COMPUTER SCIENCE (A-LEVEL)

Topic to be covered

Form Five

1. **Computer Basics**
2. **Data Representation**
3. **Problem Solving**
4. **C++ Programming**
5. **Web Development**
6. **System Development**

TOPIC ONE

COMPUTER BASICS

Computer Organization

Computer:- Is defined as an electronic device that process a user input referred to as data and produce a desired output also known as information.

A computer is composed of hardware and software, and can exist in a variety of sizes and configurations.

Computer System: - Is a collection of data or simply hardware and software that work together to receive, process, manage and present information in a meaningful format.

HARDWARE

Hardware: - Refers to a physical or tangible component that makes up a computer system.

Input and Output devices as the Hardware Component of the Computer

A: Input Devices

Input devices: - These are components which are used to feed commands and data into the computer.
Let you give information and instructions to the computer. Following are functions of computer input devices

Keyboard

A computer keyboard is an input device used to enter characters and functions into the computer system by pressing buttons, or keys. It is the primary device used to enter text.

A keyboard typically contains keys for individual letters, numbers and special characters, as well as keys for specific functions.

- ***Alphabet keys:*** Main section of letters on the keyboard. You use these letters mainly for typing and, in various combinations, as action shortcuts in programs and computer games.

- ***Numeric keypad:*** Designed for users to enter numbers the part of a computer keyboard to the right of the main keys that has keys with numbers on them.

- ***Function key:*** A special button on a computer keyboard that is used for a particular operation in a program. The keys near the top of a keyboard marked 'F1' to 'F12' are function keys being used.

- ***Special keys:*** A keyboard *key* that performs a *special* function not included with the traditional 104-*key* keyboard. *Special keys* are found on keyboards often referred to as a multimedia keyboard.

- ***Arrow keys:*** Are four computer keys marked with an up, down, left, or right arrow, used for moving the cursor

Mouse

A mouse is a pointing device that enables the user executes commands by pointing and clicking on items.

The main goal of any mouse is to translate the motion of your hand into signals that the computer can use.

Parts of a Mouse

There are main three parts of a mouse

i. Scrolling wheel
ii. Right button (Secondary button)
iii. Left button (Primary button)

Trackball

Trackball acts as type of overturned mouse. The ball is on the top side of the object. By rolling the ball you can move the pointer across the screen.

Touchpad (Trackpad)

A touchpad is an input device commonly used in laptop computers. It is used to move the cursor using the movement of the user's finger.

Joysticks
A joystick is a device that is familiar for use in games to move objects on the screen.

Microphone

Microphone is used to input audio or sound. The sound is detected by the microphone and an electrical signal is transmitted to the computer. Special hardware is used to convert this analogue data into digital data so it can be stored and manipulated.

Webcam
A webcam is an input device because it captures a video image of the scene in front of it. It is either built in to the computer (e.g. laptop) or it is connected through an USB cable.

Scanner
Scanner allows you to scan printed material and converts it into format which may be used within the PC.

SCANNING DEVICES (INPUT DEVICES)
An input devices act as the scanning devices includes barcode reader, magnetic stripe reader, point of sale terminal (POS), optical mark reader (OMR), and magnetic ink character recognition (MICR)

Barcode reader
Bar code reader is an input device (scanning device) that can read and interpret bar codes and input the data into the computer.

Magnetic stripe reader

Magnetic stripe readers are thin strip of magnetic tape (Metallic strip) which are found on the back of plastic credit and debit cards.

Point of sale terminal (POS)
Point of sale terminal (POS) is a special purpose terminal which can update inventory while calculating the sale.

Optical mark reader (OMR)
Optical mark reader recognition used to mark multiple choice question of a structure questionnaire.

Magnetic ink character recognition (MICR)

MICR are used in banks to read characters written using magnetic ink.

B: Output Devices

Output devices: Are devices that the computer uses to give out information of the processing.

