open Notepad in Windows

Step 2: Write the HTML code as shown in Fig. 5.4.3.

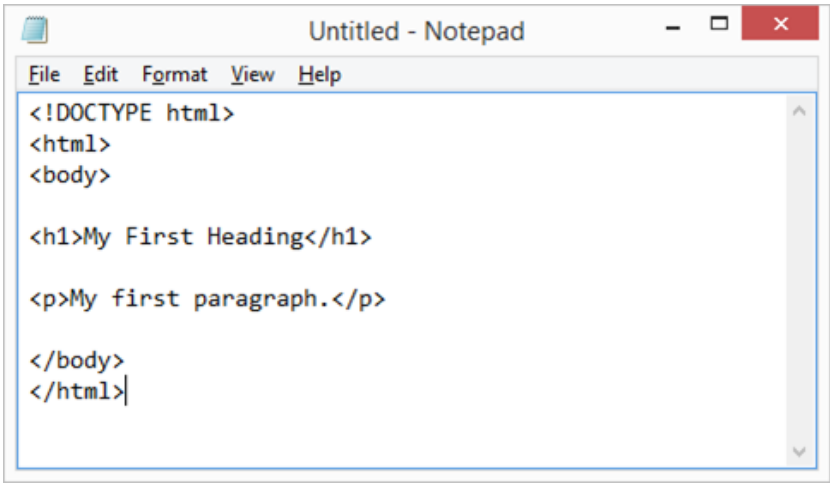


Fig 5.4.3 Notepad showing HTML Code

The above figure 5.4.3 shows how to write HTML code in a notepad. This HTML code displays the content between the ***body*** opening and closing tags.

Step 3: Save the HTML Page as shown in Fig. 5.4.4.

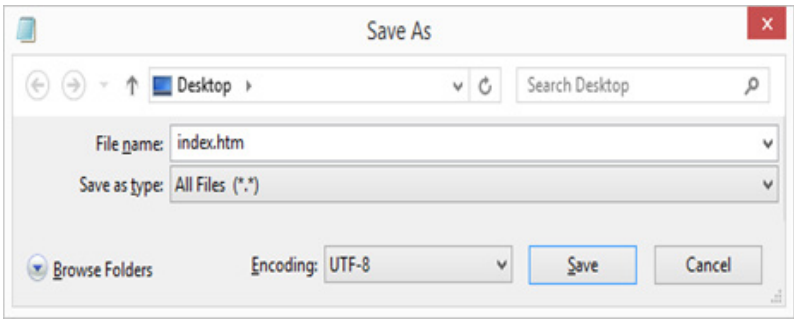


Fig 5.4.4 Saving the HTML Code

As you can see, we can save the file on your computer by giving a file name, for example, "index.html" or "index.htm". You have to also set the encoding to UTF-8 which is the preferred encoding for HTML files.

Step 4: View the HTML Page in the browser as shown in Fig. 5.4.5.

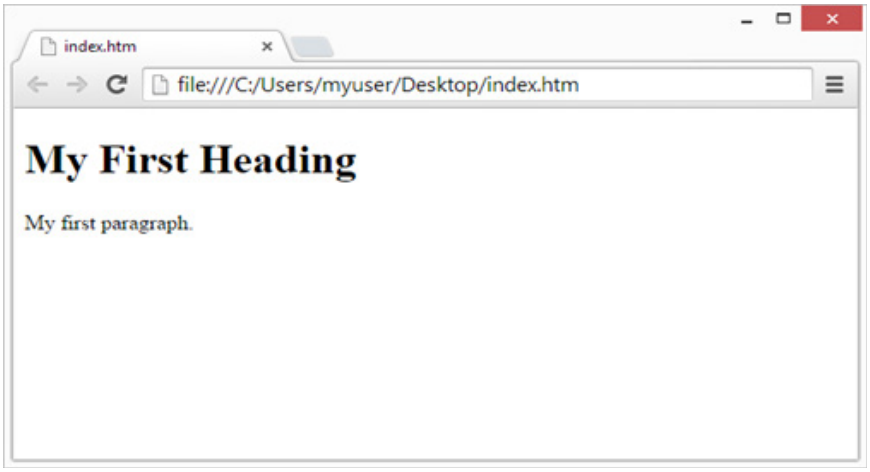


Fig. 5.4.5 HTML Page in the Browser

As shown above, you can view the saved HTML file in your browser by double-clicking the saved file. You can see the output of the HTML file which is the content between the body tags of the HTML file.

In addition to the above text editors, you can also use an HTML editor called Sublime Text. It helps you to color the syntax of an HTML file and to differentiate your HTML tags from text content, tag parameters, and other values.

For the creation of a webpage in your web server, you can copy the .html file to the main directory of your web server, and then you can view the page by navigating through a web browser.

5.4.5.4 How to select the CSS selectors

The next step is to get knowledge of the CSS selectors. The CSS has selectors similar to the tags in HTML. These selectors are used to describe the appearance of the HTML document. Consider an example of changing the appearance of the font in a paragraph. It is given below:

Example of font-size CSS selector:

```
p {
font-size: 18px;
}
```

Description:

The above selector indicates that all HTML <p> tags within the document have a font size of 18 pixels.

Another way of selecting the CSS selectors is the assigning of "classes" to each tag. By using class selectors, you can assign different styles to different tags. The example of a class selector in CSS is given below:

Example of a class selector in CSS:

```
.normal-text {
font-size: 18px;
}
```

Description:

You can see a dot (.) before the name of the class normal-text. This helps you to assign class only to the specific HTML tags to make the font-size 18 pixels.

5.4.5.5 Combining the CSS documents

As you know, every element in the HTML document follows a structure and order. This helps you in the construction and presentation of the web page. Likewise, you have to arrange the CSS documents in the order of the class definitions for the better appearance of the web page.

5.4.5.6 Installation of Bootstrap Software

This is the sixth step used in the creation of a website. We can have a look at bootstrap software. It is an open-source software used for creating a website with HTML and CSS. It is released under a license where the copyright holder grants permission to the users to use, study, change and distribute the software.

Bootstrap helps you to bring a framework to construct and optimize the webpage for further development with HTML and CSS. It also helps you to create new web pages and make them look exactly as you want them.

5.4.5.7 Pick a Design

This is the seventh step to be followed in the creation of a website. The Bootstrap tool consists of different templates from which you are free to use any template you like. The templates have well-optimized, trouble-free, and good designs. After selecting the template, you can move its contents to the main directory of your local web server or your web hosting account. Next step is to open that location through your web browser and you can see the template on the browser.

5.4.5.8 Customize Website with HTML and CSS

This is the eighth step in creating the website. On a website, first, we have to work on the design of the homepage. This helps you to bring in the graphics, texts, and tune everything up in general. When you open the .html file of your Bootstrap site, you will see a head section like this as given below:

Example of head section:

```
<head>

<meta charset=”utf-8”>

<meta name=”viewport” content=”width=device-width, initial-scale=1, shrink-to-fit=no”>

<title>Creative - Start Bootstrap Theme</title>

<!-- Theme CSS - Includes Bootstrap -->

<link href=”css/creative.min.css” rel=”stylesheet”>

</head>
```

Description:

- <meta name="viewport" content="width=device-width, initial-scale=1, shrink-to-fit=no"> – bootstrap declaration tags that defines the size of the website’s viewport
- <link href="css/creative.min.css" rel="stylesheet"> –loads the CSS document of the creative template and the default stylesheet of bootstrap.

5.4.5.9 Add Content and Images

This is the ninth step for the creation of a website. in this section, you can change the title, customize the different sections using header tags, footer tags, section tags, assigning of CSS selectors, etc.

5.4.5.10 Fine-Tune Colors and Fonts

This is the tenth step in which you can change the colors of the fonts using HTML and CSS. For example, if you want to change the color of the text font to red, you use the HTML code as below:

Red text

where “#FF0000” represents the hex value of red. You can also change the font colors using CSS selectors

5.4.5.11 Create Additional Pages

This is the final step in website creation. Having created and customized the homepage, now it is time to start working on additional pages and then link them to the homepage. Some of the common pages that you should include in a website are given below:

- about page
- contact
- portfolio
- products/services
- team
- policies (privacy policy, terms, etc.)

You can use the different steps above to create additional pages. Finally, we can put together all the individual pages using HTML, CSS, and Bootstrap tools to create the website.

Recap

- Hyperlink connects one web page to another in HTML document
- HTML link has two ends - anchor and direction
- Anchor - text marks beginning and end of hyperlink
- Link starts at source anchor and ends at destination anchor
- Blue, Purple and Red colours are used for unvisited, visited and active links respectively
- Links created using anchor tags
- Internal hyperlink- links documents within same web page
- Internal links may be absolute or relative paths
- Absolute path relates to original URL of webpage

- Relative path relates to the path of the page
- CSS selectors describe the appearance of HTML documents
- Bootstrap constructs and optimizes the webpage

Objective Type Questions

1. How can we connect one web page to another in an HTML document?
2. What is a tag that marks the beginning and end of a hyperlink?
3. Where did the hyperlink start?
4. What colour has an unvisited link?
5. What is the colour of the active link?
6. Which HTML tag is used for creating a hyperlink?
7. Which attribute represents the URL of the webpage?
8. Which link connects documents within the same webpage?
9. What relates to the original URL of the webpage?
10. Which symbol is used for creating internal links?
11. Which tag is used as a referred link to another web page?
12. What defines the styling or presentation of a web page?
13. Which is the CSS selector used for assigning different styles to different tags?
14. Which is an open-source software used for creating a website?

Answers to Objective Type Questions

1. Hyperlinks
2. anchor tag <a>
3. source anchor
4. blue
5. red
6. anchor
7. href
8. Internal
9. absolute path

10. #
11. anchor
12. CSS
13. class
14. Bootstrap

Assignments

1. Define HTML links and explain their significance in webpage navigation.
2. What are internal links in HTML? Provide examples.
3. Discuss the concept of external links in HTML with examples.
4. Explain the purpose of the anchor tag in HTML and its syntax.
5. How are hyperlinks applied to text, images, and other HTML elements?
6. Describe the default colors for unvisited, visited, and active links in HTML.
7. How can one connect one webpage to another in an HTML document?
8. What is the text that marks the beginning and end of a hyperlink called?
9. Where does a hyperlink start and end in an HTML document?
10. Explain the process of creating internal links in HTML with the help of hash symbols and IDs.
11. Discuss the usage of anchor tags for creating linked images in HTML, providing examples.
12. Outline the steps involved in creating a website using HTML and CSS, from studying the basics to creating additional pages.

Suggested Reading

1. P.K. McBride, Nat McBride, HTML 4.0 Made Simple, 2001.
2. Thomas A Powell , The Complete Reference HTML & XHTML, 4thEdition.
3. Steven A. Gabarro, "Introduction to HTML," in Web Application Design and Implementation: Apache 2, PHP5, MySQL, JavaScript, and Linux/ UNIX , IEEE, 2007.
4. B. Douglas Blansit , An Introduction to Cascading Style Sheets (CSS), Journal of Electronic Resources in Medical Libraries, 2008.

Reference

1. For the live demo to understand the HTML image tags, use the link: https://www.w3schools.com/tags/tag_a.asp
2. To understand about the different HTML internal and external links, use the link:https://way2tutorial.com/html/html_internal_links.php
3. To learn about the bootstrap software, use the link:https://getbootstrap.com/docs/4.0/getting-started/download/

BLOCK 6

Trends in Information Technology

Applications of IT

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- study the application of IT in Business
- familiarize regarding IT in Banking
- understand the role of IT in Education
- introduce the impact of IT in Science
- list the application of IT in the Medical Field
- learn how IT supports Mobile Applications development

Prerequisites

The application of Information Technology(IT) has become an integral and transformative force across various sectors, profoundly influencing the way organizations operate, individuals interact, and societies evolve. IT involves the use of computers, software, networks, and electronic systems to store, process, transmit, and retrieve information. As a result, its application spans a wide array of fields, from business and healthcare to education and entertainment.

Since you are living in this information age, you might have heard the term Information Technology frequently in your everyday life.

Suppose, you are doing a business related to building and construction. You want to make an advertisement for improving your business activities. You can use offline advertisements like newspapers, radio, television, etc for giving advertisements, but it requires more time and money. There comes the advantage of IT. You can give online advertisements using the Internet through various social media applications like Facebook, WhatsApp, Twitter, etc. to save time and money.

What is Information Technology (IT). It includes everything that is associated with computer technology such as networking, hardware, software, the Internet, etc., or the people who use these technologies. You should also understand that IT is a wide

discipline that assists you to deal with the processing, management, transfer, storage, protection, and retrieval of information. Fig. 6.1.1 helps you to understand the various terms associated with IT.

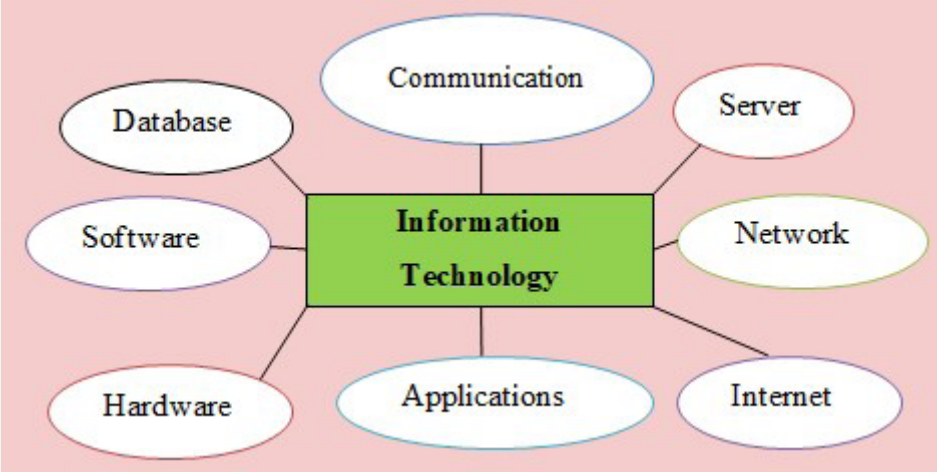


Fig. 6.1.1 Terms associated with IT

As the above Fig 6.1.1 shows, there are different terms associated with IT. All the terms have already been studied in the previous units. We shall refresh the different terms one by one.

As you know hardware relates to the different physical parts of the computer such as keyboard, mouse, monitor, speakers, etc. The second term, Software deals with the programs that allow you to tell the computer how to work. The Database refers to the collection of information that helps you to organize, access, manage and update the data easily. Communication helps you to transfer information from one computer to another using email, Whatsapp, etc.

Next is Server, which is a computer that provides data to other computers for storing and sharing resources like files, programs, applications, etc. The Network is a collection of computers as well as network devices connected and communicating with each other for sharing resources, data, and applications.

The Internet is a global network connection of millions of computers around the world for sharing resources and communicating with each other.

Finally the term, applications refers to the implementation of the above referred computer-related terms in Information technology. A detailed explanation of the different IT applications is discussed in the succeeding sections.

Key Concepts

E-commerce, MICR, ATM, Mobile Applications Development

Discussion

6.1.1 Applications of IT

In the preceding section, you learned the meaning and the different terms associated with IT. In this unit, we will look into the different applications of IT.

IT helps you in banking-related activities such as Internet banking, Mobile banking, etc. IT in education helps you to provide online classes, conferences, access to study materials, etc by facilitating services. IT is also helpful in the medical field such as

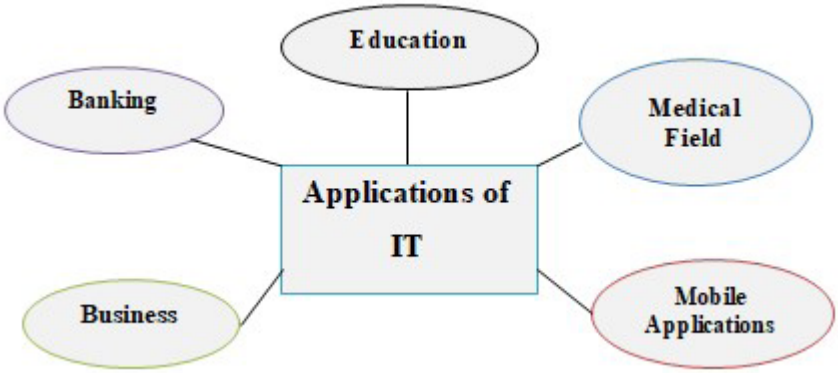


Fig. 6.1.2 Applications of IT

Some of the most important online applications of IT are in business, banking, education, the medical field, and mobile application development. The involvement of IT in different applications is depicted in Fig. 6.1.2.

