COMPUTER STUDIES
A subject that deals with features, uses, benefits and effects of computers.

WHAT IS A COMPUTER?
It is an electronic device that works under the control of stored programs to automatically accept, store and process data into information. Therefore, a computer has the following characteristics:

- **It is electronic**:- can only work when there is electricity
- **It is a device:** a machine
- **Is controlled by programs:** Works according to instructions, written in computer language, given by the user for it to perform a specific tasks.
- **Is automatic in operation**: Can work with minimum or no human intervention.
- **Can accept data**: data can be entered into the computer through various means and the computer accepts it.
- **Can store data and programs**: Data and programs entered into the computer can be stored for future use.
- Can process data into information

DATA AND INFORMATION
1. Data: refers to raw facts and figures of an activity. It can just be a list of numbers, names or a combination of these. Data is meaningless and needs to be processed. Data cannot be used for decision making purposes as it is meaningless.

2. Information: It is data that has been converted into meaningful form. In general it is processed data. Information can be understood and therefore can be used for decision making purposes. Information is meaningful. To get relevant information, data entered into the computer must be relevant, accurate and up-to-date. If data entered into the computer is wrong (Garbage In) the results will also be wrong (Garbage Out), and is generally referred to as **Garbage-In Garbage-Out (GIGO)**. It is a rule stating that the quality of the output is a function of the quality of the input; put garbage in and you get garbage out. Therefore the accuracy of the results produced by the computer depends on how accurate the user enters data, functions, formulae and codes program procedures.

The Data Processing Cycle
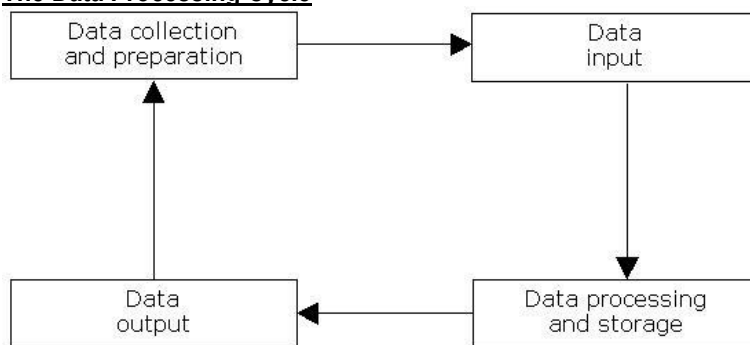
COMPUTER GENERATIONS
Refers to stages through which computers developed from the 1940s to date. These are as follows:

1. **First Generation Computers (1945 -1955):** These are the earliest computers that used valves in controlling machines, e.g. EDVAC, ACE and UNIVAC machines. These were very large computers, fitting about the size of an average room. They were programmed in a language understandable by the machine. Such computers used a lot of electricity and were very expensive to purchase. Only very large organisation could afford these computers. Such computers were *huge*, *slow*, *expensive* and *often undependable*.

2. Second Generation Computers (1955 -1965): These are computers that used transistors instead of valves. They were faster, had reduced size, were more reliable and less expensive.
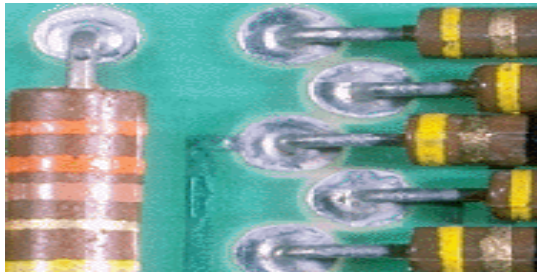

Transistor

Second generation computers were: faster, more reliable, smaller, much cheaper to build, gave off virtually no heat, conduct electricity faster

3. Third Generation Computers (1965 – 1980): These used integrated circuits e.g. the IBM (International Business Machines) computers. The integrated circuit, also referred to as semiconductor chip, packs a huge number of transistors onto a single wafer of silicon. These computers have *increased the power*, *lowered cost*, *carry out instructions in billionths of a second*, and are *smaller*.

4. Fourth Generation Computers (1980-1990): The Fourth Generation Computers that used microprocessors and concentrated on miniaturisation of high processing components. Fourth Generation Computers are grouped into mainframe, mini, micro and super computers, depending on their sizes, capabilities and memory size.
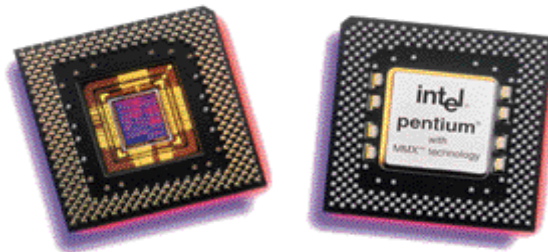
Microprocessor

5. Fifth Generation Computers (1990 to date and beyond): These use natural language and can flexibly interact with the human being. Such systems are used in medical diagnosis, mineral prospecting and in geological researches. Such computer systems are capable of human intelligence and are commonly called expert systems.

TYPES OF COMPUTERS
The types of computers are: **Micro-computers, mainframe computer, super computer & mini-computer.**
1. **Micro Computers:** These are computers with a microprocessor inside them, and include the following:

Microcomputers

  a. **Desktop Computers:** These are computers with a separate CPU and monitor and fit on a desk during usage.
  b. **Personal Computers (PC):** - These are microcomputers made for use at home for general purpose, and includes desktop computers.

c. **Palmtops:** These are portable microcomputers that can fit in the palm and are used as diaries and for other small business applications.

They are Handheld Computers that are small enough to be carried in a pocket and include **Personal Digital Assistants (PDAs)** and **Cell phones**.

d. **Laptops (Notebook computers): -** These are portable computers that use an internal battery for power and can be placed on laps during usage.

Laptops are small like a briefcase and are portable and can be used in areas where there is no electricity. They have llight weight and battery powered.

However, laptops can easily get stolen, they need recharging from time to time, some find it difficult to use the laptop keyboard and inbuilt mouse, and they are even expensive to buy and to repair. They also have limited expandability and docking stations

Laptop computer

e. **Tablet Personal Computers***:* Type of notebook that accepts input from an electronic pen

Tablet PCs (a) Slate model   (b) Convertible model

For schools and school children, laptops have the following advantages:
Users can save data in their own storage area wherever they are. Users can get any networked software wherever they are. School needs fewer printers. Users do not need to keep using the same machine. Users can access school intranet from anywhere. Users can access Internet from anywhere. Users do not need to carry CD ROMs. It is easier to communicate with. Can email work to teachers even from home. Staff can monitor students easily. Students and teachers can share files and notes easily.

However, the following problems may arise:
Work can be hacked into more easily. If no convenient network point, users cannot work. It is expensive to buy many network cards. If server goes down users cannot work. Students can use Internet inappropriately, for instance watching pornography. Viruses can be downloaded easily. Costs of updating or replacing server are high.
<u>NB</u>: - Microcomputers perform general purposes like word-processing, processing small amounts of data, playing music, etc. However, these days, microcomputers can also be used in large organisations because of improved efficiency in their usage.

2. Mini-Computers: these are in-between mainframe computers and microcomputers computers. They are suitable for large business organisations like in banks where they process client accounts. They are however less powerful than mainframes.

3) Mainframe Computers: They are mostly used in large organisations like banks and where bulk data processing is needed such as census, industry/consumer statistics, and financial transaction processing.

These are very big in size and extremely fast. They have very large memory capacity and can be used in educational designs.

Mainframe computers

4. Super Computers: These are very powerful computers that are used to perform detailed calculations and for design purposes, for example, modelling of aircraft wings, testing bombs, etc. They are the fastest and most expensive computers

Supercomputer

*NB:- The classification of computers as micro, mini, mainframes and super computers have become blared due to recent technological advancements since a microcomputer can now perform all functions that were believed to be for mainframes.

