

COMPUTER STORAGE (TERMS)

Reading is the process of transferring data, instructions, and information from a storage medium into memory.

Writing is the process of transferring these items from memory to a storage medium.

Memory is a temporary area for holding data, instructions, and information.

Storage capacity refers to how much data a storage medium is able to hold.

Access time Refers to the time it takes to locate an item on a storage medium.

Storage medium refers to the physical material on which a computer keeps data.

Storage device refers to hardware components that are used to record and retrieve data to and from a storage medium

Transfer rate This refers to the speed at which data is transferred from one device to another.

Data/information access mode

Refers to how an item can be accessed on a medium either sequentially or randomly.

There are two type of data access modes i.e

- **Direct/random access mode**

This is a mode of access in which data items are accessed without following any sequence.

- **Sequential access mode**

This is a type access in which data items are accessed in order from the first to the last.

CLASSIFICATION OF STORAGE

FACTORS CONSIDERED IN CLASSIFYING STORAGE

Amount of data stored.

Method of data access.

Technology used to store data.

Whether the medium is fixed or removable

Whether the storage device is internal or external

Whether the storage device can hold data for a short time or for a long period of time?

Whether storage device is fast or slow to access

Whether the storage capacity of device can be expanded or not.

MEMORY (INTERNAL/PRIMARY STORAGE)

- A computer's memory in the system unit is located physically close to the CPU to decrease access time.
- It provides the CPU with a working storage area for program instructions, data and information.
- Memory is also known as primary storage or internal storage.
- Memory usually consists of one or more chips on the motherboard.

TYPES OF MEMORY:

- The system unit contains two types of memory: volatile and nonvolatile.
- The contents of *volatile memory* are lost when the computer power is turned off.
- *The contents* of nonvolatile memory are not lost when power is turned off.
- RAM is the most common type of volatile memory.
- Examples of nonvolatile memory include ROM, flash memory, and CMOS.
- Below, we discuss these types of memory.

(RAM)

- *Random Access Memory (RAM) chip is the memory chips that are mounted directly on the motherboard or mounted on peripheral cards that plug into the motherboard.*
- When the computer is powered on, certain operating system files are loaded from a storage device such as a hard disk into RAM. These files remain in RAM as long as the computer is running. As additional programs and data are requested, they are read from storage into RAM. The processor acts upon the data while it is in RAM. During the running time, the contents of RAM may change as the program is executed.

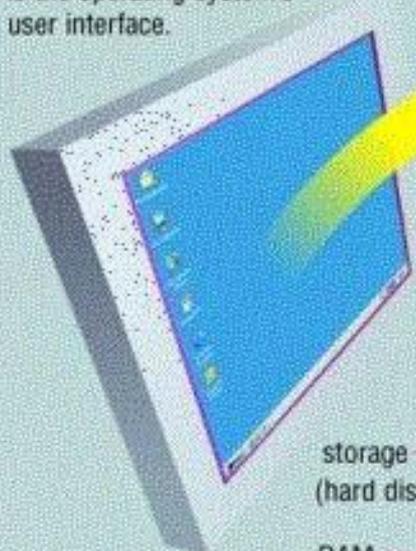
RANDOM ACCESS MEMORY (RAM)

- The amount of RAM a computer requires often depends on the types of applications you plan to use on the computer. A computer only can manipulate data that is in memory. A computer needs a certain amount of memory to store programs, data and information.
- The more RAM a computer has, the faster the computer will respond.
- A software package usually indicates the minimum amount of RAM it requires. RAM in computers purchased today ranges from 128MB, 512MB, 1GB to 64GB.

How program instructions transfer in and out of RAM

Step 1:

When your computer is running, certain operating system files are in RAM. Shown here is the operating system's user interface.



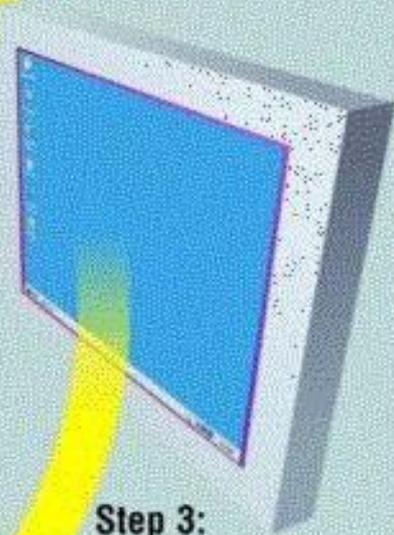
Step 2:

When you start a word processing program such as Word, the program loads into RAM from a hard disk. As you create a document, it is in RAM and displays on your screen.



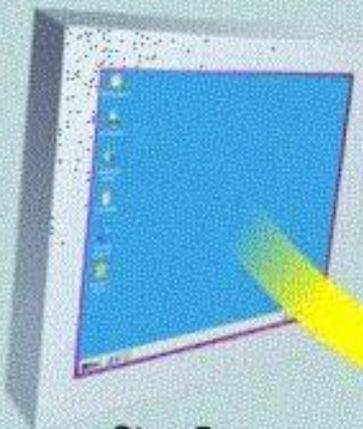
storage
(hard disk)

RAM



Step 3:

When you quit Word, RAM may be used to store another program or data. Word is removed from your screen, and the operating system's user interface redisplay.



Step 5:

When you quit Excel, RAM may be used to store another program or data. Excel is removed from your screen and the operating system's user interface redisplay.



Step 4:

When you start a spreadsheet program such as Excel, the program loads into RAM from a hard disk. As you create a spreadsheet, it is in RAM and displays on your screen.

BASIC TYPES OF RAM

- **Dynamic RAM (DRAM)** must be refreshed (or recharged) constantly by the CPU static RAM, and
- **Static RAM (SRAM)** is faster and more reliable than any form of DRAM. The term static refers to the fact that it does not have to be re-energized as often as DRAM.
- **Magneto resistive RAM (MRAM)**, stores data using magnetic charges instead of electrical charges. MRAM has greater storage capacity, consumes less power, and has faster access times.
- **Virtual RAM (VRAM)**: Modern operating systems can use spare storage space on the hard disk as if it is working memory and this is referred to as Virtual memory or Virtual RAM

READ-ONLY MEMORY (ROM)

- *Read-only memory (ROM) chip refers to memory chips storing permanent data and instructions. I.e. the items stored in ROM chips cannot be modified—then, the name read-only. ROM is usually nonvolatile.*
- In ROM, the combination of circuit states is fixed, and therefore its contents are not lost if the power is removed. The data, instructions, or information stored on ROM chips often are recorded when the chip is manufactured.
- ROM chips that contain permanently written data, instructions, or information are called *firmware*. *Firmware can be read and used, but cannot be changed by user.*

BASIC TYPES OF ROM

- Programmable read-only memory (**PROM**) is a blank ROM chip on which you can permanently place data and programs. Once the data and instructions are programmed into PROM chip, the chip functions like a regular ROM and cannot be erased or changed.
- A variation of the PROM chip, called erasable programmable read-only memory (**EPROM**) chip, allows a programmer to erase with ultra violet rays.
- A variation of the PROM chip, called electrically erasable programmable read-only memory (**EEPROM**) chip, allows a programmer to erase the microcode with an electric signal.