As shown in the figure 6.1.2 above, IT is very much useful in businesses like marketing, advertising, shopping, etc. also online monitoring of patients, Electronic Health Records (EHR), Electronic Medical Records (EMR), telemedicine, etc. IT assists you to develop various mobile applications for entertainment, business, education, etc.

You must keep in mind that most organizations have IT departments for handling the computers, networks, and

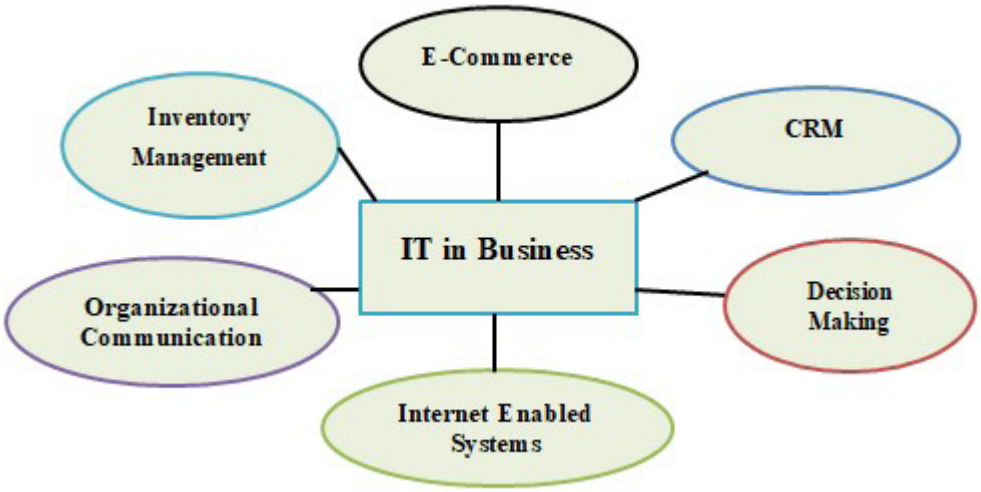


Fig 6.1.3 IT in Business

other technical areas of their businesses.

6.1.2 IT in Business

In this section, you can have a look at the various aspects of IT in business and know how IT helps you in processing and managing the business activities to attain the objectives. Fig 6.1.3 shows how IT supports various business activities.

6.1.2.1 Organizational Communication

An important use of IT in business is communication. It helps you to transfer information related to business activities through email, google meet, etc.

Suppose, you are the Managing Director of a company. Currently, you are abroad and want to hold a meeting with the employees of the company. What is the solution? You can use google-meet to communicate with employees instantly. IT allows you to hold virtual meetings with staff and clients around the world. In addition employees can access or share information and submit their work reports regardless of their location.

6.1.2.2 Inventory Management

Another role of IT comes in the form of Inventory Management. This is done with the help of Inventory Management Systems.

Imagine that, you are the Manager of Inventory Control of a cotton shirts company. If you want to gather the information about raw cotton used for making the shirts, you can use the Inventory Management software to monitor and get updates of the stocks automatically without the help of others.

Inventory Management software is used in organizations that support you to maintain the stock, track the quantity of each item, order additional stock whenever required, and provide reports to the managers.

6.1.2.3 E-commerce

Next, we can move on to E-commerce. It refers to the buying and selling of services and goods online with the help of IT. What are the advantages of e-commerce? It helps you to save time, labor, money for offline advertisements, etc.

Assume that you want to sell a product online. How can you sell it online? You can use social media applications like Facebook, Whatsapp, youtube, etc. to sell your product. You can also use different shopping websites to sell the product easily.

6.1.2.4 Customer Relationship Management

Information Technology helps you to ensure a good customer experience through improved customer service. This is done with the help of Customer Relationship Management (CRM) systems.

Suppose you are the manager of an insurance company. A client of the company wants information about his accident claim after business hours. There is no one at the office to assist the customer. How will you solve the problem? Using CRM systems you can solve the issue as it supports online mode. Thus, the customer can get information even after business hours.

CRM systems assist you to ease the relation between the company and the customer. This is done by tracking the customer's previous purchases, assisting the customer every day at any time or helping them interact with the company on its website and through social media, email, and custom instant messaging services.

6.1.2.5 Decision-Making

Would you like to know the role of IT in decision-making? IT can help you make decisions at the right time. This is done with the support of decision support systems.

Suppose, you are the owner of the company producing various products. The performance of one of your products is below par due to the lack of promotion. In this regard, you can use the decision support systems to decide whether to give further promotion or stop its production.

Decision-making systems help managers to see the performance of a company in real-time such as the company's capitals, sales, and marketing trends. This helps the Managers to decide on the promotion of products, control of expenses, etc.

6.1.2.6 Internet Enabled Systems

Finally, we shall discuss the Internet Enabled Systems. These systems help you to improve the security of business, reduce the risks of theft and loss of confidential information. An example of Internet-Enabled Systems is Closed-Circuit Television (CCTV).

6.1.3 IT in Banking

In the previous section, you saw how IT plays an important role in Business applications. This section discusses how IT helps in banking-related activities as shown in Fig. 6.1.4.

As you can see in Fig. 6.1.4., it shows different banking activities with the help of IT. A detailed explanation of each activity is given below.

6.1.3.1 Electronic Clearing Services (ECS)

Consider, you have 25 employees working in your organization. You have to pay them their monthly salary without delay. What is the solution? You can use the ECS system to transfer the required fund to their bank account from your account without any delay.

Do you know, the ECS is an electronic payments system for transferring funds from one bank account to another bank account. It is also used for bulk transfer of funds from one account to many accounts or vice-versa.

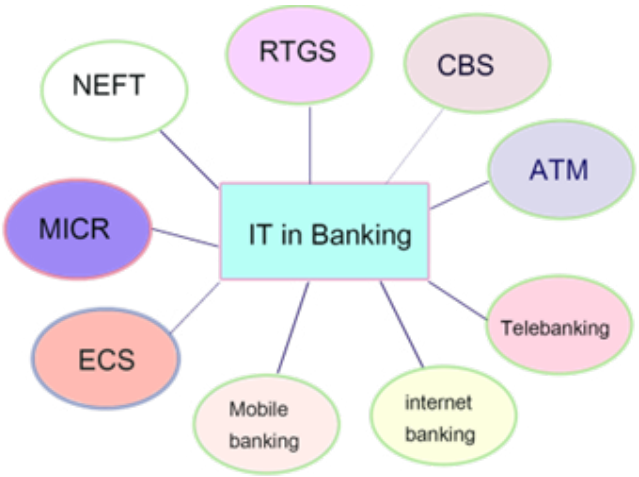


Fig. 6.1.4 IT in banking

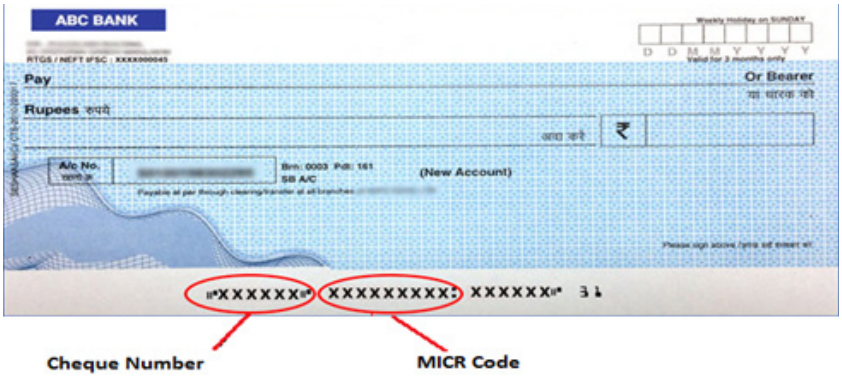


Fig. 6.1.5 Cheque with MICR Code

6.1.3.2 MICR Technology

Next, we have to look at Magnetic Ink Character Recognition (MICR) technology. This technology is an electronic way of clearing cheques. Here, the cheques are printed with a code using MICR technology at the bottom. This enables the identification and faster processing of cheques. A MICR code is a 9-digit code that uniquely identifies the bank and branch participating in ECS. A sample cheque with MICR code is given in Fig. 6.1.5.

As you can see in the figure, the cheque number and MICR code have been marked. In the MICR code, the first three digits represent the city (City Code). The next 3 digits represent the bank (Bank Code) and the last 3 digits represent the branch (Branch Code).

6.1.3.3 National Electronic Fund Transfer (NEFT)

We shall now discuss another online transfer of electronic funds, called NEFT.

Assume, you want to do an NEFT transfer of an amount from your account to your friend's account. Is it possible? Yes, it is possible, but you have to do the following steps:

- Open Internet banking using your username and password
- Go to the Fund Transfer section and select NEFT.
- Add beneficiary details first.

Once the beneficiary is successfully added, you can transfer the fund by entering the amount you want to send.

NEFT is a nationwide electronic funds transfer mechanism maintained by the Reserve Bank of India (RBI). NEFT enables you to transfer funds between any two NEFT-enabled bank accounts on a one-to-one basis using electronic messages. This improves the security in the transfer of funds. You can use your account or seek the help of a bank to transfer money using NEFT.

6.1.3.4 Real-Time Gross Settlement (RTGS)

RTGS system is an online money transfer with the advancement of IT. It is a mechanism that enables you to transfer money from one bank account to another on a 'real time' basis. Settlement in 'real time' means the transfer of money is not subjected to any delay because they are processed as soon as possible. Therefore,

it is the fastest possible money transfer system through the banking channel.

6.1.3.5 Core Banking Solutions (CBS)

Have you heard of CBS in banking?CBS refers to the networking of the branches of a bank. By using this mechanism, all branches of a bank are interconnected.

Imagine, you have a Canara bank account at a particular branch. Now you are in another branch of Canara bank and have to transfer money to your friend's bank account. Can you do the transfer? Yes, you can do the transfer because both these are CBS-enabled banks and can transfer the fund easily.

The CBS system enables the customers to operate their accounts from any bank branch, regardless of the home branch account using a centralized data management system. It helps the complete operations of banks under a single technological platform.

6.1.3.6 Automated Teller Machine (ATM)

You must have seen different bank ATMs while traveling or visiting banks. What is the purpose of the ATM? Its main aim is to dispense money when you place your debit or credit cards on the card slot. The ATM cards have a magnetic strip that contains information about the customer as well as the bank. In today's world, ATMs are the most useful tool to ensure the concept of "Any Time Banking" and "Any Where Banking".

6.1.3.7 Tele Banking

Tele Banking is another innovation of Information Technology. It is a voice processing facility available on bank computers that provides the facility of 24-hour banking. To avail yourself of the use of the telebanking service, you should call the customer care number and when it gets connected, you can choose the different options related to banking such as account information, report the loss of ATM cards, etc.

Imagine, you have lost your ATM card while travelling on a train at 11.00 pm. You want to immediately block the card. What will you do? You can use the telebanking facility of your bank to block the card.

6.1.3.8 Internet Banking

Suppose, your bank is closed for two weeks. You want to transfer Rs, 10000/- to your mother residing in another place. Is there any solution to this problem? Yes, you can use your Internet banking facility to send the money to your mother.

Internet banking is a familiar term used for various banking activities nowadays. It helps the customer to avail banking-related facilities through the bank's website with the help of the Internet. For availing yourself of the Internet banking facility, you should need a username and password. You can use this facility for all the services offered on the website such as transfer of funds, information about the fixed deposit, etc. You can use your laptop or computer for performing Internet banking.

6.1.3.9 Mobile Banking

This is also a familiar term like Internet banking. It is a facility of banking available on mobile phones. Similar to Internet banking, you can use the banking services at any time. Unlike Internet banking, mobile banking needs a software application that is to be installed on the mobile device. Transactions through mobile banking help to access your account information, lists of latest transactions, fund transfers, etc.

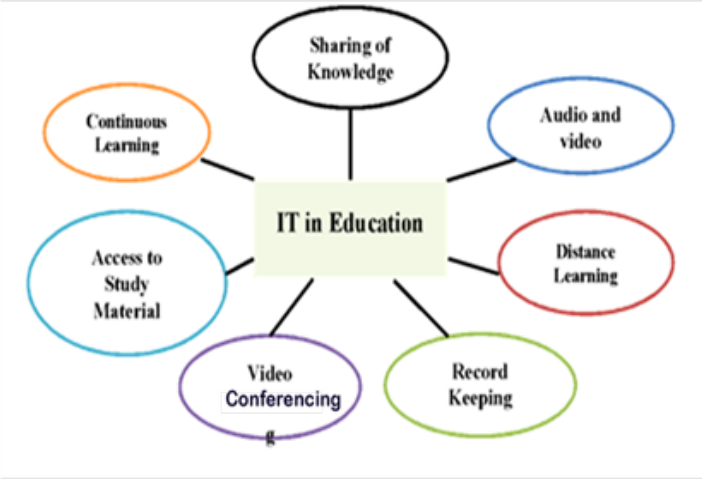


Fig.6.1.6 IT in Education

6.1.4 IT in Education

In the previous section, we have discussed the role of Information Technology in banking, and you should have got an idea of how IT is helpful in banking. In this section, we can look at how Information technology plays an important role in the field of education. This can be realized using a simple diagram as shown in Fig 6.1.6.

6.1.4.1 Access to Study Material

As you know, with the help of the Internet, it is very easy to access the study material and use it as a supplement for the studies. The various types of electronic study materials that you can access include e-books, guides, previous question papers, etc. You must take advantage of these materials to improve your knowledge base.

6.1.4.2 Continuous learning

In the present scenario, you need not have to be in the classroom for your studies. The advancement of Information Technology in education helps the students to keep on learning, irrespective of where they are. With the help of the Internet, the teachers can send learning activities or assignments to students and they can complete and submit tasks without physically attending the classrooms. This helps the students to continue their learning at any time or anywhere, and thus enhances the efficiency in the education segment.

6.1.4.3 Sharing of knowledge

This is another advantage of Information Technology. With the help of the Internet and IT, the students can share their knowledge through online discussion forums and social media platforms to engage, share experiences and learn from one another irrespective of the distance that separates them.

6.1.4.4 Audio and Visual Learning Aids

As you know, the use of IT in education helps teachers as well as students to interact with each other through online mode.We already know that we can access text material using the Internet. Besides the text materials, we can also access audio and visual materials. It helps students to develop a better understanding of the topics being taught. The audio and video

material includes voice clips, youtube videos, and other classroom videos. The audio and visual presentation helps the student to perform demos and put some practical aspects to the theory taught in the classroom.

6.1.4.5 Distance learning

You should understand that in a country like India, due to an increase in population or other reasons, it is not possible to get a good quality education for all the people offline. With the use of Information Technology, it is possible to attend online courses for students. Online courses enable the employed and older population to go back to class and get their degrees or certifications. It is also possible to attend overseas University courses in your home country and at your convenience.

6.1.4.6 Proper Record Keeping

Another benefit of IT is that it is possible to maintain and keep records of the students systematically and securely. In earlier times, there were many cases of lost files as they were kept manually. The incorporation of IT in education provides you with safe and proper record keeping options. Also, the retrieval of student information has been made much easier.

6.1.4.7 Video Conferencing

You might have heard the term Video Conferencing when you are engaged in online activities. It is a term associated with an online presentation using computers and the Internet. With the help of video conferencing technology, teachers can conduct virtual classes without any difficulty and deliver quality education from anywhere and at any time. Besides the above, various conferences, seminars, meetings, and training sessions can be conducted using video conferencing.

6.1.5 IT in the Medical Field

This section looks into the role of IT and how it is useful in the medical field.

Do you know what Health Information Technology (HIT) is? HIT is the application of IT in the medical field or healthcare. It refers to the use of electronic devices used to store, share and analyze health information by professionals. It defines the management of information among doctors and patients. HIT improves the quality and effectiveness of health care, and promotes individual and public health while increasing the accuracy in diagnoses. It reduces costs and medical errors, while improving the efficiency of both administrative and clinical processes.

6.1.5.1 Medical Practice Management (MPM)

This software helps you to manage administrative and clinical aspects of practice. It centralizes various systems so that you can run things more efficiently. It automates almost every task from organizing appointments to verifying insurance. With MPM, it is easier to keep a patient's medical data in the servers and retrieve the information whenever required.