Type	Size	Cost	Commonly used
Supercomputer	Biggest	Most expensive	Government
Mainframes	Giant	expensive	Hospitals, Airline reservation
Minicomputer	Small	Cheap	Businesses, Colleges
Microcomputers	Smallest	Cheapest	Homes

Summary: Classifications of Computers

Classification of computers can also be made relating to the use of the computer, as follows:

(a) General Purpose Computers: - these are computers that can be used to perform a number of functions like playing music, playing games, payroll processing and so on.

(b) Special Purpose Computers: - These are computers that are designed to perform one task only, for example, to monitor patients in hospital.

(c) **Analogue Computers**: these handle data in continuously varying form.

(d) Digital Computers: Handle data in discrete values; that is in 0s and 1s.

(e) Embedded Computers: – Refers to use of microprocessors in non-computer equipment like in cameras, washing machines, watches, etc. These are normally dedicated for a specific task they are designed for. Embedded computers are also found in household items like camera, microwave, washing machine, video recorder, fridge, sewing machine, air conditioning, electronic toys, rice cooker dish washer, Televisions, alarms, clock, radio, DVD players, etc. Tasks performed **by microprocessor** inside some of the devices include:

In digital camera: automatically adjust film speed, positions the end of film, adjust distance from object, adjusts light.

In Speed cameras: are used on many roads to take photographs of cars which have exceeded the speed limit. Some of these cameras use microprocessor controlled chips to store information. **The advantages of speed cameras with microprocessor controlled chips are that:**

Data and images can be transferred automatically which will be faster. Image can be viewed straight away. Can store considerably more data and photos. Can store other information (apart from photo image) e.g. road conditions. Chips can be re-used.

Tasks which would be carried out by the microprocessor as a speeding car approaches a camera include:

Sense and record speed of vehicle. Compare speed of vehicle with stored value(s) and decide whether photograph should be taken. Check on value of light intensity. Adjust focal length, focus image, adjust shutter speed and set exposure.

Tasks which would be carried out by the microprocessor as the photograph is being taken include:

Log the time. Log the date. Log the speed. Record the road conditions. Operate "flash". Operate shutter. Store the image. Check on value of light intensity. Adjust focal length and focus image.

In washing machine: Controls the amount of water. Adjust and controls speed of wash. Control temperature of water and the time taken to wash the clothes.

In fridges: Controls temperature level. Control the display panel. Switch on lights if door is opened and off when closed.

In air conditioners: Controls temperature. Controls timing and the display panel

Advantages of using computers

They process data at very high speed, thus large volumes of goods can be produced. Computers are very accurate in making calculations and thus ensure that no calculation errors occur. Computers are very reliable to use since they rarely makes mistakes. Computers store large volumes of data for a long period of time. Computers cut labour costs as they can perform duties that need many people. They replace humans and thus cut labour costs on wages, medical aid, retirement benefits, leave payments, etc. Computers can work for 24 hours a day with no complains as humans. They do not get tired. Computers create employment for the community, for example, computer teachers (tutors), programmers, computer technicians, database administrators, etc. High quality goods are produced using computers. Ensures efficient, easier and faster communication through the internet.

Disadvantages of using computers

Continuous usage can lead to health problems like Repetitive Strain Injury (RSI), back ache, eye problems, etc. Lead to increase in computer crimes like computer fraud, hacking, music and software piracy, data theft using computers, sending of viruses, etc. Can lead to unemployment since computers can replace human labour as in car assemblies. Expenses related to repairs, maintenance and safety can be high. They only work when there is electricity.

NB*

Computer crime: *the use of computer to perform unlawful activities, e.g. piracy, hacking, etc*

Software piracy: *illegal copying, selling and buying copyrighted software without certification.*

Hacking: *Obtaining unauthorised accessed to protected and secure computer systems or network, usually using intelligent methods*

Computer fraud: *improper electronic transfer of funds from one account to another using computers*

Copyright: *A document granting exclusive right to use, publish and sell software, musical or artistic work.*

End-user: *A person or organisation who are the final beneficiaries of a program or a   device like a computer.*

FACTORS TO CONSIDER WHEN BUYING A COMPUTER

-Hard disk storage capacity: Affects the volume of data that can be stored by the computer.

-RAM size: affect the number of programs that can be run on the computer and the overall speed of the computer. The bigger the RAM size the better.

-Processor Speed: Determines the amount of data that can be processed at a given period of time. The processor speed can be affected by clock speed, word size (16, 32, 64, 128 bits), bus size.

-Application intended for: what the computer will be used for, general purpose or specialised purpose.

-Method of operating the computer: single user, multi-access, etc.

- Number of Input and output devices it can handle.

ELEMENTS OF A COMPUTER

The main elements (components) of a computer are classified into Hardware elements and Software elements

HARDWARE: These are parts of a computer that exits in physical form, for example mouse, keyboard. Hardware refers to tangible devices of a computer. Hardware is grouped into: **Input Hardware, Processing Hardware, Output Hardware and Storage devices.**

INPUT HARDWARE

These are devices used to enter data into the computer, for example mouse and keyboard. Below are some of the input hardware and their uses:

(i) Keyboard: It is a device used to enter data and instructions into the computer by typing. It is similar to the traditional typewriter. It is used to enter alphabetic letters (A-Z-both lower case and upper case), numbers (0-9, positive and negative) and other special characters like the %, $, coma, ?, and the space. Keyboard entry of data is manual and its excessive use without breaks will cause **Repetitive Strain Injury (RSI).**

*NB: - A **character** is any symbol, digit or letter that can be entered into the computer, eg. $, %, 5, h, etc. These characters can be numeric (numbers 0-9, positive and negative), alphabetic (letters A-Z, both lower and upper case), alphanumeric data (a combination of both numeric and alphabetic characters) and special characters (space, $, >, etc.).

Standard keyboard

*NB: - **Control Character**: - Refers to non-printable character code or number in the character set that do not represent a written symbol, e.g. carriage return, tab key, etc. These are mostly used in peripheral devices control and for communication purposes, for example, carriage return, tab or backspace; and others typed by depressing a key and the control key at the same time.

*NB:-**Extended Binary-Coded-Decimal Interchange Code (EBCDIC)** an 8-bit character set and encoding representing 256 alphanumeric and special characters

- ASCII - American Standard Code for Information Interchange: - a code for information exchange between computers made by different companies; in which a string of 7 binary digits represents each character; used in most microcomputers. Each character has its ASCII binary code that can be understood by the computer.

(ii) Mouse: It is a mouse shaped device used to enter data and instructions into the computer by clicking.

Mouse

It can also be used for pointing and selecting items. **Clicking** is the process of pressing and releasing the mouse button. It is a fast method of entering data and for selecting items.

(iii) Scanner: an input device used to convert images from paper into electrical signals for input into the computer.

Scanners

The images can then be edited, printed or saved. Mostly used to scan pictures, photographs, etc.

Flatbed scanners have the paper placed on top of them, in a similar way to a photocopier. These are more expensive than hand-held scanners but they are usually able to produce higher resolution images.

(iv) Digital Camera: A device use to capture photographs, films, videos or a combination of both for entry into the computer where they can be edited.

(v) Touch Screen: A screen display on which you could enter data by pointing with a finger on intended option.

Touch screen

Used on **(ATMs)-Automated Teller Machines**, cell phones, computers, etc.

A touch screen is both an input and output device.

(vi) Joystick: A device specifically used for playing games.

Two types of joystick

It can be an alternative to a mouse. It consists of a base and a stick perpendicular to the base. The stick can be moved in any direction, enabling the user to move an object around the computer screen. A joystick can perform a similar function to a mouse or trackball, but is only commonly used for playing games.

(vii) Tracer ball: It is an input device with a small ball that can be moved by passing the palm of your hand over it. This will move an arrow on the screen.

Tracer balls

It is used to draw designs and to select options from menu. It is mostly found on laptop computers.

(viii) Microphone: It is an analogue input device that recognises human voice for data entry into the computer.