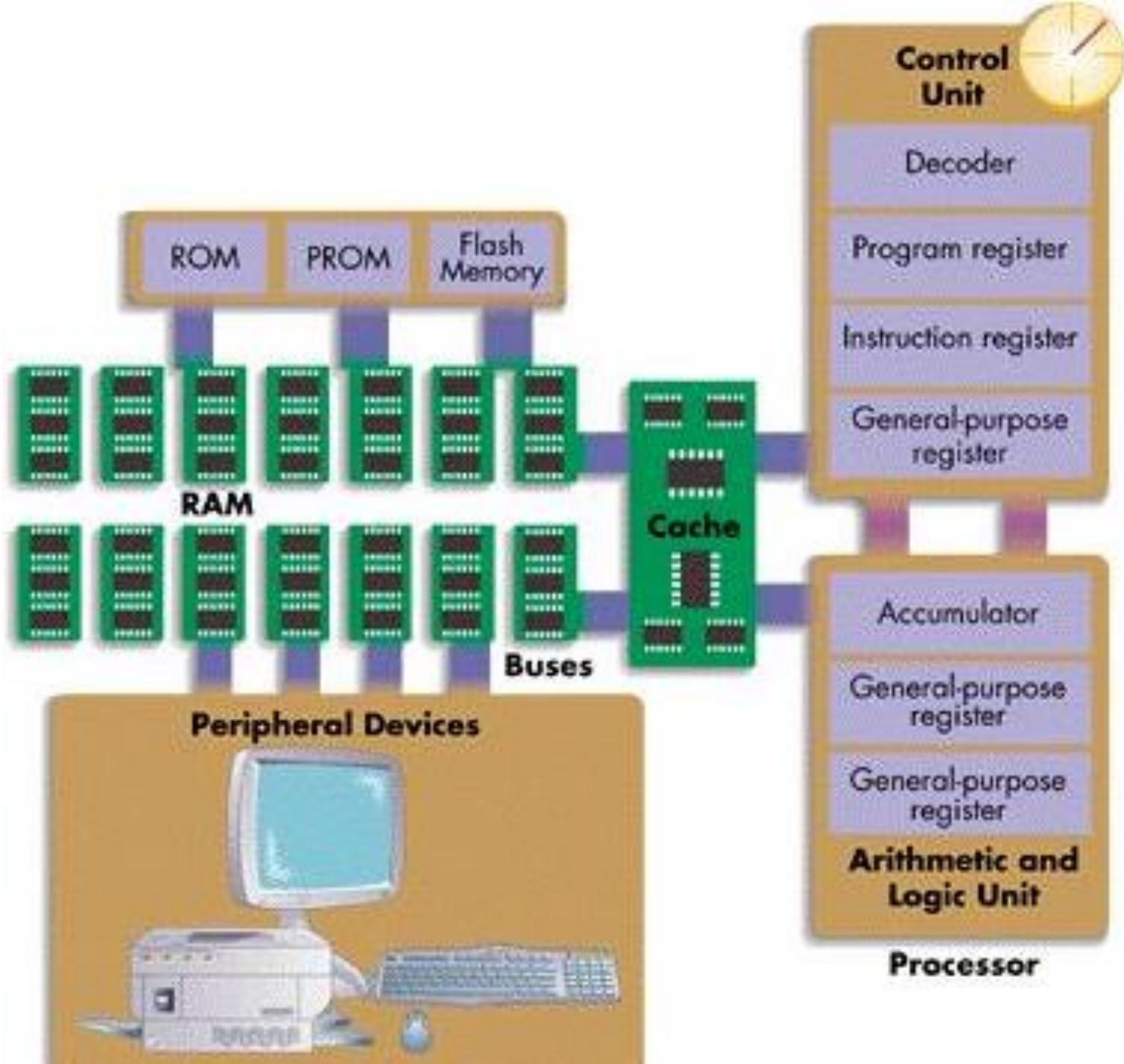
DIFFERENCES BETWEEN RAM AND ROM

| RAM | ROM |
|---|---|
| 1. Volatile, temporally | 1. Non Volatile, permanent |
| 2. Contents lost when power goes off | 2. Contents remain when power goes off |
| 3. Read and Write | 3. Read Only |
| 4. Can be increased | 4. Cant be Increased |
| 5. Not installed at Factory | 5. Installed at Factory |

MEMORY CACHE

- A cache is a relatively small block of very fast memory designed for the specific purpose of speeding up the internal transfer of data and software instructions.
- Cache uses internal storage technologies that are much faster than conventional RAM.
- Cache speeds up processing time because it stores frequently used instructions and data.

The processor first checks cache, then RAM for needed data and instructions



FLASH MEMORY

- Flash memory is a chip also that keeps its contents when the power is shut off.
- Flash memory can be erased electronically and reprogrammed.
- Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents.

CMOS

- Complementary Metal-Oxide Semiconductor (CMOS) technology provides high speeds and consumes little power.
- CMOS technology uses battery power to retain information even when the power to the computer is off.
- Battery-backed CMOS memory chips, for example, can keep the calendar, date, and time current even when the computer is c



FUNCTIONS OF PRIMARY MEMORY

- To store programs and files under current use.
- To Store files needed for a complete boot process of the computer.
- To determine efficiency and performance of a computer.
- To provide extra space for the CPU while processing data by swapping files in and out of the hard drive.
- To enable users to recover work in memory for the last 5 minutes in case of a power cut.
- Very important for a user to take a purchase decision of a computer set

UNITS OF MEASURING COMPUTER MEMORY

- The smallest unit of measuring Computer Memory is a Binary digit (Bit)
- Binary digits are the numbers 1 and 0 which can be represented in a computer by switching voltage on and off.
- Eight little bits make one BYTE.
- The storage capacity of computers (RAM and ROM) and that of auxiliary storage units like disks are generally given in bytes.
- One BYTE stores approximately one character.

MEMORY MEASUREMENT UNITS

Bit: This is the smallest unit of memory measurement

Nibble: This is a group of four binary bits.

Byte: This is a set of eight bits. Each byte represents a character.

Kilobyte (KBs): This is a set of 1024 bytes.

Megabyte(MBs): This is a set of 1024 KBs.

Gigabyte(GBs): This is a set of 1024 MBs.

Terabyte(TBs): This is a set of 1024 GBs

MORE UNITS OF COMPUTER

MEMORY:

- Kilobyte (1K or 1 Kb) is $2^{10} = 1024$ bytes. (Approximately 1 thousand bytes)
- Megabyte (Mb) is $2^{10} = 1024$ Kilobytes or 2^{20} bytes, (Approximately 1 million bytes)
- Gigabyte (GB) is $2^{10} = 1024$ Megabytes or 2^{30} bytes, (Approximately 1 billion bytes)
- Terabyte (TB) is $2^{10} = 1024$ Gigabytes or 2^{40} bytes, (Approximately 1 trillion bytes)
- Other higher prefixes are Peta(2^{50}), Exa(2^{60}), Zetta(2^{70}), Yotta(2^{80}), approximately equal to 10^{15} , 10^{18} , 10^{21} , and 10^{24} bytes respectively.
- NB In computing today, the approximation 1024 to 1000 has brought about confusion and many manufactures quote a disk with 1,000,000,000 bytes as 1 GB (10^9) instead of 1,073,741,824 bytes (2^{30})

Examples and Exercises

I. How many bits are required to store the following words?

- a) COMPUTING
- b) BOYS' SCHOOL
- c) 36°C
- d) U.N.E.B

Examples and Exercises

- Q.2 Does a text document with 1,000,000 characters fit onto a 1.4 MB floppy disk?
- Q. 3 Arrange the elements below in terms of their relative size in ascending order:
 - a) Character > Document > Page > Word > Paragraph
 - b) Gigabyte > Kilobyte > Megabyte > Bit > Byte
- Q.4 Convert:
 - (i) 200 kb to bits
 - (ii) 5,120,000 Bytes to Megabytes
 - (iii) 2GB to kb

Answer Q4

- (ii) 5,120,000 Bytes to Megabytes
- Ans: 1 MB = 1000Kb = 1,024,000 bytes
- Therefore, 1 byte = MB
- So, 5,120,000 bytes = X5,120,000
- = 5MB
- (iii) 2GB to kb

Ans: 2,000,000

Computer Data representation & numbering systems

- Humans understand decimal (base ten) just because they have ten counting fingers.

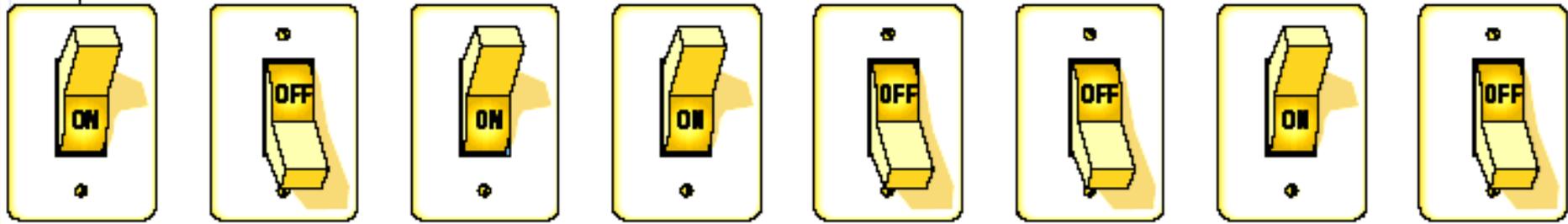


- Digital electronics (computers) understand binary because binary consists of only two digits which correspond to the two power states. 0 representing electrical charge OFF and 1 representing electrical charge ON.
- Octal (base 8) and Hexadecimal (base 16) number systems are used to represent complex binary data in a more compact form.

BINARY NUMBERING SYSTEM

- Binary is a numbering system that is a series of 1s and 0s only.
- The idea of binary was created in the 1600s.
- Binary has been used in nearly everything electronic; from calculators to supercomputers.
- Machine code language is in binary digits.

BINARY NUMBERING SYSTEM



- As an example the following bit pattern represents the word 'HELLO'.
- computer does all that at very high speed during typing and you only see the resulting 'HELLO' on screen.

H E L L O

01000001 00100110 01100101 01100101 00111111

BINARY CODING SCHEMES

- A binary coding scheme is a method used for representing all of the digits, letters, special characters, and control characters available to a digital computer using a combination of bits 0 and 1.
- The off/on 0s and 1s are arranged in such a way that they can be made to represent each character uniquely.
- In a binary number, a digit 0 or 1 is called a bit. For example, 1001 is a 4-bit binary number, and, 11000110 is an 8-bit binary number.
- There are three commonly used binary coding schemes: ASCII, EBCDIC and Unicode

ASCII:

- ASCII is an abbreviation for American Standard Code for Information Interchange.
- It is a character-encoding scheme based on the ordering of the English alphabet.
- ASCII-7 includes coding for $2^7 = 128$ characters
- ASCII-8 includes coding for $2^8=256$ characters.
- The name ASCII-8 is often used for binary codes that use all values in a full byte (8 binary digits).