Example includes monitor, printer, speaker, headphones, plotters, projectors etc. Output devices can be classified into two categories namely

i. Softcopy output devices
ii. Hardcopy output devices

Softcopy Output Devices

Softcopy output refer to intangible output that can be seen or heard, such as screen display and sound.
Example of such devices includes monitors, LCD projectors and speakers

Monitor

A monitor also known as Visual Display Unit (VDU) is used to showing the main output of the computer in a way that humans can understand.

There are four common types of monitors namely:

i. Cathode Ray Tube (CRT)
ii. Liquid Crystal Display (LCD or Flat-panel)
iii. Gas Plasma Display (GPD)
iv. Light Emitting Diode (LED)

Cathode Ray Tube (CRT)

Cathode ray tube (CRT) monitors consists of a long glass tube with an electron gun on one end and the screen on the other. Resemble televisions and less expensive than LCD monitors. Take up more desk space and use more energy than LCD monitors.

Liquid Crystal Display (LCD or Flat-panel)

Liquid crystal display (LCD) is made of special liquid crystals and more expensive than CRT monitors. Take up less desk space and use less energy than CRT monitors.
Types of LCD monitors includes

i. Passive-matrix LCD
ii. Active-matrix LCD

Gas Plasma Display

Gas Plasma Display, resembles LCDs only that they make use of gas instead of liquid crystals. They contain millions of pixel that are illuminated by charged neon gas. Unlike LCDs, image displayed on gas plasma do not suffer from angle distortion.

Following are factors that influence a monitor's quality

1. *Screen / Display size*
   This is the diagonal measurement of the screen surface in inches.

2. *Resolution*
   This is the number of pixel per inch displayed on the screen. (The higher the resolution, the closer together the dots, hence the clear image)
3. *Dot pitch*
   Is the distance between the centers of a pair of like-colored pixel.

4. *Refresh rate*
   The speed with which a monitor redraws the image of the screen.

Data Projector

Projectors are used to display output from a computer onto a plain white screen like a wall or whiteboard.

Speakers

Speakers produce sound such as beeps, audio or digital. Most computers are sold with inbuilt speakers while others have capabilities to add a pair of speakers to your system unit.

Headphone

Most computers allow you to plug headphones into one of the computer socket.

Hardcopy Output Devices

Hardcopy output is a printed copy of information from a computer which is tangible.

Sometimes referred to as a printout, a hardcopy is so called because it exists as a physical object.

Printer

A printer is an output device that produces a hardcopy of the computer's output. There are three main types of printer

1. Laser printer
2. Dot matrix
3. Inkjet printer

Laser Printer
Laser printer operates by shining a laser beam to create an image on rotating drum. Forms images using an electrostatic process.

Dot matrix printer
A dot matrix printer has a set of pins on the printer's head which strikes on an ink ribbon placed over the paper.

Inkjet Printer
Inkjet printer makes images by forcing droplets through nozzles.
Note:
Printers are classified according to different printing mechanism. The two categories are

a. Impact printers
b. Non-impact printers

Impact Printer
Impact printers print using striking mechanism. This means that they strike the paper in order to form an imprint on it. Example is dot matrix printer.

Non-Impact Printer
Non-impact printers are faster and more quite than the impact printer. They print using ink, thermal or photo printer. Examples are inkjet, thermal and photo printer.

Factors to Consider When Purchasing a Printer

i. Print quality
ii. Initial cost
iii. Running cost
iv. Speed
v. Color printing

Plotter

Plotter is a device mostly used for printing geographical, architectural and engineering drawing e.g. maps, advertisement posters to be placed on billboards and machine parts.
It is a printer that uses a pen that move over a large revolving sheet of paper.

Central Processing Unit (CPU)

Central Processing Unit (CPU): Is the electronic circuitry within a computer that carries out th6e instructions of a computer program by performing the basic arithmetic, logical, control and input/output (I/O) operations specified by the instructions.