*NB:-An **analogue device** is a device that recognises data in continuously varying form, e.g. microphone, wall watches (with minute, hour and second hand), fuel petrol gauge, speedometer, etc.

A microphone is used in **voice recognition systems (voice synthesis)**. These are computerised systems that allow users to communicate with the computer by talking (voice input). **Such systems have the following advantages:**

The systems are over 90% accurate. They are appropriate for the handicapped, especially those without hands. They are very fast in entering data and in giving instructions to the computer. They are speaker independent. They can recognise natural language.

Disadvantages:
Older systems are speaker dependent. They allow the user to speak slowly, using specific words that were programmed for it to understand.
NB: Multimedia speakers, sound cards, a microphone and voice recognition software are needed in voice recognition systems.

(ix) Light pen: A ballpoint shaped device used to enter data by writing on an ink pad. It is also used to make alterations on the screen to the drawings, to write directly on the screen and to select commands.

Light pen

(x) Kimball Tags: These are punched cards with a magnetic strip which contains details of a product, mostly clothes in a shop.
(xi) Graphics tablet: Devices used to provide interface for drawing on the screen and links with the light pen
(xii) Webcam: A digital camera designed to take digital photographs and transmit them over the internet.
(xiii) Sensor: an input device that automatically records data by sensing the environment it is supposed to record, e.g. humidity sensor.
(xiv) Magnetic Stripes: Magnetic stripes can be seen on train tickets or bank or credit cards.

(a) Card with magnetic strip   *(b) Magnetic strip reader*

These stripes hold a small amount of data (64 characters) and can be read by a magnetic stripe reader (card reader) that is connected to a computer system. These provide a quick and accurate way of entering details into a computer system and are simple to operate.

(xv) Smart Cards: Most bank and credit cards are now *smart cards*.

Cards have their own processor and memory that can hold up to 64KB of data. The data that is stored can be updated and the processor can process simple programs.

Smart cards

(xvi) Barcode Reader: These are devices at **Electronic Point of Sale terminals (EPOS)** that read barcodes on products for automatic data entry into the computer. Mostly used in library systems, luggage handling systems at airports, warehouse stock control, etc.

Barcodes are numbered vertical lines and spaces of varying size on products that provide data for such a product to the computer when read by barcode readers.
If the barcode reader fails to read the barcodes, data is entered manually through the keyboard by entering the numbers below the barcodes.

Barcodes

Barcodes have the following advantages:
They are cheap and easy to use. They are very accurate in entering data. They are a very fast means of entering data since they are an automatic data entry method. Customers can be served quickly. Automatic re-ordering of goods in supermarkets is possible. Automatic stock taking is possible. Need for fewer people in the stores thereby cutting labour expenses. Out of date items can be automatically identified. There is no need for supermarket workers to remember prices. It becomes easier to do price changes.

Information found on barcodes includes:
Product name, Price, Check digit, Product number, Country of origin, Manufacturer's number, Weight.

How does the computer system checks that the barcode has been read correctly?
Either the computer performs the following:
Calculates the check digit; remainder = 0 if barcode has been read correctly OR uses the weights and modulus 11 and use remainder

DOCUMENT READERS

These are devices used for entering data automatically into the computer by reading through documents. These include:

(i) Optical Mark Recognition (OMR): The Optical Mark Readers use light sensitive devices to sense pencil marks on a piece of paper for automatic data entry into the computer. Light is reflected from the document onto the Optical Mark Reader which records the output. It then records low intensity/zero intensity at certain points. OMR is mostly used in marking **multiple choice exams** at ZJC and 'O' Level and reading pupils' registers. OMR is fast and accurate in entering data. An Optical Mark Reader is the device that is used for automatic data entry in OMR systems.

(ii) Optical Character Recognition (OCR): It is the use of light sensitive devices to recognise alphabetic characters and numbers on a sheet of paper for automatic data entry into the computer. Mostly used by insurance companies, in billing systems and processing of Bank Giro-forms. An Optical Character Reader is the device that is used for automatic data entry in OCR systems.

(iii) Magnetic Ink Character Recognition (MICR): A method of automatically entering data into the computer by reading characters on documents past a magnetised field with iron oxide, e.g. reading numbers on the bottom of a cheque.
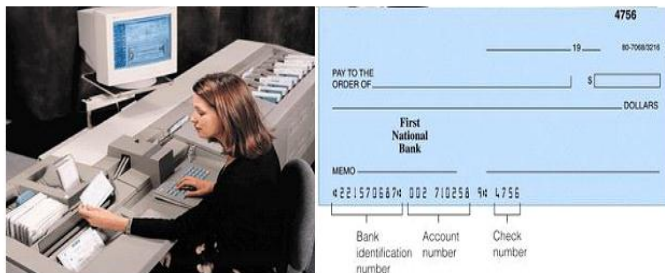
Magnetic Ink Character Recognition (MICR) Device (b) Cheque

Advantages of using magnetic ink on cheques include:
Bundles of cheques can be processed very quickly.
It is very difficult to forge a cheque.
The ink can be read by the reader even if the cheque gets marked or dirty. A Magnetic Ink Character Reader is the device that is used for automatic data entry in MICR systems

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FACTORS TO CONSIDER WHEN PURCHASING HARDWARE

The following must be considered: Volume of data to be handled. Number of users. Location of user (in one office, separate office or in completely different locations). Type of users (used by the public or by technical specialists). Nature of the system (batch, online, etc). Security features. Software type, etc.

OUTPUT DEVICES

These are devices used to display and produce data and information held inside the computer, for example: screen, printer and graph plotters. These are described below:

(i) Printers: A printer is a device that is used to produce hard copies of data held in the computer. Hardcopy is a document printed on paper. Output from the printer appears as displayed on the computer screen, thus What You See Is What You Get (WYSIWYG).

Types of Printers

Printers can be classified into **impact and non-impact printers**.

(a) Impact Printers: these are printers whose write heads hit ink ribbon against paper during printing, e.g. dot matrix printer. Thus, there is contact between the paper and the write heads during the printing stage. Examples include drum printers, dot matrix printers, daisy wheel printers and chain printers. Impact printers have the following advantages**:** they are very cheap to buy. They are cheap to repair and to maintain. They can use continuous paper. They are economic in terms of ink usage.

However, Impact printers have the following disadvantages: They produce a lot of noise. They are very slow in printing since most are line printers. They produce poor quality printout.

Dot matrix printer

(b) Non-Impact Printers: These are printers that do not produce contact between paper, write heads and ink cartridge during printing. Most of the printers use light and are therefore called laser printers.

The advantages of laser printers are as follows**:** They print at very high speeds since they are page printers. They produce high quality text and graphics. They produce less noise than dot-matrix printers (they are quiet in their operation). Have paper trays both for input and output and therefore need no supervision once setup.

LaserJet printers

The disadvantages of laser printers are as follows: they are very expensive to buy, they are large and therefore take up a lot of desk space, they are quite complex and therefore repair bills can be very high, Multipart stationery cannot be used, Cannot be used with continuous stationery since they are page printers.

*NB: - Printers can also be classified as **page printers** (these print one page at a given time and are therefore faster) and **line printers** (print one line at a time, very slow). Mostly Non-impact printers are page printers while impact printers are line printers.

(ii) Screen / Monitor: it is a television shaped device used to display contents on the computer as soft copy. Soft copy refers to data viewed on the screen. The screen can also be called the Visual Display Unit (VDU). The screen can differ in terms of resolution, that is low resolution screens display less number of dots per inch on the computer and therefore the display will be of poor quality. High resolution monitors are needed mostly in graphics packages where colour and many dots per inch are needed.

(iii) Graph Plotter: This is a device used to produce high quality drawings in various paper sizes and is used in **Computer Aided Design (CAD).**

Graph plotter

PROCESSING DEVICE

A device used to convert and to manipulate data as per user requirement. The sole processing device of a computer is the processor, which is inside the Central Processing Unit (CPU) casing. Processing involves sorting of data, updating records, searching certain records, adding a sequence of numbers, and others. Functions of the processor include: Controls the sequence of instructions, Processes all instructions given by the user, Give commands to all parts of the computer, Carry out data processing like making calculation to data given by the user.

