MACHAKOS UNIVERSITY

CENTRE FOR OPEN, DISTANCE AND e-LEARNING

IN COLLABORATION WITH

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

MODULE

SCO 100: FUNDAMENTALS OF COMPUTING

Written by:

Eng. Weramwenja, Raphael Kaibiru, Dr. Erick Omuya, Dr. Mwaniki, Eng. Kilungu, Eng. Carol Mwende

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COURSE OUTLINE

Course Purpose

This course unit is intended to equip the student with the history of computers, basic aspects of the different types and the appropriateness of use of computers in solving of business problems.

Expected Learning Outcomes of the course;

At the end of the unit the student should be able to:

i. Explain the basic principles of computer communication through number systems, data representations and computer networks.
ii. Discuss the evolution of computers, its different parts and integration.
iii. Explain the functioning of the CPU
iv. Explain various types of computer memories
v. Assemble and disassemble computers parts. And troubleshoot basic computer problems and install operating system.
vi. Explain career and certifications in computer science.

Course Content

LECTURE 1: INTRODUCTION TO COMPUTERS

- Definitions and terminologies
- Computer systems
- Components of a computer

LECTURE 2: HISTORY AND CLASSIFICATION OF COMPUTERS

- Introduction
- History of computing
- Classification of computers
- Application of computers

LECTURE 3: COMPUTER INPUT DEVICES

- Human data entry devices
- Pick data entry devices

LECTURE 4: COMPUTER OUTPUT DEVICES

- Hardcopy devices
- Softcopy devices

LECTURE 5: COMPUTER SOFTWARE

- System software
- Application software
- Utility Programs

LECTURE 6: CONTINUOUS ASSESSMENT TEST 1 (CAT 1)

Test the covered topics

LECTURE 7: PRIMARY MEMORY

- Introduction
- Primary memory
- Primary memory-RAM, DRAM, SRAM, ROM, EPROM, EEPROM etc

LECTURE 8: SECONDARY MEMORY

- Introduction
- Secondary memory
- Secondary memory- Hard disk, CD-ROM etc.

LECTURE 9: DATA REPRESENTATION (NUMBER SYSTEM)

- Introduction to number systems
- Decimal number systems
- Binary Number system
- Octal number system
- Hexadecimal Number System

LECTURE 10: NUMBER SYSTEM CONVERSION

- Introduction to number conversions
- Conversion of decimal to binary, octal and Hexadecimal

LECTURE 11: FRACTIONAL NUMBER SYSTEM CONVERSION

- Conversion of fractional decimal to fractional binary, fractional octal and fractional hexadecimal.
- Conversion of Hexadecimal, Octal, Binary to decimal

LECTURE 12: INTRODUCTION TO THE INTERNET AND WWW

- Introduction to internet and WWW
- History of internet and www
- Services of internet
- Email communication

LECTURE 13: CAREERS AND CERTIFICATION IN COMPUTERS

- Careers in computing
- Certification in computing

LECTURE 14: CONTINOUS ASSESSMENT TEST 2 (CAT 2)

LECTURE 15: PURCHASING A COMPUTER

- Factors to consider when purchasing a computer

COURSE REQUIREMENT

Students are expected to:

1. Do proper semester registration.
2. Obtain login credentials from ODEL Centre to enable them to access the unit online.
3. Log in to the online unit.
4. Actively participate in the online lectures.
5. Actively participate in ALL e-activities in each lecture.
6. Attempt self-test activities provided at the end of each lecture.

MODE OF DELIVERY

Lectures, practical and tutorial sessions, exercises in Computer Laboratory, individual and group assignments/ online classes.

INSTRUCTIONAL MATERIALS AND EQUIPMENT

Overhead projector and computer, hand– outs, white boards, Textbooks

Online Platform (Bigblue button, LMS)

COURSE ASSESSMENT

1. Continuous Assessment (E-tivity, Assignments 20%, Practical 20%) 40%
2. End of Semester Examination 60%

LECTURE ONE: INTRODUCTION TO COMPUTERS AND COMPUTER SYSTEMS

1.1 Introduction

Computers have become part and parcel of human life. Currently almost every person-literate or illiterate is using computers from the most sophisticated to the simplest form. In this lecture, we shall introduce ourselves to the field of computing and get to learn the foundational concepts in computing.

In this lecture, you will cover the following:

1. Learning outcomes
2. Definition of key terms in computers
3. Characteristics of computers
4. Generations of computers
5. Classifications of computers
6. Areas of Computer Application in the society
7. Summary
8. Areas of further study
9. Reference

1.2 Expected Learning Outcomes

At the end of this lecture the student should be able to:

i. Define a computer
ii. Explain characteristics of a computer
iii. Discuss various computer generations and their special features
iv. Classify computers based on processing speed, memory capacity and size
v. Discuss areas of computer applications in the society.

1.3 Definition of computer and related key terms

What is a computer?

Computer is an ***advanced electronic device*** that takes **raw data as input** from the user and ***processes these data*** under the control of set of instructions (called program) and ***gives the result*** (output) and ***saves output*** for the future use. It can process both numerical and non-numerical (arithmetic and logical) calculations.
A computer has four functions:
Accepts data----------**inputs**
Processes data----------**Processing**
Produces outputs----------**Output**

Stores results----------**Storage**

Inputs: Input is the raw information entered into a computer from the input devices. It is the collection of letters, numbers, images etc.

Processes: Process is the operation of data as per given instruction. It is totally an internal process of the computer system.

Output: Output is the processed data given by computer after data processing. Output is also called result. We can save these results in the storage devices for the future use.

Information: This is processed data out of which meaningful decisions can be made. Computers work alongside knowledge workers or literates users to transform data into information.

Computer Components

Computer is made up of:

- Hardware-Internal and External physical components (inputs, outputs, processing, storage)
- Software (System, utility and application)
- Interconnecting links (Networks)
- People (skilled workers)

Computer Systems: This is the integration of computer hardware, computer software, the interconnecting links for information passage between computers and the people who work with these computers to improve decision making within an organization or for individual use.

E-tivity 1.3.1: Definition of key terms

Numbering, pacing and sequencing	**1.3.1**
Title	**Definition of key terms**
Purpose	The purpose of this e-tivity is to help you learn the definition of key terms in computing.
Summary of overall task	Read the document in the link provided Watch the video on introduction to computers.
Spark	A computer is like a factory.

Individual task	1. Define the term computer 2. Explain the components of a computer
Interaction begins	Post your answers in the discussion Forum 1 Engage by responding to posts from other students in Forum 1.
E-moderator interventions	1. Ensure that learners are focused on the contents and context of discussion. 2. Stimulate further learning and generation of new ideas. 3. Provide feedback on the learning progress. 4. Close the e-tivity
Schedule and time	This task should take one hour for example
Next	Characteristics of computers

1.4 Characteristics of a computer (Advantages of Computers)

Computers have unique characteristics when compared to other electronic devices. These characteristics are speed, accuracy, diligence, storage capability and versatility.

i. High Speed

The computer can process data very fast, at the rate of millions of instructions per second. Some calculations that would have taken hours and days to complete otherwise, can be completed in a few seconds using the computer. For example, calculation and generation of salary slips of thousands of employees of an organization, weather forecasting that requires analysis of a large amount of data related to temperature, pressure and humidity of various places, etc.

ii. Accuracy

Computer provides a high degree of accuracy. For example, the computer can accurately give the result of division of any two numbers up to 10 decimal places. The accuracy is dependent on the input, that is, if the input is correct the output will be accurate. Computers perform all jobs or tasks with 100% accuracy.

iii. Diligence

When used for a longer period of time, the computer does not get tired or fatigued. It can perform long and complex calculations with the same speed and accuracy from the start till the end. Unlike human beings, a computer is free from monotony, tiredness, and lack of concentration. It can work continuously without any error and boredom.

iv. Storage Capability

Large volumes of data and information can be stored in the computer and also retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory. Secondary storage devices like floppy disk and compact disk can store a large amount of data permanently. Memory is a very important

characteristic of computers. A computer has much more storage capacity than human beings and it can store large amount of data.

v. Versatility

Computer is versatile in nature. It can perform different types of tasks with the same ease. At one moment you can use the computer to prepare a letter document and in the next moment you may play music or print a document.

Disadvantages of Computers (Limitations)

Despite the above advantages, computers have limitations.

i. No I. Q

A computer has no intelligence to perform any tasks and therefore, each instruction has to be given to it. This means that a computer cannot make a decision on its own. It cannot perform instructions that it has not been programmed to do.

ii. Dependency

A computer is not an independent machine. It functions as per the user's instruction, thus it is fully dependent on humans. These instructions are the inputs received from the user.

iii. No Feeling

Sometimes human beings make decision, take actions based on their feelings. Unfortunately, computers have no feelings or emotions. Therefore, it cannot make judgment based on feeling, taste, experience and knowledge unlike human.

Despite these drawbacks, computers have become part and parcel of human life and to a greater extent the main driving force to industrial development.

E-tivity 1.4.2: Comparison between Computers and Human

Numbering, pacing and sequencing	**1.4.2**
Title	**Comparison between Computers and Human**
Purpose	The purpose of this e-tivity is to enable the student distinguish between the capabilities of a computer compared to human.
Summary of overall task	1. Watch the video provided to enable you address the spark question.
Spark	A computer is smart but not like human being. Do you agree or disagree?

Individual task	Explain some of the distinguishing features between computers and humans.
Interaction begins	Post your answers in the discussion Forum 2 Engage by responding to posts from other students in Forum 2.
E-moderator interventions	1. Ensure that learners are focused on the contents and context of discussion. 2. Stimulate further learning and generation of new ideas. 3. Provide feedback on the learning progress. 4. Close the e-tivity
Schedule and time	This task should take 30 minutes
Next	Generations of computers

1.5 Generations of Computers (Evolution)

The computer has evolved from a large—sized simple calculating machine to a smaller but much more powerful machine. The evolution of computer to the current state is defined in terms of the generations of computer. Each generation of computer is designed based on a new technological development, resulting in better, cheaper and smaller computers that are more powerful, faster and efficient than their predecessors. Currently, there are five generations of computer.

a) First Generation Computer (1940-1956)

The period of first generation was from ***1940-1956.*** The computers of first generation used ***vacuum tubes*** as the basic components for memory and circuitry for CPU (Central Processing Unit). These tubes, like electric bulbs, ***produced a lot of heat*** and the installations used to fuse frequently. Therefore, they were ***very expensive*** and only large organizations were able to afford it. In this generation, mainly batch processing operating system was used. ***Punch cards, paper tape, and magnetic tape*** was used as input and output devices. The computers in this generation used machine code as the programming language. These computers were very large in size.

The main features of the first generation are:

- Vacuum tube technology
- Unreliable (failed often hence not available when needed)
- Supported machine language only
- Very costly
- Generated a lot of heat
- Slow input and output devices
- Huge size
- Need of AC

- Non-portable
- Consumed a lot of electricity

Some examples of computers in this generation include

- Electronic Numerical Integrator And Calculator (ENIAC)
- Electronic Discrete Variable Automatic Computer (EDVAC)
- UNIVersal Automatic Computer (UNIVAC)
- International Business Machine-701 (IBM-701)
- International Business Machine-650 (IBM-650)

b) Second Generation Computers (1956-1963)

The period of second generation was from ***1956-1963***. In this generation, ***transistors*** were used that were ***cheaper, consumed less power, more compact in size, more reliable*** and ***faster*** than the first generation machines made of vacuum tubes. In this generation, ***magnetic cores were used as the primary memory*** and ***magnetic tape and magnetic disks as secondary storage devices***. In this generation, assembly language and high-level programming languages like FORTRAN, COBOL were used. The computers used batch processing and multiprogramming operating system.

The main features of second generation are:

- Use of transistors
- Reliable in comparison to first generation computers
- Smaller size as compared to first generation computers
- Generated less heat as compared to first generation computers
- Consumed less electricity as compared to first generation computers
- Faster than first generation computers
- Still very costly
- AC required
- Supported machine and assembly languages

Some computers of this generation were:

- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

c) Third Generation Computers (1964-1971)

The period of third generation was from 1964-1971. The computers of third generation used ***Integrated Circuits (ICs***) in place of transistors. A single IC has many transistors, resistors, and capacitors along with the associated circuitry. The IC was invented by Jack Kilby. This development made computers ***smaller in size, reliable, and efficient***. In this generation remote processing, time-sharing, multiprogramming operating system were used. High-level languages (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68 etc.) were used during this generation.

The main features of third generation are:

- IC used
- More reliable in comparison to previous two generations
- Smaller size
- Generated less heat
- Faster
- Few breakdown instances hence lesser maintenance
- Costly
- AC required

- Consumed lesser electricity
- Supported high-level language

Some computers of this generation were:

- IBM-360 series
- Honeywell-6000 series
- PDP (Personal Data Processor)
- IBM-370/168
- TDC-316

d) Fourth Generation Computers (1971-1980)

The period of fourth generation was from 1971-1980. Computers of fourth generation used ***Very Large Scale Integrated (VLSI) circuits.*** VLSI circuits having about 5000 transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers of fourth generation. Fourth generation computers ***became more powerful***, ***compact, reliable, and affordable***. As a result, it gave rise to Personal Computer (PC) revolution. In this generation, time sharing, real time networks, distributed operating system were used. All the high-level languages like C, C++, DBASE etc., were used in this generation.

The main features of fourth generation are:

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PCs
- Very small size
- Pipeline processing
- No AC required
- Concept of internet was introduced
- Great developments in the fields of networks
- Computers became easily available

Some computers of this generation were:

- DEC 10
- STAR 1000
- PDP 11
- CRAY-1(Super Computer)
- CRAY-X-MP(Super Computer)

e) Fifth Generation Computer

The period of fifth generation is 1980-till date. In the fifth generation, VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components. This generation is based on parallel processing hardware and AI (Artificial Intelligence) software. AI is an emerging branch in computer science, which interprets the means and method of making computers think like human beings. All the high-level languages like C and C++, Java, .Net etc., are used in this generation.