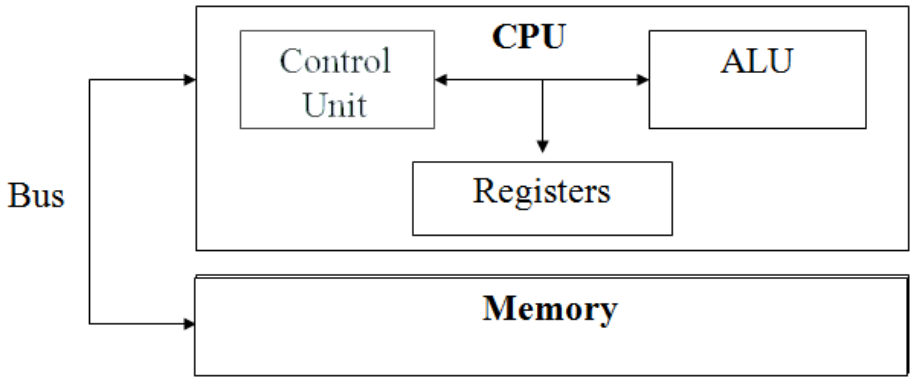
CPU is basically regarded as the brain of the computer. It is also known as the processor simply because all processing activities are carried out inside the processor.
In microcomputer, the CPU is housed inside the system unit and it is mounted on a circuit board known as the motherboard or the system board.

There are three main components to the CPU

i. Arithmetic Logic Unit (ALU)
ii. Control Unit (CU)
iii. On board cache memory

Before an instruction can be executed, program instructions and data must be placed into memory from an input device or a secondary storage device.

Illustration of a CPU shows functional elements of the CPU



Function element of CPU

Control Unit (CU)

Control unit coordinates all processing activities in the CPU as well as input, storage and output operations. It directs the computer system to execute stored program instructions.
It tells the computer's memory, arithmetic and logic unit and input and output devices how to respond to the instructions that have been sent to the processor. To coordinate these activities, the control unit uses a system clock. It directs the operation of the other units by providing timing and control signals.

Arithmetic Logic Unit (ALU)

Perform both arithmetic and logical operation. The basic arithmetic operation include; Addition (+), Subtraction (-), Multiplication (-) and Division (/).
Logical operation are based on the computer's capacity either to

- evaluate conditions (NOT, AND, OR etc)
- To compare either numbers, letters, special character (=, >, <, >=)

ALU has special temporary storage location called register in order to process data.

On board cache memory

Cache memory is very high speed memory that is used by the CPU in executing the individual instructions of the program.

It is used to hold items such as instructions that are next in line to be executed and data that is likely to be needed by the CPU.

Speed of the CPU

The CPU operates as a result of electronic pulses sent to it by another device on the motherboard called the clock. The speed of a CPU is measured by the maximum number
of pulses it is able to handle. This is measured in MHz (megahertz) or millions of pulses per second or GHz (gigahertz) thousands of millions of pulses per second.

Overall Functional Organization of the CPU

The arithmetic and logic unit, the control unit and the cache use electrical pathways or links referred to as buses.

Bus is the communication system or pathway that transfers data between components inside the computer.

There are two types of buses namely

i. Internal bus / System bus / Front-Side-Bus
ii. External bus / Expansion bus / Back-Side-Bus

Internal bus / System bus / Front-Side-Bus

The internal bus, also known as internal data bus, memory bus, system bus or Front-Side-Bus, connects all the internal components of a computer, such as CPU and memory, to the motherboard. Internal data buses are also referred to as a local bus, because they are intended to connect to local devices. This bus is typically rather quick and is independent of the rest of the computer operations.