Microprocessors

Most of the computers have micro-processors (small execution chip found in microcomputers). With MS-DOS (Microsoft Disk Operating System) computer chips progressed from 286, 386 and 486 processors. Intel Corporation then developed Pentium processors, ranging from Pentium 1, Pentium 2, Pentium 3, Pentium 4 and so on, with each processor being faster then the preceding one. Pentium 4 processors have a speed of about 2.6 GHz. Newer chips are faster in processing.

The speed of a processor determines the speed and function of a computer. Until the 1980s, most computers had one processor, but recent ones have two or more processors (called co-processors), those with two processors are called dual processors. Two or more processors share loads and therefore perform operations faster. The speed of a computer is also determined by the **clock speed** for each microprocessor. This speed is measured in Megahertz (MHz). The general structure of the CPU or Processor is as illustrated below:
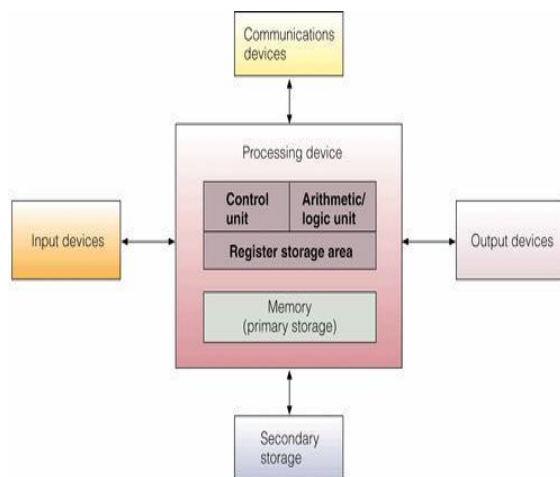
The processor comprises of: Arithmetic and Logic Unit (ALU) and the Control Unit (CU) and Registers

(a) Arithmetic and Logic Unit (ALU)
- Carries out arithmetic operations like add, subtract, divide, etc.
-Performs logic operations, like AND, OR,..etc

(b) Control Unit (CU)
- It coordinates and controls all hardware operations,
- It carries out the Fetch-Execute Cycle.

(c) Registers: High-speed storage area in the CPU used to temporarily hold small units of program instructions and data immediately before, during and after execution by the CPU.

NB: Memory (Main memory): Stores programs and data for programs currently running on the computer. Main Memory is very close to the processors and therefore the two can coordinate their activities very fast.
- **ALU** operations on data are first loaded into the **accumulator register**, a memory which stores instructions, data being processed and results of an operation.
The function of the microprocessor is to fetch, decode and execute instructions. This is also called the Fetch-Execute cycle.

The Fetch-Execute Cycle
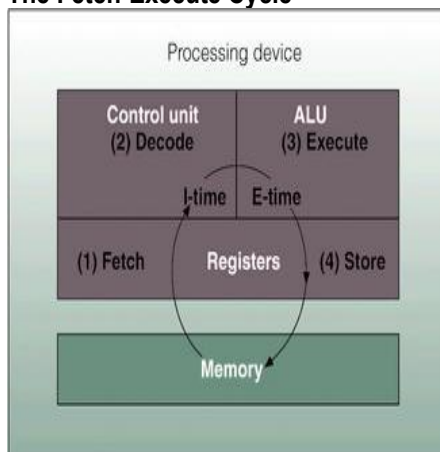
The Fetch-Execute Cycle

Step 1. Fetch instruction: In the instruction phase, the computer's control unit fetches the instruction to be executed from memory. Microprocessor gets software instruction telling it what to do with data.
Step 2. Decode instruction: Then the instruction is decoded so the central processor can understand what is to be done. Microprocessor determines what the instructions mean.
Step 3. Execute the instruction: In the execution phase, the ALU does what it is instructed to do, making either an arithmetic computation or a logical comparison. Microprocessor performsms the instruction.
Step 4. Store results: Then the results are stored in the registers or in memory.
Step 3 & 4 are called the execution phase. The time it takes to complete the execution phase is called the EXECUTION TIME (E-time). After both phases have been completed for one instruction, they are again performed for the second instruction, and so on.

STORAGE MEDIA
These are devices used to store data and programs for future use.

Methods of storing data:
Refers to ways files and records are stored on a storage media, that is the arrangement of data. These include:
- **Serial Storage:** Data is stored as they occur without following any order, as on magnetic tapes.
- **Sequential Storage:** Data is stored using a predefined order, either in ascending or descending order of a key field, as occurs on magnetic tapes.
- **Direct (Random) Storage:** Data is stored in a random way using an index, as on diskettes, hard disks, CD-ROMs, etc.

Methods of Accessing Data
These are methods used to retrieve data held on storage media. These include:
(1) Serial Access: Data is retrieved in the order it is stored, reading files one after another from the first until the required data is found in an unsorted list of records. It is very slow and time wasting in accessing records far away from the first position but is faster to access data at first position of the disk. It is used in magnetic tapes.
(2) Sequential Access: Data is retrieved in the order stored, from the first until the required data is found, using a key field in a sorted list of records, as in magnetic tapes.
(3) Direct (Random) Access: Data is retrieved by going directly to the needed file, as applied in hard disks, diskettes, CD-ROM, DVD-ROM, Memory Sticks, etc. It is a very fast method of accessing data.

Storage Capacity
Refers to the amount (volume) of data a device can store. The following storage measurements can be used:
Bit: The smallest unit of data a computer can store, either a 1 or a 0.
Nibble: refers to half a byte, that is, a group of 4 bits.
Byte: a group of 8 bits representing a character. For example, the letter C is represented by the byte 01000011.
Kilobyte (KB): this refers to 1024 bytes.
Megabyte (MB): 1 MB is equivalent to 1 048 576 bytes.
Gigabytes (GB): 1024 megabytes (approximately 1 billion bytes)
Terabytes (TB): refers to 1 099 511 627 776 bytes (approximately 1 024 GB)
*NB:-**Formatting (initialising)** a disk: this is the process of creating new tracks and sectors on the disk that will be used in storing data. When a disk is formatted, existing tracks and sectors are destroyed, including the data stored on them, and new ones are created. After formatting, the disk will be blank. Formatting is done using the FAT or the NTFS file system. **FAT (or FAT16)** stands for **File Allocation Table**:- It is a file system used by MS-DOS and Windows operating systems to organise and manage files. It is a data structure that Windows creates when you format a volume by using FAT or FAT32 file system. Windows will store information about each file in a FAT so that it can retrieve the file later. FAT uses 16 bit filing system. FAT32 uses 32 bit values and uses drive space more efficiently and supports drives of up to 2 TB. Storage media is grouped in **primary storage** and **secondary storage**:

1. PRIMARY STORAGE (MAIN MEMORY, MAIN STORE, IMMEDIATE ACCESS MEMORY, INTERNAL STORAGE)
Refers to a group of chips inside the processing unit where data is held temporarily whilst processing takes place. Main memory is very fast and reliable to use. Data is instantly accessed due to its proximity to the processor.
Main storage is used for: Storage of instructions waiting to be obeyed by the computer. Storage of programs currently being run on the computer. Storage of data currently being processed. Storage of input data before processing. Storage of output data, waiting to be saved or output to the printer. Acts as a working area for data currently being processed.
Main memory is grouped in to **RAM** and **ROM**.

(a) RAM (Random Access Memory):
A memory chip inside CPU casing used to store data and programs temporarily during processing.
The uses of RAM are: To store programs currently running on the computer. Storage of data being processed in the computer. Storage of output data. Acts as a working area for data and programs.