AI includes:

- Robotics
- Neural Networks
- Game Playing
- Development of expert systems to make decisions in real-life situations
- Natural language understanding and generation

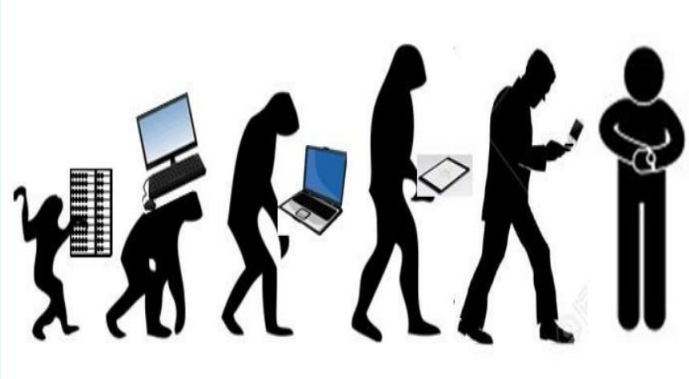
The main features of fifth generation are:

- ULSI technology
- Development of true artificial intelligence
- Development of Natural language processing
- Advancement in Parallel Processing
- Advancement in Superconductor technology
- More user-friendly interfaces with multimedia features
- Availability of very powerful and compact computers at cheaper rates

Some computer types of this generation are:

- Desktop
- Laptop
- NoteBook
- UltraBook
- ChromeBook

E-tivity 1.5.3: Discussion of Evolution of Computers

Numbering, pacing and sequencing	**1.5.3**
Title	Evolution of computers
Purpose	The purpose of this activity is to help the student explain the evolution of computers.
Summary of overall task	Read the document in the provided link and answer questions in the individual task.
Spark	
Individual task	1. How many generations of computers are there 2. Discuss the characteristics of current computers

Interaction begins	Post your answers in the discussion Forum 3 Engage by responding to posts from other students in Forum 3
E-moderator interventions	Ensure that students are within the topic under discussion.
Schedule and time	This task should take one hour
Next	Classification of computers

1.6 Classification of Computers

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

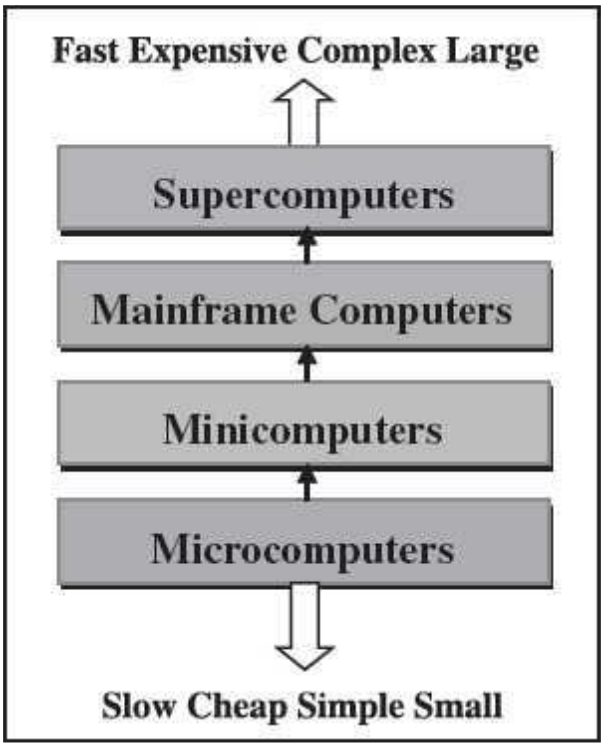


Figure 1: Classification of computers based on size and type

a) Microcomputers

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

b) Minicomputers

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

c) Mainframe Computers

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

d) Supercomputer

Supercomputers are the fastest and the most expensive machines. They have high processing speed compared to other computers. The speed of a supercomputer is generally measured in FLOPS (Floating point Operations Per Second). Some of the faster supercomputers can perform trillions of calculations per second. Supercomputers are built by interconnecting thousands of processors that can work in parallel.
Supercomputers are used for highly calculation-intensive tasks, such as, weather forecasting, climate research (global warming), molecular research, biological research, nuclear research and aircraft design. They are also used in major universities, military agencies and scientific research laboratories. Some examples of supercomputers are IBM Roadrunner, IBM Blue gene and Intel ASCI red. PARAM is a series of supercomputer assembled in India by C-DAC (Center for Development of Advanced Computing), in Pune. PARAM Padma is the latest machine in this series. The peak computing power of PARAM Padma is 1 Tera FLOP (TFLOP).

1.7. Applications of Computers

Computers have proliferated into various areas of our lives. For a user, computer is a tool that provides the desired information, whenever needed. You may use computer to get information about the reservation of tickets (railways, airplanes and cinema halls), books in a library, medical history of a person, a place in a map, or the dictionary meaning of a word. The information may be presented to you in the form of text, images, video clips etc. Detailed discussion on areas of application computers is provided in the following section.

1. Education

Computers have wide range of application within the education.

- Education research- there are electronic journals and books existing in the internet. These material can be read anytime from anywhere enabling students and scholars to research on various areas of interest.
- E-learning can be conducted using CD-ROM, Websites where lecture notes exists in electronic format

- Electronic exams are common application whereby students log on to a specific website and undertake exams online e.g. MCSE, GMAT, GRE etc

2. Security

Computers enable organizations and individuals to improve on security in various ways.

- For example they are used to control access to various rooms or buildings using access control mechanisms such as plastic cards, image recognition, and electronic codes.
- Using CCTVs computers can be used to store images of various occurrences within a building, a room or on roads.
- Computers are also used to program such as metal detectors, smoke detectors, motion detectors and these improve security in organizations by giving early warnings.
- Within the military computers are used to guide and man aircrafts, laser guided missiles.

3. Transport

In the transport industry computers have been used to reduce accident cases and other related eventualities. Areas such as;

- **Fleet management**- Using Global Positioning System (GPS) one can track the car movement of vehicles within country or globally. This enables the fleet managers to organize and schedule their vehicle optimally. Track and Truce,
- **GPS navigation**- aircraft and submarine rely on GPS to identify their exact locations. This way they are able to navigate around obstacles or warn the manager of oncoming obstacle(s).
- **Online transport-** computers can be used for online ticket reservation whereby passengers are able to schedule their trips from their offices.
- Computers are used to control traffic for decongestion purpose and speed control.

4. Entertainment

Computers provide recreational tools both at home and in the office. Users play games, watch movies, and listen to music stored within or from an online source such as Youtube, Netflix etc.

5. Communication

Computers can be interlinked with each other using the telecommunication infrastructure to create a large network of interconnections. This enables people from different locations to use the interconnection to send messages and data to each other. The internet is an example of such an interconnection providing variety of services e.g. ***email.*** This enables user to send data and attached files between each other thereby providing an alternative to the slow courier services.

Teleconferencing, video conferencing and chat facilities enable people to interact online providing immediate responses to request or queries. Using telephone connections, the SMS and voice over internet protocol have become popular means of quick correspondence between communicating parties.

6. Office Use

Computers have changed the way we operate in the office since they are able to store and retrieve data very efficiently.

- Creation of documents using word processor, excel, Power Point, has been made easier since one can retrieve documents and edit them to make them current.
- Using the DBMS data is usually stored in related tables making it easily to be retrieved. Most top management systems rely on database and DBMS software to manage their resources.
- Accounting systems have also been incorporated to assist accountant to perform their work more accurately. The trend nowadays to utilize office application forming the enterprise resource planning modules which have finance components, HR components, Production components and customer relationship modules.
- Computers also provide means to improve designs and models using CAD software. This gives architects room to develop various prototypes that can be approved by their clients.

7. Health

Computers have improve the health industry enabling accurate diagnosis for suffering patients.

- Through X-rays, CT-Scan, Ultrasound, body tissues can be checked for abnormalities e.g. broken bones, internal growth, and health status of the fetus enabling the medic to make appropriate decision about the patients.
- Computers are also used to control life support machines within the ICU. Through them patients in critical conditions can be attended to thereby saving their life.
- Radiology and eye based are mechanisms through which computers based treatment can be implemented.
- The e-doctor program is an online facility which can be used to provide first aid when emergencies occur.

8. Industrial Use

Computers can be incorporated within manufacturing firms to control industrial equipment.

- They are used to control packaging, quality control, simulations and modelling of product.
- Computers are also used to control procedures within dangerous materials handling such as explosives, dangerous chemicals, and dangerous equipment.
- Computer are employed in higher precision areas such chipset manufacturing, molding etc.

E-tivity 1.7.4: Areas of computer application

Numbering, pacing and sequencing	**1.7.4**
Title	**Areas of Computer application**
Purpose	The purpose of this e-activity is to make the student discover other areas of the computer application apart from the ones discussed in this lecture.
Summary of overall task	Read the document in the following link to get more information on areas of computer application.
Spark	

Individual task	1. Explain three areas of computers
Interaction begins	Post your answers in the forum 4 and also respond to at least 3 reactions in the discussion forum 4
E-moderator interventions	Ensure that students are within the topic under discussion.
Schedule and time	This task should take one hour
Next	End the e-tivities

1.8. Further Reading

1. Define the term computer
2. What makes the computer different from human beings?
3. What makes the current computers superior to previous generation computers?
4. Discuss at least five areas of computer application giving relevant examples.

1.9. Summary

In this lecture we have discussed the foundational concept of computers with a focus on defining the computer, characteristics of computers, history and generations of computers, classification of computers and areas of computer application.

1.10. References

Reference Books

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

Core Journals

i. Journal of Computer and System Science. ISSN: 0022-000 https://www.journals.elsevier.com/journal-of-computer-and-system-sciences

ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

Recommended Reference Textbooks

i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.

ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

Lecture 2: Computer Input Devices

Computer Hardware (Input, Output, CPU and Memory)

2.1 Introduction

As discussed in the introduction to computer fundamentals, computer is made up of hardware and software. These two components are interrelated in the sense that hardware depend on software and the reverse is true. Therefore, computer hardware refers to any physical and tangible component either inside or outside the computer. Of importance in computer hardware is the input-output unit, central processing Unit and the Memory.

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

The outline of this lecture is as follows;

i. Introduction
ii. Lecture objectives
iii. Input devices (Human data entry and source data entry devices)
iv. Summary
v. References

2.2 Expected Learning Outcomes

At the end of this lecture the student should be able to:

i. Define input devices

ii. Categorize input devices into their respective classes

iii. Distinguish between human data entry and source data entry devices.

iv. Explain specific areas of each input device.

2.3 Input Devices

Input devices allow users and other applications to input data into the computer, for processing. The data input to a computer can be in the form of text, audio, video, etc. The data is entered manually by the user or with minimal user intervention. Input devices are classified as follows;

a) Human data entry devices

- Keyboard
- Pointing devices—mouse, trackball, joystick, digitizing tablet
- Pick devices—light pen, touch screen

b) Source data entry devices

- Audio input—speech recognition
- Video input—digital camera
- Scanner—hand-held scanner, flat-bed scanner
- Optical Scanner—OCR, OMR, MICR, barcode reader

The input is provided to the computer using an input device, and must be translated to a form that the computer can understand. The translation is done by the input interface of the input device. In addition to the above devices, the input to a computer can also be provided from a storage device on the computer, another computer, or another piece of equipment, such as a musical instrument, thermometer or sensors.

2.4 Human Data Entry Devices

Input devices that require data to be entered manually to the computer are identified as human data entry devices. The data may be entered by typing or keying in, or by pointing a device to a particular location.

a) Keyboard

Keyboard is a common input device. It is provided along with the computer, and is easy to use. It is used for entering the text data. For inputting the data, the user types the data using the keyboard. When the data is being typed, the display monitor displays the typed data. Cursor is a vertical line, an underscore, blinking line, etc. Cursor moves with each typed character. The position of cursor indicates the location on monitor where the typed-in character will be displayed.

The design of a keyboard is similar to a standard typewriter. The modern keyboards are QWERTY keyboard (Q, W, E, R, T, Y are the sequence of keys in top row of letters). Standard keyboard contains 101 keys which are arranged in the same order as a typewriter. The keyboard has five sections

(1) Typing keys (1, 2, 3…, A, B, C…),

(2) Numeric keypad (numeric keys on right side),

(3) Function keys (F1, F2…. on top side),

(4) Control keys (cursor keys, ctrl, alt.…), and

(5) Special-purpose keys (Enter, shift, spacebar…). Some keyboards have 110 keys, where the extra keys are designed to work with the Windows operating system.

Figure 2: Key Board

b) Pointing Devices

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

i. Mouse

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

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

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

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

The mouse can be used in five different ways, as follows—

- ***Pointing*** points to a location or object on the computer screen. Moving the mouse by hand moves the cursor on computer screen. The cursor moves in the direction in which the mouse moves.
- ***Left Click or Click*** means pressing the left button of mouse and releasing it. Clicking is used to select a button, command or icon on the screen.

Right Click involves pressing the right button on mouse and releasing it. Right click displays a menu that contains options like cut, copy, paste, font, paragraph, etc. for the item on which the mouse is pointing.

Double Click means pressing the left button of mouse twice successively, without moving the mouse, and then releasing the mouse. It is used to start a program or open a folder.

Drag and Drop drags an object and drops it at another location. Drag means pointing mouse to an object on screen, pressing the left button of mouse, keeping it pressed and moving the mouse to point to a new location. The object gets dragged to the new location along with the mouse. When the left button of mouse is released, the object gets dropped at the new location. Drag and drop is used for moving folders, files and icons to new locations on the screen.

Figure 3: Mouse

ii. Trackball

Trackball looks like an upside-down mouse. Instead of moving the whole device to move the cursor on computer screen, trackball requires the ball to be rotated manually with a finger. The trackball device remains stationary. The cursor on the computer screen moves in the direction in which the ball is moved. The buttons on trackball are used in the same way as mouse buttons.

Trackball is a device that is a variant of the mouse but has the functionality of mouse. It is easy to use and takes less space than a mouse. Trackball is generally built in laptops since there is no space for the mouse to move on the lap. Trackballs come in various sizes—small and big.

Figure 4: Trackball

iii. Joystick

It is a stick with its base attached to a flexible rubber sheath inside a plastic cover. The plastic cover contains the circuit that detects the movement of stick and sends the information to computer. The position of the stick movement is given by the x and y coordinates of the stick.

Joystick is a device, which is commonly used for playing video games. Joystick is mainly used to control the speed of the cursor and is thus popular in games involving speed like racing and flying games. The direction of push of the stick and the amount of deflection determines the change in position and the change in speed, respectively.

Figure 5: Joystick

iv. Digitizing Tablet

It is an input device used primarily to input drawings, sketches, etc. Digitizing tablet is used for Computer Aided Design (CAD) for the design of buildings, automotive designs, and designing of maps, etc.

Digitizing tablet consists of two parts—electronic tablet and pen. The electronic tablet is a flat bed tablet. The pen looks like a ball pen but has an electronic head. The pen in moved on the tablet. Each position on the tablet corresponds to a fixed position on the screen. Drawings can be made on the tablet using a pen, and is provided as input to computer, where, a location on the tablet corresponds to a specific location on the screen.

Figure 6: Digitizing Tablet

c) Pick Devices

Pick devices are used for providing input to the computer by pointing to a location on the computer monitor. The input data is not typed; the data is entered by pointing the pick device directly on the computer screen. Light pen and touch screen are some common pick devices.

i. Light Pen

It is a light sensitive pen-like input device and is used to select objects directly on the computer screen. It is used for making drawing, graphics and for menu selection. Figures and drawings can be made by moving the pen on computer screen.

The pen contains a photocell in a small tube. When the pen is moved on the screen, light from the screen at the location of pen causes the photocell to respond. The electric response is transmitted to the computer that can identify the position on screen at which the light pen is pointing.

Figure 7: Light Pen

ii. Touch Screen

It is an input device that accepts input when the user places a fingertip on the computer screen. The computer selects the option from the menu of screen to which the finger points. Touch screen are generally used in applications like Automated Teller Machine (ATM), public information computers like hospitals, airline reservation, railway reservations, supermarkets, etc.

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

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

E-tivity 2.4.1: Input Devices

Numbering, pacing and sequencing	2.4.1
Title	Identification of input devices

Purpose	The purpose of this e-tivity is to introduce you to various input devices and how they are used
Summary of overall task	Access the material in this link. Watch and listen to the video.
Spark	Like a factory computers need assistive devices to provide raw data to the computer
Individual task	1. What is the purpose of input devices in computers? 2. Differentiate between human data entry and source data entry devices.
Interaction begins	Post your responses in the comment section and respond to other comments from your class members in forum 5
E-moderator interventions	1. Ensure that learners are focused on the contents and context of discussion. 2. Stimulate further learning and generation of new ideas. 3. Provide feedback on the learning progress. 4. Close the e-tivity
Schedule and time	This activity will take 1 hour to complete
Next	Output devices

2.5 Source Data Entry Devices

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

a) Audio Input Devices

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

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

The computer can be operated using voice commands. The user can dictate the commands to the computer, instead of typing them. The computer has to be trained to recognize the voice of user using the speech patterns and pronunciation of words. The system thus adapts to the voice of user. Speech recognition systems are costly and difficult to develop. They are generally used by people who have difficulty in typing, people with disabilities or by corporate world for dictation. Audio input can be recorded on an mp3 recorder and provided as an input to computer. Open source software like Audacity is used for recording and editing of audio files.

b) Video Input Device

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

Digital camera works like video camera but can capture still images. The digital camera digitizes images, compresses them and stores them on a memory card like flash memory. The information from the digital camera can be brought into the computer and stored.

c) Optical Input Devices

Optical input devices allow computers to use light as a source of input. Scanner is an example of optical input device. Other common optical input devices are magnetic ink character reader used for Magnetic Ink Character Recognition (MICR), optical mark reader used for Optical Mark

Recognition (OMR), optical character reader for Optical Character Recognition (OCR) and Barcode Reader.

i. Scanner

Scanner is an input device that accepts paper document as an input. Scanner is used to input data directly into the computer from the source document without copying and typing the data. The input data to be scanned can be a picture, a text or a mark on a paper. It is an optical input device and uses light as an input source to convert an image into an electronic form that can be stored on the computer. Scanner accepts the source paper document, scans the document and translates it into a bitmap image to be stored on the computer. Scanners come with utility software that allow the stored scanned documents to be edited, manipulated and printed. Hand-held scanner and flat-bed scanner are the two common types of scanners.