The system bus is categorized into three buses

- Control bus

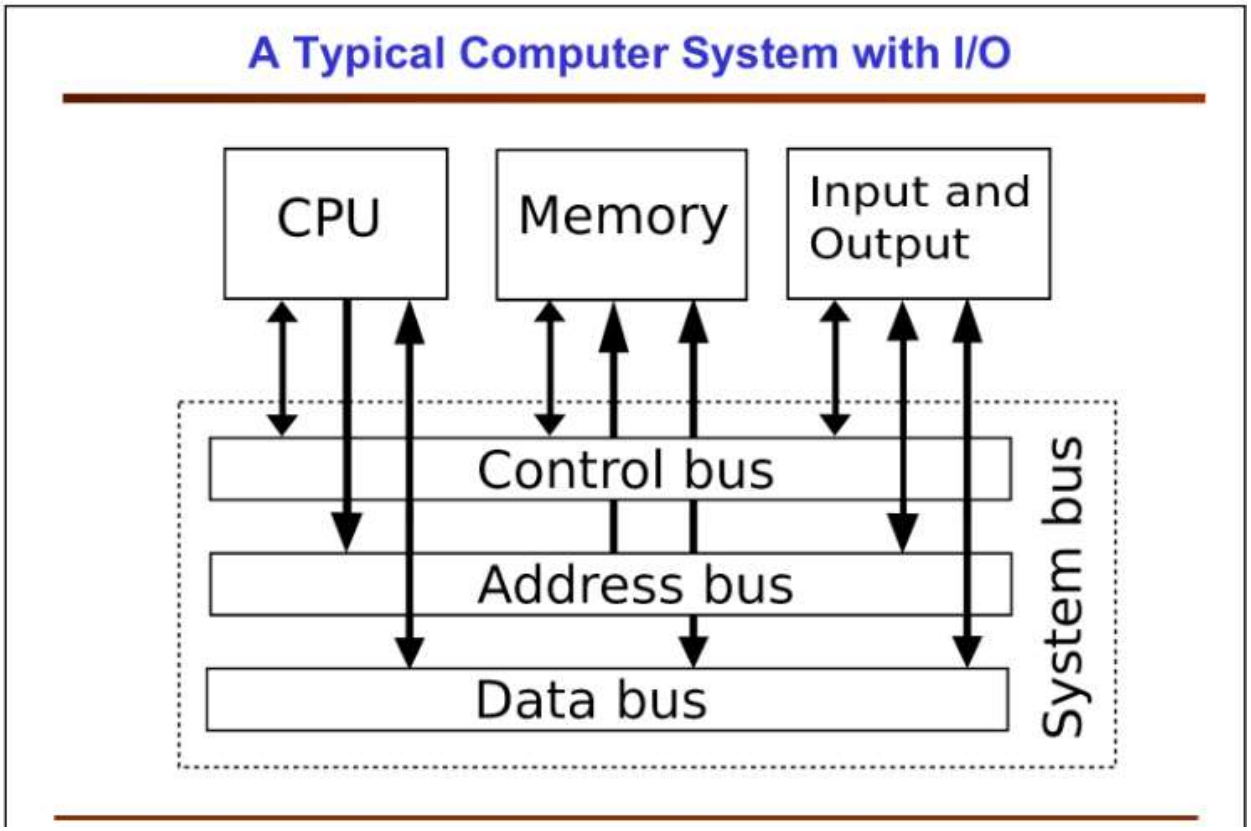
This is the pathway for all timing and controlling functions sent by the control unit to other parts of the system.

- Address bus

This is the pathway used to locate the storage position in memory where the next instruction data to be processed is held.

- Data bus

This is the pathway where the actual data transfer takes place.



External bus / Expansion bus / Back-Side-Bus

The external bus or expansion bus is made up of the electronic pathways that connect the different external devices, such as printer to the computer.

SOFTWARE

Computer Software: This is the set or collection of instructions which make the computer work.

It includes application software such as word processor which enable a user to perform a task and system software such as operating system which enables other software to run properly by interfacing with hardware and other software.

There are two types of computer software or simply software

i. System software (Operational Software)
ii. Application software

System Software

System software is the computer software designed to operate and control the computer hardware and to provide a platform for running application software.

Systems software is further subdivided into **operating systems, utilities, and firmware and network software**. The operating system is the program that actually makes the computer operates. Utilities are programs which either improves the functioning of the operating system or supply missing or additional functionality.

Following are functions of the system software

i. Storing and retrieving files
ii. Performing operations such as retrieving, loading, executing and storing application programs
iii. Performing a variety of system utility functions
iv. Booting the computer and making sure that all the hardware elements are working properly.