RAM is **volatile**, which means that it loses its contents when power is switched off. RAM is in two forms; that is, dynamic and static RAM. **Static RAM** is a Random Access Memory chip whose contents do not change as long as there is continuous power supply. **Dynamic RAM** is Random Access Memory chip whose contents can be lost even if there is continuous power supply. Dynamic RAM needs to be refreshed to prevent loss of data.

The size of RAM also affects the speed of operation of a computer and the number of programs that can be run on it. RAM size can be 16 MB, 32 MB, 64 MB, 126 MB, 256 MB, 448 MB, 1 GB, etc. The bigger the RAM size, the better the efficiency of the computer and the bigger the number of programs it can run at a given time.

(b) ROM (Read Only Memory): ROM is a semi-conductor circuit (chip) whose contents can only be read from and cannot be erased or modified. ROM contents are fixed during manufacturing, that is, they are hard – wired. These contents can only be read from and cannot be modified.

The uses of ROM are: Stores the Basic Input-Output System (BIOS-refers to software that test hardware at start-up, starts the operating system and support data transfer between devices.) of the computer. Stores control programs for the operation of the computer and its peripherals. Stores translator programs.

ROM is grouped into:

Programmable Read Only Memory (PROM): This is a ROM chip whose contents can be changed but only once. It is re-programmable only once.

Erasable Programmable Read Only Memory (EPROM): This is a Read Only Memory chip whose contents can be erased and modified several times.

Electrically Erasable Read Only Memory (EEPROM): This is a Read Only Memory chip whose contents can be erased and modified several times using electricity.

*NB:- **Firmware (microcode)**:-refers to coded instructions that are stored permanently in read-only memory, for example BIOS.

SECONDARY STORAGE (BACKING STORAGE/AUXILIARY STORAGE/EXTERNAL STORAGE)

These are devices used to store data and programs for future use outside the computer systems. It is a supplement to main storage. Backing storage is non-volatile. Backing storage is grouped into **magnetic storage and optical storage.**

Magnetic Storage

These store data on magnetised field of iron oxide and include magnetic tapes, zip drives, diskettes, hard drives and flash drives.

(a) Magnetic Tapes: They are similar to a normal cassette tape in shape. They store data in serial and sequential order. They are mostly used to backup data. Their storage capacity can be up to 20 GB. Data is also accessed in serial or sequential order. They can be used as off-line storage media.
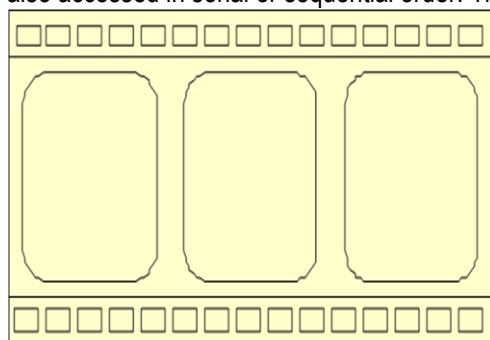
Magnetic tape

Magnetic tapes have the following advantages: Data can be arranged in any ordered sequence. They are re-usable, that is can be overwritten several times. Suitable for high hit rate processing systems like payroll, billing systems, etc. They last for a very long period of time, and thus can be used to keep historical records. They are very cheap to buy. They store very large volumes of data, of up to 20 GB.

However, they have the following disadvantages: It takes too long to find (search for) a needed record in a long list of data records. It is very difficult to update record held in a magnetic tape. It takes too long to update records, time wasting. They are prone to humid (moist) conditions.

(b) Hard Disk (Hard Drive): These are disks used to store large volumes of data and programs, including operating systems and are resident in the CPU casing. Data is stored on tracks in a random way and data retrieval is in a random way. Hard disks can store data of up to 300 GB, but ranges from 2 GB, 8 GB, 20 GB, 40 GB, 80 GB, 120 GB, etc.

Hard disc

Uses of Hard Disk: Creating backups for data. Storing communication and applications software. Storing of the operating system from which the computer will boot. Transferring large volumes of data from one computer to another.

Hard disks have the following advantages: It is easier to access data stored on hard disks. They have a long life span, of about 5 years or more. Provides direct access to data. It is easier and faster to update data on hard disks. They are more robust. Have large storage capacity, about 300 GB or more.

Disadvantages of Hard Disks: Are fixed inside the CPU casing and therefore cannot be repaired once damaged. Not suitable for processing of files with a high hit rate (they are low processing disks). Can easily crush if computer is not switched off properly. They are expensive to buy.

(c) Diskette (Floppy Disk): A 3.5 inch and plastic magnetic disk enclosed in a stiff envelope with a radial slit; used to store data or programs. They have a storage capacity of 1.44 MB. They are used as backing storage for small volumes of data. Data is stored on tracks in a random way. Direct access to data is provided. Its features are shown below:

Diagram of a Diskette:
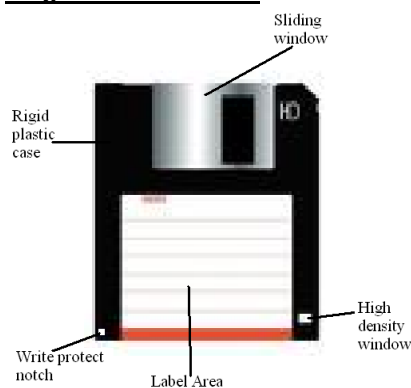
Notes on Diagram

Rigid plastic case: - protects the disk inside from damage.

Write protect Window: When it is open, data cannot be written on disk, unless it is closed. It is a method of preventing data on disk from being modified.

Disk Label: this is where the user writes some information, for example his/her name, disk contents, etc.

High Density Window: - indicates that a disk can store data on two sides, thus allowing more data to be stored on them. 1.44 MB disks are double density disks.

Uses of diskettes are: Creating backups for small amounts of data. Transferring small amounts of data from one computer to another. Booting up the computer in case of system failure, for system recovery. Storage of small programs and data.

Advantages of Diskettes: They are portable (easy to carry around as they can fit in a shirt pocket.). Conceals less electricity. Most are high Double Density Diskettes.

Disadvantages of Diskettes: have very short life span (not durable). Can be affected by humid conditions. Can easily be affected by dusty conditions. Can easily be damaged if placed close to the screen for a long time. Takes long to read data into memory than from a hard disk. Hold very small amount of data, 1.44 MB.

Caring for diskettes: Do not place them near magnetised field or near the computer screen. Keep them free from dust. Keep of dry place. Do not expose them to direct sunlight.

(d) Zip Drives: Similar to diskettes in shape but does not flop. Data is stored in a random way. Data is accessed in a random way. Storage capacity is 100 MB.

Zip drive

Advantages of Zip Drives: They are portable (easy to carry around as they can fit in a shirt pocket.). Conceals less electricity. Most are high Double Density drives. More durable than diskettes

Disadvantages of Zip Drives: Hold small amount of data of about 100 MB. Can be affected by humid conditions. Can easily be affected by dusty conditions. Can easily be damaged if placed close to the screen for a long time.

(e) Memory Sticks / Flash Drive: These are small drives that can be plugged on the Universal Serial Bus (USB) of the CPU. Provide direct storage and access to data.

Memory stick

Storage capacity ranges from 1 GB, 2 GB, 4 GB, 8 GB and 32 GB.
Advantages of Memory Sticks: have a long life span about 3 yrs. Have large storage capacity about 8 GB or more. Provide direct access to data. Very cheap to buy. Portable since they can fit in a pocket.
Disadvantages of Flash Drives: Older machines have no sockets to plug in memory sticks. They need software/drivers installed for them to work. They can get lost easily. Virus spread quickly through them.

1. Bus: A communication line used for data transfer among the components of a computer system
2. USB: - An external bus that supports Plug and Play installation of devices. Using USB, you can connect and disconnect devices without shutting down or restarting your computer. You can use a single USB port to connect up to 127 peripheral devices, including speakers, telephones, CD-ROM drives, joysticks, tape drives, keyboards, scanners, and cameras. A USB port is usually located on the back of your computer near the serial port or parallel port.
3. USB port: An interface on the computer that enables you to connect a Universal Serial Bus (USB) device. USB is an external bus standard that enables data transfer rates of 12 Mbps (12 million bits per second).