EBCDIC

- The Extended Binary Coded Decimal Interchange Code (EBCDIC) uses 8 bits to represent a symbol in the data.
- EBCDIC was devised in the 1960s by IBM .
- EBCDIC allows $2^8 = 256$ combinations of bits.
- 256 unique symbols are represented using EBCDIC code.
- EBCDIC codes are used mainly, mainly on IBM mainframe and midrange computer systems.

UNICODE

- Unicode is a universal character encoding standard for the representation of text which also includes symbols in multi-lingual environments.
- Unicode uses 32 bits to represent a symbol in the data.
- Unicode allows $2^{32} = 4164895296$ (~ 4 billion) combinations.
- Unicode codes can uniquely represent any character or symbol present in any language like Chinese, Japanese etc.

CONVERTING FROM BINARY TO DECIMAL

- a) Multiply each bit of the **binary** number by its corresponding bit-weighting factor .
- b) Sum up all of the products in step (a) to get the decimal number.

- Eg: Covert 1011 binary to Decimal

- Soln: 1011 binary = $1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 +$
 $= 8 + 0 + 2 + 1$
 $= 11$

CONVERTING FROM BINARY TO DECIMAL

- a) Divide the decimal number by **2**; and record the remainder.
- b) If the quotation is zero, the conversion is complete. Otherwise repeat step (a) using the quotation as the decimal number. The new remainder is the next most significant bit of the **binary** number.

Convert 235 decimal to binary code

| B | N | R |
|---|-----|---|
| 2 | 235 | 1 |
| 2 | 117 | 1 |
| 2 | 58 | 0 |
| 2 | 29 | 1 |
| 2 | 14 | 0 |
| 2 | 7 | 1 |
| 2 | 3 | 1 |
| 2 | 1 | 1 |
| 2 | 0 | - |

So, 235 decimal = 11101011 binary

THE OCTAL NUMBERING SYSTEM

- The octal numeral system is a base 8 numeral system. It uses the numerals 0 through 7.
- At one time, the octal system was used mainly for work with computers. It provided an easier way to work with binary numbers. As computers changed from using 24-bit systems to 32- and 64-bit systems, hexadecimal replaced octal for most uses.
- The octal numeral system uses a three-bit binary coding. Each digit in an octal numeral is the same as three digits in a binary numeral. The grouping of the binary digits is done from right to left.

HEXADECIMAL NUMERAL SYSTEM

- The hexadecimal numeral system, also known as just hex, is a numeral system made up of 16 symbols (base 16).
- It uses the common symbols in the decimal numeral system (0 through 9) and includes six extra symbols. These symbols are characters taken from the English alphabet: A, B, C, D, E and F.
- The hexadecimal system replaced the octal numeral system for much of the work done on computers.

ADVANTAGES OF USING HEX

- Hexadecimal numbers are very compact .
- As computers become more advanced, they tend to use larger groups of bits but they use multiples of 8 (16, 24, 32, 64, etc).
- Hexadecimal makes it easier to write these large binary numbers.
- The hexadecimal, or base 16 number system is important to programmers because it's a shorthand way of writing out and inputting binary. It's simpler and easier because you can work with fewer symbols, or "numbers".
- It is easy to convert from hex to binary and binary to hex.
- Octal is similar to hexadecimal because they are both easily converted to binary. Where octal is equal to three-digit binary, hexadecimal is equal to four-digit binary.

| Decimal | Binary | Octal | Hexadecimal |
|----------------|---------------|--------------|--------------------|
| 0 | 0000 | 0 | 0 |
| 1 | 0001 | 1 | 1 |
| 2 | 0010 | 2 | 2 |
| 3 | 0011 | 3 | 3 |
| 4 | 0100 | 4 | 4 |
| 5 | 0101 | 5 | 5 |
| 6 | 0110 | 6 | 6 |
| 7 | 0111 | 7 | 7 |
| 8 | 1000 | 10 | 8 |
| 9 | 1001 | 11 | 9 |
| 10 | 1010 | 12 | A |
| 11 | 1011 | 13 | B |
| 12 | 1100 | 14 | C |
| 13 | 1101 | 15 | D |
| 14 | 1110 | 16 | E |
| 15 | 1111 | 17 | F |

Decimal, Binary, Octal and Hexadecimal Counting Table/ Chart

Examples

• 1. What is the octal and hexadecimal equivalent of:

• $111011101_{\text{binary}}$

• 10010101_{binary}

• 45_{decimal}

(b) What is the binary equivalent for :

• $1A4C_{\text{hex}}$

• 4553_{oct}

SECONDARY STORAGE

Secondary storage also called **auxiliary storage** is non-volatile storage that supports primary storage to keep large volumes of user and system data.

Secondary storage media include;

- **Flash disks,**
- **CD-ROM,**
- **CD-R,CD-RW,**
- **DVD, Blu-ray,**
- **Hard disks,**
- **Floppy disks,**
- **memory cards. etc.**

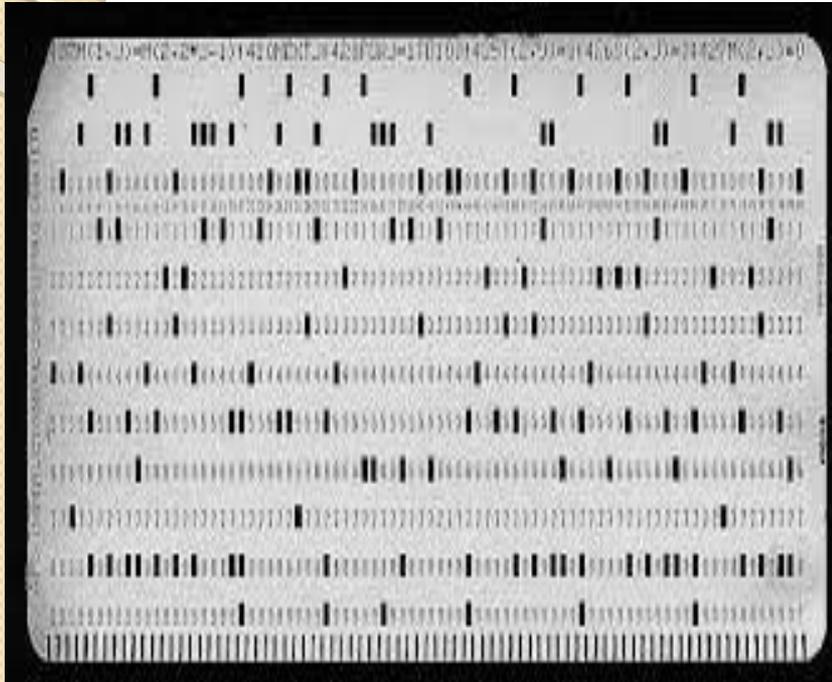
CLASSES OF STORAGE BASED ON TECHNOLOGY

1. **Magnetic Storage Technology** is storage that uses magnetism to keep data. Media in this class are; Magnetic tape, Digital Audio Tape, Floppy disk, Hard disk, Reel-to-reel audio tape recording, Compact audio cassette
2. **Optical Storage Technology** is storage where data is written/ read by use of laser. Media in the class are; Compact disc, DVD, Blue ray
3. **Solid State Storage Technology** is storage that reads/writes data on media without any moving parts. E.g. Flash disk, Memory cards.
4. **Online Storage Technology** is storage over a network like the internet e.g. Google drive, drop box, I-cloud, e-mail storage

FUNCTIONS OF COMPUTER STORAGE MEDIA

- To serve & work as backing storage.
- To store large programs and files needed by the computer to work.
- To keep user's files for future use in a more permanent nature.
- To act as a yardstick considered when a user is to take an accurate decision before computer purchase.
- To work as an ideal storage location and distribution of software products to end users

I. THE PUNCH CARD / "HOLLERITH" CARD



- Is a recording medium for holding information for use by automated data processing machines.
- Made of stiff cardboard
- The punch card represents information by the presence or absence of holes in predefined positions on the card.

2. MAGNETIC TAPE

- Data is stored as magnetic fluctuations along the length of a specially coated plastic tape, similar to the common audiotape
- Data is accessed sequentially as the first to store will be the first to access and the last will be the last to access in that order.
- Information stored on the tape cannot be modified, changed or updated at any one time.
- Magnetic tapes are still used in the mainframe and minicomputers as an ideal media for backup copies of data.



USE OF MAGNETIC TAPES

- Can hold thousands of megabytes (MB) of data depending on the length of the tape.
- Useful for daily backups of all work and programs on a large network.
- Can be set to run automatically during the night and then will only be needed in an emergency.

DISADVANTAGE OF USING TAPE

- Very slow, as need to wind tape (perhaps a long way) to find any specific position of data to view.

3. FLOPPY DISK



- Data is stored magnetically and uses a material similar to tape.
- It needs to be formatted each time data is stored.
- Each disk can hold only 1.44 megabytes or 360 KB of data.

HOW TO CARE FOR FLOPPY DISKS

- Keep diskettes away from magnet fields, such as near wire telephones, loud speakers, and other appliances, which contain magnets.
- Do not keep heavy objects on top of the diskettes.
- Do not fold or bend diskettes.
- While labeling or writing on the diskettes use felt tip pen, not pencil or ballpoint pen.
- Do not expose the disk to excessive heat or light.
- Do not pull out the diskette from its drive when the drive light is still on.