Application Software (Application Package)

Application software's are programs that are designed to help the user accomplish specific tasks.

They are controlled by an operating system which is the system software therefore cannot work without a system software. They are specific in function or operational goals.

Examples and Uses of Application Software

Software	Uses	Examples
1. Word processor	Typing documents	Ms Word, Lotus word pro, OpenOffice writer etc.
2. Spreadsheet	Calculating budgeting	Ms Excel, Lotus 1-2-3
3. Desktop publishing	Designing publications like newspaper and books	Adobe PageMaker, Ms publisher, Adobe InDesign
4. Computer Aided Design	Technical drawing	Auto CAD, Maya, Cinema 4D etc
5. Database	Keeping records and files	Ms Access, My SQL, FoxBase, Paradox etc.
6. Graphics software	Designing and manipulating graphics	Corel Draw, Photoshop

Similarities between System Software and Application Software

i. They are all set of instructions
ii. They are all stored inside the hardware as programs
iii. They are all non-tangible (non-physical)
iv. They are all tells the computer what to do
v. They are all developed by programming concepts and configured due to a desired object.

Differences between System Software and Application Software

System Software	Application Software
1. Controls application software	Controlled by system software
2. They are general in performance	They are specific in performance
3. Can operate without application software	Cannot operate without system software
4. Manage other software and hardware	Manage the accomplishing of a specific software
5. Complex set of instructions	Simple and specific set of instructions

Difference between Computer Hardware and Computer Software

Computer Hardware	Computer Software
1. Are tangible devices	Are not tangible
2. Are physical components	Are sets of instructions
3. Can store software programs inside its parts	Are stored inside the hardware parts as programs
4. They do not tells a computer what to do	They tells a computer what to do
5. Are designed and assembled physically with their parts and connections	Are the sets of instructions which developed by programming concepts

Operating System

Operating system (OS) is an interface between the user and the computer hardware that facilitates the execution of other application programs and the access to hardware and software resources.

Types of Operating

The classification of Operating system is categorized into two groups.

i. Classification of operating system based on their user interface
ii. Classification of operating system based on number of users and number of task

Classification of Operating System Based On Their User Interface

User interface is used to interact with the computer to perform various tasks. User gives commands to computer and enters the data into computer. Based on the user interface, there are two types of operating systems.

1. Graphical User Interface (GUI)
2. Command Line Interface (CLI)

Graphical User Interface (GUI) Operating System

Graphical user interface (GUI) operating system present commands in graphical form. For example, application programs, commands, disk drives, files etc. are presented in the form of icons.

Usually a command is given to the computer by clicking with mouse on the icon. GUI also provides menus, buttons and other graphical objects to the user to perform different tasks. GUI is very easy to interact with the computer.

Example

Examples of GUI operating systems are Windows, Linux, and Solaris. Today Windows is commonly used in PCs. In Windows, mouse is used as input device.

Features of Graphical User Interface OS

Interfacing

Provides commands in graphical form on the computer screen. The user gives commands to computer by clicking with mouse on the icon. The users have not to memorize commands. Usually mouse is used for interfacing with computer.

Control

Although a GUI offers a better control of a file system and computer resources but often users have to use command line to complete a specific tasks.

Ease
It is easy to learn and use.

Multitasking
GUI provides facility to open multiple programs each in a separate window. So it enables a user to view and to manipulate things at a time on computer screen.

Speed
A GUI is easier to use. However it is slower to perform different tasks.

Scripting
Although a GUI enables a user to create shortcuts or other similar sections to complete a task. However GUI does not provide the facility of scripting a sequence of commands to perform task.

Command Line Interface Operating System

A command line interface operating system provides a command prompt on the computer screen that allows the user to type in commands that can immediately provide results. The commands are given to the computer by typing on the keyboard. The commands are typed according to the predefined format. The main problem with command line interface is that users have to memorize commands and rules of writing these commands. It is not an easy way to interface with the computer. This is downside for people who are not fond of memorizing commands.