(f) Memory Cards: memory card is like a portable hard disk that fits into personal computer card slot.

Memory cards

They offer direct access to data, are portable, can fit even on tablet computers like cell phones, have large storage capacity of up to 8 GB.
They can get lost easily. Virus spread quickly through them.

OPTICAL STORAGE MEDIA:
Refers to devices that use light to store data on them and these include Compact Disks, Digital Versatile Disks, Video Compact Disks, etc
1. CD (Compact Disk): It is spherical disc that uses laser beam technology to read and write data. It stores data on tracks in a random way. Data retrieval is in random order. Storage capacity is 750 MB. Writing of data on CD is done by a device called CD writer/burner.

Compact disc

Uses of compact disks: Transferring data from one computer to another. Creating backup storage for programs and data. Booting the computer when loading the operating system or restoring damaged system files (system repair).
Advantages of CDs: Provide fast and direct access to data. Has large storage capacity of about 750 MB. Produces high quality sound and pictures. It is a multi-media device.
Disadvantages of CDs: Can be affected by direct sunlight. Less durable. They can easily get scratched.

Types of CDs
1. **CD-ROM (Compact Disk Read Only Memory)** a common form of optical Disks on which data, once it has been recorded, cannot be modified.
2. **CD-W (CD-Writeable)** an optical disk that can be written upon, but only once.
3. **CD-RW (CD-Rewriteable)** on optical disk that allows personal computer users to replace their diskettes with high-capacity CDs that can be written upon and edited over.

Advantages to schools of storing learning materials on a CD-ROM other than using the Internet
No danger of accessing doubtful websites. Does not take as long to find required information. Do not have to have a modem. Do not need for a telephone line. Once CD ROM is bought there is no additional expenditure. Do not have to remember user id/password. Usually quicker to load material. Information on CD is more reliable

Disadvantages to schools of storing learning materials on a CD-ROM other than using the Internet
CD ROM can be lost easily. CD ROM can be damaged easily. Internet is up to date while CD ROM is soon out of date. CD ROMs are expensive to replace and to update. Less information can be stored on the CD-ROM as compared to the internet.

2. DVD (Digital Versatile Disc): Are spherical in shape that can store data on 2 sides. Stores data on tracks in a random way. Data retrieval is in random order. Storage capacity is about 4 GB. Writing of data on DVD is done by a device called DVD writer/burner.
Uses of DVDs: Transferring larges volumes of data from one computer to another. Creating backup storage for programs and data. Booting the computer when loading the operating system or restoring damaged system files (system repair)
Advantages of DVDs: Provide fast and direct access to data. Has large storage capacity of about 4 GB. Produces high quality sound and pictures. It is a multi-media device.
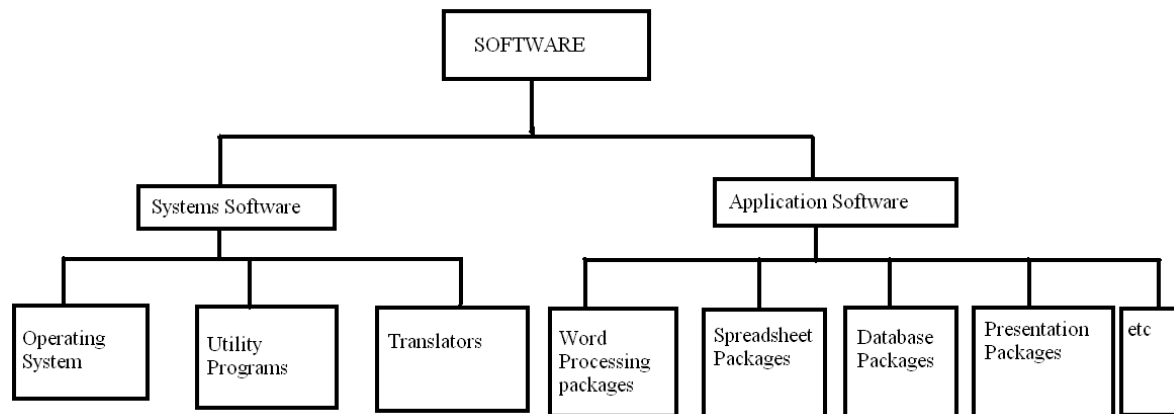**Disadvantages of DVDs:** Can be affected by direct sunlight. Less durable. They can easily get scratched.
Caring for DVDs, VCDs and CDs: Do not expose them to direct sunlight. Do not touch the recording surface. Use soft marker for labelling and not ball point. Keep the free form dust conditions.

*NB: - Virtual Memory – Refers to temporary storage (on hard disk) used by the computer to run programs that need more memory (RAM) than the computer has. For example, programs could have access to 4 gigabytes of virtual memory on a computer's hard drive, even if the computer has only 32 megabytes of RAM.

SOFTWARE

Software refers to a set of instructions written in computer language that tell a computer to perform a specific task, like adding a set of numbers. Without software, a computer will be useless. Software is grouped into systems software and application software. The diagram below illustrates branches/groups of software:

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                              ┌─────────────┐
                              │  SOFTWARE   │
                              └─────────────┘
                   ┌─────────────────┴──────────────────────┐
          ┌──────────────────┐                    ┌──────────────────────┐
          │ Systems Software │                    │ Application Software │
          └──────────────────┘                    └──────────────────────┘
        ┌──────────┼──────────┐           ┌──────┬──────┬──────┬──────┐
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 │ Operating ││ Utility  ││ Translators││  Word   ││Spreadsheet││ Database ││Presentation││ etc │
 │  System   ││ Programs ││            ││Processing││ Packages ││ Packages ││  Packages  ││     │
 │           ││          ││            ││ packages ││          ││          ││            ││     │
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Systems Software: Refers to programs that control and manages the performance of all computer systems. Systems software comprises of: (a) operating systems (b) Utility programs (c) Translators

1) Operating System: - refers to the programs that supervise, control and manage the performance of the computer hardware and software in accordance with set objectives, for example, Windows XP. Examples of operating systems include: Windows 95/98/2000/XP/ VISTA/ Windows 7/Windows 8, Microsoft Disk Operating System (MS-DOS), Unix, Linux, OS/2, etc.

Functions of the operating system: Controls movement of data to and from peripherals. Acts as a background on which application programs can run. Manages hardware, software and memory resources of a computer. Acts as an interface between the user and the computer. Scheduling and loading of programs to provide continuous job processing sequence. Provides a log of users for the computer. Handling of errors and correcting them where possible. Protect hardware, software and data from improper use. Control over the selection and operation of input, output and storage devices of the computer. Booting and shutting down the computer.

Features (characteristics) of operating systems: Must be reliable in terms of being free from errors and handling of all jobs. Must be efficient, that is should be able to use resources fully ensuring good job processing, response time, turnaround time, etc. Must be maintainable. Must be small in terms of storage space on the disk.

***NB**: **Response time** – the time that elapses from the moment an instruction is given to the computer and the time that instruction is carried out.

Turn around time – the time taken from the moment a document is produced by a computer and the moment it is used as an input document to that computer again.

NB. Most operating systems are written in low level language. This is for them to quickly coordinate computer activities since they will not be converted as they are already in machine language. The following must be considered when buying an operating system: Hardware type and computer design e.g. windows operating system works well on IBM compatible machines. Applications intended for the computer e.g. accounting, stock taking, etc. Method of communicating with the computer, that is, use of few or many peripherals and terminals. Method of operating the computer e.g. multi access, multi programming, etc

TYPES OF OPERATING SYSTEMS

1. Single User Operating Systems: These are operating systems that allow one computer user at a time in an interactive mode, for example MS-DOS, CP/M, OS/2, etc.

Advantages of Single user operating systems are: They are cheap to buy. They are interactive, that is, they allow a two way communication between the user and the computer in a conversational mode. They ensure better security to data since they only allow one user at a time. They provide simple command language.