6.1.5.2 Electronic Health Records (EHR) / Electronic Medical Records (EMR)

Do you know that EHR/EMR emphasizes the documentation and storage of a patient's medical information? With the help of EHR, doctors can very easily record medical information on their computer or mobile device. Also, it eliminates the time and errors that came with the manual charting of patient data. It allows the sharing of medical data of patients when he moves from one hospital

to another. This is useful for other doctors to treat the patients effectively.

6.1.5.3 Remote Patient Monitoring (RPM)

RPM technology uses medical sensors (devices that sense the different information like blood sugar, pressure, heartbeat, etc) to send patient data to the doctor's mobile or laptop.The doctors can provide proper treatment and prescribe medicine according to the condition of the patient. Thus it reduces costs and time and saves the lives of patients with chronic diseases. Thus IT plays a very important role in the field of Medical Science.

6.1.6 IT in Science

The advent of Information Technology has made great contributions to the fields of science. With the help of IT, a vast amount of information can be collected and stored according to different purposes.

IT supports and interacts with science in several ways. The first one is dealing with the collection and processing of information. With the help of IT, computations can be done in seconds that humans would take more than one lifespan to complete. For example, the computation of the digits of Pi. IT helps you in the detection of particular data from millions of data that would not be accomplished by humans.

Automated machines are machines that are controlled using IT. For example, automated machines like robotic arms are used in science to handle dangerous radioactive samples. These robotic arms allow the scientist to safely handle and perform the test on the samples easily.

With the help of IT, scientists around the world can share their ideas and information with their peers anywhere in the world. Also, it is possible for easier collaboration of different projects with colleagues anywhere in the world. Using the computer simulation technique, you can easily make computer models and analyze the results before going to a physical experiment in the laboratory.

6.1.7 Mobile Applications Development

The advancement of Information Technology also supports the development of mobile applications.

Mobile application development is the creation of software intended to run on a mobile platform. Do you know, there are three types of mobile applications as given below:

- Native applications
- HTML5 applications
- Hybrid applications

6.1.7.1 Native Applications

With the help of IT, native mobile applications are created for a specific platform (Android). This is done with the support of software development tools and languages supported by those operating systems. The application developers often prefer native apps because of their capability to use a device's full potential. As smart home devices are becoming more popular, developers are creating unique applications that integrate for personalized experiences. Example: Whatsapp, Facebook, etc.

6.1.7.2 HTML5 Applications

Based on the standards of web technologies like HTML5, JavaScript, and CSS,

and with the support of IT, this type of mobile application has been developed. It makes use of a write-once-run-anywhere approach to mobile development. The applications developed in this framework are compatible with many platforms. Therefore, it requires only minimal changes to ensure complete functionality on each operating system.

6.1.7.3 Hybrid Applications

Do you know, the hybrid mobile application makes use of both the concept of native and HTML5 applications? It is like a container developed in the native system that makes it possible to embed an HTML5 app within it. This helps you to make use of the varied and unique elements of each native system. Before creating your application, you must consider utilizing existing apps for greater impact. Example: Twitter, Gmail, Instagram, etc.

Recap

- IT deals with processing, management, transfer, storage, protection, and retrieval of information
- Inventory Management software helps to maintain stock and inventories
- E-commerce refers to buying and selling of services and goods
- CRM provides good customer experience through improved customer service
- Decision-making systems help to improve performance of companies in real-time
- Internet Enabled Systems improve the security of business
- ECS transfers electronic funds from one bank account to another
- MICR - electronic way of clearing cheques
- MICR uses Magnetic Ink Character Recognition technology
- MICR code is 9-digit unique code that identifies the bank and branch
- NEFT is nationwide electronic funds transfer mechanism
- Internet banking avail banking-related facilities using Internet
- Mobile banking allows banking on mobile phones
- Video conferencing - online presentation using computers and the Internet
- HIT uses electronic devices to store, share and analyze health information
- MPM manages administrative and clinical aspects of practice

- EHR/EMR emphasizes the documentation and storage of patient's medical information
- RPM uses medical sensors to send patient data to doctor's mobile or laptop
- Native mobile applications created for a specific platform like android
- HTML5 uses a write-once-run-anywhere approach to mobile development.

Objective Type Questions

1. What describes the processing, management, transfer, storage, protection, and retrieval of information?
2. Which software helps to maintain stock and inventories?
3. What refers to the buying and selling of services and goods?
4. What helps to ensure good customer experience through improved customer service?
5. What helps to improve the performance of companies in real-time?
6. Which system improves the security of business?
7. Which technology uses the clearing of cheques electronically?
8. What represents the first three digits of MICR code?
9. Which system uses the transfer of funds on a real-time basis?
10. What is the networking of bank branches called?
11. What ensures "Any Time Banking"?
12. Which banking uses a voice processing facility?
13. How can we use banking facilities in mobile phones?
14. What is an online presentation using computers and the Internet called?
15. Which technology uses electronic devices to store, share and analyze health information?
16. How can we manage administrative and clinical aspects of practice?
17. What emphasizes the documentation and storage of patients' medical information?
18. Which technology uses medical sensors to send patient data to a doctors' mobile or laptop?
19. Which mobile applications are created for a specific platform?
20. Which uses the write-once-run-anywhere approach to mobile development?
21. Which mobile application uses the concept of native and HTML5?

Answers to Objective Type Questions

1. Information Technology
2. Inventory Management
3. E-commerce
4. CRM
5. Decision-making systems
6. Internet Enabled
7. MICR
8. City
9. RTGS
10. CBS
11. ATM
12. Telebanking
13. Mobile banking
14. Video conferencing
15. HIT
16. MPM
17. EHR/EMR
18. RPM
19. Native
20. HTML Application
21. Hybrid

Assignments

1. Define Information Technology (IT) and explain its significance in modern business operations.
2. Describe the role of IT in inventory management
3. Discuss the advantages of e-commerce and how IT facilitates online buying and selling activities.
4. Explain the concept of Customer Relationship Management (CRM) and how IT systems support it for improved customer service.
5. How does Information Technology aid decision-making in businesses? Provide examples.

6. Explain Electronic Clearing Services (ECS) and its significance in modern banking transactions.
7. What is MICR technology, and how does it streamline the process of clearing cheques electronically?
8. Describe the process of National Electronic Fund Transfer (NEFT) and its benefits in electronic funds transfer.
9. Explain Real-Time Gross Settlement (RTGS) and its advantages over traditional fund transfer methods.
10. Discuss the concept of Core Banking Solutions (CBS) and how it enables seamless banking operations across branches.
11. Describe the features and benefits of Mobile Banking and how it has revolutionized banking services for customers.

Suggested Reading

1. Dennis P Curtin, Information Technology: The Breaking wave, McGrawhill, 2014
2. Terry Corbitt, Information Technology and Its Applications, Longman Scientific & Technical, 1994
3. Butler, Jeremy G., A History of Information Technology and Systems, University of Arizona, 2012
4. Gans D, Kralewski J, Hammons T, Dowd B "Medical groups' adoption of electronic health records and information systems". Health Affairs (Project Hope). (2005).

Reference

1. https://books.google.co.in/books?id=iim25OLcUdYC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2. https://books.google.co.in/books?id=LzXQsYQ3XjIC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

IT in other disciplines

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- introduce the role of IT in bioinformatics, medicine, and healthcare
- familiarize with significance of IT in economics and finance
- make student aware of the relevance of IT in cognitive science, quantum computing and nanotechnology
- discuss the applications of IT in education and learning

Prerequisites

With advancements and widespread application of computers, internet technology, electronic communication technology, etc., people have now entered the information age. Computer science has been widely used and has developed significantly, and has provided the possibility of development and reinvention in various fields.

Today's world is characterized by three major elements in the scientific field: the development of classical sciences, evolution in the field of computer science and, as a result, the emergence of a large number of new border sciences or interdisciplinary and transdisciplinary sciences. Computational thinking is a way to ‘understand and change the world. It crosses subject boundaries giving a powerful way to understand (and change) our digital, physical and social worlds.

Application of Information Technology, applied through modeling and simulation, fundamentally changes research in the biological, social and physical sciences. For example, models of neurons help us understand the way the brain works; evolutionary models help to explain biological phenomena; agent-based models shed light on social systems; computational models give scientists a way to understand the climate. Exploring such applications gives a fertile context to encourage computational thinking and to motivate the interest in Computing. It also provides a powerful way to learn topics in other subjects, promoting interdisciplinary understanding. In this section, we look at links between opportunities for computational applications across a variety of

other subject domains.

In this unit, we emphasize the reasons why it is necessary to teach computer science in an interdisciplinary and/or transdisciplinary way, as computational techniques find applications across various disciplines.

Key Concepts

Bioinformatics, Computational economics, Cognitive science, Computer-assisted therapy, Computer-aided Diagnostics

6.2.1 Bioinformatics

There is an increase in the growth of biological data now a days. World Wide Web and fast Internet connections have made it easier to access and process biological data quickly and efficiently. Many computer-based models are used widely in biological research. Bioinformatics is the combination of biology and information technology. The discipline encompasses many computational tools and methods used to manage, analyze and manipulate large sets of biological data.

The term Bioinformatics was invented by Paulien Hogeweg in 1979 to study the processes of information technology in biological systems. Before 1990, computers were used mainly for the creation of databases and the design of various algorithms to improve the efficiency of DNA sequence analysis.

In 1990, the United States proposed the "Human Genome Project", and the development of bioinformatics entered the genome stage, with the aim of recording the complete human gene sequence by using the principle of DNA complementarity.

Now, with the completion of human genetic sequencing, people realize that the 23 human chromosomes contain 60,000-100,000 genes, and the essence of genes is composed of different base pairs, and these 100,000 genes are about 3 billion base pairs, which shows how huge the amount of information is. It is difficult to process and analyze such large volumes of data manually. Thus computers and computational models have become an essential tool in the storage, processing and analysis of biological data.

The science of bioinformatics develops algorithms and biological software for computers to analyze and record the data related to biology, for example, the data of genes, proteins, drug ingredients and metabolic pathways.

There are three major components in Bioinformatics:

- The creation of databases allowing the storage and management of large biological data sets.
- The development of algorithms and statistics to determine relationships among members of large data sets.

- The use of these tools for the analysis and interpretation of various types of biological data, including DNA, RNA and protein sequences, protein structures, gene expression profiles, and biochemical pathways.

6.2.1.1 Importance of computers in Bioinformatics

Bioinformatics is largely a computer-based discipline. Many bioinformatics problems require the same task to be repeated millions of times. For example, comparing a new DNA sequence to every other sequence stored in a biological database or comparing a group of sequences systematically to determine relationships between the sequences. Such applications require processing a large amount of information and complex computations.

The problem-solving ability of computers can be utilized to solve the folding pathways of protein given its amino acid sequence or deduce a biochemical pathway given a collection of RNA expression profiles.

The advancements in computer science made it possible to integrate a wide variety of data sources such as clinical and genomic data. This will enable the use of disease symptoms to predict genetic mutations and vice versa. The integration of GIS data, such as maps, and weather systems, with crop health and genotype data, will allow us to predict successful outcomes of agriculture experiments. The modeling and visualization of complex genetic networks could be used to predict how the system (or cell) reacts to a drug for example.

6.2.1.2 Applications of Bioinformatics

Bioinformatics has applications in various sectors:

- Pharmaceuticals: Bioinformatics researchers play a major role in pharmaceutical research, especially for infectious diseases. Moreover, bioinformatics has also innovated personalized medical research thus bringing new discoveries in terms of drugs that can be personalized to someone's genetic pattern.
- Preventive medicine: Bioinformatics can be combined with epidemiology to create preventive medicine by understanding the causes of health issues, community healthcare infrastructure, disease patterns, etc.
- Gene Therapy: Bioinformatics also finds useful for gene therapy, especially for individual genes that have been adversely affected. Gene Therapy is a process through which genetic materials are incorporated into unhealthy cells in order to treat, cure as well as prevent diseases. Analyzing protein targets, identifying cancer types, and evaluating data, assessing MicroRNA, etc. are some of the applications of Bioinformatics in Gene Therapy.
- Drug Discovery: Computational biology, an essential element of bioinformatics, helps scientists analyze the disease mechanism process and validate new and cost-effective drugs.

- Crop Improvement: Bioinformatics is used in the development of strong, more drought-resistant, and insect-resistant crops.

6.2.2 IT in medicine

The application of information technology in various fields of medicine is discussed below:

6.2.2.1 Hospital Information System

Computers have become an important tool in organizing and managing information in support of patient care, biomedical research and education. A computerized hospital information system can establish consistent standards in the transmission and storage of data and continuously monitor all transactions. It provides easy access to valuable patient care information. Physicians can have direct access to all the information of their patients through the use of computers. A hospital information system generally covers areas like registration, admission/transfer/discharge, billing, medical records, indexes, wards, operation theater scheduling, stores/inventory, pharmacy, diet, biomedical maintenance, payroll, accounts, etc.

6.2.2.2 Data Analysis in Medicine

In medical research a large amount of data is collected. This data is to be compiled, analyzed and interpreted. For this purpose, various statistical methods are to be applied. Statistical methods are time-consuming. With the help of a computer, a large number of statistical calculations can be performed in a very short time.

6.2.2.3 Laboratory Computing

Laboratory analysis includes blood chemistry, photometry, microbiology, etc. Results must match with patient identification details and should be valid. Quick access to laboratory systems can contribute to an efficient patient care system. Computers help to deliver accurate results in a short time.

6.2.2.4 Computer- Assisted Decision making (CADM)

It is an interactive computer system that directly assists doctors with clinical decision-making tasks. The system is intended to support doctors, complementing their natural abilities to make judgments with the computer's vast memory, reliability and processing capabilities. A general model of computer-assisted medical decision-making is shown in Fig. 6.2.1.

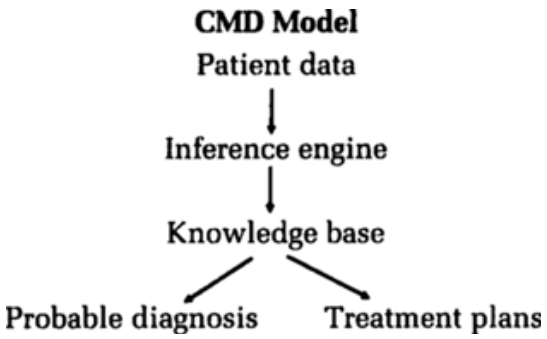


Fig. 6.2.1 Computer-assisted medical decision-making model

6.2.2.5 Care of Critically Ill Patients

Caring for critically ill patients requires many therapeutic interventions to optimize their chances of survival. Many variables such as blood oxygen saturation, respiratory rate, heart rate, platelet counts etc., must be collected frequently. The data derived from these variables must be made available to the clinicians and nursing staff. This results in a large quantity of information. This information must be recorded and presented in a clear manner. In the intensive care unit, it is now possible to computerize the total management of data recorded on the patients. Data management includes the entry, integration and reporting of all vital signs, medications, intake and output volumes and laboratory values.

A closed loop system for the direct computer control of the infusions of a vasodilator (medications that open (dilate) blood vessels) is shown in Fig. 6.2.2. An intra arterial cannula, a tube inserted into the artery of the patient, is connected to a suitable cardiovascular monitor. This monitor provides the input signal to the computer. A pump which infuses the vasodilator drug to the patient is controlled by a computer to maintain the arterial pressure within predetermined units.

6.2.2.6 Computer-Assisted Therapy

Computational methods have been developed for planning, monitoring and adjusting dosages of powerful and potentially toxic drugs during therapy. The physician can plan dosage regimens using these methods.

6.2.2.7 Medical Imaging

Computers have been used widely for high-resolution image generation. Dedicated hardware and software are required to generate such images in CT scans, MRIs, ultrasounds, and gamma cameras. It is possible to integrate these workstations into the main hospital information system. Computers are used for generating three dimensional images of living human anatomy.