Example
Examples of Command line operating systems are DOS (Disk Operating System), and Unix.

Features of Command Line OS

Interfacing
Provides a commands prompt on the computer screen. The user gives commands to computer by typing on the keyboard. The users have to memorize commands and rules of writing these commands. Usually keyboard is used for interfacing with computer.

Control
It provides full access to computer resources.

Ease
It is difficult to learn and use.

Multitasking
Although many command line operating systems allow multitasking, but it is difficult in these operating systems to view multiple things at a time on computer screen.

Speed

The command line interface is faster than GUI to perform different tasks.

Classification of Operating System Based On the Number of User and Number of Task

Following are main four types of operating system based on the number of user and number of task they perform.

Single User Single Task Operating System

Is the system software which is used by a single user and it can perform a single task at a time.

Example

The Palm operating system handheld computers (i.e. Android OS, Symbian OS) are good examples of a modem single user single task operating system.

Single User Multitask Operating System

This operating system allows a single user to simultaneously run multiple applications on their computer at a time. This is the type of operating system found on most personal desktop and laptop computers.

Example

Windows operating system (i.e. windows 10, windows 7), Mac OS etc.

Multiuser Multitask Operating System

This can be used by many users also can perform many functions at a time. The operating system must make sure that the requirements of the various users are balanced, and that each of the programs they are using has sufficient and separate resources so that a problem with one user does not affect the entire community of users.

Example

UNIX, Solaris, Linux, Windows NT are examples of multiuser multitask OS.

Real time Operating System

Often used as a control device in a dedicated application such as controlling experiments, medical imaging systems, and industrial control systems etc.

Example

RTlinux, VXWorks, Windows CE, QNX etc.

Functions of Operating System

There are many functions those are performed by operating system but the main goal of operating system is to provide the interface between the user and the hardware means of provides the interface for working on the system by the user.

The various Functions those are Performed by the Operating System are as Explained below:-

Interface Platform

It provides a graphical user interface to the user as well as an interface for running other application.

Resource Management
The resource management function of an OS allocates computer resources such as CPU times, main memory, secondary storage and input / output devices for use as well as managing software resources.

Memory Management
Decide which processes are loaded into memory when memory space becomes available.

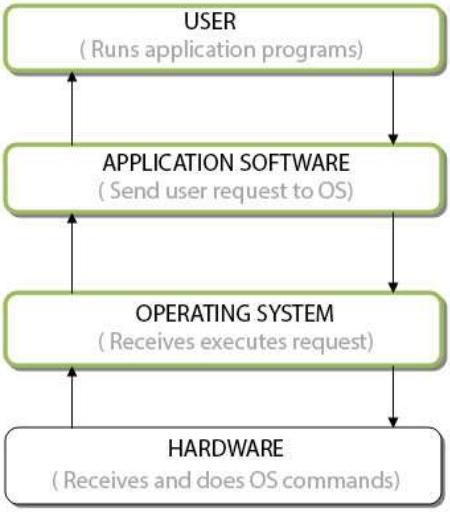
Security Management
By security management operating system manages the alert messages, dialogue boxes, firewall and password.

File management
Refer to the way that the operating system manipulates, store, retrieve and save data.

Role of an Operating system

An operating system exists for two main purposes. One is that is responsible for the management and coordination of activities and the sharing of the resources of the computer. Another is that it provides an environment for the development and execution of programs.

Following is the diagram which shows the role of an operating system



Using Operating System

Procedure for Switching On and Off the Computer

Booting is a process of powering on a computer and getting into the operating system.
During the boot process, the computer will perform a self- diagnostic also known as POST and load necessary drivers and programs that help the computer and devices communicate.

Boot Devices

Booting can be done either through hardware (pressing the start button) or by giving software commands. Therefore, a boot device is a device that loads the operating system. Moreover, it contains the instructions and files which start the computer. Examples are the hard drive, floppy disk drive, CD drive, etc. Among them, the hard drive is the most used one

Steps of Booting

We can describe the boot process in six steps:

1. **The Startup**

It is the first step that involves switching the power ON. It supplies electricity to the main components like BIOS and processor.