Disadvantages of Single user operating systems are: They are very slow in processing data. Most of the computers are dedicated to one task. The commands are difficult to learn and to use. Commands are difficult to master.

NB- Control Programs: These are programs that monitor hardware operation on the computer.

- Monitor (supervisor) programs: - These are programs that supervise and manage hardware and software elements of the computer

2. Time sharing operating systems: This type of operating system allows many users to use the same processor at a time, using the round robin method by use of time slices. In Round Robin, each user is given a fraction of a second to use the processor so that all users seem not to be sharing the processor.

*NB: - Time slice: A brief period of time during which a particular task is given control of the microprocessor in a time-sharing multitasking environment. A computer's processor is allocated to an application, usually measured in milliseconds. Time slice is also called quantum.

Multitasking: It is the concurrent execution of two or more programs on the same computer by use of time slices.

3. Multi Access / Multi user operating systems: It is when many online users access one processor at the same time to make use of multi-programming.

4. Multi-programming: This is whereby two or more programs (tasks) are being processed (run) at the same time on one computer by use of time slices, for example playing music while typing a document. Programs may take turns to make use of the processor, thus when one is using the CPU, others will be using the peripherals. It uses interrupts to pass control from one program to another.

5. Multiprocessing: A type of operating system that allows one computer to have two or more processors but sharing the same memory, e.g. dual core computers.

6. Batch Processing System: - A system in which data is collected over a long period of time, put in groups and processed with minimum or without user interaction as in payroll processing. Jobs can be entered at a remote terminal, that is, without direct communication with the host computer. Thus batch processing promotes **Remote Job Entry (RJE):** which is the entering of data into the computer through a terminal far away from the host computer.

- For instance, a central computer can process batches of cheques collected from different branches, mostly during the night. If there are errors, the results will also be wrong. Batch processing is very cheap to operate and easy to run. Users can also perform some other tasks while batch processing takes place.

- In batch processing, there is minimum or no human intervention during data processing period. It is used where large amounts of data is processed and where processing does not need to be done immediately, e.g. in Payroll processing, water billing, electricity billing, telephone billing, clearance of cheques, etc).

Advantages of batch processing are as follows: It is less expensive to use. Processing does not need to be done with anyone present. Users do not need to be specialists in computers. It allows remote job entry.

Disadvantages of batch processing are as follows: Batch processing systems are not interactive. Data is processed after a long period of time. No action can be taken if anything wrong happens during processing.

b. Translators: - These are programs that convert source code to object code. Translators are in two forms, which are **interpreters and compilers.** These will be covered in more detail under Programming Languages.

c. Utility Programs: These are programs used to perform specific, useful and frequently needed tasks in a computer. Utilities include the following:

i. Virus Scan Utility: These are programs that protect computers from virus attacks, for example Norton Antivirus, AVG, Avast, Esat NOD32, MacAfee, etc.

ii. Sort Utilities: These are programs used to arrange data, files and records into a specific ordered sequence, for instance in ascending or descending order of a given key.

iii. Debuggers: These are utilities used for assisting in correcting errors in programs.

iv. Dump Utilities: These are programs that assist in copying data from main storage to output devices and to other storage devices like the hard drive.

v. Editors: These are programs used to make changes to data already held in the computer.

vi. Peripheral Transfer Utility: These are programs used to transfer data from one peripheral device to another.

vii. System Status Utilities: These are programs that provide information on the state of files, memory, users and peripherals.

viii. File Maintenance Utilities: These are programs used to reorganise programs and to update them.

APPLICATION SOFTWARE

This refers to programs and their documentation, designed to perform a specific task like payroll processing, word processing, etc.

Application package (suite):- a collection of application programs purchased as one package, for example Microsoft Office 2010.

Integrated Package: A collection of a word processor, spreadsheet, database and presentation packages bought as one package, for example, Microsoft Office 2010.

Advantages of Integrated Packages are: It is cheap to buy as compared to buying single application programs at a time. Programs have been tried and tested and therefore are free from errors. Programs are designed in a similar way, making it easier to learn others if you are able to use one of them. Programs are easier to use and to learn, for example, when designing a database using Microsoft Access. Regular updates are provided on the internet or on disks.

Disadvantages of integrated packages are as follows: They are not tailored for individual user requirements. Organisations purchasing them have little or no control over their use. The packaged programs can only be modified by the programmers (owners). Most of the need regular updating, which may be expensive.

Methods of Acquiring Software

1. Off-the-Shelf: This refers to buying generalised software like Microsoft Word from software vendors.

Generalised (generic) software refers to application programs designed for use in a number of organisations without problems, for example Microsoft Word. A **software vendor** is an organisation that specialises in selling generic software.

Advantages of generic software: Cheaper than custom written (tailor made) packages. They are immediately available in shops. They are tried and tested and therefore are free from errors. Documentation is always provided in form of manuals, user guides and tutorials that may be in soft or hardcopy. Training courses can be available from other end-users. Technical support is always available from other users and from the internet. Other users of the package can be consulted before purchasing or when a problem occurs. Upgrades are always available every year or two. It is easy to share files produced by the software with others as chances are they also have the software available to open the file

Disadvantages of Generic Software: May not meet the individual needs of an organisation. May not run on the organisation's hardware. May not interface with other software already in use in the organisation. Organisations purchasing them have little or no control over their usage. Organisations purchasing them have no right to modify them. The software can be very sophisticated and will usually include large sections that you will never use (e.g. Excel or Word)

2. Tailor-made Software (bespoke): These are programs specifically designed to meet the needs of only one organisation, for example a bank. The organisation would employ or hire an analyst / programmer who will first asses the needs of the organisation before designing a program that will solve the problems of the organisation. Easier and more intuitive to use. You will receive much better support and can in many cases talk directly to the developers concerned

Disadvantages of Tailor-made software: It is very expensive to develop. They take too long to develop and to implement. If you pick the wrong developer you could end up with an application that is unstable, unreliable and full of bugs

*NB: **A programmer** is a person who specialises in designing, coding and testing computer programs. Software House is an organisation that specialises is developing software; this includes both generic and tailor-made.

Special Purpose Application Software: - These are programs designed for one specific business purpose, for example Pastel for accounting purposes.

Advantages of Generic Software Over tailor made software: Off - the - self software is cheaper to buy while tailor-made software is expensive. Generic software has been tried and tested hence free from errors while tailor-made software may have some errors. Generic software is easier and faster to implement while tailor made software takes long to implement. Generic software is used by many organisations; therefore users can share information on its usage while tailor-made software is only used by one organisation. Generic software has regular updates available for download on the internet while tailor-made software does not.

Advantages of tailor made software as compared to Generic Software: Tailor-made software is designed to meet the requirements of an organisation while generic software might not meet the needs of an individual company. Organisations have full control over tailor-made software as compared to off-the-shelf software which is controlled by the programmers.

TYPES OF APPLICATION SOFTWARE:

These include:

1. Word Processing Packages: These are application packages used for creating, editing and formatting text documents like letters and reports. Word Processing packages include Microsoft Office Word, WordPerfect, WordPro, Notepad, etc. Word processing packages have the following **advantages over the typewriter**: Produces more attractive documents. Word processors are less noise than typewriters. Documents can be edited and formatted before printing, which reduces spelling and other typing mistakes on printed documents. Typed documents can be stored in the computer for future use. Document layout can be viewed on the screen before printing and can be changed easily. A word processed document can be printed more than once. Other text and diagrams can be added without the need to retype the document. Word processors can move some parts of text to another part of the document easily. They have the ability to delete words, sentences and paragraphs. They are less manual than typewriters.

*NB: **Editing**: the process of correcting mistakes in a document, for example, spelling mistakes.
Formatting: making a document look more attractive by bolding, underlining, inserting borders, etc

2. Spreadsheet Packages: These are application programs used to manage and analyse statistical, numeric and financial data, for example Microsoft Office Excel, Lotus 1-2-3, SuperCalc, etc.