4. HARD DISK

- Made of stronger material (Aluminium) and fixed permanently together with its drive mechanism inside the computer.
- Data is stored magnetically. It is very much faster to access than a floppy disk or CD-ROM (faster than 1 MB per second)
- It can hold thousands of megabytes (GBs or TBs) of data. It is used for storing all programs and work files for very fast access by the computer.



ADVANTAGES OF USING HARD DISK FOR DATA STORAGE.

- They provide a greater storage capacity
- They are speedy
- They are cheaper than floppy disks per mega byte.
- They are more reliable than floppy disks
- It's not easy to misplace them since they reside inside.
- The life of hard disks is long once in use.

DISADVANTAGES OF USING HARD DISKS FOR DATA STORAGE

- They are not portable compared to flash disks
- They are easily attacked by viruses in unprotected systems.
- They lose data due to vibration and shaking.

5. COMPACT DISCS

- Uses laser (light) technology to store the data.
- Like a floppy disk, it has to spin up to the correct speed each time it is accessed.

ADVANTAGES OF USING A CD – ROMS

- Much faster to access than a floppy but currently slower than a hard disk .
- Can hold 650 MB -700 MB of data and more.
- Useful for the distribution of today's large programs and information libraries, which you can then copy (all or in part) onto your hard disk.
- Also widely used by music industry as they give quality sound and do not wear out like cassette tape.
- It is the safest form of storage, provided that you don't attack it with a sharp or heavy object.

CARE FOR COMACT DISKS



6. DIGITAL VERSATILE DISK (DVD):

- Also known as a Digital Video Disk is a very large capacity CD with similar access speed.
- It can store up to 4.7 GB (gigabytes) of data, which is more than enough to store 8 music albums with full video presentation, or 4 feature-length films. A DVD drive can also read a normal CD-ROM.

7. BLUE RAY

- Refers to the blue laser used to read the disc, which allows information to be stored at a greater density than is possible with the longer-wavelength red laser used for DVDs.
- These store large amounts of data than other optical devices (up to 128GB)



CLOUD/ONLINE STORAGE

- Online / cloud storage is storage for keeping data with a third party accessed via the internet.
- Online storage is virtual storage approach & its accessed remotely



FACTORS TO CONSIDER BEFORE BUYING A NEW STORAGE MEDIUM

- Capacity of the storage medium
- Whether removable or fixed
- The access speed of the storage medium
- The access method of storage medium
- Technology of the storage medium
- Access time of the storage medium
- The cost of the storage medium against the buyer's budget

HOW TO CARE FOR STORAGE

MEDIA

- Don't eat anything while you are working and using storage media.
- Install strong, genuine and updated Anti-virus software to protect storage media from malware.
- Keep away magnets from the magnetic storage media.
- Don't keep your computer storage media in the moist temperature..
- Don't keep heavy or huge things on the storage media
- Keep away eatables or drinks of any type.
- Make your computer protected from the dust.
- Don't keep storage media under direct sun light especially optical storage media.
- Keep optical storage media in jackets.

EXERCISES

- Explain the meaning of the following terms used in computer storage
(i) Writing (ii) Reading (iii) Storage capacity (iv) Storage medium (v) Storage device (vi) Access time (vii) Access method (viii) Transfer rate (ix) cache memory (x) flash memory (xi) virtual memory (xii) online storage
- What is the difference between primary and secondary storage?
- Distinguish between random and sequential modes of access used in storage media
- Explain some forms of primary memory that ensure proper performance of a computer
- Distinguish between removable and fixed storage
- With examples explain the term primary memory
- State the difference between RAM and ROM
- With examples, explain the difference between volatile and non-volatile memory
- Explain the following technologies used in computer storage
 - a) Solid state technology
 - b) Optical technology
 - c) Magnetic technology
- State three advantages of DVDs over compact discs
- State the four ways you would care for optical storage media
- What factors would you consider before buying storage media for use?
- How many bits are in the characters that form your surname?

PROCESSING HARDWARE

THE CPU

- This is a computational device whose major task is to process data. It is also called the *brain* of the computer.
- It carries out all instructions and tells hardware components how to work.



FUNCTIONS OF THE CPU

- It controls devices under its care.
- It helps in all the stages of data processing.
- It is the chief brain of the computer which performs logical, computational and comparisons of data.
- It determines how fast the computer performs a given function.
- It is used as yardstick to determine type and model of computer.
- It helps the user to work with many programs at the same time.
- It controls which part to handle which category of task within the computer.
- It stores data temporarily for the computer.

PARTS OF THE CPU

- a) Control unit
- b) Arithmetic logical unit
- c) Registers

- The control unit directs and coordinates most of the operations in the computer.
- The ALU performs the arithmetic, comparison, and logical operations in a computer. It performs the execution step of a machine cycle. *Arithmetic operations include addition, subtraction, multiplication, and division. Logical operations work with conditions and logical operators such as AND, OR, and NOT.*
- Registers are high-speed working storage areas *that temporarily hold instructions and data WITH IN THE CPU.*

Types of registers

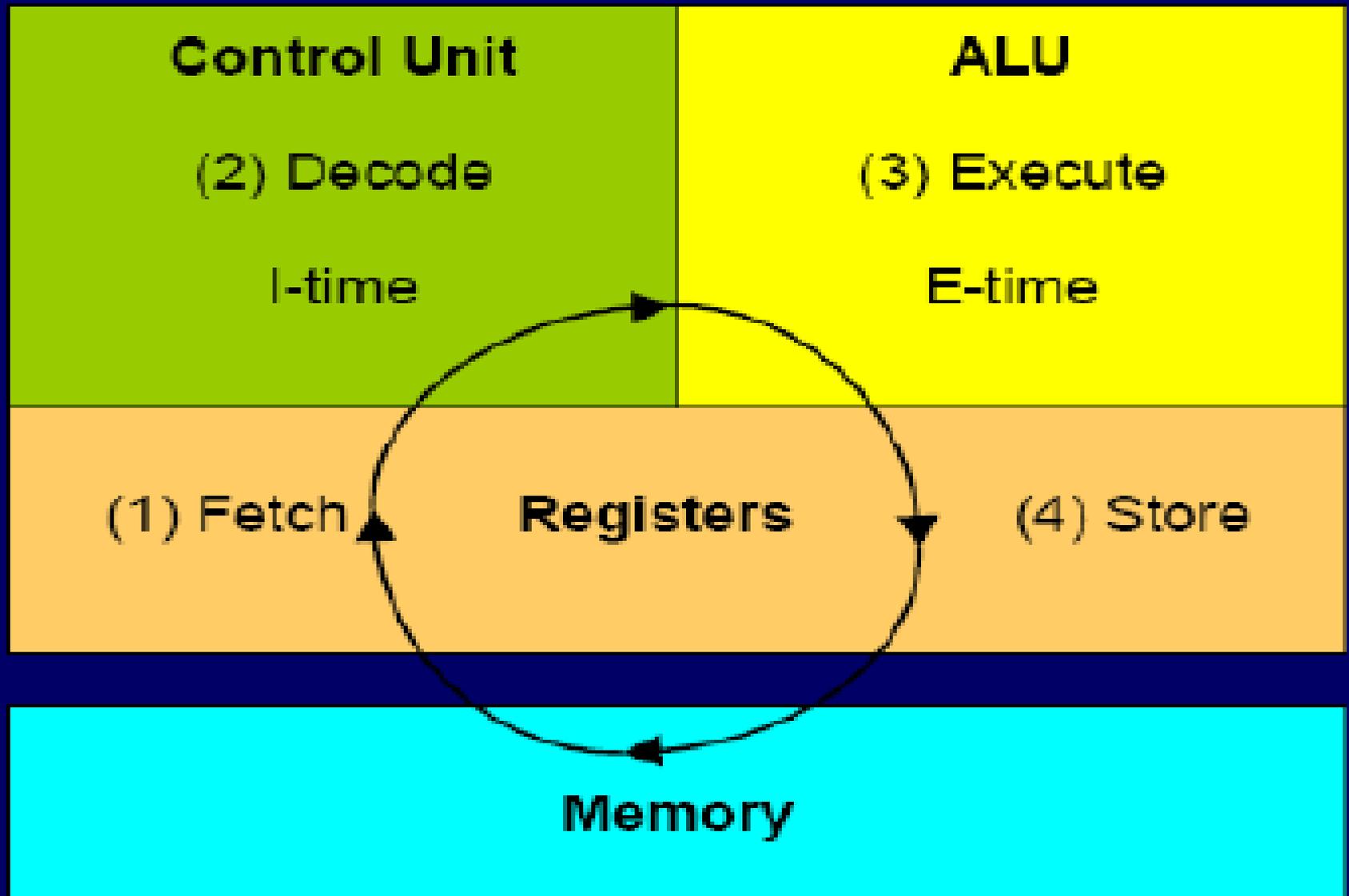
- **Instruction register**, which contains the instruction being executed;
- **Address register**, which keeps track of where a given instruction or piece of data is stored in memory;
- **Storage register**, which temporarily holds data taken from or about to be sent to memory;
- **The Accumulator**, which collects the result of computations;
- **General-purpose register**, which is used for several functions, as assigned by the CU

THE MACHINE CYCLE

The central processing unit carries out instructions in a series of stages called the machine cycle.