6.2.2.8 Computer-Aided Diagnostics

Computer-aided detection (CADe), also called computer-aided diagnosis (CADx), are systems that assist doctors in the interpretation of medical images. Radiologists and other medical professionals use imaging techniques such

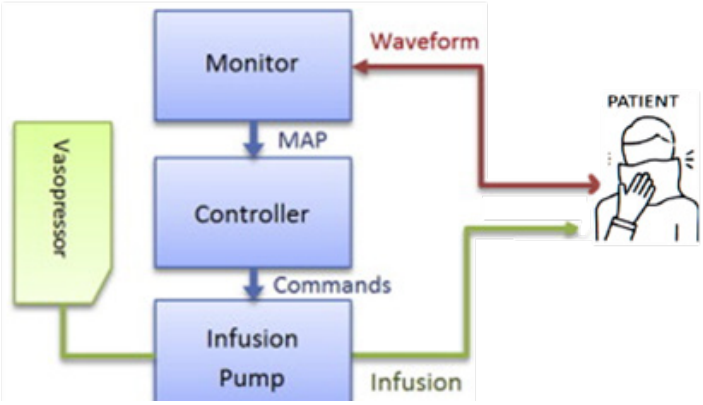


Fig 6.2.2 Closed loop system for the direct computer control of the infusions of vasodilator

as X-ray, MRI, Endoscopy and ultrasound diagnostics to analyze and evaluate various medical conditions. CAD systems process digital images or videos for typical appearances and to highlight conspicuous sections, such as possible diseases, in order to offer input to support a decision taken by the professional.

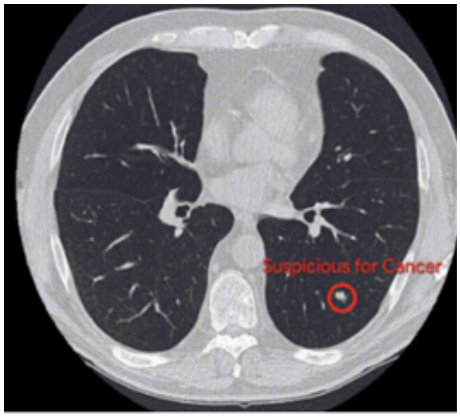


Fig 6.2.3 Malignant lung tumour detected by an AI model on CT scan (Source: https://venturebeat.com/ai/googles-lung-cancer-detection-ai-outperforms-6-human-radiologists/)

The most common applications of CAD systems are for the detection of breast cancer on mammography, the detection of polyps in Colonoscopy, pulmonary nodules on chest CT, brain tumors and lung cancer. Fig. 6.2.3 shows the results of a lung tumor detected by an AI on CT scans.

6.2.3 Computational Economics

Computational Economics is an interdisciplinary area that involves computer science, economics, and management science. This area involves computational modeling of economic systems. The increasing computational and predictive capabilities of modern computers have made them invaluable tools for researching economic trends and developing strategies around them. Computational economics has changed the way governments and companies assess economies.

Let us discuss some of the applications of computational economics.

6.2.3.1 Computational Finance

Computational finance is an interdisciplinary process that incorporates elements of mathematical science, economic theory, statistics, and computer simulation and modeling. The applications for computational finance are varied, but they typically focus on investment planning and risk management. Using available statistical data, computers generate simulations that show the outcomes of investments under various situations and the potential for gains and losses. Using this information, companies develop plans to minimize potential losses and prepare for the different scenarios that may occur.

6.2.3.2 Economic Forecasting

Computers are used in the creation of complex forecasting models. As in computational finance, computer simulations and models can be used to predict how markets will change. While no forecast is completely reliable, these forecasts factor in a diverse array of variables in a fraction of the time a human could manually crunch the numbers. Current policies and models can also be quickly adapted to changing situations with new predictions available almost instantly and ready for assessment.

6.2.3.3 Online Trading and E-commerce

The emergence of e-commerce and online trading of goods, services and stocks has considerably changed the way we do business. Many transactions, especially

those between two businesses as opposed to a business and a consumer, are now performed online, with the exchange of information and digital purchases taking place instantly. This has vastly changed the way stocks are traded, as enormous bulk trades can be made instant prices change, and exchanges are made based on computer algorithms with preset parameters rather than based on instructions from a human trader.

6.2.3.4 Stock Markets

Information technology has made a great impact on the stock market. Let us discuss the role of IT in the stock market.

- Online trading apps: Online trading apps have revolutionized the trading experience. Users can directly trade and analyze the stock market using these apps without the help of any stock broker or paperwork. They have made the online trading experience hassle-free, convenient and accessible. They help to reduce trading costs and give the users a better understanding of their investment.
- Stock prediction: Automated robots are used to analyze thousands of data points. They help the user to execute trades at minimal prices and eliminate the risks. Further, it enhances the accuracy to provide the maximum return.
- Faster Transaction: In earlier days, stock market participants were required to go through a hectic and time-consuming process to regulate any transaction. The advances in information technology have made stock market transactions more faster and secure. As intermediaries in the system get minimized, further monetary issues like manual records, audits, and verification are eliminated.
- Real-Time Monitoring: The latest technological advancements make it feasible for investors and brokers to get accurate and trusted prices. It has eliminated the risk of human errors in trading. Now it is really easy to research the progress of the stock and choose the right investment option. Investors can now react as quickly as possible. Quick availability of information is linked with faster changes in the market than ever. All this has made the trading experience less hectic and more feasible.
- Enhanced Security Features: Technological advancements have provided a secure platform for trading activities. It keeps a record of all transactions, which brings complete trust and transparency to the market.
- Use of Blockchain in Trading: Stock markets across the globe are embracing Blockchain technology for faster and more secure transactions. It has a huge potential for secure trading and monitoring risks. Many markets regulating authorities like Japan financial services agencies, NYSE, Deutsche Borse, etc., are willing to use blockchain in their infrastructure. SEBI has also taken steps to embed blockchain technology and derive the benefits. The use of blockchain will bring a

complete transformation to the stock market. It can eliminate the risk of third-party authorities using smart contracts and network regulation. It provides a robust platform to implement security measures by tracking and reporting illegitimate activities. Blockchain will completely transform the stock market by providing robust security measures, higher liquidity, lower transaction cost, automated surveillance, and much more.

6.2.4 Cognitive Science

Cognitive Science and Artificial Intelligence is a comprehensive interdisciplinary program that integrates the study of artificial intelligence with the study of human cognition. It covers topics from the realms of language, reasoning, learning, vision, and human-human and human-technology interaction. It also deals with the ethical and moral aspects of AI. Computational cognitive science deals with intelligent systems operation(like self-learning robots and software that can take over or support human activities) and how this is related to the workings of the human brain. What are the various ways computers can learn to solve a problem? Do computers and brains work similarly? And how can we ensure that advanced intelligent systems can also 'explain' what they do?

Technological advancements and innovations have made it possible to stimulate the human brain on a computerized system with better precision and accuracy. In other words, it is the cognitive science AI that has ensured the effective utilization of the power of computers to supplement the thinking ability of human beings. Computer simulation in AI can be regarded as the reproduction of a system's behavior for achieving simple as well as complex goals. Speech recognition and handwriting recognition are the two most common areas of cognitive science AI that attracted researchers' attention. Some of the significant applications of cognitive science AI are as follows.

6.2.4.1 Speech-to-text and text-to-speech

Integration of AI with cognitive science has led to the development of speech to text services which in turn have offered human beings with a diverse range of capabilities. For instance, utilization of these services would support several transcription scenarios like speech or conversation transcription and custom speech transcription. The first type has been designed to convert spoken audio into text. And for this, one is only required to call for the API for recognising the source of the audio, followed by real-time streaming. The second type of application is suitable for in-person meetings as one can capture speeches in real time with its use. Not only this, rather this advancement has fostered smooth recording of discussions, identification of the speaker, time and also follow-up. Two common examples of both speech-to-text and text-to-speech include Android's native Text-to-Speech feature, Voice Aloud Reader and Google Assistant and OneNote, respectively. The first example automatically works with Google apps that offer a read aloud feature.

6.2.4.2 Personalise

Use of personalized interactions is the outcome of cognitive science AI, thereby allowing individuals to rely on and create rich and personalized experiences for users. To be more specific, this modern application lets an organization prioritize

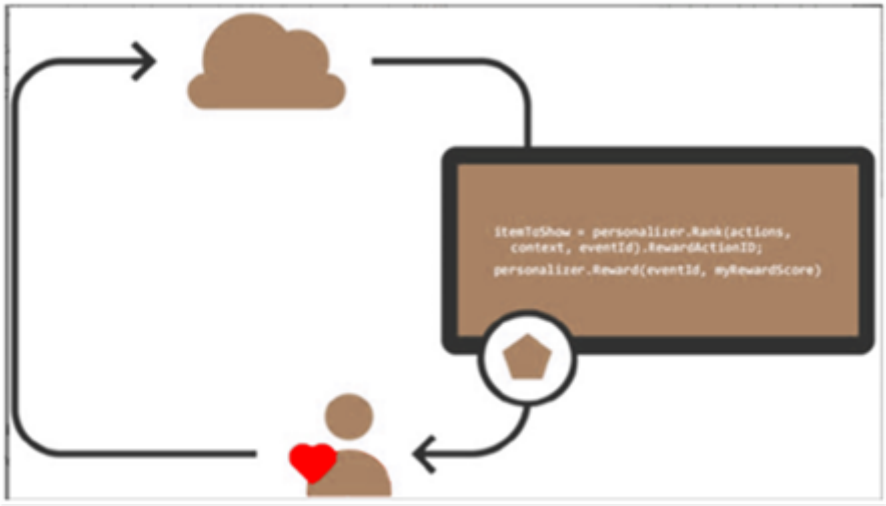


Fig 6.2.4 Reinforcement learning loop of personaliser

contents as these are the medium to improve the experience of users. The more relevant the content is, the more satisfied users are. Cognitive services as offered by Microsoft Azure include Personaliser Preview wherein, reinforcement learning-based capability is delivered.

Achieving the desired level of brain simulation is limited as most of the cognitive operations within a human brain depend on analogue transactions, whereas a computerized system is fully digital. As a result of this, the simulation of operations like neurotransmitter concentration, spike frequencies, and potential of membrane and metabolic gradients are lagging behind. In other words, present-day brain simulation using AI requires the inclusion of parameters like extracellular interactions of a brain and receptor binding.

The advent of nanotechnology, which is aimed at increasing the speed and memory of computational hardware, is estimated to be the future of human brain simulation. Moreover, modern cognitive science AI theories are analyzed to foster a better understanding of the mind and brain. Advancements in the fields of cognitive and psychological science enabled diverse understanding of human behavior, thereby making scopes for intelligent agents. Most of the cognitive simulations of today's world emphasize only processes. Inputs to these simulations are hand-generated, whereas outputs are hand evaluated.

It can, therefore, be concluded that AI is a useful tool in the research area of cognitive science as this technological innovation facilitates a better understanding of the human mind. Useful insights about human recognition have been made possible with AI-based applications like speech to text, text to speech, natural language understanding and personalizer. It is estimated that intelligent agents enhance the ability of human brain simulation. However, there are certain complexities that might end up limiting the scopes of brain simulation for which improvements like nanotechnology and cognitive science AI theories are desired.

6.2.5 Applications of Artificial Intelligence in Lifestyle

Artificial Intelligence has a lot of influence on our lifestyle. Let us discuss a few of them.

- Autonomous Vehicles

Automobile manufacturing companies like Toyota, Audi, Volvo, and Tesla use machine learning to train computers to think and evolve like humans when it comes to driving in any environment and object detection to avoid accidents.

- Spam Filters

The email that we use in our day-to-day lives has AI that filters out spam emails sending them to spam or trash folders, letting us see the filtered content only. The popular email provider, Gmail, has managed to reach a filtration capacity of approximately 99.9%.

- Facial Recognition

Our favorite devices like our phones, laptops, and PCs use facial recognition techniques by using face filters to detect and identify in order to provide secure access. Apart from personal usage, facial recognition is a widely used Artificial Intelligence application even in high security-related areas in several industries.

- Recommendation System

Various platforms that we use in our daily lives like e-commerce, entertainment websites, social media, video sharing platforms, like youtube, etc., all use the recommendation system to get user data and provide customized recommendations to users to increase engagement. This is a very widely used Artificial Intelligence application in almost all industries.

- Navigation

GPS technology can provide users with accurate, timely, and detailed information to improve safety. The technology uses a combination of Convolutional Neural Network and Graph Neural Network, which makes lives easier for users by automatically detecting the number of lanes and road types behind obstructions on the roads. AI is heavily used by Uber and many logistics companies to improve operational efficiency, analyze road traffic, and optimize routes.

6.2.6 Quantum computing

Quantum computing is a rapidly emerging technology that harnesses the laws of quantum mechanics to solve problems that are highly complex for classical computers. Quantum computing is an area of computer science that uses the principles of quantum theory, which explains the behavior of energy and material on the atomic and subatomic levels. Quantum computing uses subatomic particles, such as electrons or photons. Quantum bits or qubits allow these particles to exist in more than one state at the same time.

6.2.6.1 Evolution and Progress of Quantum Computing

The field of quantum computing emerged in the 1980s. It was discovered that certain computational problems could be tackled more efficiently with quantum algorithms than with their classical counterparts. Quantum computing has the capability to sift through huge numbers of possibilities and extract potential solutions to complex problems and challenges. Where classical computers store information as bits with either 0s or 1s, quantum computers use qubits. Qubits carry information in a quantum state that engages 0 and 1 in a multidimensional way. Such massive

computing potential and the projected market size for its use have attracted the attention of some of the most prominent companies. These include IBM, Microsoft, Google, D-Waves Systems, Alibaba, Nokia, Intel, Airbus, HP, Toshiba, Mitsubishi, SK Telecom, NEC, Raytheon, Lockheed Martin, Rigetti, Biogen, Volkswagen, and Amgen. The field of Quantum Information Science and Technology (QIST) brings together two major advances of the 20 th century: quantum mechanics and information technology.

6.2.6.2 The Building Blocks - Quantum Bits

For digital information manipulation and handling bits are used, so data is processed, stored, and communicated as bits. The two states of a conventional data bit 0; and 1 take many forms ie, two different voltages across a transistor on a chip, orientations of a magnetic domain on a disk or tape, voltages propagating down a wire, light pulses traveling down an optical fiber, and so on which dependents upon what is being done with the data. At any time a bit is always in state 0 or state 1 hence the name, although bits get flipped as data is processed or memory is rewritten. However, the quantum analog of a conventional bit, a qubit, has rather more freedom.

6.2.6.3 Usage of AI Technologies in Quantum Computing

Machine learning, artificial intelligence (AI), and Big Data search are used with Quantum computing. It is also used for the secure sharing of information between sender and receiver. For stronger online security, quantum computing can help for designing better data encryption and ways to use light signals to detect intruders in the system.

6.2.6.4 The programming Language used in Quantum Computing

Silq is a high-level programming language for quantum computing with a strong static type system, developed at ETH Zürich.

6.2.7 Nanotechnology

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

6.2.7.1 Fundamental Concepts in Nanotechnology

One nanometer is a billionth of a meter or 10 -9 of a meter. Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms. But something as small as an atom is impossible to see with the naked eye. The microscopes needed to see things at the nanoscale were invented in the early 1980s. Once scientists had the right tools, such as the scanning tunneling microscope (STM) and the atomic force microscope (AFM), the age of nanotechnology was born. Although modern nanoscience and nanotechnology are quite new, nanoscale materials were used for centuries. Alternate-sized gold and silver particles created colors in the stained glass windows of medieval churches hundreds of years ago. Today scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and

greater chemical reactivity than their larger-scale counterparts.

6.2.7.2 Application using IT in Nanotechnology

Data exploration and visualization using information technology. This kind of data-driven exploring requires rich and easy-to-use environments for visualization and data interactivity. A good tool will hide the complexity of the data management from the user and will respond in real-time to user interactivity, even though the data analysis may be occurring on a distant parallel machine.

6.2.7.3 Computational Geometry

Efficient methodologies for representing and manipulating such geometries can have a significant impact on the overall performance of some computations. Computational geometry is a mature area of algorithmic computer science, but the specific geometries arising in nanoscience would benefit from specialized algorithms.

6.2.7.4 Software Usage

The need for well-designed, object-oriented, open-source codes that can be used on a variety of platforms is essential to the overall success of the nanoscale initiative. There are simply too many modules necessary for simulation and analysis that can be developed in one place. For modular optimization and statistical algorithms, software needs to be developed in such a framework to provide tools for scientific understanding leading to advanced engineering and analysis tools with guaranteed accuracy for design and manufacture.