2. **BIOS and Power On Self-Test**

BIOS (Basic Input Output System): Is a program uses to get the computer system started after you turn it on.
The BIOS is built into all personal computer motherboards and is the first program to run when the computer powers up.
It provides the necessary functionality to start the boot sequence from the boot device, normally located on the primary hard drive.

POST (Power On Self-Test): This is the diagnostic testing sequence that a computer's BIOS runs to determine if the computer hardware like RAM, disk drives and other hardware are working correctly. It is a part of ROM-BIOS functionality. Moreover, if any error occurs, the system produces a beep sound.

3. **Loading of OS**

In this step, the operating system is loaded into the main memory. The operating system starts working and executes all the initial files and instructions.

4. **System Configuration**

In this step, the drivers are loaded into the main memory. Drivers are programs that help in the functioning of the peripheral devices.

5. **Loading System Utilities**

System utilities are basic functioning programs, for example, volume control, antivirus, etc. In this step, system utilities are loaded into the memory.

6. **User Authentication**

If any password has been set up in the computer system, the system checks for user authentication. Once the user enters the login Id and password correctly the system finally starts.

There are main two processes of booting up the computer.

i. Cold booting
ii. Warm booting

- **Cold booting:** This is when the computer is started after being switched off.

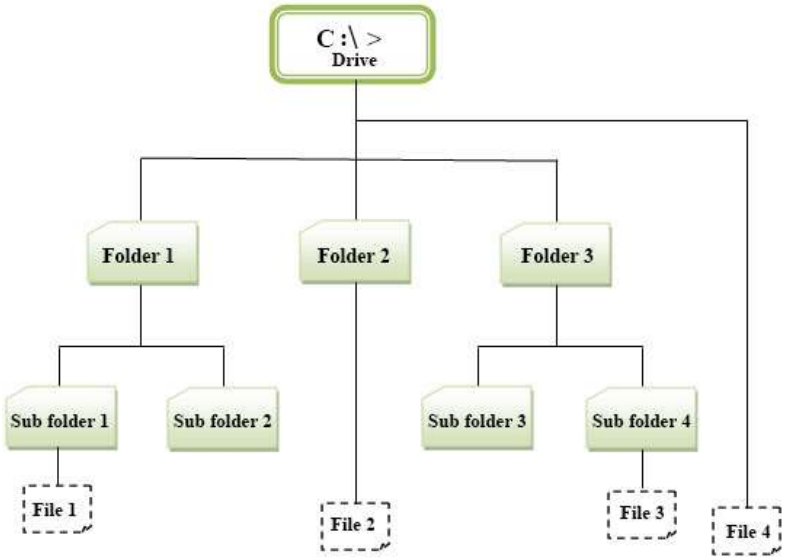
- **Warm booting:** This is when the operating system alone is restarted without being switched off.

How An Operating System Organise Information In A Three-Tier Hierarchy.

Most operating system organize information in a three – tier hierarchy

i. Drives
ii. Folder
iii. Files

The figure below shows how an operating system organizes information on a harddisk



Information organization 3-tier hierarchy

Drives (Directory)

The operating system recognizes storage media or devices as drives. Drives may be given letters A-Z to identify them.

Folder

A folder is a named storage location where related files can be stored.

Files

A file is a collection of related data given a unique name for ease of access, manipulation and storage on a backing storage.

Types of Files

There are three types of files namely

i. System files: This contains information that is critical for operation for the computer.

ii. Application files: This holds programs and is executable.

iii. Data files: This contains user's specific data.

The table below shows some extensions and whether it is a system, application or data file.

Extension	File type	Description
• Doc	Data	A Microsoft Word document file
• Txt	Data	A plain text file created using notepad
• Tif	Data	A graphic file created using application such as Adobe Photoshop
• Exe	Application file	The file that launches particular applications e.g. Windows.exe etc
• Bat	System file	File containing series of commands loaded during boot up
• Sys	System file	System files that perform fundamental operation in a computer