- 1. **Fetching** is the process of obtaining a program instruction or data item from memory.
- 2. **Decoding** is the process of translating the instruction into commands that the computer understands.
- 3. **Executing** is the process of carrying out the commands.
- 4. **Storage** is the keeping of data in the CPU location temporary.

Processing Device



HOW TO CARE FOR HARDWARE

- Don't eat anything while you are working with the computer.
- Install the Anti-virus software.
- Check unknown files that you receive over internet.
- Keep away magnet from the computer's hardware.
- Don't keep your computer in the moist temperature.
- Protect your computer from the voltage deviation.
- Make sure that the wires of the computer plugged correctly.
- Don't keep heavy or huge things on the keyboard or mouse.
- Keep away eatables or drinks of any type.
- Make your computer protected from the dust.
- Don't unplug the system while it is running.
- Keep the system firewall enabled.
- Don't keep floppy disk or CD disk in the sun.
- Keep the hardware protected from jerks.

EXERCISE

- What is a CPU?
- State the parts that make up the CPU
- Describe a five functions of the CPU
- Compare the roles of the ALU and the control unit in the CPU
- Explain the roles of the different Registers found in the CPU
- What is meant by the machine cycle?
- Discuss the stages of the machine cycle
- What are buses
- State the function of buses in data processing
- Explain any three types of buses involved in data processing



COMPUTER SOFTWARE

INTRODUCTION TO SOFTWARE

The usefulness of computer hardware depends on available.

- **Software** is the detailed instructions that control the operation of a computer system.
- It can be defined as a set of instructions that tell the hardware how to work.
- **Software** is a collection of **programs** that control the working of the computer hardware.
- **A program** is a set of instruction arranged in a logical way that a computer can run
- Hardware is tangible whereas software is intangible, i.e. it cannot be touched

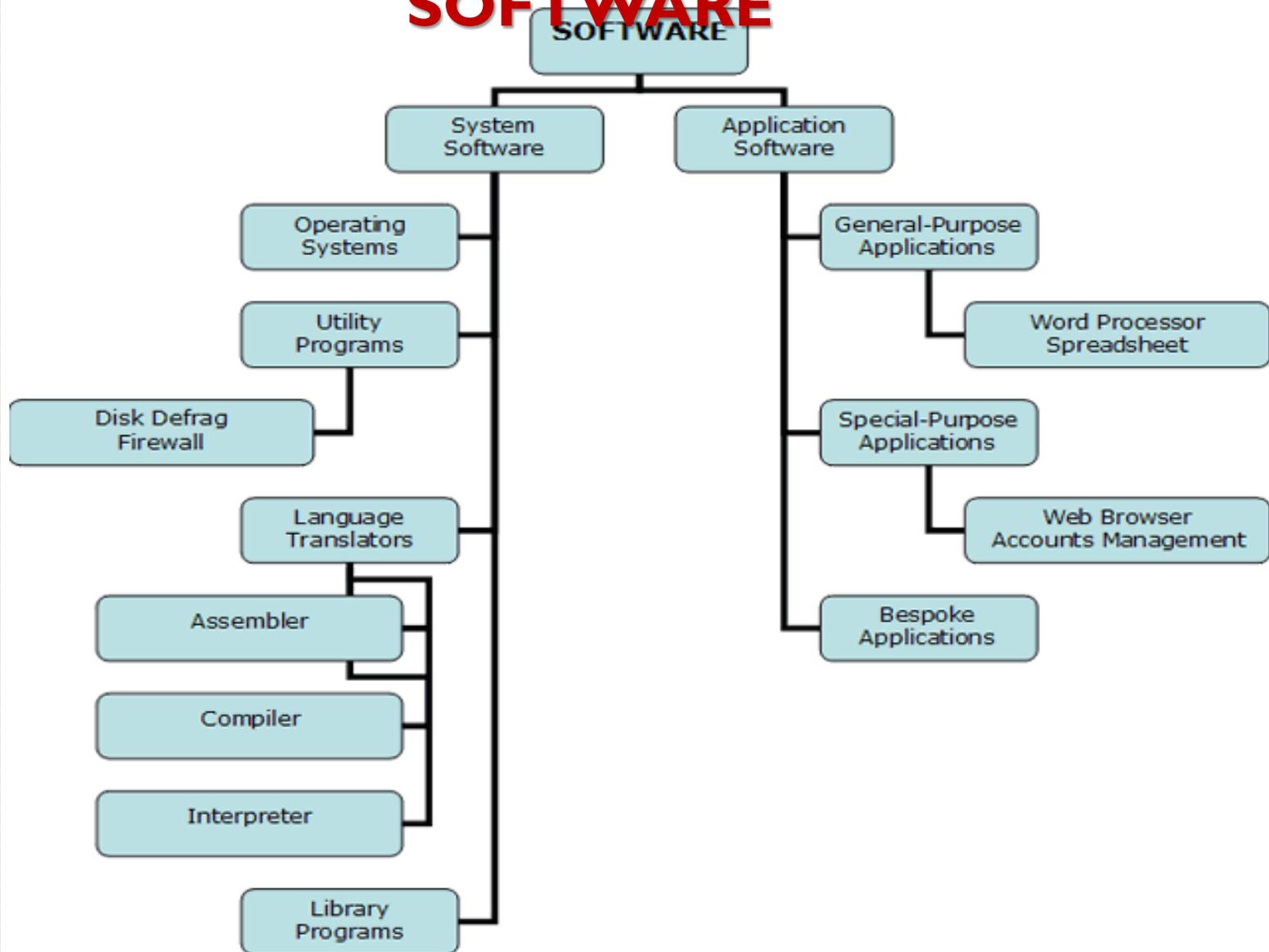
CHARACTERISTIC OF GOOD SOFTWARE

- 1). Good software should provide the required functionality.
- 2). Good software should be usable even by the inexperienced users.
- 3). Good software should be reliable and dependable.
- 4). Good software should function efficiently.
- 5). Good software should have a "life-time" at least measured in years.
- 6). Good software should provide an appropriate user interface
- 7). Good software should be accompanied by complete documentation
- 8). Good software should be "easily" maintained

FUNCTIONS OF SOFTWARE

- Manage the computer resources of the organizations.
- Provide tools for people to take advantage of these resources.
- Act as an intermediary between organizations and stored data and information.

CLASSIFICATION OF COMPUTER SOFTWARE



CLASSIFICATION OF COMPUTER SOFTWARE

- Computer software is mainly based on purpose the software serves. This can be broadly classified into two categories i.e. **Systems** and **Application software**
- **System software** refers to programs that control the operations of a computer and its devices.
- System software also serves as the interface between the user, the application software and hardware. There are three categories of systems software.

Three categories of system software are;

1. **Operating system,**
2. **Programming languages**
3. **Utility programs.**

THE OPERATING SYSTEM

- An **operating system** (OS) is a set of programs containing instructions that co-ordinate all the activities among computer hardware devices.
- The operating system so much relies on the **device driver** to communicate with each hardware device.

NB. **A device driver** is a small program that tells the OS how to communicate with the device.

Functions of operating systems

To provide basic working environment/user interface on a computer.

To control the use of peripherals (both input and output).

To control the loading and running of application programs.

To manage allocation of memory

To manage booting process of a computer.

To manage files

To protect hardware and software.

To manage the process of connecting devices to work with a computer (configuring devices)

To manage the processor e.g. multitasking and time sharing.

TYPES OF OPERATING SYSTEM SOFTWARE

There are different types of operating systems. These are as follows:

Real-time Operating System: It is a multitasking operating system that aims at executing real-time applications.

Distributed Operating System: An operating system that manages a group of independent computers and makes them appear to be a single computer is known as a distributed operating system.

Embedded System: The operating systems designed for being used in embedded computer systems are known as embedded operating systems.

TYPES OF OPERATING SYSTEM SOFTWARE

Single-user, single task: This is designed to manage the computer so that one user can effectively do one thing at a time.

Single-user, multi-tasking: This allows a single user have several programs in operation at the same time.

Multi-user operating system: enables two or more users to run a program simultaneously.

Multitasking operating system: allows a single user to work on two or more applications that reside in memory at the same time.

Multiprocessing operating system: can support two or more CPUs running programs at the same time.

USER INTERFACES

This is the environment given by the OS to control how a user enters data and instructions and how information is displayed. There are two types of user interfaces;

I. Command line interface (CLI)

This is the type of an interface in which users enter data and instructions by typing key words or pressing special keys.

Advantages a CLI

- Takes little memory space
- Does not require very fast processors.
- Operations are fast since command are entered using the keyboard.
- Many commands can be sent together as a batch file for repetitive tasks.

Disadvantages of CLI

Commands have to be learnt and memorised.

It is not user friendly

The interface may vary from one application to the other.

Graphical user interface.

This is a type of interface in which users use menus and visual images (icon) to enter command into the computer.

Advantages of a GUI

It is user friendly

No need to type or memorize any command language

The interface is similar for any application.