Recap

- Bioinformatics - combination of IT and biology
- Gene therapy - genetic materials incorporated to diseased cells
- Computer-assisted Decision Making systems - assist doctors in clinical decision making systems
- Computer-aided Diagnostic systems - assist doctors in computer interpretation of medical images
- Computational Finance - elements of mathematical science, economic theory, statistics, and computer simulation and modeling
- Computational Economics - computational modeling of economic systems
- Computational forecasting - predict how markets will change
- Text to speech - convert text to speech
- Personaliser - Microsoft application create rich and personalised experiences for users
- Cognitive science -study of artificial intelligence with the study of human cognition
- Qubits - property of quantum computing allows particles existing in more than one state at the same time
- Silq - high level programming language is used for quantum computing with a strong static type system

Objective Type Questions

1. Which area is the combination of biology and information technology?
2. What is the process through which genetic materials are incorporated into unhealthy cells in order to treat, cure as well as prevent diseases?
3. What is an interactive computer system that directly assists doctors with clinical decision-making tasks?
4. Which systems assist doctors in the interpretation of medical images?
5. What is an interdisciplinary process that incorporates elements of mathematical science, economic theory, statistics, and computer simulation and modeling?
6. What area involves computational modelling of economic systems?
7. Which process uses computer simulations and models to predict how markets will change?
8. Name two applications of cognitive computing.
9. Which interdisciplinary program that integrates the study of artificial intelligence with the study of human cognition?
10. Which property of quantum computing allows particles existing in more than one state at the same time?
11. For which development purpose the high level programming language 'Silq' with a strong static type system is used?

Answers to Objective Type Questions

1. Bioinformatics
2. Gene therapy
3. Computer-assisted Decision Making systems
4. Computer-aided Diagnostic systems
5. Computational Finance
6. Computational Economics
7. Computational forecasting
8. Text to speech, personaliser
9. Cognitive science
10. Qubits
11. Quantum computing

Assignments

1. What is bioinformatics, and how has it evolved over time? Discuss its significance in modern biological research.
2. Provide examples of bioinformatics applications that heavily rely on computational power.
3. Discuss the major applications of bioinformatics in various sectors such as pharmaceuticals, preventive medicine, gene therapy, drug discovery, veterinary sciences, and crop improvement.
4. How does information technology (IT) contribute to advancements in the field of medicine? Discuss the role of IT in hospital information systems, data analysis, laboratory computing, and computer-assisted decision-making in medical care.
5. Describe the concept of computer-assisted medical decision-making (CMD) and its significance in optimizing patient care in intensive care units (ICUs).
6. Discuss the role of computers in medical imaging. How are computers utilized to generate high-resolution images in various medical diagnostic procedures?
7. What is computer-aided diagnostics (CAD) in medical imaging? Provide examples of CAD systems and their applications in detecting diseases such as breast cancer and lung tumors.
8. What is computational economics, and how does it utilize computer science principles to analyze economic trends and develop strategies? Discuss its applications in finance, economic forecasting, online trading, and e-commerce.
9. Describe the evolution and progress of quantum computing. How does quantum computing differ from classical computing, and what are its potential applications?
10. Discuss the fundamental concepts of nanotechnology and its applications in various fields, including data exploration, computational geometry, and software development.

Suggested Reading

1. https://iopscience.iop.org/article/10.1088/1742-6596/1915/3/032042/pdf
2. https://www.ijarcce.com/upload/november/6-Bioinformatics%20A%20revolutionary.pdf
3. https://leverageedu.com/blog/application-of-bioinformatics/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6257447/

5. https://radiopaedia.org/articles/computer-aided-diagnosis-1#:~:text=Computer%20aided%20diagnosis%20(CAD)%20is,on%20a%20computer%20algorithm%20only.
6. https://www.techwalla.com/articles/uses-of-computers-in-economics
7. https://www.geeksforgeeks.org/how-technology-has-influenced-the-stock-market/

Reference

1. https://www.techtarget.com/searchsecurity/tip/10-common-types-of-malware-attacks-and-how-to-prevent-them
2. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/computer-virus
3. https://www.malwarebytes.com/polymorphic-virus
4. https://link.springer.com/referenceworkentry/10.1007/978-1-4419-5906-5_838

UNIT 3

Computer Security and Malware

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- learn the concepts of computer security
- acquire knowledge on terminologies used in computer security
- obtain the concepts of malware
- study the concepts of computer virus
- gain awareness on the different types of computer viruses

Prerequisites

In the previous unit, we learned about various careers and research areas in the field of Computer Science and Information Technology. In this section, we are going to learn about the concepts of Computer Security and Malware. Today's world, the computer and the Internet are inevitable parts of our daily life. As we are using sensitive data to store, process, and transfer; it is necessary to protect the data and computers from others' misuse or stay away from external cyber attacks. Therefore, we need to secure our computer and data properly while using computers and the Internet.

What are the security measures you must take to protect the data or the computer systems? Security measures mean the precautionary measures taken toward possible danger or damage of the computer system. There are 6 types of security measures used for data protection which are shown in Fig 6.3.1

We can discuss the types of security measures starting from firewall to antispyware. A Firewall is a piece of hardware or software that functions in a network setting to prevent communications prohibited by the security policy. It means the firewall might permit partial access from inside or outside the network perimeters or from a certain user or for certain activities. Human Aspects refers to the unwanted actions done by the user

and the intruder of a computer system. It is one of the toughest tasks to give protection to the system. An Intruder is an individual or software program that enters a computer system without any permission or authorization. Example: hacker.

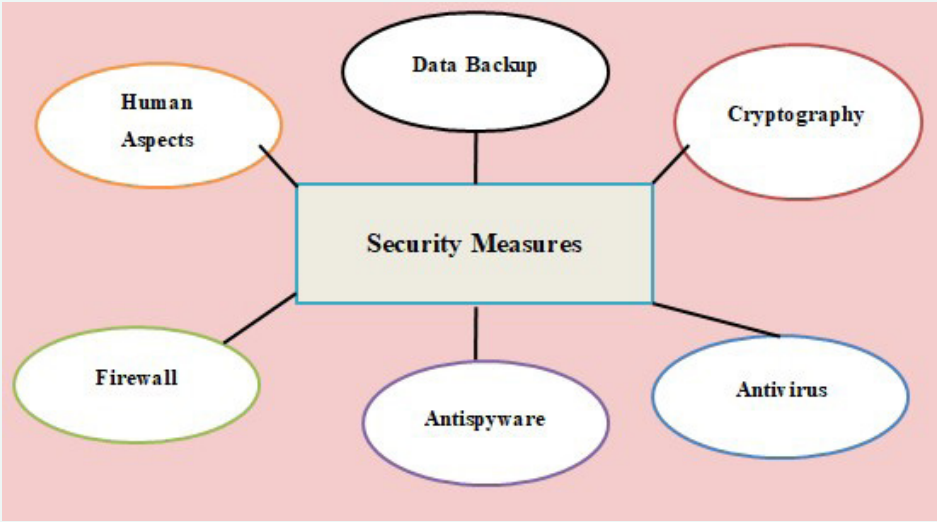


Fig.6.3.1 Security Measures

Data Backup is a program of file duplication in which we can recover the data in case of an emergency or loss. You must back up the data depending on the importance of the information in daily, weekly, or biweekly backups from a hard disk to the backup servers. For example, Whatsapp has a data backup feature in which if you lose your mobile, you can retrieve the data as the data is saved on its servers.

You might have heard the term, Cryptography. Do you know what it refers to? Suppose, you want to send a confidential message "attack" to your officer. How can you do this using cryptography? You can encrypt the message "attack" as @2&7?+ and send it with a key. The officer can decrypt the data using the key and see the message "attack".

Cryptography refers to the method of hiding the data by changing the real information into different representations. During the process, you can encrypt or decrypt the information using a key that contains symbols, numbers, letters, etc. Encrypt converts the (information or data) into a code to prevent unauthorized access. Decrypt converts the encrypted code back into information. Antivirus is a familiar term you must have heard frequently in the cyber world. What is antivirus? It is a program that protects your computer from viruses by identifying and removing them from the computer memory, storage devices, or incoming e-mail files. An antivirus program scans programs that attempt to modify the boot program, the operating system, or other programs that should not be modified. Examples of antivirus: Kaspersky. K7, Avira, etc.

We can move on to the final type of security measure, Anti-Spyware. Before moving to anti-spyware, you must know, what Spyware is? It is a software program that is placed

on the computer system without the knowledge of the user. It secretly collects sensitive information about the user and communicates to the outside source. Anti-Spyware or tracking software or Spybot is a program used to find and remove spyware from your computer systems. Examples of anti-spyware programs: Spybot Search and Destroy, Ad-aware, etc.

Key Concepts

Computer Security, Malware, Virus, Antivirus

Discussion

6.3.1 Computer Security

In the previous section, we discussed the types of security measures needed to secure your data and computer systems from cyber attacks. In this section, we discuss the concepts of Computer Security.

Imagine you are the security officer of a bank. What is your duty? You have to protect the bank assets from being stolen. Likewise, in the case of computers also, security is needed to prevent the loss or damage to your computer asset.

How can we define Computer Security? Computer Security is the protection of data and computer systems from harm, theft, and unauthorized use. As you are protecting the computer hardware from damage, you must also protect your computer data such as files, passwords, and other sensitive information from unauthorized usage.

There are mainly four threats that affect your data and computer systems. They are:

- Theft of data
- Computer Vandalism
- Fraud
- Invasion of privacy

While dealing with computer security, you have to address the four major threats given above.

a) Theft of data refers to the stealing of secret and sensitive data from the military, government, and other organizations for illegal use.

b) Computer Vandalism. It is a process of extracting someone's password or other sensitive data or erasing the hard disk using a program that performs malicious functions.

c) Fraudulent attempts to transfer other's data or money. For example, an employee at a bank tries to transfer funds into account from other accounts.

d) The invasion of privacy refers to the access of protected personal, financial, or medical data from a large database using an unauthorized way or illegally.

From the above, you have got an idea about the different threats that affect the cyber world. Is it possible to overcome the threats? Generally speaking, we can

overcome the different threats as given below:

a) To electronically track and record the access and activities of various users of a computer system using security software like firewall, antivirus, antispyware, etc.

b) Set strong passwords with a combination of symbols, numbers, and letters.

c) To store a system's data on a separate device, or medium, such as magnetic tape or disks, that is normally inaccessible through the computer system.

d) Data is often encrypted so that it can be decrypted only by authorized users.

6.3.2 Elements of Computer Security

Fig.6.3.2 Elements of Computer Security

In the previous section, you learned the concepts of computer security. In this section, we shall discuss the various elements of computer security.

As you have understood, Computer Security refers to the capability of detecting and preventing cyber-related attacks and recovering from these attacks. If these attacks are successful, they may cause severe damage to your data and computer systems. So the main aim of Computer Security is to prevent the disruption of information and services as low as possible. To fulfill these requirements, you should be aware of the elements of computer security. Now, let us look at the various elements of Computer Security as shown in Fig 6.3.2.

6.3.2.1 Confidentiality

The first element you have to study is confidentiality. It helps you to deal with the concealment of information or resources. That means you have to keep the information secret so that third parties are not able to access it. Accordingly, the information can be accessed only by the right person.

Assume that you want to communicate with your supervisor using an encrypted email. The supervisor can only see the content of the email if he knows the secret key attached to the email content. This helps to understand the confidentiality of computer security. This can be explained

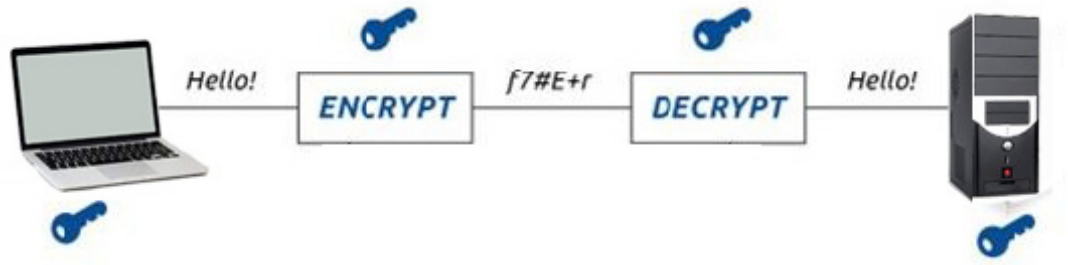


Fig.6.3.3 Example of Confidentiality

with the help of Fig 6.3.3

As shown in the figure, the sender tries to send the message “Hello!”. After that, the message is encrypted with the help of a security key and the message is converted into another code f7#E+rand again sent to the receiver. At the receiver, the encrypted message is decrypted if the receiver knows the secret key.

6.3.2.2 Integrity

Now, we can talk about the second element of Computer Security, Integrity.

Suppose, you want to send an online payment of Rs, 500/- to a seller for the purchase of a computer book. But, your information is manipulated by the seller without your knowledge by changing Rs, 500/- to Rs, 5000/-. Thus the integrity is lost.

Integrity defines the trustworthiness of data in computer systems or resources. That means it prevents unauthorized and improper changes in the data. Generally speaking, Integrity constitutes two sub-elements. They are Data Integrity and authentication. Data Integrity deals with the content of the data and authentication deals with the originality of the data.

The loss of data integrity in the above illustration can be prevented by using hashing technique in cryptography. While sending the money, you should include the hash data with the original message. The receiver can read the data if he knows the hash code. Hashing is a process by which the data is converted into a unique string of text. Thus any type of data can be hashed without looking into its size or type. The operation of the hash (#) function is given in Fig 6.3.4.

As you can see in the figure while sending the information you have to insert the hash function with the plain text. After the insertion of the hash function, it is converted to another code or hashed text. On the receiving side, the receiver can read the message if he knows the hash code.

6.3.2.3 Availability

Next, we can move on to the last element of Computer Security, Availability.

Suppose, you need to access the bank server for the repayment of your loan. But a hacker has attacked the server and put it down. As you are an authenticated user you cannot access the bank server and the payment has not been made. This example shows the unavailability to access the server.

Availability denotes the capability to access the data of a resource when it is needed. That means the data should be accessed only by the right person at the right time depending on the availability of data. Sometimes, if a server is attacked, you cannot access the data at the right time.

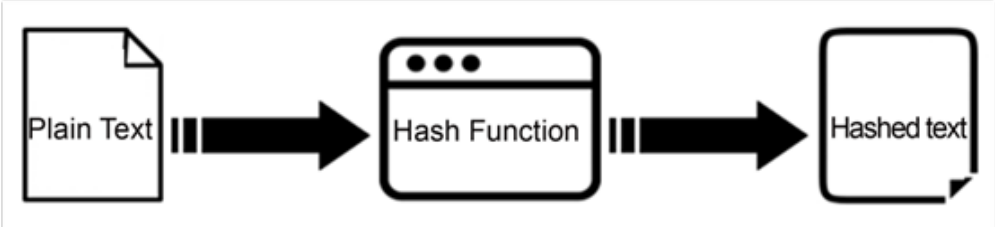


Fig. 6.3.4 Operation of Hashing

6.3.3 Computer Security - Terminologies

In the previous section, you have learned the elements of Computer Security. In this section, we are going to study the different terminology used in Computer Security. They are given below:

- Unauthorized access
- Hacker
- Threat
- Vulnerability
- Attack
- Antivirus
- Virus
- Social Engineering
- Firewall

Unauthorized access refers to the accessing of a server, website, or other sensitive data without the owner's knowledge. Hacker is a person who attempts to exploit a computer system for money, a social cause, fun, etc. The threat is an action or event that might effect computer security.

Vulnerability is the flaw or weakness in a computer system or network that causes damage or allows an attacker to manipulate the system. This may lead to an unexpected and undesirable event regarding the security system. The attack is an assault on the computer system security, that is delivered by a person or a machine to a system and violates security. An antivirus is software that operates on different OS which is used to prevent malicious software.

The virus is malware that installs on your computer without your permission for performing damage to files and computer systems. Social Engineering is a method by which the hacker tries to steal data from a person for different purposes by psychological manipulation. A firewall is a software or hardware which is used to filter network traffic based on rules.

6.3.4 Malware

You have already studied Computer Security, its elements, and terminologies.