- ***Hand-held Scanners*** are portable and are placed over the document to be scanned. They consist of light emitting diodes. The scanned documents are converted and stored as an image in the computer memory. Hand-held scanners have to be moved at a constant speed over the document to be scanned, to get good quality scans. They are preferably used for low volume of documents, small pictures or photos. They are difficult to use if there is a need to scan a full page document. Some of the documents that are primarily scanned using hand-held scanners are price tags, label and ISBN number on books.
- ***Flat-bed Scanners*** provide high quality scan in a single pass. It is a box shaped machine similar to a photocopy machine and has a glass top and a lid that covers the glass. The document to be scanned is placed on the glass top, which activates the light beam beneath the glass top and starts the scan from left to right. They are largely used to scan full page documents.

Optical Character Reader (OCR)

OCR is a technique for the scanning of a printed page, translating it, and then using the OCR software to recognize the image as ASCII (American Standard Code for Information Interchange) text that is editable. OCR uses optical character reader for recognition. The optical character reader stores the scanned image as bitmap image which is a grid of dots. Thus, you cannot edit the text that has been scanned. To edit the scanned text, you need OCR software. The OCR software translates the array of dots into text that the computer can interpret as words and letters. To

recognize the words and letters of text, the OCR software compares the pattern on the scanned image with the patterns stored inside the computer. The text files generated via OCR can be stored in different formats.

Magnetic Ink Character Reader (MICR)

MICR is used in banks to process large volumes of cheques. It is used for recognizing the magnetic encoding numbers printed at the bottom of a cheque. The numbers on the cheque are human readable, and are printed using an ink which contains iron particles. These numbers are magnetized. MICR uses magnetic ink character reader for character recognition.

When a cheque is passed through Magnetic Ink Character Reader, the magnetic field causes the read head to recognize the characters or numbers of cheque. The readers are generally used in banks to process the cheques. The numbers in the bottom of the cheque include the bank number, branch number and cheque number. The reading speed of MICR is faster than OCR.

Optical Mark Recognition (OMR)

OMR is used to detect marks on a paper. The marks are recognized by their darkness. OMR uses an optical mark reader to read the marks. The OMR reader scans the forms, detects the mark that is positioned correctly on the paper and is darker than the surrounding paper, and passes this information to the computer for processing by application software. For this, it uses a beam of light that is reflected on the paper with marks, to capture presence and absence of marks.

OMR is widely used to read answers of objective type tests, where the student marks an answer by darkening a particular circle using a pencil. OMR is also used to read forms, questionnaires, order forms, etc

Barcode Reader

Barcodes are adjacent vertical lines of different width that are machine readable. Goods available at supermarkets, books, etc. use barcode for identification. Barcodes are read using reflective light by barcode readers. This information is input to the computer which interprets the code using the spacing and thickness of bars. Hand-held barcode readers are generally used in departmental stores to read the labels, and in libraries to read labels on books.

Barcode readers are fast and accurate. They enable faster service to the customer and are also used to determine the items being sold, number of each item sold or to retrieve the price of item.

2.6 Further Reading

i. What is a peripheral device?

ii. Discuss the difference between human entry devices and source data entry devices.

iii. Discuss giving real life examples of areas of optical input devices.

2.7 Summary

In this lecture we have discussed computer input devices. Computer input devices are categorized into two- human entry devices and source input devices. Human entry devices require human intervention and manipulation in order to input data into the computer. Source data entry devices does not require human to type to enter data into the computer.

2.8 Further Reading

Recommended reference

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

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i. Journal of Computer and System Science. ISSN: 0022-000 https://www.journals.elsevier.com/journal-of-computer-and-system-sciences

ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

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i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.

ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LECTURE 3: COMPUTER OUTPUT

3.1 Introduction

In lecture 2 we learnt about input devices. Computers accept input data and produce output after processing the data. The output is made possible by the availability of output devices. Therefore, in this lecture we are going to discuss about computer output devices.

This lecture is organized as follows:

i. Introduction
ii. Lecture objectives
iii. Output devices (Hardcopy devices, softcopy devices)
iv. Further reading
v. Summary
vi. References

3.2 Expected Learning Outcomes

At the end of this lecture the student is expected to

i. Discuss the two classification of output devices
ii. Discuss giving examples areas of application of each output device

3.3 Output Devices

Output devices provide output to the user, which is generated after processing the input data. The processed data, presented to the user via the output devices could be text, graphics, audio or video. The output could be on a paper or on a film in a tangible form, or, in an intangible form as audio, video and electronic form. Output devices are classified as follows—

a) Hard Copy Devices

- Printer
- Plotter
- Computer Output on Microfilm (microfiche)

b) Soft Copy Devices

- Monitor
- Visual Display Terminal
- Video Output
- Audio Response

3.3.1 Hard Copy Devices

The output obtained in a tangible form on a paper or any surface is called hard copy output. The hard copy can be stored permanently and is portable. The hard copy output can be read or used without a computer. The devices that generate hard copy output are called hard copy devices. Printer, plotter and microfiche are common hard copy output devices.

i. Printers

A printer prints the output information from the computer onto a paper. Printers are generally used to print textual information, but nowadays printers also print graphical information. The print quality (sharpness and clarity of print) of the printer is determined by the resolution of the printer. Resolution is measured in dots per inch (dpi). Printers with a high resolution (more dpi) provide better quality output. Different kinds of printers are available for different types of applications. Printers are classified into two categories—**impact printer and non-impact printer.**

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

- ***Dot Matrix Printers*** print one character at a time. The speed of dot matrix printer lies between 200 and 600 characters per second (cps) and their resolution ranges from 72 to 360 dpi. Dot matrix printers normally come in two sizes—80 column printer and 132 column printer. Dot matrix printers can print alphanumeric characters, special characters, charts and graphs. They can print only in black and white. Some dot matrix printers can

print in both directions - left to right and right to left. Dot matrix printers are commonly used for printing in applications like **payroll and accounting.**

- ***Daisy Wheel Printers*** print one character at a time. They produce letter quality document which is better than a document printed by a dot matrix printer. The speed of daisy wheel printers is about 100 cps. The print head of the printer is like a daisy flower, hence the name. These printers are slow, can only print text (not graphics), and are costly in comparison to dot matrix printers. Daisy wheel printers are used where high quality printing is needed and no graphics is needed.
- ***Drum Printers are line printers.*** They are expensive and faster than character printers but produce a low quality output. They can print 200–2500 lines per minute. Drum printers are generally used for voluminous print outputs.

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

- ***Ink-jet Printers*** spray ink drops directly on the paper like a jet. Their resolution is more than 500 dpi. They produce high quality graphics and text. Ink-jet printers are commonly found in homes and offices.
- ***Laser Printers*** provide highest quality of text and graphics printing. Laser printers process and store the entire page before printing and are also known as *page printers*. The laser printer can print 5–24 pages of text per minute and their resolution ranges from 400 to 1200 dpi. They are faster and expensive than impact printers. Laser printers are used in applications requiring high quality voluminous printing.

ii. Plotters

A plotter is used for vector graphics output to draw graphs, maps, blueprints of ships, buildings, etc. Plotters use pens of different colors (cyan, magenta, yellow and black) for drawing. Plotters draw continuous and accurate lines, in contrast to printers where a line is drawn as closely spaced dots. Plotter is a slow output device and is expensive. Plotters are of two kinds—drum plotter and flatbed plotter.

In a *drum plotter*, pens mounted on the carriage are stationary and move only horizontally; for vertical movement, the drum on which the paper is fixed moves clockwise and anti-clockwise. In

a *flatbed plotter*, the paper is fixed on a flat bed. The paper is stationary and the pens mounted on the carriage move horizontally and vertically to draw lines.

Plotters are mainly used for drawings in AUTOCAD (computer assisted drafting), Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) applications.

iii. Computer Output on Microfilm

A microfilm is in a fiche or roll format, and is used to record computer output directly from the computer tape or cartridge. Computer Output on Microfilm (COM) is a high speed and low cost process. It can produce data in microfilm form at a much faster speed from that of a paper printer. The standard roll film is 16 mm wide with a film image that is 1/24 of the original document. The copy of the image on microfilm retains its original clarity. Microfilm can be indexed to facilitate retrieving information from it. For reading images stored on microfilm, a microfilm reader is used. A screen is used for viewing the enlarged images. COM is suited for storing large amounts of data for manuals and archive records for long periods of time that have to be referenced occasionally. COM is used for storing output in banking and insurance applications, medical X rays, etc.

3.3.2 Soft Copy Devices

The output obtained in an intangible form on a visual display, audio unit or video unit is called soft copy output. The soft copy allows corrections to be made, can be stored, and, can be sent via electronic mail to other users. The soft copy output requires a computer to be read or used. The devices that generate soft copy output are called soft copy devices. Visual output devices like **computer monitor, visual display terminal, video system and audio response system** are common soft copy output devices.

i. The monitor

Monitor is a common output device. The monitor is provided along with the computer, to view the displayed output. A monitor is of two kinds - monochrome display monitor and color display monitor. A monochrome display monitor uses only one color to display text and color display monitor can display 256 colors at one time.

An image on the monitor is created by a configuration of dots, also known as pixels. The clarity of image on the computer screen depends on three factors—

1. ***Resolution of Screen***—the number of pixels in horizontal and vertical direction. More the number of pixels, the sharper is the image. The common resolution of computer screen is 800x600 and 1024x768,

2. ***Dot Pitch***—the diagonal distance between two colored pixels on a display screen, and

3. ***Refresh Rate***—the number of times per second the pixels are recharged so that their glow remains bright.

Monitors may be *Cathode Ray Tube* (CRT) monitors that look like a television or *Liquid Crystal Display* (LCD) monitors that have a high resolution, flat screen, flat panel display. Nowadays, LCD monitors are generally used.

Visual Display Terminal

A monitor and keyboard together are known as *Visual Display Terminal* (VDT). A keyboard is used to input data and monitor is used to display the output from the computer. The monitor is connected to the computer by a cable. Terminals are categorized as dumb, smart and intelligent terminals. The dumb terminals do not have processing and programming capabilities. Smart terminals have built-in processing capability but do not have its own storage capacity. Intelligent terminals have both built-in processing and storage capacity.

ii. Video Output

Screen image projector or data projector is an output device that displays information from the computer onto a large white screen. The projector is mainly used to display visual output to a large gathering of people required for the purposes of teaching, training, meetings, conference presentations, etc.

iii. Audio Response

A complete sound system consists of sound card, microphone, speaker and the appropriate software. In addition to recording and playing the sound, the software allows editing of sound, like cutting, copy, amplification and creation of vibrant sound effects.

Audio response provides audio output from the computer. Audio output device like *speakers, headset or headphone* is used for audio output sound from computer. The signals are sent to the speakers via the sound card that translates the digital sound back into analog signals. The audio response from the computer may be generated by synthesizing the input human speech to give audio output, or may be a result of a set of rules that are used to create artificial speech.

Audio output is commonly used for customer service in airlines, banks, etc. It is also used in video conferences, surveys, etc. Audio response is used by visually impaired to read information from the screen. For speech impaired people, audio response helps them to communicate with other people.

E-tivity 3.3.1: Output devices

Numbering, pacing and sequencing	**3.3.1**
Title	Output Devices
Purpose	The purpose of this e-tivity is to enable the student identify commonly used output devices.
Summary of overall task	Watch the video on combined Input and output devices
Spark	Output devices produce different outputs.
Individual task	1. Explain the difference between softcopy and hardcopy devices.
Interaction begins	Post your responses in the discussion section and respond to other comments from your class members in forum 6

E-moderator interventions	1. Ensure that learners are focused on the contents and context of discussion. 2. Stimulate further learning and generation of new ideas. 3. Provide feedback on the learning progress. 4. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	The Central Processing Unit

3.4 Furth Reading

i. What is the difference between hardcopy and softcopy output?

ii. Explain how impact printers work.

3.5 Summary

In this lecture we have discussed the output devices in computers. A computer output can be either hardcopy or softcopy.

3.6 Further Reading

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

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Lecture 4: Central Processing Unit (CPU) and Memory

4.1 Introduction

Central processing unit (CPU) is one of the main hardware component of a computer. In this lecture we shall discuss the components of a CPU and how it interact with the main memory (RAM).

4.2 Expected Learning Outcomes

By the end of this lecture the learner should be able to:

i. Define central processing unit
ii. Discuss the components of a CPU
iii. Explain the interaction between the CPU and memory.

4.3 Central Processing Unit (CPU)

Central Processing Unit (CPU) or the processor is also often called the *brain of computer*. CPU consists of Arithmetic Logic Unit (ALU) and Control Unit (CU). In addition, CPU also has a set of registers which are temporary storage areas for holding data, and instructions.

ALU performs the arithmetic and logic operations on the data that is made available to it. *CU* is responsible for organizing the processing of data and instructions. *CU* controls and coordinates the activity of the other units of computer. CPU uses the registers to store the data, instructions during processing.

CPU executes *the stored program instructions*, i.e. instructions and data are stored in memory before execution. For processing, CPU gets data and instructions from the memory. It interprets

the program instructions and performs the arithmetic and logic operations required for the processing of data. Then, it sends the processed data or result to the memory. CPU also acts as an administrator and is responsible for supervising operations of other parts of the computer.

The CPU is fabricated as a single Integrated Circuit (IC) chip, and is also known as the *microprocessor*. The microprocessor is plugged into the motherboard of the computer (*Motherboard* is a circuit board that has electronic circuit etched on it and connects the microprocessor with the other hardware components).

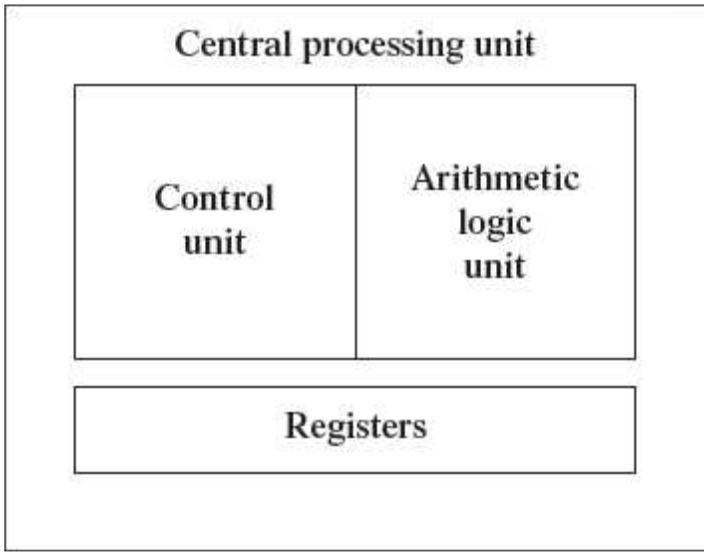


Figure 8: CPU

Arithmetic Logic Unit

ALU consists of two units—arithmetic unit and logic unit.

- The **arithmetic unit** performs arithmetic operations on the data that is made available to it. Some of the arithmetic operations supported by the arithmetic unit are—addition, subtraction, multiplication and division.
- The **logic unit** of ALU is responsible for performing logic operations. Logic unit performs comparisons of numbers, letters and special characters. Logic operations include testing for greater than, less than or equal to condition.

ALU performs arithmetic and logic operations, and uses *registers* to hold the data that is being processed.

Register

Registers are high-speed storage areas within the CPU, but have the least storage capacity. Registers are not referenced by their address, but are directly accessed and manipulated by the CPU during instruction execution.