Disadvantages of a GUI

Requires more memory

Requires very fast processors.

It is difficult to automate functions for expert users.

Occupies more disk space to hold the files for all the different applications

Basic Components of a GUI

- **Pointer:** A symbol that appears on the display screen and that you move to select objects and commands.
- **Pointing device:** A device, such as a mouse or trackball, that enables you to select objects on the display screen.
- **Icons:** Small pictures that represent commands, files, or windows. By moving the pointer to the icon and pressing a mouse button, you can execute a command or convert the icon into a window.

- 
- **Desktop:** The area on the display screen where icons are grouped is often referred to as the desktop because the icons are intended to represent real objects on a real desktop.
 - **Menus:** Most graphical user interfaces let you execute commands by selecting a choice from a menu.

Examples of GUI Operating Systems

- **Microsoft Windows:**

Windows 7 Desktop



Start button

Taskbar icons

Windows Notification Area

Time and Date

Windows 10



Android OS



Macintosh OS



Linux OS



Factors to consider when Choosing an operating

- Hardware specifications of the computer
- Processor type and memory of the computer
- Application software intended for use on the computer
- Ease of installation and use of the OS
- The cost of the OS against the budget
- The network and data security provided by OS
- Number of processors and users supported by the OS
- Available documentations

Exercise I

1. What is meant by the term computer software?
2. State the two categories of computer software
3. Differentiate between systems software and application software giving an example of each
4. What is an operating system as used in computer software?
5. Explain five functions of the operating system
6. Outline four devices controlled by the CPU
7. Explain how the operating system;
Schedules processor jobs
Manages memory
Allocates resources
1. Mention any four categories of operating system

UTILITY PROGRAMS

- **Utility programs** are special programs are used to enhance performance of the computer system.
- They help to manage, maintain and control computer resources. These programs include: **File viewers, File compression utility, backup utilities, antivirus, screen savers, etc**

FUNCTIONS OF UTILITY PROGRAMS

- Scan and fix computer viruses.
- Help in file back up.
- Compress files of disks.
- Partition disks into individual logical drives.
- Perform tasks on files (move files, delete files, etc)
- Diagnose computer problems.

COMMON UTILITY PROGRAMS

Personal computers come loaded with utility programs designed to help resolve issues and maintain optimum performance. These utilities are easily accessed through “Advanced Settings.”

Data Back Up

- Backing up data is the process of creating copies of your data and keeping them in a separate and secure place.

Back up software

This is a software designed to duplicate important data in the event of a hard drive failure, user error, disaster or accident. Backup software help to back up your data automatically.

REASONS FOR BACKING UP DATA

- ❖ In case your laptop or personal computer gets lost or stolen



❖ In case of hard disk failure. Hard disks do break down from time to time. The hard disk is where data is stored permanently on the computer system.

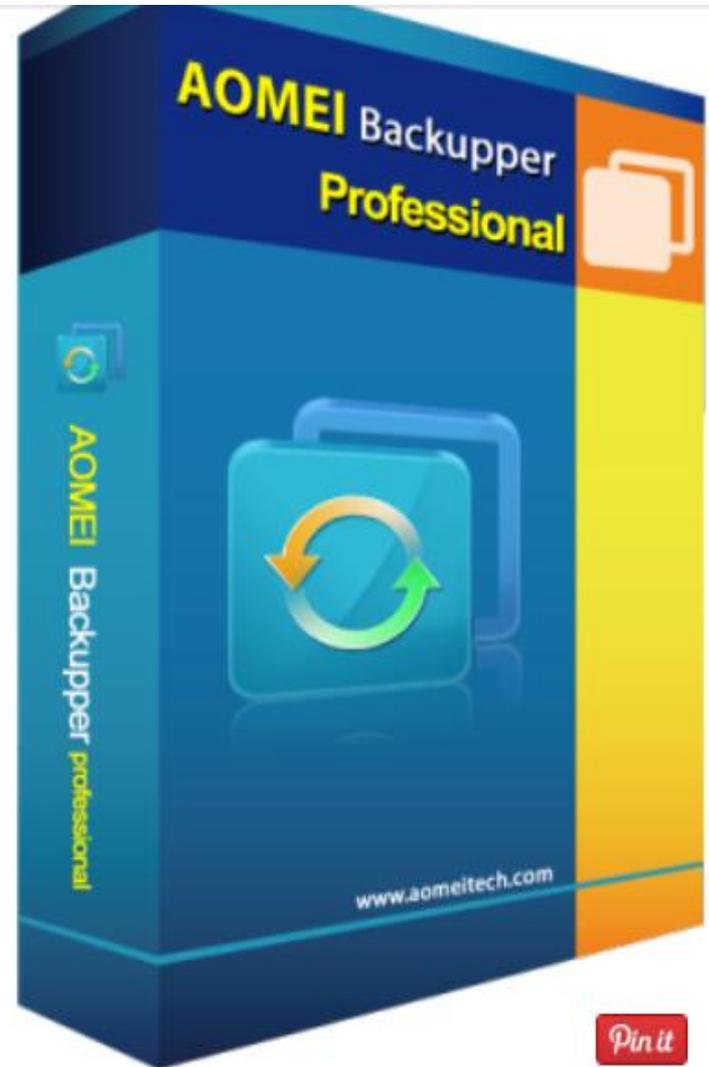
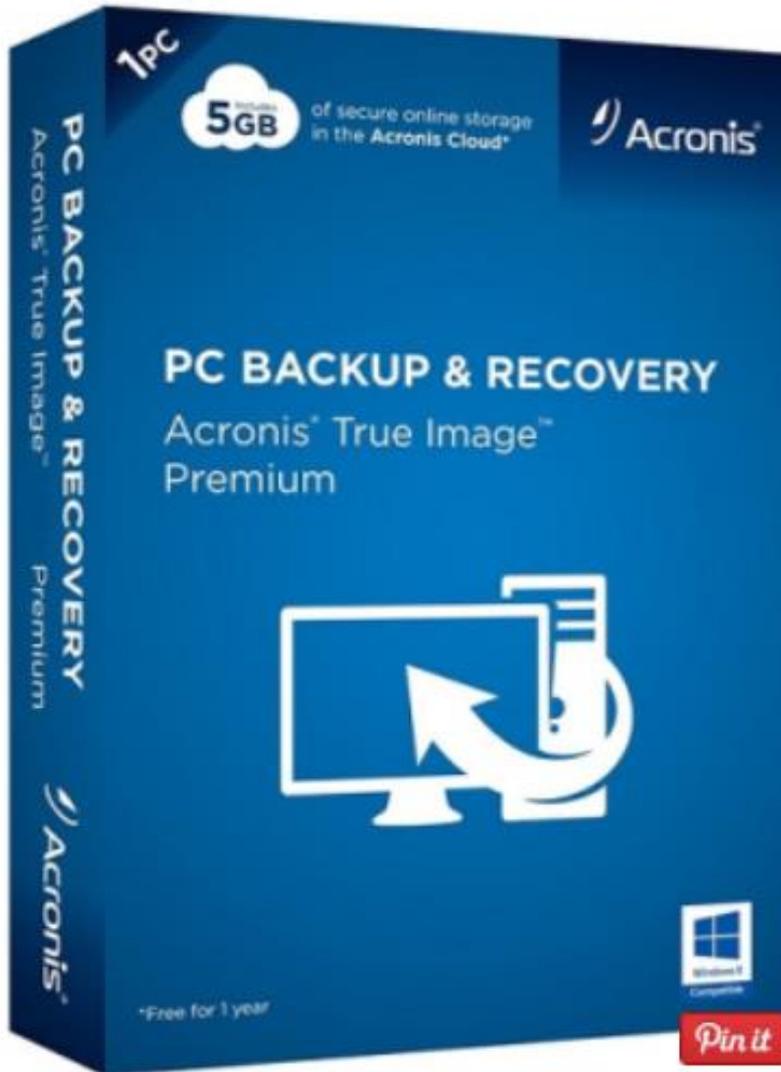
❖ We back up data due to virus attacks. Without backup files, you may never see that information again.