You are using computers in your daily activities. Sometimes, your system has been attacked with malicious software or viruses. Have you ever thought of those malicious programs that attacked your

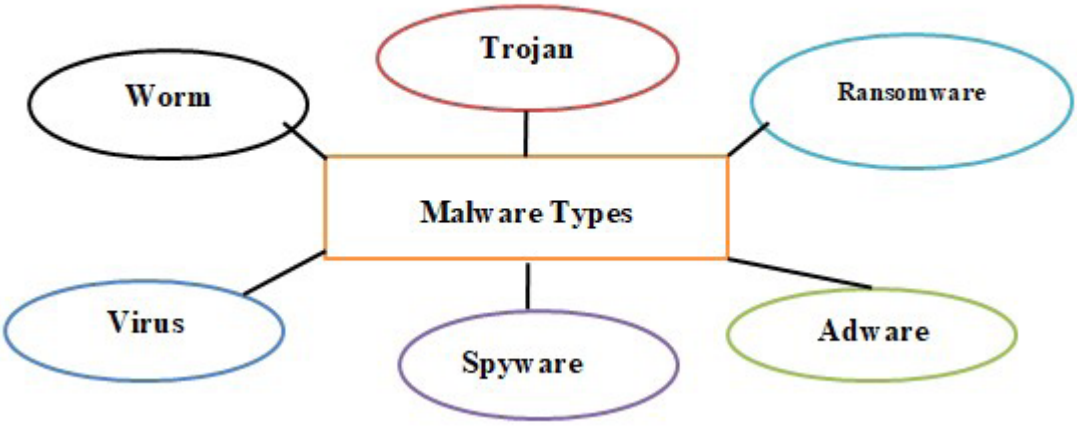


Fig. 6.3.5 Malware Types

system? They are called malware.

We can discuss, what is malware? Malware or malicious software is the collective name of viruses, ransomware, worms, Trojans, adware, spyware, and other harmful computer programs or software. It consists of unwanted programs or code developed by cyber attackers or hackers. These programs can cause severe damage to data and systems or gain unauthorized access to a network to obtain sensitive information. Malware is typically delivered in the form of a link or file over the Internet and requires the user to click on the link or open the file to execute the malware and cause destruction to the system.The different types of malware are given in Fig 6.3.5.

1. Virus, which is the type of malware that inserts itself into the code of another standalone program and then forces that program to take malicious action and spread itself to perform destruction to the computer system.

2. Malware that you have to focus on is the worm. It refers to a standalone malicious software that replicates itself and spreads from computer to computer.

3. Trojan is a malicious program or code that looks legitimate but can take control of your computer systems. The Trojan acts like authentic software and tricks the user to install it on the computer. Once installed, a Trojan can perform its action to damage and spread.

4. Ransomware, a malicious software that tries to encrypt your hard drive's files and demands a payment, in exchange for the decryption key.

5. Adware is a malicious code that forces your browser to redirect to web advertisements, which often themselves seek to download further, even more, malicious software.

6. Spyware is a malicious code used to secretly gather data without the knowledge of the user. It spies the sensitive data on your computer and sends it to third parties.

6.3.5 Computer Virus

In the previous section, you have got an idea about malware. In this section, we are going to understand in detail about Computer viruses.

You must have heard of coronavirus and the impact of this virus on the whole world. When it is affected to a person, it causes destruction to the victim as well as spread to other people. Likewise, when a computer is affected by a computer virus, it affects that computer and spreads to other computers.

How does a computer virus attack? Once a virus successfully attaches to a program file or document, it will stay inactive until the execution of the infected program. When a virus causes infection to a single computer, it can infect other computers on the same network. Other functions of the virus include stealing of passwords, corruption of files, spamming your email contacts, erasing data, or causing permanent damage to your hard disk.

How do computer viruses spread? They spread through email attachments, Internet file downloads, and links of social media scams.

What are the signs of a computer virus? We can see the below symptoms if a computer is affected by a computer virus.

- Repeated pop-up windows
- Blue screen errors
- Changes the homepage
- Bulk emails sent from your email account to other accounts

- Repeated crashing of the system
- Some files may be missing
- Unusual slow computer performance
- Unknown programs startup when you turn on your computer
- Unusual activities like password changes
- Disabling of security software

6.3.6 Types of Computer Viruses

In the previous section, you learned about the attack, spread, and signs of a computer virus affecting the computer.

6.3.6.1 Boot Sector Virus

First of all, we shall discuss the boot sector virus. It copies the virus code in the boot sector of the disk and can take control when you start or boot your computer. Do you know, the boot sector is a dedicated section of a hard disk or other storage devices that contain data used to boot a computer system? Once the virus is loaded into the hard disk, it infects other files. This virus spreads by inserting an infected USB drive into your computer.

Imagine your pendrive is infected with Boot Sector Virus and your computer is not. You insert the pen drive into your computer and switch it on. What will happen? During the booting of your computer, the virus code will affect the boot sector of the disk causing damage to the system.

6.3.6.2 Web Scripting Virus

This is the second type of virus you have to study. This virus affects your web browsers and web pages.

Assume that you are accessing a shopping website. The webpage you have searched is affected by Web Scripting Virus. Is there any problem that will affect your computer? Yes, the virus from the webpage will infect your computer.

Web Scripting Virus program tries to exploit the code of web browsers and web pages. If you access such a web page, the virus can infect your computer.

6.3.6.3 Browser Hijacker

Imagine that your browser is affected by the Browser Hijacker virus. Without knowing about it, you start browsing an insurance webpage. On the webpage, you see an advertisement for money-making. When you click on the link, you are redirected to an unwanted site, thus losing your personal information.

A browser hijacker is a virus that modifies your web browser's settings without your permission. The result is the placement of unwanted advertising into your browser, and possibly the replacement of an existing home page or search page with the hijacker page. The idea is to take you to visit certain websites whether you want to or not thereby stealing sensitive data.

6.3.6.4 Resident virus

Now, it is time to understand, what is a resident virus? It is a type of computer virus that stores or inserts itself in a computer memory even after the originally infected program stops running or is terminated. Being stored in memory, the virus can easily spread as it has more access to other parts of the computer destroying or damaging the whole system.

Suppose, you have realized that your computer browser is infected with a resident virus while installing new software. You suddenly terminate or

uninstall the software, what will happen? After terminating the newly installed software, the resident virus continues to run on the computer and causes damage to the system.

6.3.6.5 Direct Action Virus

Imagine your important file, example.exe is affected by the Direct action virus. Will the virus affect the file? Yes, it will affect the file when it starts executing and makes the file inaccessible to the user.

Direct Action Virus comes into action when you execute a file containing the virus program, otherwise, it remains inactive. This type of virus will mostly attach to the .exe and .com files. While you execute the files, the virus becomes active and starts spreading.Once the files are infected with direct action viruses, you cannot access those files, but it does not delete anything or delay your computer's performance.

6.3.6.6 Polymorphic Virus

Consider your file is infected with Polymorphic Virus and you have a traditional antivirus program installed in your computer. Can the antivirus detect the virus? As the Polymorphic Virus changes the code every time during execution, the antivirus cannot detect it.

A polymorphic virus is a type of computer virus which can create modified versions of the virus itself. That means the virus changes its code each time an infected file is executed. It helps the virus to escape from traditional antivirus and thereby avoid detection.

6.3.6.7 Multipartite virus

Now, we shall move on to the multipartite virus or hybrid virus. This is a dangerous type of virus that attacks both the boot sector and executable files simultaneously. As it affects both the boot sector and the program files simultaneously, it is more dangerous than other kinds of viruses. A multipartite virus contaminates computer systems multiple times and at different times.

6.3.6.8 Macro virus

Finally, we can move on to the last type of computer virus called a macro virus. It is a computer virus written in the macro language that is used by software applications like Microsoft Word and Excel. The virus code is embedded in the document and allows them to run automatically when the documents are open.

6.3.7 Antivirus

In the previous section, we have discussed the different types of computer viruses. Now, it is time to move on to the last topic of this unit, Antivirus.

Antivirus software is a program or set of programs that are designed to prevent, search, detect, and remove malicious software or viruses from your files or computer system.

Why do you need Antivirus Software? As you know, hackers are releasing new types of viruses daily onto the Internet. The computers without antivirus will be infected with the virus while connecting to the Internet. Also, the viruses can be programmed to cause damage to your data or system, prevent you from accessing data, or take control of your computer.

What does antivirus software do? We can discuss the various functions performed by antivirus:

- Scanning of files or directories or external devices for any

malware functions

- Scheduling of automatic scans
- Removal of any malicious programs detected
- Shows the 'health' of your computer
- Parental control of online activities by children
- Act as a firewall
- Manages sensitive information
- Warning about dangerous websites and links
- Protection of online accounts

Recap

- Firewall prevents communications prohibited by the security policies.
- Data Backup is file duplication that recovers data during emergency or loss.
- Spybot removes spyware from the computer system.
- Computer security - protection of data and computer systems from unauthorized use.
- Cryptography alters actual information into different representations.
- Cryptography performs encryption and decryption.
- Computer Vandalism extracts password or sensitive data.
- Confidentiality deals with concealment of information or resources.
- Integrity defines trustworthiness of data in computer systems.
- Availability denotes the capability to access the data of a resource.
- Vulnerability is flaw or weakness in a system or network
- Attack is assault on computer system security
- Social Engineering steals data by psychological manipulation
- Malware - collective name of viruses, ransomware, worms, etc.
- Malware delivered in link or file over Internet
- Trojan - malicious code takes control of computer systems.
- Adware - directs the browser to web advertisements
- Boot sector virus copies the virus code in boot sector of disk
- Web Scripting virus exploits the code of web browsers

- Browser hijacker modifies web browser's settings without permission
- Resident virus inserts itself in computer memory
- Direct action virus attaches to .exe and .com files
- Polymorphic virus creates modified versions of the virus
- Macro virus is written in the macro language
- Antivirus prevents, searches, detects, and removes malicious software or viruses

Objective Type Questions

1. Which type of software prevents communications prohibited by the security policies?
2. How is a spyware removed from the computer system?
3. Which is the process of extracting someone's password or other sensitive data?
4. What deals with the concealment of information or resources?
5. What denotes the trustworthiness of data in computer systems or resources?
6. What is an action or event that might compromise computer security?
7. Who is the person that attempts to exploit a computer system ?
8. What is a malicious program that inserts itself into the code of another standalone program?
9. Which software directs the browser to web advertisements?
10. Which type of malicious software tries to encrypt hard drive's files?
11. Which virus affects web browsers and web pages?
12. What modifies the web browser's settings without permission?
13. What creates modified versions of the virus itself ?
14. Which virus attacks the boot sector and executable files simultaneously?
15. What language is used by Microsoft word?

Answers to Objective Type Questions

1. Firewall
2. Spyware
3. Computer Vandalism
4. Confidentiality
5. Integrity
6. Threat
7. Hacker
8. Malware
9. Adware
10. Ransomware
11. Web Scripting
12. Browser Hijacker virus
13. Polymorphic virus
14. Multipartite
15. Macro language.

Assignments

1. Define computer security and explain its importance in protecting data and computer systems.
2. Identify and describe the four major threats that affect data and computer systems.
3. Explain the concept of confidentiality in computer security, providing examples to illustrate its importance.
4. Describe the elements of computer security and their significance in safeguarding information and services.
5. Discuss the concept of integrity in computer security, highlighting its role in maintaining the trustworthiness of data.
6. Explain how availability is essential in computer security and its impact on accessing data when needed.
7. Define unauthorized access and its implications for computer security.
8. Describe the role of antivirus software in preventing, detecting, and removing malicious software from computer systems.

9. Discuss the different types of computer viruses and their characteristics, including how they spread and their impact on systems.
10. Explain the significance of firewalls in computer security and how they help prevent unauthorized access to networks.
11. Discuss the term “social engineering” in the context of computer security
12. Describe the measures individuals and organizations can take to enhance computer security and protect against cyber threats.

Suggested Reading

1. Richard B. Levin,The Computer Virus Handbook, McGraw-Hill, 2009
2. Jan Hruska, Computer Viruses and Antivirus Warfare, Ellis Horwood, 1992
3. Schatz, Daniel; Bashroush, Rabih; Wall, Julie, “Towards a More Representative Definition of Cyber Security”. Journal of Digital Forensics, Security and Law, 2017
4. William Stallings, “Cryptography and Network Security: Principles and Practice”, Fifth edition Pearson.
5. Mark Stamp’s Information Security: Principles and Practice by Deven NShah, Wiley Publishers.

Reference

1. https://www.google.co.in/books/edition/Computer_Viruses_and_Malware/xnW-qvk1gzkC?hl=en&gbpv=1
2. https://www.google.co.in/books/edition/A_Pathology_of_Computer_Viruses/_VLmBwAAQBAJ?hl=en&gbpv=1

Latest Trends in Computer Science

Learning Outcomes

After the successful completion of the unit, the learner will be able to:

- study the latest trends in Computer Science
- familiarize the concepts of Virtual Reality and Augmented Reality
- acquire knowledge on Artificial Intelligence and Automation
- attain awareness on the Internet of Things and its applications

Prerequisites

The previous unit dealt with the concepts of Computer Security and Malware. In this section, we can have a look at the latest trends in Computer Science. In today's world, almost all of us use the Internet and Information Technology simultaneously for daily activities in business, education, banking, entertainment, etc. As a result, researchers are trying to make more inventions in the field of IT and Computer Science to ease the living conditions of humans. You must be very curious to know about the latest trends in Computer Science and IT. We will focus on the new trends as given in Fig 6.4.1.

As you can see in the figure 6.4.1, various trends in computer science and IT are given as a diagram. We can discuss the various trends one by one. Virtual Reality (VR) refers to an environment created using computers so that the user can feel they are immersed in the real surroundings with scenes and objects. Augmented reality (AR) is a technology that helps you to superimpose digital content such as images, sounds, text, etc over a real-world environment. Artificial intelligence (AI) speaks of the imitation of human intelligence in machines that are programmed to think like humans and mimic their actions. The Internet of Things, or IoT, describes a system of interrelated and interconnected objects to collect and transfer data over a network without the intervention of humans. Cyber Security relates to the practice of defending computers, networks, and data from malicious electronic attacks. A detailed explanation of the above is given in the succeeding sections.

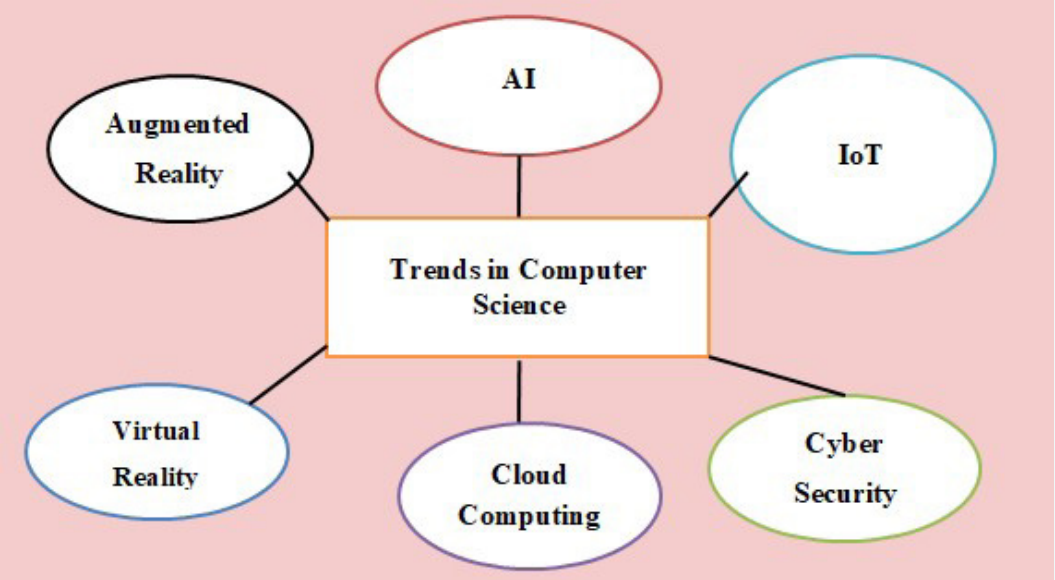


Fig. 6.4.1 Trends in Computer Science

Cloud computing is the on-demand delivery of IT resources over the Internet like data centers and servers, storage, and databases, as per requirement from the cloud provider.

Suppose, you are running a bank and you need an additional server to store the bank details. What are the options you have? One option is to buy a physical server and the other one is to demand a server through a cloud provider. You can choose the second option as it does not require any space in the bank. Example: Amazon Web Services (AWS).

Key Concepts

Virtual Reality, Augmented Reality, Smart Technology, Internet of Things

Discussion

6.4.1 Virtual Reality

As you know Information technology is moving rapidly, new inventions are made according to the needs of the modern world. In this scenario, two technologies have been developed for interacting humans with computers. They are

- Virtual Reality
- Augmented Reality

First of all, we shall discuss Virtual Reality (VR). Do you know what Virtual Reality

actually is ?