- Registers store data, instructions, addresses and intermediate results of processing. Registers are often referred to as the CPU's *working memory*.
- The data and instructions that require processing must be brought in the registers of CPU before they can be processed. For example, if two numbers are to be added, both numbers are brought in the registers, added and the result is also placed in a register. Registers are used for different purposes, with each register serving a specific purpose.

Some of the important registers in CPU are as follows—

- Accumulator (ACC) stores the result of arithmetic and logic operations.
- Instruction Register (IR) contains the current instruction most recently fetched.
- Program Counter (PC) contains the address of next instruction to be processed.
- Memory Address Register (MAR) contains the address of next location in the memory to be accessed.
- Memory Buffer Register (MBR) temporarily stores data from memory or the data to be sent to memory.
- Data Register (DR) stores the operands and any other data.

The number of registers and the size of each (number of bits) register in a CPU helps to determine the power and the speed of a CPU. The overall number of registers can vary from about ten to many hundreds, depending on the type and complexity of the processor.

The size of register, also called *word size*, indicates the amount of data with which the computer can work at any given time. The bigger the size, the more quickly it can process data. The size of a register may be 8, 16, 32 or 64 bits. For example, a 32–bit CPU is one in which each register is 32 bits wide and its CPU can manipulate 32 bits of data at a time.

Nowadays, PCs have 32–bit or 64–bit registers. A 32-bit processor and 64-bit processor are the terms used to refer to the size of the registers. Other factors remaining the same, a 64-bit processor can process the data twice as fast as one with 32-bit processor.

Control Unit

The control unit of a computer does not do any actual processing of data. It organizes the processing of data and instructions. It acts as a supervisor and, controls and coordinates the activity of the other units of computer.

CU coordinates the input and output devices of a computer. It directs the computer to carry out stored program instructions by communicating with the ALU and the registers. CU uses the instructions in the Instruction Register (IR) to decide which circuit needs to be activated. It also instructs the ALU to perform the arithmetic or logic operations.

When a program is run, the Program Counter (PC) register keeps track of the program instruction to be executed next.

CU tells when to fetch the data and instructions, what to do, where to store the results, the sequencing of events during processing etc.

CU also holds the CPU's Instruction Set, which is a list of all operations that the CPU can perform.

The function of a (CU) can be considered **synonymous** with that of a conductor of an orchestra. The conductor in an orchestra does not perform any work by itself but manages the orchestra and ensures that the members of orchestra work in proper coordination.

E-tivity 4.3.1:Components of a CPU

Numbering, pacing and sequencing	**4.3.1**
Title	**Central Processing Unit (CPU)**
Purpose	The purpose of this e-tivity is to introduce the learner to the components of a CPU and their functions
Summary of overall task	Watch this video on the components of CPU
Spark	 How is a computer able to perform so many tasks so fast and at the same time?
Individual task	**(a)** Write additional information regarding the functions of CPU components that you picked form the video
Interaction begins	a) Post your responses in the discussion section and respond to other comments from your class members in forum 4
E-moderator interventions	5. Ensure that learners are focused on the contents and context of discussion. 6. Stimulate further learning and generation of new ideas. 7. Provide feedback on the learning progress. 8. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Computer software

4.4 Further Reading

i. Discuss the functions of the components of a CPU
ii. What is the difference between primary and secondary memory?
iii. Explain the interaction between the CPU and memory

4.5 Summary

In this lecture we have discussed the Central Processing Unit (CPU). For a computer to function there must be a processor. A processor is divided into three sections. The CPU works in close relation with the primary memory.

4.6 References

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

Core Journals

i. Journal of Computer and System Science. ISSN: 0022-000 https://www.journals.elsevier.com/journal-of-computer-and-system-sciences

ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

Recommended Reference Textbooks

i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.

ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LESSON FIVE: COMPUTER SOFTWARE

5.1. INTRODUCTION

A computer system consists of hardware and software. The computer hardware cannot perform any task on its own. It needs to be instructed about the tasks to be performed. **Software** is a set of programs that instructs the computer about the tasks to be performed. Software tells the computer how the tasks are to be performed; hardware carries out these tasks. Different sets of software can be loaded on the same hardware to perform different kinds of tasks. In this lecture, we will learn the types of software used in computers

The outline of this lecture is as follows;

i. Introduction
ii. Lecture objectives
iii. Types of computer software
iv. System software
v. Application software
vi. Summary
vii. References

5.2. Expected Learning Outcomes

At the end of this lecture, the student should be able to:

i. Define computer software
ii. Explain the types of software
iii. Discuss functions of operating system

Types of Software

Computer software can be broadly classified in two categories:

1. System Software and
2. Application Software.

System software provides the basic functions that are performed by the computer. It is necessary for the functioning of a computer.

Application software is used by the users to perform specific tasks. The user may choose the appropriate application software, for performing a specific task, which provides the desired functionality.

The system software interacts with hardware at one end and with application software at the other end. The application software interacts with the system software and the users of the computer. The figure below shows the hierarchy of software, hardware and users.

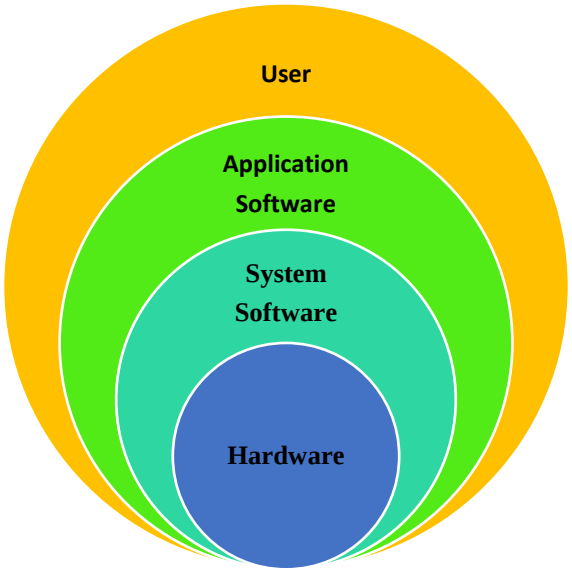


Figure 9: Software Hierarchy

System Software

System software provides basic functionality to the computer. System software is required for the working of computer itself.
The purpose of the system software are:

- To provide basic functionality to computer
- To control computer hardware and
- To act as an interface between user, application software and computer hardware.

The main examples of system software are **Operating system and system Utility software.**

Operating System

Operating System (OS) is an important part of a computer. OS intermediates between the user of a computer and the computer hardware. Different kinds of application software use specific hardware resources of a computer like CPU, I/O devices and memory, as needed by the application software. OS controls and coordinates the use of hardware among the different application software and the users. It provides an interface that is convenient for the user to use, and facilitates efficient operations of the computer system resources. The key functions of OS are—

- It provides an environment in which users and application software can do work.
- It manages different resources of the computer like the CPU time, memory space, file storage, I/O devices etc. During the use of computer by other programs or users, operating system manages various resources and allocates them whenever required, efficiently.
- It controls the execution of different programs to prevent occurrence of error.
- It provides a convenient interface to the user in the form of commands and graphical interface, which facilitates the use of computer.

Some available operating systems for PC are Microsoft Disk Operating System (MS-DOS), Windows 7, Windows XP, Windows 8, 8.1, Windows 10, Linux, UNIX, and Mac OS X Snow Leopard.

Operating System in phone include Android, iOS, Blackberry, Asha, Windows phone, Symbian OS.

System Utility Software

System utility software is required for the maintenance of computer. System utilities are used for supporting and enhancing the programs and the data in computer. Some system utilities may come embedded with OS and others may be added later on.

In general, the utility program is defined as special software written to take care of the operating system maintenance and management to keep the performance of a computer system at the appropriate level. The utility programs could be a part of operating system or a product of third party developers. Whether you want to install programs or move file to a different folder, search for a document or set the connection to the network, you are using the utility program tools. Another important improvement the utilities can help you with is your hard drive performance. Disc check, disc clean up and disc defragmentation programs alone with a files compression utility will let you keep your storage organized and reduce the time of the searching, retrieving and

displaying information you requested. The last but not least task the utility programs are being applied for is the operating system and your data protection. The backup and recovery programs let us be sure that we will not lose all data in case of system malfunctions and will be able to return back to restore point, when the system was working properly, while the antivirus, antispyware and firewalls – utility programs – will protect the computer from data theft.

Examples of utility software include:

i. File Manager Program

They organize files and are available for the user to access them. There are six important concepts that the file management programs have. First, it has a navigation system that gives the user access to the file hierarchy and be able to find their work. The actions to proceed are using the "up" and "down" to navigate through the folders and "go to" to reach their data.

Another function is the operations functions which allow the user to interact with the files. The common functions along with this are as follows: open, save, close, copy, move, delete, rename, new and share. The user would obviously be concern about the security of their files. With this being said, the files can be blocked with a login procedure which will only give people that know the username and password access to the file. To keep your file program organized its necessary to maintain the storage on the program in which you should delete any unneeded files. For the conveyance to the user, there is a communications function in which there are links available in order to send out a file to a given location. Lastly, there's a search function in which you can find a particular file you are looking for.

ii. Diagnostic and Disc Management Programs

With technology playing such an important role in our everyday life, it is important to make sure that is it maintaining itself and running properly. Instead of having to go through and check every aspect of the computer ourselves, computers come with built in diagnostic management program and disc management programs. Diagnostic management programs deal with making sure that everything on the system is working the way it should be. Examples include windows memory diagnostic, while disc management systems programs worry about the hard drive operating correctly e. g defragmentation and disk optimization tool. Most computers come with the basics of this software already built in.

iii. Uninstall and Cleanup Utilities

Once computer programs are uninstalled, program files are left occupying spaces in the disk. To free up this space cleanup utility programs are used to clean up the hard disk. Disk cleanup is the utility used in windows operating system.

iv. File Compressor Programs

File compression programs are designed to reduce the size of files, which allows the user more storage space. For Windows users, these compressed files usually have the .zip or .zipx file extension. The most popular programs are Winrar, Winzip and 7-Zip.

v. Backup and Recovery

To make a copy of all information stored on the disk. It also restores the backed up contents in case of disk failure. This capability is useful in the event when the system becomes unresponsive because of system file failure or installation of a bad program that slows or damages the system files.

vi. Security programs

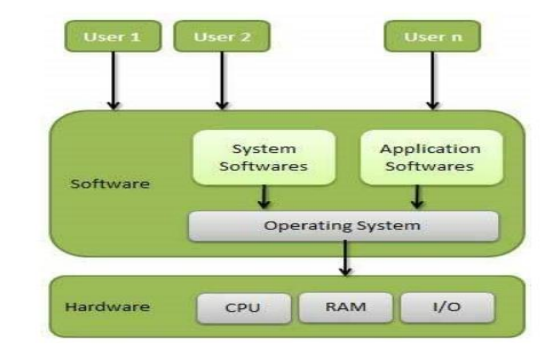
Computers are usually insecure due to the data and information stored in them. To ensure security of data and information from people various programs are used. They include anti-virus program e.g. Windows defender, Kaspersky, McAfee, Avira, Firewall, Antispyware, anti-spam etc.

vii. Network Manager

Used to check the computer network and to log events.

E-tivity 5.5.1: Functions of Operating System

Numbering, pacing and sequencing	**5.5.1**

Title	Functions of Operating System
Purpose	The purpose of this e-activity is to expose the student to the functions of the operating system.
Summary of overall task	Using the link provided read more content on the functions of the operating system.
Spark	
Individual task	1. Explain other functions of an operating system from the reading you have done.
Interaction begins	Post your responses in the discussion section and respond to other comments from your class members in forum 7
E-moderator interventions	9. Ensure that learners are focused on the contents and context of discussion. 10. Stimulate further learning and generation of new ideas. 11. Provide feedback on the learning progress. 12. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	

APPLICATION PROGRAMS

The software that a user uses for accomplishing a specific task is the *application software*. Application software may be a single program or a set of programs. A set of programs that are written for a specific purpose and provide the required functionality is called software package.

Examples of Application Programs include:

- *Word Processing Software:* For writing letter, reports, documents etc. (e.g. MS-WORD).
- *Image Processing Software:* For assisting in drawing and manipulating graphics (e.g. Adobe Photoshop).
- *Accounting Software:* For assisting in accounting information, salary, tax returns (QuickBooks, SagePastel software).
- *Spreadsheet Software:* Used for creating budget, tables etc. (e.g. MS-Excel).
- *Presentation Software:* To make presentations, slide shows (e.g. MS-PowerPoint)
- *Suite of Software having Word Processor, Spreadsheet and Presentation Software:* Some examples are MS-Office, Google Docs, Sun OpenOffice, Apple iWork.
- CAD/CAM *Software:* To assist in architectural design. (e.g. AutoCAD, Autodesk)
- *Geographic Information Systems:* It captures, stores, analyzes, manages, and presents data, images and maps that are linked to different locations. (e.g. ArcGIS)
- *Web Browser Software:* To access the World Wide Web to search documents, sounds, images etc. (e.g. Internet Explorer, Netscape Communicator, Chrome, Mozilla etc).

E-tivity 5.5.2: Identification of Application Programs

Numbering, pacing and sequencing	**5.5.2**
Title	Application software
Purpose	The purpose of this e-activity is to expose the student to application software
Summary of overall task	Read the article in the link provided

Spark	
Individual task	1. Explain the difference between an application program and a system program 2. List two application software that you use in your class work.
Interaction begins	Post your responses in the discussion section and respond to other comments from your class members in forum 7
E-moderator interventions	1. Ensure that learners are focused on the contents and context of discussion. 2. Stimulate further learning and generation of new ideas. 3. Provide feedback on the learning progress. 4. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Computer Memory

SOFTWARE ACQUISITION

Different kinds of software are made available for use to users in different ways. The user may have to purchase the software, can download for free from the Internet, or can get it bundled along with the hardware. Nowadays with the advent of Cloud computing, many application software are

also available on the cloud for use through the Internet, e.g. Google Docs. The different ways in which the software are made available to users are:

- **Retail Software** is off-the-shelf software sold in retail stores. It comes with printed manuals and installation instructions. For example, Microsoft Windows operating system.
- **OEM Software stands** for "Original Equipment Manufacturer" software. It refers to software which is sold, and bundled with hardware. Microsoft sells its operating system as OEM software to hardware dealers. OEM software is sold at reduced price, without the manuals, packaging and installation instructions. For example, Dell computers are sold with the "Windows" OS pre-loaded on them.
- **Demo Software** is designed to demonstrate what a purchased version of the software is capable of doing and provides a restricted set of features. To use the software, the user must buy a fully- functional version.
- **Shareware** is a program that the user is allowed to try for free, for a specified period of time, as defined in the license. It is downloadable from the Internet. When the trial period ends, the software must be purchased or uninstalled.
- **Freeware** is software that is free for personal use. It is downloadable from the Internet. The commercial use of this software may require a paid license. The author of the freeware software is the owner of the software, though others may use it for free. The users abide by the license terms, where the user cannot make changes to it, or sell it to someone else.
- **Public Domain Software** is free software. Unlike freeware, public domain software does not have a copyright owner or license restrictions. The source code is publicly available for anyone to use. Public domain software can be modified by the user.
- **Open-Source Software** is software whose source code is available and can be customized and altered within the specified guidelines laid down by the creator. Unlike public domain software, open-source software has restrictions on their use and modification, redistribution limitations, and copyrights. Linux, Apache, Firefox, OpenOffice are some examples of open-source software.

5.3. Further Reading

1. Define computer software
2. Discuss the difference between system software and application software
3. Explain the functions of operating system

5.4. Summary

In this lecture we have covered computer software-system software and application software.

Software is a set of programs that instructs the computer about the tasks to be performed. Software tells the computer how the tasks are to be performed; hardware carries out these tasks. Different sets of software can be loaded on the same hardware to perform different kinds of tasks. The operating system manipulates the hardware directly while the application software enables the computer user to achieve specific objectives.