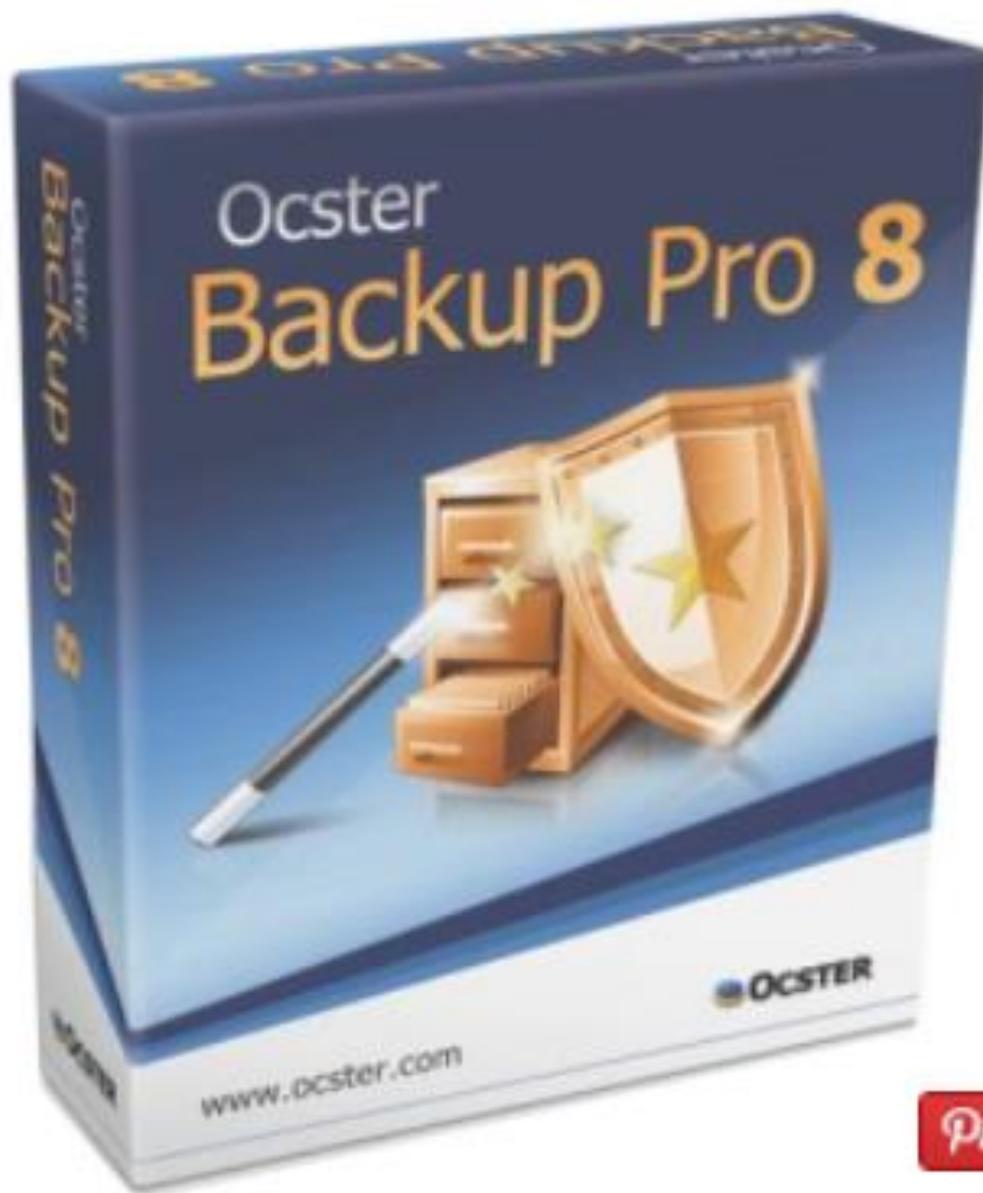
❖ Electrical power failures.

Ways to ensure efficient back up of data

1. Making regular backups
2. Backing up work on removable storage (secondary) media
3. Keeping backup media in a different location from that of the computer
4. Setting up of automatic backup intervals

Some commercial Back up software





❖ **System Restore**

"System Restore" resets the computer to an earlier setup. For example, let's say a computer begins functioning poorly after a new software program is installed, and the problem persists even after removing the program. "System Restore" sets the machine to a state prior to the installation of the program, often solving the issue.

❖ **Disc Defragmenter**

"Disc Defragmenter", also called "defrag," enhances computer performance by consolidating file fragments. Locating requested files affects a computer's speed, and by consolidating incomplete files, "defrag" makes the process faster.

❖ **Scheduled Tasks**

"Scheduled Tasks" accesses a wizard, setting selected programs to run automatically at a chosen time and frequency. For example, if a software program backs up files, the Schedule Tasks function can schedule that program to run daily at 3 a.m.

❖ **Hardware Diagnostics**

Under the Device Manager you can see hardware that is working improperly, because it will have a warning icon next to it. Right-click that device and choose to troubleshoot. This will bring up the device troubleshooting utility that will often try to update the driver or fix an existing driver.

❖ **Disk partitions**

Divides an individual drive into multiple logical drives.

❖ **Disk space analyzers**

To get the size for each folder/sub folders and files in folder or drive. Showing the distribution of the used space.

- 
- ❖ **Screen savers:** These are designed to prevent phosphor burn-in on LCD and plasma computer monitors.
 - ❖ **Sorting utility:** For organizing files and folders on a storage media.
 - ❖ **Data Recovery:** Enables the user to get back all the data that might have been deleted or lost by a virus from the computer.
 - ❖ **Debuggers:** helps to find out the error in computer program and fix it.
 - ❖ **Uninstall utility:** It enables the user to remove an application program and its associated attributes from the system.

- 
- ❖ **Registry cleaners:** Clean and optimize the Windows registry by removing old registry keys that are no longer in use.
 - ❖ **System monitors:** For monitoring resources and performance in a computer system.
 - ❖ **Disk storage utilities:** Ensures that data is stored and files arranged in order of ascending. It also helps the computer to re-arrange data files.
 - ❖ **System Profilers:** Provide detailed information about the software installed and hardware attached to the computer.

DIFFERENCES BETWEEN OPERATING SYSTEMS AND UTILITY PROGRAMS.

OPERATING SYSTEM

An operating system contains instructions that coordinate all the activities among computer hardware resources.

An operating system is very important; computers cannot be used or started without an operating system.

Linux, Mac OSX, Unix, Windows XP

UTILITY PROGRAM

A utility program performs maintenance-type tasks, usually related to managing a computer, its devices or its programs.

A utility program helps managing a computer easier; computers can still be used or started without it.

Antivirus, diagnostic utility, file manager, screen saver, image viewer, personal firewall, uninstaller, disk scanner, disk defragmenter and backup utility.

APPLICATION SOFTWARE

- These are programs designed to meet user-specific needs.
- The primary function of application software is to apply the computer to users solve problems and accomplish specific tasks.
- Application software, such as word processing, spreadsheets, e-mail, database, and Web browser, can help you perform tasks such as creating documents, analyzing finances, sending messages, organizing data, and viewing pages on the World Wide Web respectively.

CLASSIFICATION OF APPLICATION SOFTWARE

Application software can be classified into 2, that is **Off- the shelf software** and **Custom written/Bespoke/In-house developed software**.

I. Off- the shelf software

This is software designed and packaged for sale. A user will find it readily available in shops for sale.

Off-the -shelf is further subdivided into 2:-

- i. General purpose software**
- ii. Special purpose software.**

General purpose application software

- **General purpose** application software is a type of software that can be used for a variety of tasks.
- It is not limited to one particular function. For example a word processor could be classed as general purpose software as it would allow a user to write a novel, create a restaurant menu or even make a poster.

Special purpose application software

Special purpose application software is a type of software created to execute one specific task.

For example a camera application on your phone will only allow you to take and share pictures.

Another example would be a chess game, it would only allow you to play chess, web browsers, calculators, media players, calendar programs etc.

Advantages / reasons of using off-the-shelf software

- It is relatively cheap, especially when compared to custom written software
- It is easily available from most computer shops
- It will have been thoroughly tested so there won't be any serious problem or bugs
- There is lots of user support i.e. books, user guides, online help and discussion forums on the internet

Bespoke/Customized Application Software

Bespoke application software is tailor made for a specific user and purpose. For example a factory may require software to run a robot to make cars, however, it is the only factory making that car in the world, so the software required would have to be specially build for the task.

Other examples might include software for hospitals and medical equipment, software being written inside banks and other financial institutions.

Advantages Customized / Bespoke Application Software

1. The company will get the exact software they need.
2. The software will work exactly how they want it to work.
3. The software will only have the features that they specifically need in their business.

The Main Disadvantages of Customized/Bespoke Application Software Include;

1. It costs a lot of money to develop such a software
2. It may take some time to develop the software, when off- the-shelf software could be brought straight away
3. The company may need to develop a team of people such as business analysts, programmers, testers etc.
4. Unlike off- the-shelf software, there is unlikely to be any internet forums or websites to help users. For example popular spreadsheet applications have dozens of online help sites run by users and professionals
5. The software is more likely to be buggy as it probably won't have thousands of clients using and testing it.

Differences between System software and Application software.

| System Software | | Application Software |
|---|--------------------|---|
| Enables the computer to function properly. | Usage | Enables users to work efficiently with documentation such as letters, accounting reports and presentations. |
| Compulsory – each computer must have a system software to function. | Need | Optional – depends on usage and needs. Without an application software, the computer is still able to function. |
| Each computer only needs one system software. | Number of software | Each computer can have more than one application software. |
| Independent – system software can function without an application software. | Dependency | Dependent – application software cannot work without system software. |
| Provides the environment in which the applications run. | Function | Provides the environment to enable users to accomplish specific tasks. |

Some terminologies used in computer software:

Firmware

- Is a software program or set of instructions programmed on a hardware device. It provides instructions on how that device should operate.
- Unlike normal software, **firmware** cannot be changed or deleted by an end-user without the aid of special programs and remains on that device regardless if it's on or off.

Software License

- A software license is a legal instrument that governs how the software can be used and distributed. When you download or install software, you are asked to agree to the terms of a license before you proceed with the installation.
- A license does not mean you have to pay for the software because even free software is licensed.