Suppose, you are listening to the passing of a train with your headset and your eyes closed. You will feel that the train is passing nearby and you may experience that you are in a railway station. You must note that actually, the physical train is not near but you can experience the passing of the physical train. This example is similar to VR in which you can experience the imaginary or virtual world in your hand.

Virtual Reality helps you create a simulated or virtual environment or an alternate world of reality with the help of Information Technology. Let us go through a few examples. Is it possible to go to Mars, swim with sharks, touch a tiger, etc? The answer is probably not, because these are very difficult tasks. There comes the advantage of VR. Using this technology you can experience these difficult tasks as well as simple tasks while staying at your home. Real Reality means the actual world in which you are living and Virtual Reality means creating an imaginary world like that of the real world.

6.4.1.1 How can you set up VR?

VR can be made possible with the support of computers and sensory equipment like VR headsets and gloves. By using VR technology, you can immerse and interact with the real world instead of viewing a screen in front of you. Accordingly, the user may feel and experience different senses such as vision, hearing, touch, etc. The different applications of VR include 3D movies, video games, education, science, etc. You should know that it is possible to immerse into the VR technology by tracking the user's motions like head and eye movements.

Apart from the above movements, you should adjust the images on the user's display correspondingly to reflect the change in VR. Some of the popular examples of VR technology include HTC's Vive and Sony's PlayStation VR, etc.

Now, we can focus on the setup of VR technology. This can be explained with the diagram as shown in Fig 6.4.2.

The setup diagram consists of:

- A - VR headset
- B - Battery pack (provides battery to the VR headset controller box)
- C - VR headset controller box
- D - Laptop [D]
- E- USB cable (connects battery and controller)
- F-HDMI cable(connects laptop and controller)

From the diagram, you can see that all

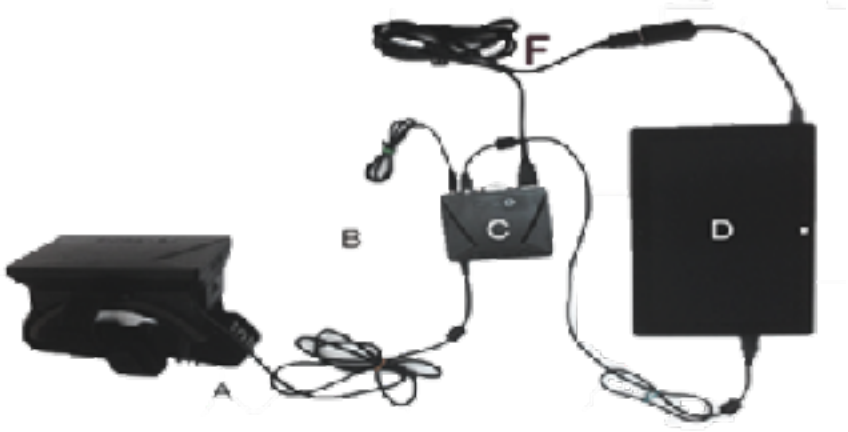


Fig. 6.4.2 Setup diagram of VR

the devices are connected to the VR headset controller box. It controls all the components of the VR setup. First, you have to switch on all the devices and play a video on the laptop. After that, wear the VR headset screen in front of your eyes. This helps to eliminate any interaction with the real world. In VR, two lenses are placed between the screen, you have to adjust the eyes based on the individual movement of the eye and its positioning. The visuals on the screen can be rendered by using an HDMI cable connected to a PC or mobile phone. Try to use goggles, speakers, and handheld wearables to simulate a real-world experience. In virtual reality, you can construct an immersive environment by employing simulations related to video, audio, and haptic (touch) elements

6.4.1.2 What are the Different Types of Virtual Reality?

There are three main types of virtual reality that allow you to transform the world. They are given below:

- Fully-Immersive
- Semi-Immersive
- Non-Immersive

Fully immersive VR helps you to feel the most realistic experience possible, with visual and audio effects. The VR headsets can provide you with high-resolution content with a wide field of view. This is commonly used for gaming and other entertainment purposes.

Semi-Immersive experiences provide users with a partially virtual environment to interact with. This type of VR is mostly used for educational and training purposes with the support of computer graphics and large projector systems.

Non-Immersive VR is very common in your everyday life as an average video game.

6.4.1.3 What are the Benefits of Virtual Reality?

The benefits of Virtual Reality include the following:

- Imparts immersive learning experience
- Creates an interactive atmosphere
- Enhance the working skills
- Creates a realistic environment to explore the world
- Improves easy and comfortable education
- Experiments with an artificial environment

6.4.2 Augmented Reality (AR)

As you have understood, Virtual Reality helps you immerse yourself into the imaginary or virtual world, but in the case of Augmented Reality, it exists in the real world.

Suppose, you got a document and it is difficult to read with normal eyes. How can you read the document? You can use a magnifying glass to read the document or you can take a picture of the document with your smartphone and enlarge the document to see it. From this, we can understand that the viewing experience is enhanced like augmented reality.

Now, we can define, what AR is? AR helps you to generate an interactive experience, where the objects in the real world are enhanced (or "augmented") by digital objects.

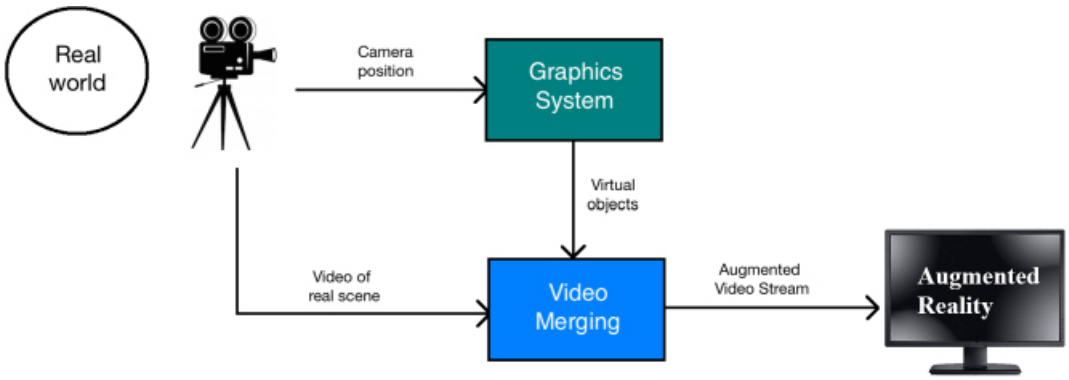


Fig 6.4.3 Working diagram of AR

6.4.2.1 How to set up Augmented Reality?

The AR bridges the gap between the real world and the virtual world. It helps you to bring the elements of the virtual world to the real world to create an artificial environment. In AR, computer-generated elements like image, sound, video, etc. are superimposed on the real world.

Accordingly, it enhances user experience by the way you see, listen, and feel the virtual world. The setup or working diagram of AR is given in Fig 6.4.3.

As you can see, the camera captures and sends the real-world data to video merger. There is a graphics system in which it sends the virtual objects to the video merger. Then the video merger combines the real world and virtual world data and sends it as an augmented video stream to the user. The user experiences AR with the help of the following devices:

- Head Up Display (HUD)
- Smart Glass
- Holographic Display
- Smartphones

HUD helps you to view complex information in a smaller area. Therefore, you can see the displayed information and interact with the real environment. Smart glasses support you to enter into real-world information with a camera attached to them. Holographic displays do not require any wearable device to see the display. Here, the required information is displayed in 3D space. By installing AR applications on Smartphones, you can experience augmented reality.

6.4.2.2 What are the different types of Augmented Reality?

According to how you interact with AR and how the digital information is superimposed on the real world, AR is classified into four types as given below:

- Marker Based AR
- Superimposed AR
- Location Based AR
- Projection Based AR

In the case of Marker Based AR, you can connect the digital world with the real world. Here the visual markers are added in the real world. Example: QR code. In Superimposed or Markerless AR, you can use digital information such as images or virtual objects and superimpose them

on the physical world. Here the user can move virtual objects in the real world.

Location-Based AR utilizes GPS, compass, etc., to provide data based on user location. Example: Google Map. Projection Based AR works with the help of projecting the light on actual surfaces and after that, it senses the human interaction by discriminating the difference between expected and altered projection. Example: Interactive Hologram

6.4.2.3 Benefits of Augmented Reality

The various benefits of Augmented Reality include the following:

- Used in education, healthcare, gaming, etc
- It offers innovation and continuous improvement
- Increases accuracy
- Increases the knowledge and information of user
- Share your experiences over long distances.

6.4.3 Artificial Intelligence (AI) and Automation

The previous two sections dealt with the concepts of VR and AR. In this section, we are going to discuss the role of Information Technology in Artificial intelligence (AI) and Automation.

You have already studied the concept of AI in previous units. Now, we can have a look in detail about AI. The term Artificial Intelligence (AI) was first coined by John McCarty in 1956. He defined AI as the Science and Engineering of making intelligent machines. As you know, AI is a technique of getting machines to work and behave like humans. In the recent past, AI was able to accomplish this by creating machines and robots that are used in a wide range of fields including social media networks, healthcare, automobile, surveillance, education, etc.

Consider, you are searching for some content on Google or Facebook? Have you ever thought about how Google can give you such accurate search results or how your Facebook feed always gives you content based on your interest? The answer to these questions is AI.

Now, we shall have a look at automation. Likewise AI, Automation refers to the production and delivery of goods and services with minimal human intervention. It improves the efficiency, reliability, and speed of many tasks. From the above definitions of AI and Automation, we can see that both are interrelated to each other.

6.4.3.1 How Does Artificial Intelligence Work?

Similar to human intelligence, AI works by taking in large amounts of data, processing it through algorithms that have

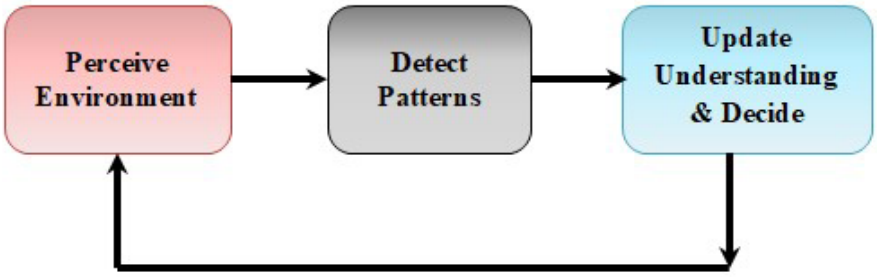


Fig.6.4.4 Working of AI

been adjusted by past experiences, and using the patterns found within that data to improve decision-making. Now, we can discuss the working of AI with a block diagram as given in Fig 6.4.4

As shown in the figure, the first step of the AI process is to perceive the surrounding environment such as data. The next step is to detect the patterns in the environment and the final step is to learn from the detected patterns and update them with experiential memory. Then, these steps are repeated until there is enough data to make confident predictions and support decision-making.

6.4.3.2 What are the Different Types of AI?

As you know, AI is the science of getting machines to mimic the behavior and action of humans. This term can be applied to those machines that exhibit human behaviors with an approach to learning and problem-solving. AI can be classified into 3 types as given below:

- Artificial Narrow Intelligence
- Artificial General Intelligence
- Artificial Super Intelligence

We can move on to the first type, Artificial Narrow Intelligence or, weak AI. It involves applying AI only to specific tasks. Do you know, many currently existing systems that claim to use AI are operating as weak AI focused on a narrowly defined specific problem. Alexa is an example of Narrow Intelligence as it operates within a limited predefined range of functions. There is no genuine intelligence or self-awareness. Other examples are face verification in your smartphone, Google maps, etc.

Now, take a look at the second type, Artificial General Intelligence or strong AI. It comprises those machines having the ability to perform any intellectual task like that of a human being. We have a strong processing unit that can perform high-level computations, but they are yet not capable of thinking and reasoning like a human.

Finally, we can focus on Artificial Super Intelligence or super AI. This is a term that refers to the period in which the capabilities of computers will exceed the abilities of human beings. It is seen as a hypothetical situation as depicted in movies and science fiction books where machines will take over the world.

You have learned the different types of AI. Now, we can have a look at how AI is used in the real world. Google's AI eye doctor is an initiative taken by Google where they are working to develop an AI system that can examine retina scans and identify a condition called diabetic retinopathy which causes blindness. While dealing with social media platforms like Facebook, AI helps you to recognize face verification. Another example is twitter's AI which is used to identify hate speech and terrorist language in tweets.

What are the applications of AI?

As you know, AI technology is emerging everywhere because it can solve complex problems efficiently in multiple industries. The various applications of AI in today's society are given below in Fig 6.4.5.

AI has created a good impact on Health care. For example, Fitbit or an iWatch, is a device that helps you to collect sleep patterns, heart rate, etc. When powered with AI, it is useful for the early detection of diseases. Also, it is helpful to the doctors for making decisions and researching with AI.

In the area of automobiles, AI helps you to create self-driving cars, maps that run on some algorithms. In surveillance, AI has made it possible to develop face recognition tools that may be used for observation and security purposes. While moving on to Social Media, AI helps you to create Intelligence tools that work silently in the background to find your search and browsing history and behavior.

In the area of entertainment, online streaming services rely on the information collected from the users like you. They provide recommendations based upon the previously viewed content. In the education segment, many problems have been solved by the implementation of AI. This helps the teachers to monitor the academic, psychological, mental and physical well-being of the students for their overall development.

However, many AI applications are not perceived as AI because we often tend to think of AI as robots doing different daily activities. But the truth is that AI has found its way into your daily lives as it has become so general and you do not realize it while using AI.

6.4.4 Smart Technology

In the previous section, you have understood the concepts of Artificial Intelligence and automation. In this section, you will get an idea of Smart Technology.

Imagine, you want to control your smart fan with your voice. Is it possible? Yes, it is possible with voice-enabled smart speakers. For example, Amazon Echo is a smart speaker that is designed around your voice. Once it is plugged in, you can operate it entirely using bare hands and thus a smart fan can be operated with your voice command.

You must have heard of smart television, smartwatch, smartphone, etc. Why are we calling it smart or What is Smart Technology? The word "smart" represents "self-monitoring, analysis, and reporting technology". This technology uses Artificial Intelligence and Machine Learning to provide intellectual awareness to objects so that they can perform smartly.

What are the types of Smart Technology?

Do you know, the types of smart technology are divided into three kinds:

- Internet of Things (IoT) devices
- Smart Connected Devices
- Smart Devices

Internet of Things (IoT) devices are a

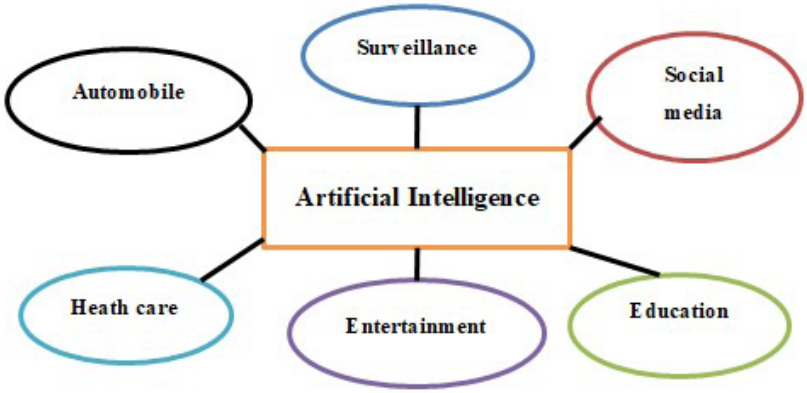


Fig. 6.4.5 Applications of AI

network of devices that make use of sensors, gateway, software applications, servers, and user interfaces to bring static physical objects to life. Examples include smart cities, smart homes, etc.

Smart Connected Devices are those devices that can be controlled using remote and smartphones. The devices are usually connected using the Internet or Bluetooth or WiFi.You should note that smart connected devices offer a customized experience but they can not adapt to the extent as IoT devices do. Examples: Smart security cameras, smart bulbs, etc.

Smart Devices are those having only limited automation, do not require Internet connectivity, and programmable nature. Examples: Smart coffee makers

Benefits of Smart Technology

Some of the significant benefits of using smart technology are as follows:

- Easier accessibility
- Ensures Sustainability
- Security
- Efficiency
- Saves Money and Time

6.4.5 Internet of Things

In this previous section, we have mentioned the Internet of Things or IoT under smart technology.Would you like to know about it in detail?