5.5 References

Recommended reference

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7
ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751
iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

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ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

Recommended Reference Textbooks

i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.
ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LESSON 6: COMPUTER MEMORY

6.1 Introduction

The computer's memory stores data, instructions required during the processing of data, and output results. Storage may be required for a limited period of time, instantly, or, for an extended period. Different types of memories, each having its own unique features, are available for use in a computer. The cache memory, registers, and RAM are fast memories and store the data and instructions temporarily during the processing of data and instructions. Secondary memory like magnetic disks and optical disks have large storage capacities and store the data and instructions permanently, but are slow memory devices. The memories are organized in the computer in a manner to achieve high levels of performance at the minimum cost. In this chapter, we discuss different types of memories, their characteristics and their use in the computer.

The outline of this lecture is as follows;

i. Introduction
ii. Learning outcome
iii. Memory representation
iv. Memory Hierarchy
v. Primary memory
vi. Secondary memory
vii. Summary
viii. Further reading
ix. References

6.2. Expected Learning Outcome

At the end of this lecture, the student should be able to:

i. Explain the memory representation
ii. Discuss the types of RAM and ROM
iii. Discuss examples of secondary memory

6.3. Memory Representation

The computer memory stores different kinds of data like input data, output data, intermediate results, etc., and the instructions. ***Binary digit*** or ***bit*** is the basic unit of memory. A *bit* is a single binary digit, i.e., 0 or 1. A bit is the smallest unit of representation of data in a computer.

However, the data is handled by the computer as a combination of bits. A group of 8 bits form a **byte**. One byte is the smallest unit of data that is handled by the computer.

1 bit = 0 or 1
1 Byte (B) = 8 bits
1 Kilobyte (KB) = 2^{10} = 1024 bytes
1 Megabyte (MB) = 2^{20} = 1024KB
1 Gigabyte (GB) = 2^{30}= 1024 MB = 1024 *1024 KB
1 Terabyte (TB) = 2^{40}= 1024 GB = 1024 * 1024 *1024 KB

6.4. Memory Hierarchy

The memory is characterized on the basis of two key factors—capacity and access time.

Capacity is the amount of information (in bits) that a memory can store. *Access time* is the time interval between the read/ write request and the availability of data. The lesser the access time, the faster is the *speed of memory*.

Ideally, we want the memory with *fastest speed and largest capacity*. However, the cost of fast memory is very high. The computer uses a hierarchy of memory that is organized in a manner to enable the fastest speed and largest capacity of memory. The hierarchy of the different memory types is shown bellow.

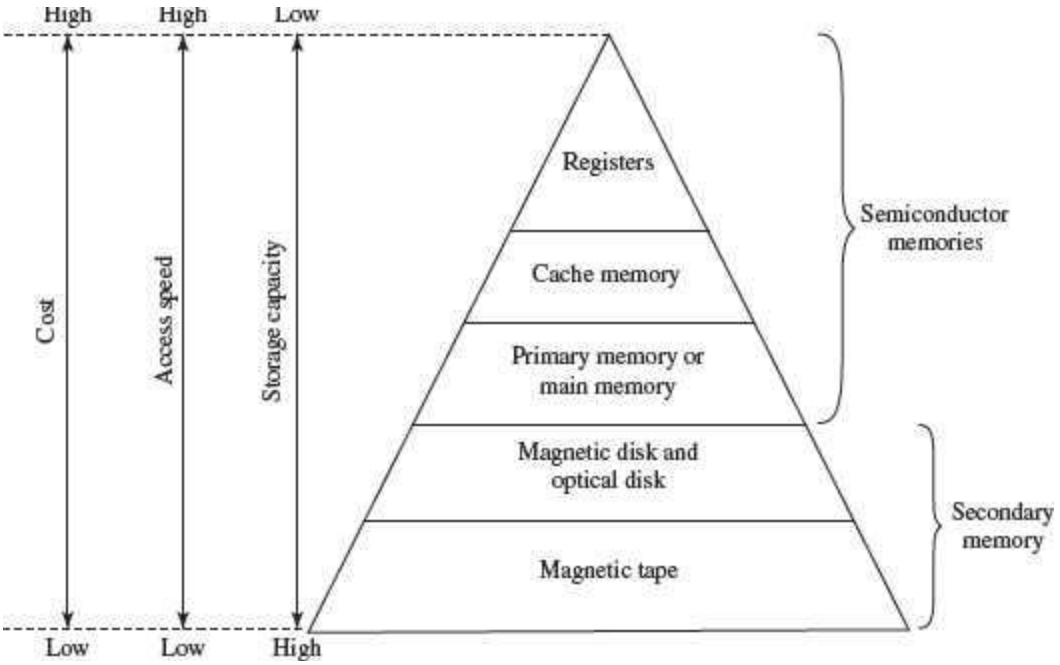


Figure 10: Memory Hierarchy

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

Internal Memory—The key features of internal memory are- (1) limited storage capacity, (2) temporary storage, (3) fast access, and (4) high cost. Registers, cache memory, and primary memory constitute the internal memory.

The primary memory is further of two kinds-RAM and ROM. Registers are the fastest and the most expensive among all the memory types. The registers are located inside the CPU, and are directly accessible by the CPU. The speed of registers is between 1-2 ns (nanosecond). The sum of the size of registers is about 200B. Cache memory is next in the hierarchy and is placed between the CPU and the main memory. The speed of cache is between 2-10 ns. The cache size varies between 32 KB to 4MB. Any program or data that has to be executed must be brought into RAM from the secondary memory. Primary memory is relatively slower than the cache memory. The speed of RAM is around 60ns. The RAM size varies from 512KB to 16GB.

Secondary Memory—The key features of secondary memory storage devices are—(1) very high storage capacity, (2) permanent storage (non-volatile), unless erased by user, (3) relatively slower

access, (4) stores data and instructions that are not currently being used by CPU but may be required later for processing, and (5) cheapest among all memory. The storage devices consist of two parts—drive and device. For example, magnetic tape drive and magnetic tape, magnetic disk drive and disk, and, optical disk drive and disk. The speed of magnetic disk is around 60ms. The capacity of a hard disk ranges from 32 GB to 1,600 GB (1.6 Tera Bytes).

The interaction between the CPU and the Memory

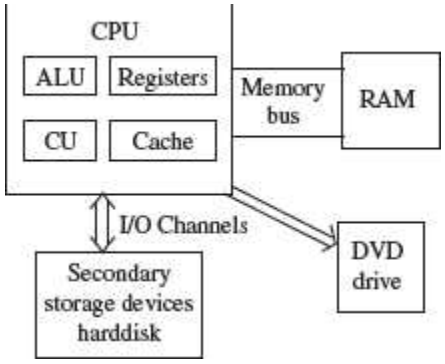


Figure 11: CPU and Memory

To get the fastest speed of memory with largest capacity and least cost, the fast memory is located close to the processor. The secondary memory, which is not as fast, is used to store information permanently, and is placed farthest from the processor. With respect to CPU, the memory is organized as follows-

- Registers are placed inside the CPU (small capacity, high cost, very high speed)
- Cache memory is placed next in the hierarchy (inside and outside the CPU)
- Primary memory is placed next in the hierarchy
- Secondary memory is the farthest from CPU (large capacity, low cost, low speed)

The registers, cache memory and primary memory are semiconductor memories. They do not have any moving parts and are fast memories. The secondary memory is magnetic or optical memory, has moving parts and has slow speed.

CPU Register

Registers are very high-speed storage areas located inside the CPU. After CPU gets the data and instructions from the cache or RAM, the data and instructions are moved to the registers for processing. Registers are manipulated directly by the control unit of CPU during instruction execution. That is why registers are often referred to as the CPU's *working memory*. Since CPU

uses registers for the processing of data, the number of registers in a CPU and the size of each register affect the power and speed of a CPU.

Cache Memory

Cache memory is placed in between the CPU and the RAM. Cache memory is a fast memory, faster than the RAM. When the CPU needs an instruction or data during processing, it first looks in the cache. If the information is present in the cache, it is called a *cache hit*, and the data or instruction is retrieved from the cache. If the information is not present in cache, then it is called a *cache miss* and the information is then retrieved from RAM.

The content of cache is decided by the cache controller (a circuit on the motherboard). The most recently accessed information or instructions help the controller to guess the RAM locations that may be accessed next. To get good system performance, the number of hits must far outnumber the misses. The two main factors that affect the performance of cache are its size and level (L1, L2 and L3).

E-tivivty 6.4.1: Memory Hierarchy

Numbering, pacing and sequencing	**6.4.1**
Title	**Memory Hierarchy**
Purpose	The purpose of this e-tivity is to enable you to get an understanding of memory organization to offer processing speeds and efficiency.
Summary of the overall task	Watch the video provided and engage in the forum discussion in the online platform
Spark	Imagine a memory pyramid. The top part is dependent of the strong base
Individual task	1. Why does the memory register closer to the CPU? 2. What are the tradeoffs between primary memory and secondary memory in relation to the hierarchy?

Interaction begins	b) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	13. Ensure that learners are focused on the contents and context of discussion. 14. Stimulate further learning and generation of new ideas. 15. Provide feedback on the learning progress. 16. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Primary memory

6.5. Primary Memory

Primary memory is the main memory of computer. It is a chip mounted on the motherboard of computer. Primary memory is categorized into two main types-

- Random Access Memory (RAM), and
- Read Only Memory (ROM)

RAM is used for the temporary storage of input data, output data and intermediate results. The input data entered into the computer using the input device, is stored in RAM for processing. After processing, the output data is stored in RAM before being sent to the output device. Any intermediate results generated during the processing of program are also stored in RAM. Unlike RAM, the data once stored in ROM either cannot be changed or can only be changed using some special operations. Therefore, ROM is used to store the data that does not require a change. *Flash memory* is another form of rewritable read-only memory that is compact, portable, and requires little energy.

Random Access Memory (RAM)

- RAM is used to *store data and instructions during the operation of computer*.
- The data and instructions that need to be operated upon by CPU are first brought to RAM from the secondary storage devices like the hard disk.
- CPU interacts with RAM to get the data and instructions for processing.

- RAM loses information when the computer is powered off. It is a *volatile memory*. When the power is turned on, again, all files that are required by the CPU are loaded from the hard disk to RAM. Since RAM is a volatile memory, any information that needs to be saved for a longer duration of time must not be stored in RAM.
- RAM provides *random access* to the stored bytes, words, or larger data units. This means that it requires same amount of time to access information from RAM, irrespective of where it is located in it.
- RAM can be *read from and written to* with the same speed.
- The *size of RAM is limited due to its high cost*. The size of RAM is measured in MB or GB.
- The performance of RAM is affected by—

- Access speed (how *quickly* information can be retrieved). The speed of RAM is expressed in nanoseconds.
- Data transfer unit size (how *much* information can be retrieved in one request).

- RAM affects the speed and power of a computer. More the RAM, the better it is.
- RAM is a microchip implemented using semiconductors.

There are two categories of RAM, depending on the technology used to construct a RAM- (1) Dynamic RAM (DRAM), and (2) Static RAM (SRAM).

Dynamic RAM

DRAM is the most common type of memory chip. DRAM is mostly used as main memory since it is small and cheap.

- It uses transistors and capacitors. The transistors are arranged in a matrix of rows and columns. The capacitor holds the bit of information 0 and 1. The transistor and capacitor are paired to make a *memory cell*. The transistor acts as a switch that lets the control circuitry on the memory chip read the capacitor or change its state.
- DRAM must be refreshed continually to store information. For this, a memory controller is used. The memory controller recharges all the capacitors holding a 1 before they discharge. To do this, the memory controller reads the memory and then writes it right back.

- DRAM gets its name from the refresh operation that it requires to store the information; otherwise it will lose what it is holding. The refresh operation occurs automatically thousands of times per second. DRAM is slow because the refreshing takes time.
- Access speed of DRAM ranges from 50 to 150 ns.

Static RAM

SRAM chip is usually used in *cache memory* due to its high speed.

- SRAM uses multiple transistors (four to six), for each memory cell. It does not have a capacitor in each cell.
- A SRAM memory cell has more parts so it takes more space on a chip than DRAM cell.
- It does not need constant refreshing and therefore is faster than DRAM.
- SRAM is more expensive than DRAM, and it takes up more space.
- It stores information as long as it is supplied with power.
- SRAM are easier to use and very fast. The access speed of SRAM ranges from 2–10 nanosecond.

Memory chips are generally available as part of a card called a *memory module*. There are generally two types of RAM modules—Single Inline Memory Module (SIMM) and Dual Inline Memory Module (DIMM).

- SIMM modules have memory chip on one side of the PCB. SIMM modules can store 8 bits to 32 bits of data simultaneously.
- DIMM modules have memory chips on both sides of the PCB. DIMM format are 64–bit memories. Smaller modules known as Small Outline DIMM (SO DIMM) are designed for portable computers. SO DIMM modules have 32–bit memory.

Read Only Memory (ROM)

ROM is a *non-volatile* primary memory. It does not lose its content when the power is switched off. The features of ROM are described as follows—

- ROM, as the name implies, has only read capability and no write capability. After the information is stored in ROM, it is permanent and cannot be corrected.
- ROM comes programmed by the manufacturer. It stores standard processing programs that permanently reside in the computer. ROM stores the data needed for the start up of the computer. The instructions that are required for initializing the devices attached to a computer are stored in ROM.

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

- *Power On Self Test (POST)* is a program that runs automatically when the system is booted. BIOS performs the power-on self-test. It checks that the major hardware components are working properly.
- BIOS setup program, which is a built-in utility in BIOS, lets the user set the many functions that control how the computer works. BIOS displays the system settings and finds the bootable devices. It loads the interrupt handlers and device drivers. It also initializes the registers.
- *Bootstrap Loader* is a program whose purpose is to start the computer software for operation when the power is turned on. It loads the operating system into RAM and launches it. It generally seeks the operating system on the hard disk. The bootstrap loader resides in the ROM. The BIOS initiates the bootstrap sequence.

ROMs are of different kinds. They have evolved from the fixed read only memory to the ones that can be programmed and re-programmed. They vary in the number of re-writes and the method used for the re-writing. Programmable ROM (PROM), Erasable Programmable ROM (EPROM) and Electrically Erasable Programmable ROM (EEPROM) are some of the ROMs. All the different kinds of ROM retain their content when the power is turned off.

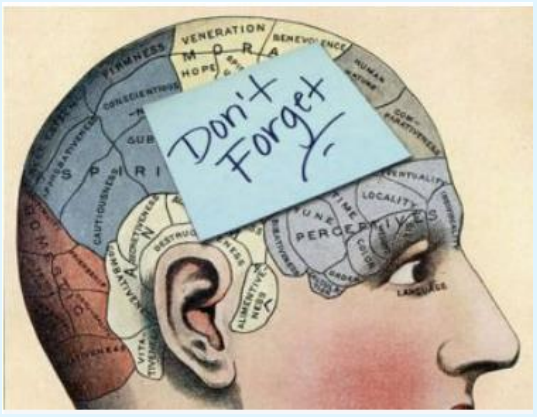
- ***PROM*** can be programmed with a special tool, but after it has been programmed the contents cannot be changed. PROM memories have thousands of fuses (or diodes). High voltage (12 V) is applied to the fuses to be burnt. The burnt fuses correspond to 0 and the others to 1.
- ***EPROM*** can be programmed in a similar way as PROM, but it can be erased by exposing it to ultra violet light and re-programmed. EPROM chips have to be removed from the computer for re-writing.
- ***EEPROM*** memories can be erased by electric charge and re-programmed. EEPROM chips do not have to be removed from the computer for re-writing.

- ***Flash Memory*** is a kind of semiconductor-based non-volatile, rewritable computer memory that can be electrically erased and reprogrammed. It is a specific type of EEPROM.

✓ It combines the features of RAM and ROM. It is a random access memory and its content can be stored in it at any time. However, like ROM, the data is not lost when the machine is turned off or the electric power is cut. Flash memory stores bits of data in memory cells.

✓ Flash memories are high-speed memories, durable, and have low-energy consumption. Since flash memory has no moving part, it is very shock-resistant. Due to these features, flash memory is used in devices such as digital camera, mobile phone, printer, laptop computer, and record and play back sound devices, such as MP3 players.