Software copyright

- It is a law used by proprietary (commercial) software companies to prevent the unauthorized copying of their software.

SOFTWARE PIRACY

This is the act of illegally using, copying or distributing software without ownership or legal rights.

Types of software piracy include:

- **Soft lifting:** Borrowing and installing a copy of a software application from a colleague.
- **Client-server overuse:** Installing more copies of the software than you have licenses for.
- **Hard-disk loading:** Installing and selling unauthorized copies of software on refurbished or new computers.

- **Counterfeiting:** Duplicating and selling copyrighted programs.
- **Online piracy:** Typically involves downloading illegal software from peer-to-peer network, Internet auction or blog.

Packaged software:

- Is commercial software, which is copyrighted and designed to meet the needs of a wide variety of users.

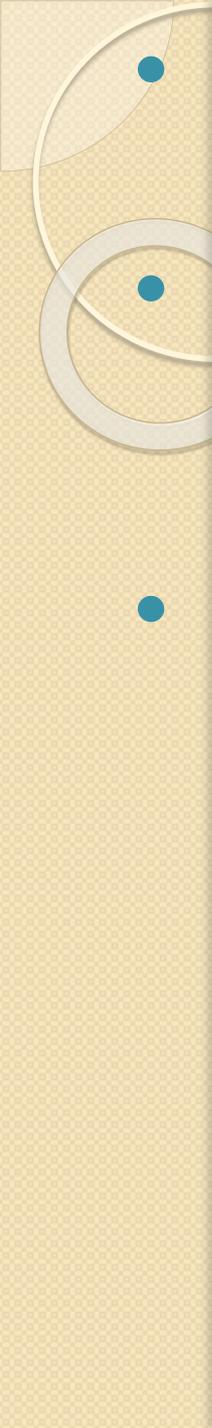
SOFTWARE SUITES

A software suite, also known as application suite or productivity suite, **is a software package that has several applications that work well together because they have related functions, features and user interfaces, and are able to interact with each other.**

Business applications often come in suites, e.g. Microsoft Office, OpenOffice.org, and iWork, which bundle together a word processor application, a spreadsheet application, presentation graphics, database and e-mail applications, etc.

Advantages of software suites

- It is easy to transfer data from one component of the application to another.
- An integrated software takes up less disk space than individual packages.
- The user can move faster from one application to the next.
- It is usually easier to learn how to use the applications in a software suite because the user interface for choosing commands is similar for all applications.

- 
- A software suite tends to be more powerful and versatile than individual applications.
 - A software suite is less likely to crash and contains fewer errors (bugs), since it has been widely tried and tested.
 - The producers of software suites often offer after-sales services (e.g. online help facilities); users can also get support from user groups and magazines.

SOFTWARE ACQUISITION

Computer software can be acquired in three main ways:- freeware, shareware, and commercial software

- **Freeware** : this refers to free software but with copyright restrictions. (*does not require any payment from the user.*)
 - a) **Public domain software** : This is free software with no restrictions.
- **Shareware**: It refers to a type of software that is given to the users to use freely for a certain period(trial), but when that period ends a user must pay in order to continue using the software.
- **Commercial software**: Refers to software that requires payment before it can be used. Commercial software programs typically come in a physical box, which is what you see displayed in retail stores, while others are available as downloads over the Internet.

OPEN SOURCE SOFTWARE

Open source software is:

- i. Software provided for use, modification and redistribution.
- ii. Software that any programmer can download from the Internet for free and modify with suggested improvements. The only qualification is that changes can't be copyrighted,

Why is it popular? Because any programmer can make improvements which can result in better quality software.

Examples: Linux

ADVANTAGES OF OPEN SOURCE SOFTWARE

- The source codes are available to users and they have the rights to modify them. This will allow improvements to the software without having to invest large sum of money in research and development.
- The modified and improved source codes can be freely redistributed.
- The open source software is created according to industry demands but allows for upgrades to take place freely when the need arises. Therefore, if bugs in the codes are found, they can be fixed by anyone interested and capable.
- The software can be used in any way and for any legal purposes. There is no restriction in a unilateral way on how the software could be used.

DISADVANTAGES OF OPEN SOURCE SOFTWARE

- The codes are too complicated for beginner to understand.
- There is no particular official monitoring the works of a programmer improving the codes. This is because anyone is free to use, modify or even distribute the codes.
- Since nobody in particular is responsible for the codes, there is no exact knowledge and assurance on when the codes are going to be fixed if there a bugs in it. Thus, users will have to use the problematic software until someone rectifies the problem.

PROPRIETARY SOFTWARE

Proprietary software is also called closed source software. The closed source software or proprietary software offers a stable system with support if the software fails or malfunctions.

ADVANTAGES OF USING PROPRIETARY SOFTWARE

- The software offers a stable system support if it fails or malfunction.
- The software is safe and guaranteed to be safe from dubious threats like programming bugs and viruses thus providing ease of mind for the user.
- The software is easier to install and used as the production is planned and extensive research is carried out to ensure users purchase only the best.
- Furthermore, free updates and latest information on the software are usually provided to the user.

DISADVANTAGES OF USING PROPRIETARY SOFTWARE

- Users need to spend a long time downloading and installing security patches to fix bugs announced by the manufacturer.
- Any improvements would usually require a cost, which is often expensive.
- Users are not allowed to describe and share the software as they are licensed.
- Customizing the software is impossible because when users buy proprietary software, they will not receive the code as the code is the manufacturer's trade secret.

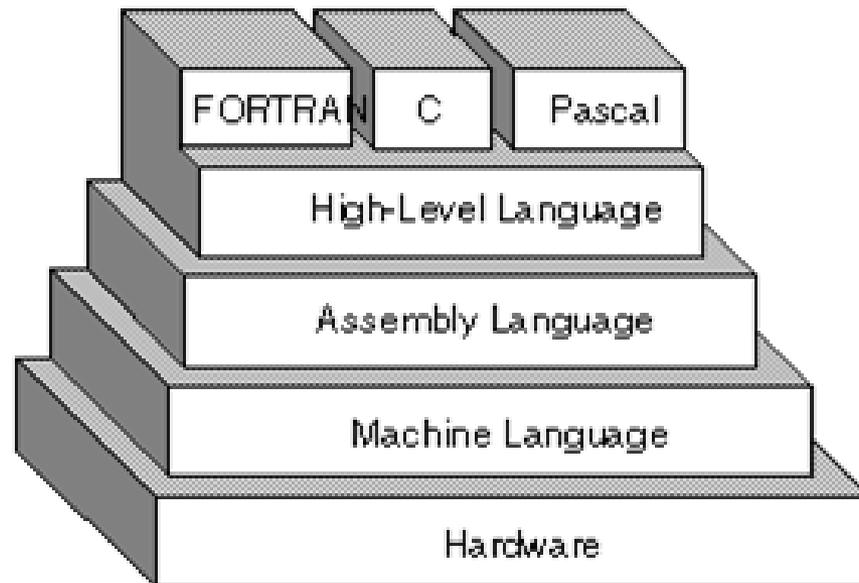
Assignment

- State five examples of application software and their respective uses
- List the two major categories of application programs
- Differentiate between single-purpose and general-purpose applications
- State the difference between in-house and off-shelf application programs. Use examples.
- What is meant by the term user interface?
- Outline the two major categories of user interfaces provided by modern Operating system
- State the similarities and difference between menu-driven and graphical user interfaces
- What is the difference between CLI and GUI

- 
- State five advantages of GUI over CLI
 - Explain any five features users interact with while using computers
 - What are utility programs?
 - State five categories of utility programs giving an example in each
 - What are the five functions of utility programs?
 - Explain the following terms as used in computer software
 - a) Proprietary software
 - b) Open source software
 - c) Freeware
 - d) Shareware
 - e) Public domain software

PROGRAMMING LANGUAGES

A **programming language** is a vocabulary and set of grammatical rules for instructing a computer to perform specific tasks. This is usually categorized into **low-level** (Assembler and machine) and **high level** (e.g. FORTRAN, C and PASCAL) languages



Low-Level Languages

Low-level languages are designed to operate and handle the entire hardware and instructions set architecture of a computer directly.

- Programs and applications written in low-level language are directly executable on the computing hardware without any interpretation or translation. **For example;** developing new operating systems or writing firmware codes for micro-controllers.
- **Machine language** is a collection of binary digits or bits that the computer reads and interprets.
- **Assembly language** implements a symbolic representation of the machine code needed to program a given CPU architecture.



- **High-Level Language (HLL)**

- High-level language is any programming language that enables development of a program in much simpler programming context and is generally independent of the computer's hardware architecture.
- High level languages are designed to be used by the human operator or the programmer. They are referred to as "closer to humans." In other words, their programming style and context is easier to learn and implement, and the entire code generally focuses on the specific program to be created.

FACTORS TO CONSIDER BEFORE BUYING A COMPUTER PROGRAM

- Cost of software against buyer's budget.
- Usability of the program.
- Requirements of available hardware.
- Type of program needed.
- Needs of the organization.
- Personnel to use the program.
- Functionalities of the program.
- Free from computer bugs.
- Software support and call centers.
- Type and quality of software developer.