Imagine, your 75-year-old neighbour is a chronic heart patient. The family members need to be alert every time due to this condition. Whether IoT can support the patient or family members? Yes, it can support. The patient should be implanted with a heartbeat monitor using IoT Technology. As we can connect the heartbeat monitor with the smartphone of the neighbor, he regularly gets updates on heartbeat variation and can suddenly take emergency care.

Well, we can talk about IoT. IoT refers to the system of interconnected things like computing devices, mechanical and digital machines, animals, or people. While using IoT technology, things are provided with unique identifiers (UIDs). UID is a unique identification number that is used to recognize things in IoT. It also helps to transfer data over a network without any human-to-human or human-to-computer interaction.

Do you know, what is a thing in the Internet of Things? A thing in the Internet of Things is an implanted pressure monitor, an animal with a biochip, an automobile with sensors to alert the tyre pressure, or any other things that can be able to transfer data over a network

6.4.5.1 How Does IoT Work?

As you are aware that IoT connects more than one device at a time to the Internet by enabling man-to-machine and machine-to-machine interactions. IoT-enabled devices are useful in different areas like business,

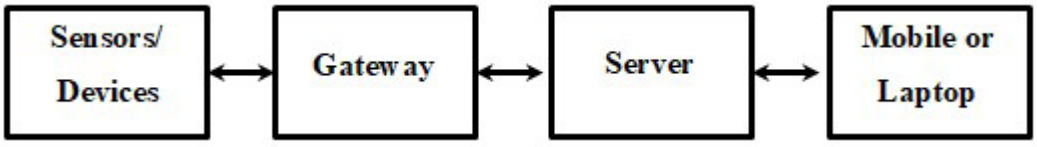


Fig 6.4.6 Working of IoT

home automation, the automobile industry, healthcare, etc. We can discuss the working of IoT with a block diagram as shown in Fig 6.4.6.

As you can see in the figure, it consists of four fundamental components of the IoT system such as sensors, Gateway, Server, and Mobile or laptop.

We can discuss the different steps in the working of IoT. The first step is to collect the data from the surroundings using Sensors or IoT-enabled devices. The data may be in various forms like temperature, pressure, heartbeat, etc. The second step is to send the collected data for processing using a Gateway. The gateway acts as a medium for transport. It includes mobile networks, satellite networks, Wi-Fi, Bluetooth, etc. You should select the networks according to power consumption, range, and bandwidth. So, choosing the best gateway option in the IoT system is important.

The third step is to process the collected information in the server using some data processing software on the acquired data. The final step is to make the processed information available to mobile or laptop. This can be achieved by triggering alarms on their phones or notifying them through texts or emails.

Suppose, you want to water a garden whenever the moisture content of the soil level drops. Is it possible to water the garden using IoT? Yes, it is possible. The sensors installed on the soil sends the moisture data of the soil to the gateway. The gateway collects data and sends it to the server for further processing. When the moisture content falls, it triggers the server (stores the information about the sensor) and turns the sprinkler on for watering the garden. Finally, the detailed report is sent to your mobile phone.

6.4.5.2 What are the Benefits of IoT?

- Ability to access information from anywhere at any time.
- Improved communication between connected devices
- Transferring data over a connected network saving time and money
- Automating tasks helping to improve the quality of a services
- Reduce the need for human intervention

6.4.5.3 What are the Applications of IoT?

The different applications of IoT can be explained with the help of the below Fig 6.4.7. We can have a look at the various applications one by one:

In the area of Consumer Segment, IoT plays a very important role. For example, you can use an IoT system for operating devices like light, fan, switch, air conditioner, television, washing machine, refrigerator, music system, etc, with the help of computers and smartphones.

Another application of IoT is Wearable Devices. For example, a smartwatch can sense pressure, oxygen level, heartbeat, tracking, etc. The sensors used in the device will send data for further processing that make our life easier and more comfortable. Wearable devices are also used for public safety. For example, during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters'.

In the area of healthcare, IoT is offering many benefits such as monitoring patients closely with the help of the generated data, inventory management for both pharmaceuticals and medical instruments, etc.

Smart buildings help you save energy by using sensors that detect how many occupants are in a room. For example, the temperature of the air conditioner can adjust automatically with the help of sensors. That means, it can turn on if the sensors detect a fully occupied conference room or turn it off in an empty space.

In Agriculture, IoT-based smart farming systems help you to monitor light, temperature, humidity, and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a Smart City, IoT sensors and deployments help to control smart streetlights and smart meters. It also helps to reduce traffic, preserve energy, monitor and address environmental problems, and improve sanitation.

Generative AI is a bit like a super-smart artist in the digital world. It learns from tons of examples pictures, stories, poems, you name it and then starts making its own creations. Think of it as a magical machine that can create new pictures, write fresh stories, or even craft videos. For example, it studies lots of cat pictures to learn how to draw realistic cats. Then, when we ask it to draw one, it comes up with a cat from thin air! However, it's essential to be aware that sometimes it can create things that aren't real, like fake news, fake pictures or fake diagnoses, so we've got to be careful how we use them. Some cool examples of GEN AI applications include ChatGPT for chatting, DALL·E for image generation, and GPT-3 /GPT4 for text generation/ summarisation.

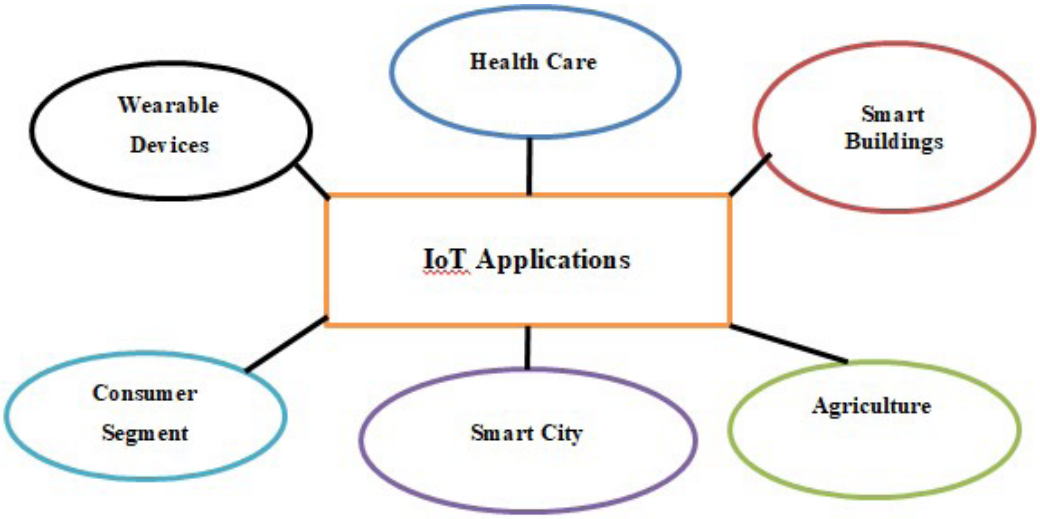


Fig. 6.4.7 IoT Applications

Recap

- Amazon Web Services is a cloud service provider
- Virtual Reality creates an alternate world of reality
- Fully immersive VR provides most realistic experience
- Semi-Immersive VR provides partially virtual environment
- AR generates interactive experiences enhanced by digital objects.
- HUD shows complex information in a smaller area
- Marker Based AR connects digital world with real world
- AI - first coined by John McCarty in 1956
- AI - Science and Engineering of making intelligent machines
- Automation- production and delivery of goods and services with minimal human intervention
- Artificial Narrow Intelligence operates within limited predefined range of functions
- Artificial General Intelligence performs any intellectual task like human being
- Artificial Super Intelligence seen as hypothetical situation in movies and science fiction books
- Fitbit or an iWatch, collect sleep patterns, heart rate, etc.
- Smart Technology uses Artificial Intelligence and Machine Learning
- Internet of Things (IoT) bring static physical objects to life
- Smart Connected Devices controlled using remote and smartphones
- Smart Devices are those having only limited automation
- UID is a unique identification number used to recognize IoT
- IoT enables man-to-machine and machine-to-machine interactions.
- Smart- Self Monitoring, Analysis, and Reporting Technology

Objective Type Questions

1. Which is a computer-generated environment that appears to be real?
2. How can we superimpose digital content over a real-world environment?
3. Which VR feels like the most realistic experience?
4. Which is used for displaying the required information in 3D space?
5. How can we show complex information in a smaller area?
6. What is the science and engineering of making intelligent machines called?
7. Who coined the term Artificial Intelligence?
8. What refers to the production and delivery of goods and services with minimal human intervention?
9. Which AI performs intellectual tasks like human beings?
10. Which is an initiative by Google to identify diabetic retinopathy?
11. What are the techniques used in smart technology
12. Which brings static physical objects to life?
13. What is the identification number used to recognize things in IoT?
14. What are the devices in an IoT system to collect data?
15. What enables man-to-machine and machine-to-machine interactions?

Answers to Objective Type Questions

1. Virtual Reality
2. Augmented reality
3. Fully immersive
4. Holographic display
5. HUD
6. Artificial Intelligence
7. John McCarty
8. Automation
9. Strong
10. Google's AI eye doctor
11. AI, ML
12. IoT
13. UID
14. Sensors
15. IoT

Assignments

1. Define Virtual Reality (VR) and explain how it creates simulated environments using computer technology.
2. What are the three main types of Virtual Reality, and how do they differ in providing immersive experiences?
3. Discuss the benefits of Virtual Reality, highlighting its applications in various fields such as education, gaming, and training.
4. Define Augmented Reality (AR) and explain how it enhances the real-world environment with digital content.
5. Describe the setup of Augmented Reality, including the devices involved and how digital elements are superimposed onto the real world.
6. What are the four types of Augmented Reality, and how do they differ in their approach to overlaying digital information?
7. Discuss the benefits of Augmented Reality, citing examples of its applications in different industries.
8. Explain the concept of Artificial Intelligence (AI) and its role in mimicking human intelligence in machines.
9. Describe how AI works, including the process of perceiving the environment, detecting patterns, and learning from data.
10. What are the four types of AI, and how do they differ in their capabilities and applications?
11. What do you know about Generative AI?

Suggested Reading

1. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC Press, 2011
2. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, John Wiley & Sons, 2003
3. Raymond Hughes, Augmented Reality: Developments, Technologies and Applications, Nova Science Publishers, 2015
4. W A Bullough, Keith Worden, J Haywood, Smart Technologies, World Scientific, 2003
5. Jamil Y. Khan, Mehmet R. Yuce, Internet of Things (IoT): Systems and Applications, CRC Press, 2019
6. Tedre, M. "Computing as a Science: A Survey of Competing Viewpoints". Minds and Machines. 21 (3): 361–387, 2011

Reference

1. https://books.google.co.in/books?id=5YM0DwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2. https://books.google.co.in/books?id=9GQ0BwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

MODEL QUESTION PAPER- SET- I

SREENARAYANAGURU OPEN UNIVERSITY

QP CODE: …… **Reg. No : .....**

Name : …….....

End Semester Examination 2024

BACHELOR OF COMPUTER APPLICATION

B21CA01DC

INTRODUCTION TO INFORMATION TECHNOLOGY

Time: 3 Hours **Max Marks: 70**

Section A

Answer any ten questions. Each carries one mark

1. Which device is commonly considered the brain of the computer?
2. Give two examples of input and output devices each.
3. Which device gives the user the result or processed data?
4. How many bytes is 1KB?
5. What is the fullform of RISC and CISC?
6. Name four phases of the instruction cycle.
7. What is the other name of a folder?
8. What is the test conducted during booting?
9. What provides a systematic way to organise files?
10. What does LAN stand for?
11. Which topology connects all nodes to a central connection point?
12. What type of transmission medium uses a physical channel?
13. Who provides internet service to home or office?
14. Which technology uses light for data transmission?
15. What is the combination of hypertext and markup language called?

(10 x 1 = 10 Marks)

Section B

Answer any five questions. Each carries two marks

16. Define Von-Neumann architecture.
17. Draw the block diagram of a digital computer.
18. What are the various types of RAMs?
19. What are the basic operations in a memory unit?
20. Define hit-ratio with its expression.
21. What is the basic use of software utilities? List any two software utilities.
22. Illustrate software layers with a diagram.
23. List various types of Internet connections.
24. Discuss the peer-to-peer operating system.
25. Demonstrate the concepts of HTML links with an example.

(5 x 2 = 10 Marks)

Section C

Answer any five questions. Each carries four marks

26. Discuss various digital codes.
27. Describe briefly the basic concepts of hardware, software, firmware and liveware.
28. Compare application software and system software.
29. What are the two major operations in memory? Discuss them in detail.
30. Differentiate compiler and interpreter.
31. Compare high-level and low-level languages.
32. Compare switch and bridge.
33. Demonstrate the basic model of a computer network with a diagram.
34. What is a URL? Explain different parts of the URL with the help of a labelled example.
35. Differentiate static and dynamic websites.

(4 x 5 = 20 Marks)

Section D

Answer any two questions. Each carries fifteen marks

36. Briefly explain various number systems with examples.
37. What is cache memory? What are the various types of cache memory? List the advantages and disadvantages of Cache memory.
38. Describe different types of operating systems.
39. Discuss different types of Network topologies.

(2 x 15 = 30 Marks)

MODEL QUESTION PAPER- SET- II

SREENARAYANAGURU OPEN UNIVERSITY

QP CODE: …… **Reg. No : .....**

Name : …….....

End Semester Examination 2024

BACHELOR OF COMPUTER APPLICATION

B21CA01DC

INTRODUCTION TO INFORMATION TECHNOLOGY

Time: 3 Hours **Max Marks: 70**

Section A

Answer any ten questions. Each carries one mark

1. List the classification of computers based on operating principles.
2. What type of storage device is a hard disk drive?
3. What is the full form of BCD?
4. What is the location of the internal registers of the CPU?
5. What is the primary function of the accumulator register?
6. What is the use of a program counter?
7. Word processor belongs to which category of software?
8. List any two features of system software.
9. Give two basic functions of application software.
10. Which type of network is limited to a building?
11. What does WAN stand for?
12. Name the application used for accessing websites.
13. What defines the structure of web pages?
14. Name any two categories of HTML documents.
15. Which element is the root of an HTML document?
16. What is the combination of hypertext and markup language called?

(10 x 1 = 10 Marks)

Section B

Answer any five questions. Each carries two marks

17. Draw an 8-bit pattern and mark the Most Significant Digit and Least Significant Digit in it.
18. Give two examples of primary memory and secondary memory each.
19. Compare and contrast SRAM and DRAM.
20. Outline the general instruction format with an example.
21. Explain various types of computer memory with their properties.
22. List the advantages of DBMS.
23. Compare application and system software.
24. Discuss the client-server network operating system.
25. What is an ISP and what are the different services offered by ISP?
26. List the elements of the head tag in an HTML document with syntax.

(5 x 2 = 10 Marks)

Section C

Answer any five questions. Each carries four marks

27. Explain the functions of input and output devices with a few examples.
28. Distinguish between the following computing devices: Notebook computers, supercomputers, wearable computers, and personal computers.
29. Discuss CISC and RISC architecture.
30. Define computer memory and explain its structure with a diagram.
31. Explain different types of programming languages.
32. Discuss the functions of virtual memory.
33. Compare hub and repeater.
34. Discuss peer-to-peer and client-server network operating systems.
35. Explain the types of HTML lists with syntax.
36. Describe the steps for creating a website.

(4 x 5 = 20 Marks)

Section D

Answer any two questions. Each carries fifteen marks

37. Discuss different types of computing systems.

38. Describe common types of optical media.

39. a) Explain the tiered architecture of software (9 marks)

    b) Describe the booting process in a computer and explain different types of booting (6 marks)

40. Discuss different types of Internet Connections.

(2 x 15 = 30 Marks)

സർവ്വകലാശാലാഗീതം

വിദ്യയാൽ സ്വതന്ത്രരാകണം
വിശ്വപൗരരായി മാറണം
ഗ്രഹപ്രസാദമായ് വിളങ്ങണം
ഗുരുപ്രകാശമേ നയിക്കണേ

കൂരിരുട്ടിൽ നിന്നു ഞങ്ങളെ
സൂര്യവീഥിയിൽ തെളിക്കണം
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INTRODUCTION TO INFORMATION TECHNOLOGY

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