E-tivity 6.6.1: Computer Memory

Numbering, pacing and sequencing	**6.6.1**
Title	Computer Memory
Purpose	The purpose of this e-tivity is to enable the student identify types of primary memory in computers.
Summary of overall task	Watch the video provided for more information about primary memory.
Spark	

Individual task	1. Explain two types of primary memory 2. Differentiate between ROM and RAM.
Interaction begins	Post your responses in the discussion section and respond to other comments from your class members in forum 6
E-moderator interventions	17. Ensure that learners are focused on the contents and context of discussion. 18. Stimulate further learning and generation of new ideas. 19. Provide feedback on the learning progress. 20. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Data representation

6.6. Secondary Memory

In the previous section, we saw that RAM is expensive and has a limited storage capacity. Since it is a volatile memory, it cannot retain information after the computer is powered off. Thus, in addition to primary memory, an auxiliary or secondary memory is required by a computer. The secondary memory is also called the storage device of computer.

In comparison to the primary memory, the secondary memory stores much larger amounts of data and information (for example, an entire software program) for extended periods of time. The data and instructions stored in secondary memory must be fetched into RAM before CPU does processing.

Magnetic tape drives, magnetic disk drives, optical disk drives and magneto-optical disk drives are the different types of storage devices.

ACCESS TYPES OF STORAGE DEVICES

The information stored in storage devices can be accessed in two ways—

i. Sequential access
ii. Direct access

Sequential Access

Sequential access means that computer must run through the data in sequence, starting from the beginning, in order to locate a particular piece of data. Magnetic tape is an example of sequential access device. Let us suppose that magnetic tape consists of 80 records. To access the 25th record, the computer starts from first record, then reaches second, third etc. until it reaches the 25th record. Sequential access devices are generally slow devices.

Direct Access Devices

Direct access devices are the ones in which any piece of data can be retrieved in a non-sequential manner by locating it using the data's address. It accesses the data directly, from a desired location. Magnetic disks and optical disks are examples of direct access devices. There is no predefined order in which one can read and write data from a direct access device. In a magnetic disk consisting of 80 records, to access the 25th record, the computer can directly access the 25th record, without going past the first 24 records. Based on access, magnetic tapes are sequential access devices, and, magnetic disks, optical disk and magneto-optical disks are direct access devices.

i. Magnetic Tape

Magnetic tape is a plastic tape with magnetic coating. It is a storage medium on a large open reel or in a smaller cartridge or cassette (like a music cassette). Magnetic tapes are cheaper storage media.

Feature of Magnetic Tape

- ✓ Inexpensive storage device
- ✓ Can store a large amount of data
- ✓ Easy to carry or transport
- ✓ Not suitable for random access data
- ✓ Slow access device
- ✓ Needs dust prevention, as dust can harm the tape
- ✓ Suitable for back-up storage or archiving

ii. Magnetic Disk

Magnetic disk is a direct access secondary storage device. It is a thin plastic or metallic circular plate coated with magnetic oxide and encased in a protective cover. Data is stored on magnetic disks as magnetized spots. The presence of a magnetic spot represents the bit 1 and its absence represents the bit 0.

The features of magnetic disk are—

- ✓ Cheap storage device
- ✓ Can store a large amount of data
- ✓ Easy to carry or transport

- ✓ Suitable for frequently read/write data
- ✓ Fast access device
- ✓ More reliable storage device
- ✓ To be prevented from dust, as the read/write head flies over the disk. Any dust particle in
- ✓ between can corrupt the disk.

Floppy disk, hard disk and zip disk are the different types of magnetic disks.

a) Floppy Disk

- ➢ Floppy disk (FD) is a flat, round, single disk made of Mylar plastic and enclosed in square plastic jacket.
- ➢ Floppy Disk Drive (FDD) is the disk drive for floppy disk.
- ➢ The floppy disk is inserted into the floppy disk drive to read or write data to it.
- ➢ Floppy disk has a write-protect slide tab that prevents a user from writing to it.
- ➢ A floppy disk may be single-sided or double-sided disk, i.e., data can be read and written on one and both sides of floppy disk, respectively.
- ➢ They are portable. They can be removed from the disk drive, carried or stored separately.
- ➢ They are small and inexpensive.
- ➢ Floppy disks are slower to access than hard disk. They have less storage capacity and are less expensive than hard disk.

b) Hard Disk

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

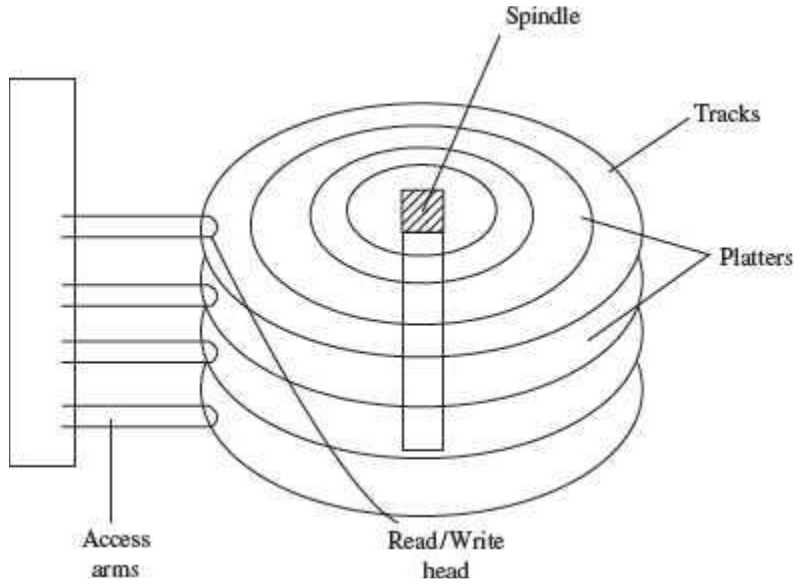


Figure 12: Hard Disk Drive

- ➢ Hard disk is a fixed disk. The disk is not removable from the drive, unlike floppy disk.

- The hard disk and Hard Disk Drive (HDD) is a single unit.
- Hard disk can store much more data than floppy disk. The data in hard disk are packed more closely (because fast spinning uses smaller magnetic charges) and they have multiple platters, with data being stored on both sides of each platter. Large capacity hard disks may have 12 or more platters.
- Unlike floppy disk, the read/write head of hard disk does not touch the disk during accessing.
- Hard disk can spin at the speed of up to 10,000 revolutions per minute and have an access time of 9—14 ms. It stores 512 bytes per sector but the number of sectors are more per track (54 or more) than floppy disk.
- Nowadays, hard disks are available that can store up to 1000 GB of data. Generally, PCs come with 160 GB hard disk.
- Hard disk is the key secondary storage device of computer. The operating system is stored on the hard disk. The performance of computer like speed of computer boot up, loading of programs to primary memory, loading of large files like images, video, audio etc., is also dependent on the hard disk.
- Nowadays, *portable external hard disk drive* is available which can be attached to the USB drive of the computer. They come in the storage capacities of 80 GB to 1000 GB.

c) Zip Disk

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

iii. Optical Disk

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

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

There are two most common categories of optical disks—read-only optical disks and recordable optical disks.

a. CD-ROM

Originally, Compact Disk (CD) was a popular medium for storing music. Now, it is used in computers to store data and is called Compact Disk-Read Only Memory (CD-ROM).

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

b. DVD-ROM

- Digital Video Disk-Read Only Memory (DVD-ROM) is an optical storage device used to store digital video or computer data.
  - DVDs look like CDs, in shape and physical size.
  - It improves on CD technology.
  - It is a high-density medium with increased track and bit density.
  - DVD-ROM uses both sides of the disk and special data compression technologies. The tracks for storing data are extremely small.
  - A full-length movie can be stored on a single disk.
  - Each side of DVD-ROM can store 4.7 GB of data, so a single DVD can store 9.4 GB of data.
  - New DVD-ROMs use layers of data track, to double its capacity. Such dual layer disks can store 17 GB of data.

Recordable Optical Disk

In addition to the read only CDs and DVDs, recordable optical disks are also available. Users can record music, video, audio and data on it. The recordable optical disks are:

- ***Compact Disk-Recordable (CD-R)*** is a Write Once-Read Many (WORM) disk. A CD-R disk allows the user to write data permanently on to the disk. Once the data is written, it cannot be erased. CD-R disk uses a laser that burns pits into the disk surface. It looks like a CD disk externally. To write to a CD-R disk, a device named CD-Writer or CD–burner is required. A CD-R disk can store 700 MB of data that can run for 80 minutes. CD-R is used to create music CDs in home computers, back up data from other storage devices, archives of large data, etc.
- ***Compact Disk Re-Writable (CD-RW)*** allows data to be written, erased and re-written on. The capacity of CD-RW is same as a CD. They generally do not play on all CD-ROM drives.
- ***Digital Video Disk-Recordable (DVD-R)*** allows recording of data on a DVD. A DVD writer device is required to write the data to DVD. The data once written on a DVD cannot be erased or changed.

6.7. Further Activity

i. Discuss the memory hierarchy.
ii. Differentiate between primary and secondary memory
iii. Explain the relationship between memory hierarchy and processing.

6.8. References

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7
ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751
iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

Core Journals

i. Journal of Computer and System Science. ISSN: 0022-000 https://www.journals.elsevier.com/journal-of-computer-and-system-sciences
ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

Recommended Reference Textbooks

i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.
ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129–0541 | ISSN (online): 1793– 6373

LESSON 7: DATA REPRESENTATION

7.1. Introduction

We use computer to process the data and get the desired output. The data input can be in the form of alphabets, digits, symbols, audio, video, magnetic cards, finger prints, etc. Since computer can only understand 0 and 1, the data must be represented in the computer in 0s and 1s. The purpose of this chapter is to introduce you to the data representation in the computer. The data stored in the computer may be of different kinds, as follows:

All kinds of data, be it alphabets, numbers, symbols, sound data, or video data, are represented in terms of 0s and 1s, in the computer. Each symbol is represented as a unique combination of 0s and 1s.

In this lecture, you will learn the number systems that are commonly used in computers.

The number systems discussed in this lecture are—(1) the Decimal number system, (2) the Binary number system, (3) the Octal number system, and (4) the Hexadecimal number system.

The outline of this lecture is as follows;

i. Introduction
ii. Lecture objectives
iii. Number systems
iv. Number conversion
v. Summary
vi. Further reading

7.2. Expected Learning Outcome

At the end of this lecture, the student should be able to:

i. Perform number conversions from decimal to binary, octal and Hexadecimal
ii. Perform number conversions from Hexadecimal, Octal, binary to decimal

7.3. Number System

The base of the number decides the valid digits that are used to make a number. In a number, the *position* of digit starts from the right-hand side of the number. The rightmost digit has position 0, the next digit on its left has position 1, and so on. The digits of a number have two kinds of values-

- **Face value, and**
- **Position value.**

The **face value** of a digit is the digit located at that position. For example, in decimal number 52, face value at position 0 is 2 and face value at position 1 is 5.

The **position value** of a digit is (base position). For example, in decimal number 52, the position value of digit 2 is 10^0 and the position value of digit 5 is 10^1. Decimal numbers have a base of 10.

The **number** is calculated as the sum of, ***face value * base position***, of each of the digits. For decimal number 52, the number is 5*101 + 2*100 = 50 + 2 = 52

In computers, we are concerned with four kinds of number systems, as follows;

- Decimal Number System —Base 10
- Binary Number System —Base 2
- Octal Number System —Base 8
- Hexadecimal Number System—Base 16

The numbers given as input to computer and the numbers given as output from the computer, are generally in decimal number system, and are most easily understood by humans. However, computer understands the binary number system, i.e., numbers in terms of 0s and 1s. The binary data is also represented, internally, as octal numbers and hexadecimal numbers due to their ease of use.

i. Decimal Number System

It consists of 10 digits—0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. All numbers in this number system are represented as combination of digits 0-9. For example, 34, 5965 and 867321.

ii. Binary Number System

The binary number system consists of two digits 0 and 1. All binary numbers are formed using combination of 0 and 1. For example, 1001, 11000011 and 10110101.

iii. Octal Number System

The octal number system consists of eight digits-0 to 7. All octal numbers are represented using these eight digits. For example, 273, 103, 2375, etc.

iv. Hexadecimal Number System

The hexadecimal number system consists of sixteen digits-0 to 9, A, B, C, D, E, F, where (A is for 10, B is for 11, C-12, D-13, E-14, F-15). All hexadecimal numbers are represented using these 16 digits. For example, 3FA, 87B, 113, etc.

Summarize the base, digit and largest digit for the above discussed number system.

Table 1: Summary of Number System

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

The following table shows binary, octal and hexadecimal equivalent of decimal number.

Table 2: Binary, Octal and Hexadecimal Equivalent

Decimal	Binary	Octal	Hexadecimal
0	0000	000	0
1	0001	001	1
2	0010	002	2
3	0011	003	3
4	0100	004	4
5	0101	005	5
6	0110	006	6
7	0111	007	7
8	1000	010	8
9	1001	011	9
10	1010	012	A
11	1011	013	B
12	1100	014	C
13	1101	015	D
14	1110	016	E
15	1111	017	F

7.4. Number Conversions

1. Conversion of Decimal to Binary, Octal and Hexadecimal

A decimal number has two parts—integer part and fraction part. For example, in the decimal number 23.0786, 23 is the integer part and .0786 is the fraction part. The method used for the conversion of the integer part of a decimal number is different from the one used for the fraction part. In the following subsections, we shall discuss the conversion of decimal integer, decimal fraction and decimal integer.fraction number into binary, octal and hexadecimal number.

a. Conversion of Decimal Integer to Binary, Octal and Hexadecimal

A decimal integer is converted to any other base, by using the division operation. To convert a decimal integer to—

- Binary-divide by 2,
- Octal-divide by 8, and,
- Hexadecimal-divide by 16.

For example, convert 25 from Base 10 to Base 2

Steps:

a) ***Make a table with three columns***
b) ***Name the columns as Operation, Quotient and Remainder***
c) ***Divide 25 by 2, write the quotient and the remainder in their respective columns.***
d) ***Divide the quotient by 2 and write the quotient and the remainder in their respective columns.***
e) ***Continue this process until the quotient is zero (0).***
f) ***Write the values in the remainder column bottom-up.***

Solution

Operation	Quotient	Remainder
25/2	**12**	**1**
12/2	**6**	**0**
6/2	**3**	**0**
3/2	**1**	**1**
1/2	**0**	**1**

The binary equivalent of number $(25)_{10}$ is $(11001)_2$

The steps shown above are followed to convert a decimal integer to a number in any other base.

Example 2: Convert 23 to base 2, 8, and 16

Solution

Operation	Quotient	Remainder
23/2	**11**	**1**
11/2	**5**	**1**

5/2	**2**	**1**
2/2	**1**	**0**
1/2	**0**	**1**

Operation	Quotient	Remainder
23/8	**2**	**7**
2/8	**0**	**2**

The Octal equivalent of 23_{10} is $(27)_8$

The binary equivalent of 23_{10} is $(10111)_2$

Solution

Operation	Quotient	Remainder
23/16	**1**	**7**
1/16	**0**	**1**

The Hexadecimal equivalent of 23_{10} is $(17)_{16}$

E-tivity 7.4.1 Number Conversion

Numbering, pacing and sequencing	**7.4.1**
Title	**Number conversion**
Purpose	This e-tivity will make you practice number conversions
Summary of overall task	Watch the video provided on how to convert decimal to binary.
Spark	Would you like to learn the language that only computer understands.
Individual task	i. Convert 94_{10} to Base 2, 8 and 16. ii. Convert 164_{10} to Base 2, 8, and 16 a.

Interaction begins	c) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	21. Ensure that learners are focused on the contents and context of discussion. 22. Stimulate further learning and generation of new ideas. 23. Provide feedback on the learning progress. 24. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Fractional number conversion

iii. Converting Decimal *fraction* to Binary, Octal and Hexadecimal

A fractional number is a number less than 1. It may be .5, .00453, .564, etc. We use the **multiplication operation** to convert decimal fraction to any other base.

To convert a decimal fraction to—

i. Binary-multiply by 2,
ii. Octal-multiply by 8, and,
iii. Hexadecimal-multiply by 16.

Steps for conversion of a decimal fraction to any other base are—

i. Multiply the fractional number with the to *Base*, to get a resulting number.
ii. The resulting number has two parts, non-fractional part and fractional part.
iii. Record the non-fractional part of the resulting number.
iv. Repeat the above steps at least four times.
v. Write the digits in the non-fractional part starting from upwards to downwards.

Example 3: Convert 0.2345 from Base 10 to Base 2

0.2345
x 2
0.4690

.4690
x 2
0.9380

.9380
x 2
1.8760

.8760
x 2
1.7520

.7520
x 2
1.5040

.5040
x 2
1.0080

The binary equivalent of (0.2345)10 is (0.001111)2

Example 4: Convert 0.865 from Base 10 to base 2, 8 and 16

0.865
x 2
1.730
x 2
1.460
x 2
0.920
x 2
1.840
x 2
1.680
x 2
1.360

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

0.865
x 8
6.920
x 8
7.360
x 8
2.880
x 8
7.040

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

0.865
x 16
5190
865 x
13.840
x 16
5040
840 x
13.440
x 16
2640
440 x
7.040

The number 13 in hexadecimal is D.

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

Numbering, pacing and sequencing	**7.4.1**
Title	**Number conversion**

Purpose	This e-tivity will make you practice number conversions
Summary of overall task	Watch the video provided on how to convert decimal to binary.
Spark	Would you like to learn the language that only computer understands.
Individual task	i. Convert 0.435_{10} to Base 2, 8, and 16. ii. Convert 0.217_{10} to Base 2. 8, and 16.
Interaction begins	d) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	25. Ensure that learners are focused on the contents and context of discussion. 26. Stimulate further learning and generation of new ideas. 27. Provide feedback on the learning progress. 28. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Fractional number conversion

e) Converting integer.fraction to Base 2, 8, 16

A decimal *integer.fraction* number has both integer part and fraction part. The steps for conversion of a decimal *integer.fraction* to any other base are:

i. Convert decimal integer part to the desired base following the steps in section (a)

ii. Convert decimal fraction part to the desired base following the steps shown in section (b).

iii. The integer and fraction part in the desired base is combined to get integer.fraction.

Example 4 Convert 34.4674 from Base 10 to Base 2, 8 and 16

Solution

to Base	Number (Quotient)	Remainder
2	34	
2	17	0
2	8	1
2	4	0
2	2	0
2	1	0
	0	1

The binary equivalent of $(34)_{10}$ is $(100010)_2$

0.4674
x 2
0.9348
x 2
1.8696
x 2
1.7392
x 2
1.4784
x 2
0.9568
x 2
1.8136

The binary equivalent of $(0.4674)_{10}$ is $(.011101)_2$

The binary equivalent of $(34.4674)_{10}$ is $(100010.011101)_2$

The octal equivalent of 34.4674 is as follows:

to Base	Number (Quotient)	Remainder
8	34	
8	4	2
	0	4

The octal equivalent of $(34)_{10}$ is $(42)_8$

0.4674
x 8
3.7392
x 8
5.9136
x 8
7.3088
x 8
2.4704

The octal equivalent of $(0.4674)_{10}$ is $(.3572)_8$

The octal equivalent of $(34.4674)_{10}$ is $(42.3572)_8$

The Hexadecimal equivalent of 34.4674 is as follows

to Base	Number (Quotient)	Remainder
16	34	
16	4	2
	0	2

The hexadecimal equivalent of $(34)_{10}$ is $(22)_{16}$

0.4674
x 16
28044
4674x
9.4784
x 16
28704
4784x
7.6544
x 16
39264
6544x
10.4904
x 16
29424
4904x
7.8464

The hexadecimal equivalent of $(0.4674)_{10}$ is $(.97A7)_{16}$

The hexadecimal equivalent of $(34.4674)_{10}$ is $(22.97A7)_{16}$

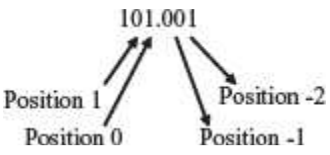
2. Conversion of Binary, Octal Hexadecimal to Decimal

A binary, octal or hexadecimal number has two parts—integer part and fraction part. For example, a binary number could be 10011, 0.011001 or 10011.0111. The numbers 45, .362 or 245.362 are octal numbers. A hexadecimal number could be A2, .4C2 or A1.34. The method used for the conversion of integer part and fraction part of binary, octal or hexadecimal number to decimal number is the same; multiplication operation is used for the conversion. The conversion mechanism uses the face value and position value of digits. The steps for conversion are as follows

i. Find the sum of the ***Face Value * (fromBase)positio*** for each digit in the number.

ii. In a non-fractional number, the rightmost digit has position 0 and the position increases as we go towards the left.

iii. *In a fractional number, the first digit to the left of decimal point has position 0 and the position increases as we go towards the left. The first digit to the right of the decimal point has position –1 and it decreases as we go towards the right (−2,−3, etc.)*



Example 5: Convert 1011 from Base 2 to Base 10.

Convert 62 from Base 8 to Base 10.

Convert C15 from Base 16 to Base 10.

1011 fromBase 2 toBase 10	62 fromBase 8 toBase 10	C15 fromBase 16 toBase 10
$1011 = 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0$ $= 1*8 + 0*4 + 1*2 + 1*1$ $= 8 + 0 + 2 + 1$ $= 11$	$62 = 6*8^1 + 2*8^0$ $= 6*8 + 2*1$ $= 48 + 2$ $= 50$	$C15 = C*16^2 + 1*16^1 + 5*16^0$ $= 12*256 + 1*16 + 5*1$ $= 3072 + 16 + 5$ $= 3093$
The decimal equivalent of $(1011)_2$ is 11.	The decimal equivalent of $(62)_8$ is 50.	The decimal equivalent of $(C15)_{16}$ is 3093

Example 6: Convert .1101 from Base 2 to Base 10.

Convert .345 from Base 8 to Base 10.

Convert .15 from Base 16 to Base 10.

.1101 fromBase 2 toBase 10	.345 fromBase 8 toBase 10	.15 fromBase 16 toBase 10
$.1101 = 1*2^{-1} + 1*2^{-2} + 0*2^{-3} + 1*2^{-4}$ $= 1/2 + 1/4 + 0 + 1/16$ $= 13/16$ $= .8125$	$.345 = 3*8^{-1} + 4*8^{-2} + 5*8^{-3}$ $= 3/8 + 4/64 + 5/512$ $= 229/512$ $= .447$	$.15 = 1*16^{-1} + 5*16^{-2}$ $= 1/16 + 5/256$ $= 21/256$ $= .082$
The decimal equivalent of $(.1101)_2$ is .8125	The decimal equivalent of $(.345)_8$ is .447	The decimal equivalent of $(.15)_{16}$ is .082

Example 7: Convert 1011.1001 from Base 2 to Base 10.

Convert 24.36 from Base 8 to Base 10.

Convert 4D.21 from Base 16 to Base 10.

1011.1001 fromBase 2 toBase 10	24.36 fromBase 8 toBase 10	4D.21 fromBase 16 toBase 10
		$4D.21 = 4*16^1 + D*16^0 + 2*16^{-1} + 1*16^{-2}$
$1011.1001 = 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0 + 1*2^{-1} + 0*2^{-2} + 0*2^{-3} + 1*2^{-4}$	$24.36 = 2*8^1 + 4*8^0 + 3*8^{-1} + 6*8^{-2}$	
$= 8 + 0 + 2 + 1 + 1/2 + 0 + 0 + 1/16$	$= 16 + 4 + 3/8 + 6/64$	$= 64 + 13 + 2/16 + 1/256$
$= 11 + 9/16$	$= 20 + 30/64$	$= 77 + 33/256$
$= 11.5625$	$= 20.4687$	$= 77.1289$
The decimal equivalent of $(1011.1001)_2$ is 11.5625	The decimal equivalent of $(24.36)_8$ is 20.4687	The decimal equivalent of $(4D.21)_{16}$ is 77.1289

3. Conversion of Binary to octal and Hexadecimal

A binary number can be converted into octal or hexadecimal number using a shortcut method. The shortcut method is based on the following information—

i. An octal digit from 0 to 7 can be represented as a combination of 3 bits, since $2^3 = 8$.

ii. A hexadecimal digit from 0 to 15 can be represented as a combination of 4 bits, since $2^4 = 16$.

The Steps for Binary to Octal Conversion are—

i. Partition the binary number in groups of three bits, starting from the right-most side.

ii. For each group of three bits, find its octal number.

iii. The result is the number formed by the combination of the octal numbers.

The Steps for Binary to Hexadecimal Conversion are—

i. Partition the binary number in groups of four bits, starting from the right-most side.

ii. For each group of four bits, find its hexadecimal number.

iii. The result is the number formed by the combination of the hexadecimal numbers.

Example 8: Convert the binary number 1110101100110 to octal.

i. Partition binary number in groups of three bits, starting from the right-most side.

1 110 101 100 110

ii. For each group find its octal number.

1	110	101	100	110
1	6	5	4	6

iii. The octal number is 16546.

Example 9: Convert the binary number 1110101100110 to hexadecimal

Given binary number 1110101100110

i. Partition binary number in groups of four bits, starting from the right-most side.

1	1101	0110	0110

ii. For each group find its hexadecimal number.

1	1101	0110	0110
1	D	6	6

iii. The hexadecimal number is 1D66.

4. Conversion of Octal, Hexadecimal to Binary

The conversion of a number from octal and hexadecimal to binary uses the inverse of the steps defined for the conversion of binary to octal and hexadecimal.

The Steps for Octal to Binary Conversion are—

1. Convert each octal number into a three-digit binary number.
2. The result is the number formed by the combination of all the bits.

The Steps for Hexadecimal to Binary Conversion are—

1. Convert each hexadecimal number into a four-digit binary number.
2. The result is the number formed by the combination of all the bits.

Example 9: Convert the hexadecimal number 2BA3 to binary.

i. Given number is 2BA3

ii. Convert each hexadecimal digit into four digit binary number.

2	B	A	3
0010	1011	1010	0011

iii. Combine all the bits to get the result 0010101110100011.

Example 10: Convert the octal number 473 to binary.

i. Given number is 473

ii. Convert each octal digit into three digit binary number.

4	7	3
100	111	011

iii. Combine all the bits to get the result 100111011.

7.5. Further Activity

Calculate the number conversion of the following

a) Convert 1011.1001 from Base 2 to Base 10.

b) Convert 24.36 from Base 8 to Base 10.

c) Convert 4D.21 from Base 16 to Base 10.

7.6. Further Reading

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

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i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.

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Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LESSON 8: THE INTERNET

8.1. Introduction

Internet is defined as an interconnection of networks. The Internet allows computers on different kinds of networks to interact with each other.

In this lesson you will learn about the internet. The lecture will cover the following sections:

i. Introduction
ii. Expected Learning outcomes
iii. The history of computer
iv. Internet services
v. Uses of Internet

8.2 Expected Learning Outcomes

At the end of this lecture you should be able to:

i. Define the term internet
ii. Explain the history of internet
iii. Explain the services of internet
iv. Discuss uses of internet

8.3. Brief History of the Internet

E-tivity 8.3.1: History of the Internet

Numbering, pacing and sequencing	**8.3.1**
Title	**Brief history of the internet**

Purpose	This e-tivity will help you understand the origin of the internet.
Summary of overall task	Watch the video and make short points to correlate with what is in this lecture
Spark	Computers are connected like a spider web.
Individual task	1. When was the internet invented?
Interaction begins	f) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	29. Ensure that learners are focused on the contents and context of discussion. 30. Stimulate further learning and generation of new ideas. 31. Provide feedback on the learning progress. 32. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Internet services

The Internet has evolved from a research prototype project to a full-grown commercial computer communication system.

The networking of computers has its origin at the US Department of Defense Advanced Research Projects Agency (DARPA).

- During 1970's DARPA developed the ARPANET as a WAN to connect different computers and later to connect computers on different networks (Internetworking). Internetworking became the focus of research at ARPA and led to the emergence of Internet. During their research, DARPA set up design goals for themselves, which included—(1) the ability to interconnect different types of network, (2) to connect through

alternate paths if some path gets destroyed, and (3) to support applications of various types like audio, video, text etc.

- Based on the design goals, a protocol named *Transmission Control Protocol/Internet Protocol (TCP/IP)* was developed for computer communication (*Protocol* is a network term used to indicate the set of rules used by a network for communication). TCP/IP has become the protocol for Internet.
- In late 1970s, the US National Science Foundation (NSF) designed a successor to ARPANET, called NSFNET, which was open for use to all university research groups, libraries and museums. This allowed scientists across the country to share data and interact with each other for their research projects. Internet grew exponentially when ARPANET was interconnected with NSFNET.
- In 1980s, many Internet applications like electronic mail, newsgroups, file transfer facilities and remote login were developed. The *Electronic mail* facility allowed users to compose, send, and receive messages. Users having common interests could exchange messages using forums like *Newsgroups*. The Telnet command allowed users to log in to a remote computer. The File *Transfer Protocol* program was used to copy files from one computer to another on the Internet.
- In the early 1990s, a new application World Wide Web (WWW) changed how Internet was used. *WWW* is a system of creating, organizing, and linking documents, and was created by British scientist Tim Berners Lee. A protocol based on hypertext was developed that allowed the documents and content on WWW to be connected via hyperlink.
- In 1993, Marc Andreessen at the University of Illinois developed the *Mosaic browser*. The WWW along with the browser made it possible to set up a number of web pages that may consist of text, pictures, or sound, and with links to other pages.

8.4. Internet Services

Over the years, the Internet has grown as the biggest network for communication and provides several services to its users. Each service has its own features and uses. Some of the important services provided by the Internet are—World Wide Web, electronic mail, news, chat, and discussion groups.

a) World Wide Web

WWW (also called as *Web*) is a large-scale, online store of information. It is a system of creating, organizing, and linking of documents. Information is stored on WWW as a collection of documents that are interconnected with each other via links. The interconnected documents may be located on one or more than one computer, worldwide, thus, the name World Wide Web.

✓ Web Browser

Web Browser (or browser) is a software program that extracts information on user request from the Internet and presents it as a web page to the user. It is also referred to as the user interface of the web. Some of the popular web browsers are—Internet Explorer from Microsoft, Mosaic browser, Google's chrome, Mozilla, and Netscape Navigator from Netscape Inc. e.t.c.

- ✓ **Uniform Resource Locator (URL)**

A web page on the Internet is uniquely identified by its address, called URL. URL is the address on the Internet at which the web page resides. The user uses this address to get a web page from the Internet.

The general form of URL is: protocol://address/path

Example http://www.dsc.com/mainpage

- ✓ **Internet Search Engines**

Internet Search engines or *Search engines* are specific web sites that help the users to find information stored on the Internet. Search engines search the Internet based on some important words (keywords) or combinations of words. Some of the search engines are google, yahoo, Bing e.t.c.

b) Electronic Mail (E-Mail)

Electronic mail (E-mail) is an electronic message transmitted over a network from one user to another. E-mail is a text-based mail consisting of lines of text, and can include attachments such as audio messages, pictures and documents. The features of e-mail are as follows:

- E-mail can be sent to one person or more than one person at the same time.
- Communicating via e-mail does not require physical presence of the recipient. The recipient can open the e-mail at his/her convenience.
- Since messages are transmitted electronically, e-mail is a fast way to communicate with the people in your office or to people located in a distant country, as compared to postal system.
- E-mail messages can be sent at any time of the day.
- A copy of e-mail message that the sender has sent is available on the sender's computer for later reference.
- In addition to sending messages, e-mail is an ideal method for sending documents already on the computer, as attachments.

c) Terminal Network

Telnet uses the telecommunication network facility that allows a computer to access the contents of another computer (also called host computer). A telnet program allows the user to access or edit files, or, issue or execute commands on the host computer. Telnet is widely used by libraries, to allow visitors to look up information, find articles, to access the computer of your office from home, etc.

d) News

News includes tens of thousands of newsgroups. Each newsgroup is focused to a specific topic for discussion. People who are interested in the topic, post their articles or views on it for others to read. People can read articles and also respond to articles.

e) Internet Relay Chat (IRC)

IRC allows users to communicate in real time by typing text in a special window. This means that other users with whom you chat are present online on their computers. It is an instant sending and

receiving of message, unlike e-mail where the receiver may not be on-line when the e-mail message is sent.

8.5. Uses Of Internet

Different people use internet for different purposes. Some uses of the internet are listed below:

- **E-Commerce** (auction, buying, selling products etc.)
- **Research** (on-line journals, magazines, information etc.)
- **Education** (e-learning courses, virtual classroom, distance learning)
- **E-Governance** (online filing of application (Income Tax), on-line application forms etc.)
- **On-line ticket booking** (airplane tickets, rail tickets, cinema hall tickets etc.)
- **On-line payments** (credit card payments etc.)
- **Video conferencing**
- Exchange of views, music, files, mails, folders, data, information etc.
- **Outsourcing jobs** (work flow software)
- Social networking (sites like facebook, linkedin, twitter, Whatsapp, Snapchat etc)
- **E-Telephony** (sites like skype)

8.6 Further Activity

1. Define internet
2. Discuss uses of internet

8.7. Summary

In this lecture you have learnt about the internet. Since its inception internet has been one of the blessing from computer technology to humanity. The internet offers numerous services and uses to human.

8.8. References

Recommended reference

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7
ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751
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LECTURE 9: COMPUTER SECURITY

9.1. Introduction

We all like to be secure in our home, office, locality, city, country, and in this world. We use different mechanisms to ensure our security. Inside our homes, we keep our valuables safely locked in a cupboard that is accessible by the elders of the house; we keep the gates of our house bolted and even have an intrusion-detection system installed. We have high walls and gates surrounding our locality and also a watchman who guards the open gates. We have police for our security within a city and armed forces for the country. We take all these measures to make ourselves and our valuables, resources, possessions secure.

The widespread use of computers has resulted in the emergence of a new area for security-security of computer. Computer security is needed to protect the computing system and to protect the data that they store and access. Transmission of data using network (Internet) and communication links has necessitated the need to protect the data during transmission over the network. Here, we use the term computer security to refer to both the computer security and the network security.

In this lecture you will cover the following:

i. Learning objectives
ii. Services of security
iii. Common malware
iv. Summary
v. References

9.2. Expected Learning Outcome

At the end of this lecture, you should be able to:

i. Define the term security
ii. Explain the five services of security

9.3. Services of Security

Computer security provides the following five services:

Confidentiality—The confidentiality aspect specifies availability of information to only authorized users. In other words, it is the protection of data from unauthorized disclosure. It requires ensuring the privacy of data stored on a server or transmitted via a network, from being

intercepted or stolen by unauthorized users. Data encryption stores or transmits data, in a form that unauthorized users cannot understand. Data encryption is used for ensuring confidentiality.

Integrity—It assures that the received data is exactly as sent by the sender, i.e. the data has not been modified, duplicated, reordered, inserted or deleted before reaching the intended recipient. The data received is the one actually sent and is not modified in transit.

Authentication—Authentication is the process of ensuring and confirming the identity of the user before revealing any information to the user. Authentication provides confidence in the identity of the user or the entity connected. It also assures that the source of the received data is as claimed. Authentication is facilitated by the use of username and password, smart cards, biometric methods like retina scanning and fingerprints.

Non-Repudiation prevents either sender or receiver from denying a transmitted message. For a message that is transmitted, proofs are available that the message was sent by the alleged sender and the message was received by the intended recipient. For example, if a sender places an order for a certain product to be purchased in a particular quantity, the receiver knows that it came from a specified sender. Non-repudiation deals with signatures.

Availability—It assures that the data and resources requested by authorized users are available to them when requested.

9.4. Malicious Software

The software that is intentionally included in a system to harm the system is called *malicious software*. Viruses, Trojan horses, and Worms are examples of malicious programs. Javascripts and Java applets written to attack, are also malicious programs.

- **Virus**

Virus is a software program that is destructive in nature. Virus programs have the following properties:

- ✓ It can attach itself to other healthy programs.
- ✓ It can replicate itself and thus can spread across a network.
- ✓ It is difficult to trace a virus after it has spread across a network.
- ✓ Viruses harm the computer in many ways—
  - corrupt or delete data or files on the computer,
  - change the functionality of software applications,
  - use an e-mail program to spread itself to other computers,
  - erase everything on the hard disk, or,
  - degrade performance of the system by utilizing resources such as memory or disk space.
- ✓ Virus infects an executable file or program. The virus executes when a program infected with the virus is executed or you start a computer from a disk that has infected system files.
- ✓ Once a virus is active, it loads into the computer's memory and may save itself to the hard drive or copies itself to applications or system files on the disk.

- ✓ However, viruses cannot infect write-protected disks or infect written documents. Viruses do not infect an already compressed file. Viruses also do not infect computer hardware; they only infect software.
- ✓ Viruses are most easily spread by attachments in e-mail messages. Viruses also spread through download on the Internet.

- ➢ **Worms**

Worm is self-replicating software that uses network and security holes to replicate itself. A copy of the worm scans the network for another machine that has a specific security hole. It copies itself to the new machine using the security hole, and then starts replicating from there, as well. A worm is however different from a virus. A worm does not modify a program like a virus, however, it replicates so much that it consumes the resources of the computer and makes it slow. Some examples of worms are—"Code Red" and "Nimda".

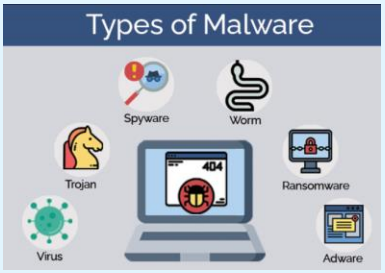
- ➢ **Trojan Horse**

Trojan horse is destructive programs that masquerade as useful programs. The name "Trojan horse" is given because of the Greek soldiers who reached the city of Troy by hiding themselves inside a large wooden horse. The people of the city of Troy themselves pulled the horse inside their city, unaware of the fact that the Greek soldiers were hiding inside the horse.

Similarly, users install Trojan horses thinking that it will serve a useful purpose such as a game or provide entertainment. However, Trojan horses contain programs that corrupt the data or damage the files. Trojan horses can corrupt software applications. They can also damage files and can contain viruses that destroy and corrupt data and programs. Trojan horse does not replicate themselves like viruses.

E-tivity 9.4.1: Malware

Numbering, pacing and sequencing	**9.4.1**
Title	**Computer Malware**
Purpose	This e-tivity will expose you to various malicious software in computing.
Summary of overall task	Read the article on common malware and make short notes to supplement what is in this lecture.

Spark	
Individual task	1. Define a malware 2. List five types of malware
Interaction begins	g) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	33. Ensure that learners are focused on the contents and context of discussion. 34. Stimulate further learning and generation of new ideas. 35. Provide feedback on the learning progress. 36. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Careers in computing

9.5. Further Activity

i. Define computer security
ii. How can you counter computer malware

9.6. Summary

In this lecture you have learnt the types of malware and their countermeasures. Malicious individuals write computer programs with an intention to disrupt the smooth operations of a computer. There is need to protect ourselves from malicious programs.

9.7. References

Recommended reference

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

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Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LECTURE 10: CAREERS AND CERTIFICATION IN COMPUTING

10.1. Introduction

Computer science offers various careers to students who pursue the course. There are several careers you can pursue in computer science. In this lecture, you will be introduced to some of the common careers and certifications.

The lecture is organized as follows:

i. Expected Learning outcomes
ii. Careers in computing
iii. Certifications in computing

10.2. Expected Learning outcomes

At the end of this lecture you should be able to:

i. Explain careers in computing
ii. Discuss certifications on computing

10.3. Careers in Computing

i. **Programmer-** this involves developing computer programs by use of various programming languages. E.g Java, C++, PHP/HTML, Javascript, Python, C#, C etc.
ii. **Database Administrator-** one can be a database developer and administrator. This career involves developing new databases and maintaining the existing ones. This is is done by use of languages such as Structured Query Language (SQL) and the database supported by MySQL, Access, MS-SQL Server etc
iii. **Computer Security-** This career deals with providing computer systems security.
iv. **Lecturer-** One can pursue a career in lecturing or teaching Computer Science in Universities, colleges and secondary schools.
v. **Network Administrator-** a network administrator addresses all issues pertaining to designing, implementing and ensuring the network (internet) is working properly.

vi. **Computer technician-** this career deals with the hardware repair of the computer.

E-tivity 10.3.1: Careers in computing

Numbering, pacing and sequencing	10.3.1
Title	**Careers in computing**
Purpose	This e-tivity will expose you to some of the careers available to you as a computer scientist
Summary of overall task	Read the article careers in computer science.
Spark	What will you become after completing your course?
Individual task	Discuss two careers in computing
Interaction begins	h) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	37. Ensure that learners are focused on the contents and context of discussion. 38. Stimulate further learning and generation of new ideas. 39. Provide feedback on the learning progress. 40. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	Purchasing a computer

10.4. Certifications in Computing

Certifications can be used to demonstrate proficiency in certain CS languages, platforms and software or industry standards. They can range widely in terms of time to completion, as well as in what kind of education or experience are required to enroll.

i. **Cisco Certified Network Associate (CCNA)-** Validates skills needed to operate, install, configure and troubleshoot a small- to medium-sized network. **Designed for:** Network Specialists, Network Administrators and Network Support Engineers with one to three years experience.

ii. **Certified Ethical Hacking (CEH)-** it was developed to help security experts detect vulnerabilities like hackers and assist companies patch these vulnerabilities.

iii. **Certified Information Security Manager (CISM)-** this one is geared toward the managers who implement IT and security policy, not the hands-on IT professional. Many people who receive this certification are security directors, managers, consultants and chief compliance officers.

iv. **Certified Information Systems Auditor-** People whose job responsibilities include auditing, monitoring, controlling, and/or assessing IT and/or business systems are who CISA is targeted at, and it tests ability to manage vulnerabilities, ensure compliance with and propose controls, processes, and updates to a company's policies, and ensure compliance with accepted IT and business standards.

v. **IT_Infrastructure Library (ITIL)-** to standardize IT management by compiling a set of best practices for aligning the services IT provides to the organization it serves. They called it the IT Infrastructure Library (ITIL®) and it is a paper library; it's a set of books that cover everything from availability and capacity management to change and incident management as well as application and IT operations management.

10.5. Further Activity

3. Apart from what you have learnt in this lecture what other emerging careers are there for you as a computer scientist?

10.11. Summary

In this lecture, you have been exposed to various careers and certifications available to you as a computer scientist. Certification gives a professional industry recognition in addition to the academic certificate in computer science or related course.

10.12. References

Recommended reference

Reference Textbook

iv. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

v. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

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Recommended Reference Journals

ii. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373

LECTURE 11: PURCHASING A COMPUTER

11.1. Introduction

Most individuals buy computers for personal use as well as for business use. Students purchase computers too, for academic purposes. However, most people are not well versed with the requirements of a computer before purchasing.

In this lecture, you will learn some of the factors to consider when purchasing a computer. The lecture will be organized as follows:

i. Introduction
ii. Expected learning outcomes
iii. Factors to consider
iv. Summary
v. Further activity
vi. References

11.2. Expected Learning Outcomes

At the end of this lecture you should be able to:

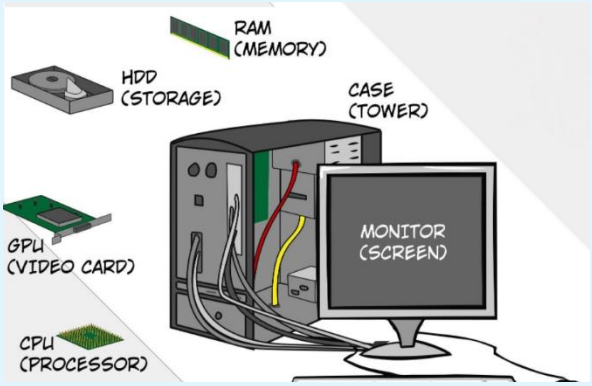
v. Apply the knowledge to purchase a computer
vi. Discuss factors to consider when purchasing a computer

11.3. Factors to Consider

When buying a computer several factors need to be looked into. The following factors can be considered when buying a computer.

Etivity: 11.3.1. Purchasing a Computer

Numbering, pacing and sequencing	11.3.1
Title	**Factors to consider when buying a computer**

Purpose	This e-tivity will help you get an understanding of factors to consider when purchasing a computer.
Summary of the overall task	Visit the website provided and read more about factors to consider when buying a computer.
Spark	
Individual task	1. What are the necessary factors to consider when buying a computer as computer scientist?
Interaction begins	i) Post your responses in the discussion section and respond to other comments from your class members in Forum
E-moderator interventions	41. Ensure that learners are focused on the contents and context of discussion. 42. Stimulate further learning and generation of new ideas. 43. Provide feedback on the learning progress. 44. Close the e-tivity
Schedule and time	This activity will take 30 minutes
Next	The end of the module

i. Usability

It is important that you first consider the tasks that you will be performing on your PC. If you wish to buy a computer for simply browsing the internet and using some online services then it might be better to buy a single-core computer that satisfies your minimum requirements. On the contrary, if you require using it for heavy video editing and professional work, then it might be better to buy a system that has enhanced multimedia options.

ii. Hard disk capacity

Hard Disk considerations might not mean much to a lay user, nonetheless, having the right amount of disk space and disk type might be necessary for the efficient management of regular tasks for a professional. A common user may merely have to decide between buying a 120GB or 320 GB hard disk system.

iii. RAM

Essentially, the more rams you have, the more browsers and applications you can open. 4Gb is the most basic nowadays. 8GB is the sweet spot for most people. If you are a gamer, photo or video editor, or planning to do CAD/CAM work, you need at least 16GB of Ram

iv. Processor

The Processor is one of the most important parts of a system and can mean the difference between a system that frequently hangs and the one that runs smoothly. Some people might think that going for the low cost single core or Dual Core processors is a good idea but I would not recommend either of them for anyone who requires using a system for more than basic usage.

v. Budget/available Money

This brings us to our next consideration of price. There might be some very fancy features that you want in your new PC. However, if you don't have the cash to pay for lets say a graphic card with 1GB memory, than you might be better off choosing suitable alternatives.

11.4. Further Activity

i. Read more material on computer specifications necessary for a computer science program.

11.5. Further Reading

In this lecture, you have learned about factors to consider when purchasing a computer. Computer are bought to be used for various purposes. These purposes determine some of the factors to consider when purchasing one.

11.6. References

Recommended reference

Reference Textbook

i. Rajaraman, V. (2018). Introduction to Information Technology (3rd Edition). PHI Learning. ISBN 978– 93– 87472– 29– 7

ii. David, R. (2016). A Balanced Introduction to Computer Science (3rd Edition). Pearson, ISBN 978– 0132166751

iii. David, E. (2011). Introduction to computing, Explorations in Language, Logic, and Machines. CreateSpace Independent. ISBN– 10: 1463687478

Core Journals

i. Journal of Computer and System Science. ISSN: 0022-000 https://www.journals.elsevier.com/journal-of-computer-and-system-sciences

ii. Journal of Computers ISSN: 1796-203X. http://www.jcomputers.us/

Recommended Reference Textbooks

i. Stallings, W. (2013). Data and Computer Communications, 8th Edition. Prentice Hall. ISBN– 10: 0131006819. ISBN– 13: 9780131006812.

ii. French, C. S. (2013). Computer Science. (5th Edition). Thomson Learning. ISBN– 13: 9780826454607. ISBN: 0826454607.

Recommended Reference Journals

i. International Journal of Foundations of Computer Science ISSN (print): 0129– 0541 | ISSN (online): 1793– 6373