3. Presentation Packages: These are programs used for designing slides for a presentation to an audience, for example Microsoft Office PowerPoint, Lotus Smart Suite, etc. Presentation packages include text, pictures, sound, animation, graphics and tables, thus being multimedia. Presentations are colourful and attractive. Speakers and projectors are needed. Presentation packages have the following **features**: Have Clip art. Can accommodate images and graphics. Can use sound, video and animation. Incorporate Word Art. Have facility to insert charts and graphs.

*NB: Animation: - Creating illusion of moving sequence using a series of still images as done in movies and cartoons.

4. Database Packages: Refers to programs used to create databases for storage and management of a collection of data related to a particular subject, for examples Microsoft Office Access, Dbase IV, etc

5. Graphics Packages: Refers to programs used to create and edit graphs, diagrams, drawings, charts and plans for buildings, for example Microsoft Paint, Harvard Graphics, Corel Draw, Real Draw, etc. Computer graphics are images designed for logos, commercial and news inserts during television advertisements or transmission.

6. Communication Software: These are programs that allow users to communicate on networked computers and to log on to the internet, for example TCP/IP software, Client – server software, etc.

*NB: - **Log On**: to provide a username and password for the user to gain access to a computer or computer network.

7. Desktop Publishing (DTP) Packages: It is an extension of word processors that incorporates images and text for creation of attractive and professional documents for publication purposes, and these include Microsoft Publisher, PageMaker and QuarkXPress. DTP is used to create brochures, magazines, wedding cards and news letters.

Features of DTP include: They have a graphic program for inserting graphics in the document. They have a page composition program. They incorporate columns on one page. They have frames for positioning texts and graphics. They have templates used for recording document properties like page size, margins, etc. They have style sheets used for making consistent main texts, headings and subheadings.

Requirements for DTP:

(a) A Scanner: - for capturing images or hand drawings on paper, for example photographs
(b) High Resolution Monitor with graphics capabilities: - For viewing publication during design stage.
(c) Colour Printer: For printing high quality and colourful documents.
(d) Digital camera: - for taking and storage of photographs that will be incorporated into the computer.
(e) Keyboard: For typing in text
(f) Mouse: - For adjusting size of pictures and for drawing purposes.
(g) Desktop Publishing (DTP) software.

Advantages of Desktop Publishing: Users have more control over text layout compared to word processors especially over formatting and layout of text. Lots of different files can be brought together on the same document. Produces colourful and attractive documents for commercial purposes like brochures.

8. Authoring Packages: Software that can be used to develop interactive computer programs without the technically demanding task of computer programming. Also used in multimedia presentations. These programs can be used for developing databases and material for Computer Aided Instruction (CAI).

*__NB__: - **Specialist Packages for Business:** These are packages for use in a specific business environment, for example, Pastel for accounting purposes.

*__NB__: - **Install**: - to add programs to the computer. Therefore to uninstall is to remove programs from the computer.

Factors to consider when purchasing an application package:
Application intended for. Easiness of installation. Mode of processing (single user, multi user, etc). User friendliness. Availability of support personnel. Availability, readability and clarity of documentation. Memory requirements. Hardware requirements.

TYPES OF SYSTEMS

1. Real Time Processing System: - An online system in which individual, discrete transactions are processed as they occur to influence the activity currently taking place, as in airline reservation. Results of the process are produced immediately. The system response quickly and give feedback of a request. Thus the system is interactive in nature. Such systems include airline reservation systems, hotel reservations, stock control, etc.

2. Transaction Processing System: A mode of processing whereby only individual items of data need immediate processing e.g., processing of salary of one worker only in an organisation, airline reservation, balance enquiry at an ATM, etc. Transaction processing's requirements include: A large quantity of hardware support. Large and fast main storage, over 1 GB. Large and fast backing storage like hard drives of about 300 GB. Efficient communication equipment like fibre optics, satellites, etc. Efficient, secure and reliable operating systems. **However**, transaction processing systems are very expensive to run.

3. On-Line System: A system that is directly linked to the host computer for real-time communication and provides interaction between the user and the job, as in POS terminals in supermarkets. In networked computers, the terminals must be directly linked to the host computer. Examples include ATM systems in banks, airline reservation systems. Online systems can just be for information retrieval. Information retrieval systems are there for users to access certain information promptly as on the internet. In contrast, **offline systems** are computer systems that work without being directly connected to the host computer.

4. Network Systems: - A system in which processing is carried out independently in more than one location but with shared and controlled access to some common facilities like file storage.

5. Control System: - A system in which one or more computers are used to monitor the operations of some non-computer equipment like in oil refineries. Control systems involve monitoring and logging of physical quantities, provide an analysis of performance and allows some user interaction. Feedback is an essential element as well as timing. Most control systems are real-time systems, e.g. oil refining, chemical processing, traffic control, etc.

6. Automated Systems: - These are control systems that are dedicated to one particular task and lack the ability to collect and analyse data as in digital cameras. They do not allow for or act on user interaction, e.g. washing machines, cameras, watches. Most control systems have embedded computers systems inside them.

7. Multimedia Systems: - Are systems that enable presentation of data in a number of formats like sound, pictures, films, video, etc. A computer that can be referred to be a multimedia system should have at least a CD – ROM/DVD-ROM drive, speakers, large RAM size, large disk storage space, sound card (device for recording and playing back music), video card and multimedia software like Windows Media Player

8. Distributed (decentralised) Systems: A system whereby processing is done independently in more than one location but with shared and controlled accessed to common facilities, like file storage as applied in departmental shops. These systems are normally found in departmental shops, bank branches that will be linked together, etc. **Advantages of distributed systems:** Users feel more involved and responsible and this increase motivation. Systems often meet user specific needs and requests for changes are more readily met. Costs of physical and electronic movement of data are reduced. The total breakdown of information processing disappears. **Disadvantages of distributed systems:** There is often lack of coordination and control. It is difficult to impose standardisation, adequate security measures and sharing of data and know-how. Difficult to obtain integrated information for top management. Duplication of data is rampant. Excessive investment in hardware, software and personnel is involved.

9. Centralised systems: This is whereby processing is carried out at one central location for an organisation with a number of branches. Users in other locations can view data and utilise it but with limited capabilities. Centralised processing has the following advantages: Hardware within the organisation will be compatible and can be linked. The organisation gets better deals in terms of maintenance contracts. Employees do not have to learn new systems when they move from one department (or branch) to another. It is easier to coordinate staff training courses using the same software and hardware for all departments (or branches). There is better control over use of unlicensed software. Data can be exchanged easily between similar types of hardware and software

Disadvantages of Centralisation: Requires high initial capital investment of sophisticated equipment, operating systems, well developed communication systems and complex application packages. Requires highly qualified and experienced personnel to run it. A system failure will paralyse the entire system unless expensive backup system is provided. Users feel not being fully involved and therefore are not motivated.

The choice of processing depends on:

- Cost of hardware: online systems are more expensive to install, including installation of communication systems like telephones and satellites.

- Volume of data involved: batch processing is appropriate where very large data is handled.

- Frequency of data change: banks need online systems for customer data changes more frequently than in payroll processing systems.

COMPUTER NETWORKS

Definition of Terms

a. Network: A connection of computers for them to share data and resources like a printer.

b. Data communication: The process of transferring data through networked computers

c. Information Superhighway (ISH): A global network of computers for moving huge amounts of information via satellite and cable connection. Information found on ISH includes home shopping, entertainment, news, software downloads and help, online banking, stock market dealing, jobs, (vacancies), university placements, etc.

d. Information Technology (IT): - The use of computers in information handling and communication.

e. Information Age: A period beginning in the last quarter of the 20th century when information became easily accessible through publications and through the manipulation of information by computers and computer networks.

f. Broadband: a communications network that provides for high quality and high speed voice, data and video transmission usually over wireless networks or over high bandwidth media like fiber optics and satellites.

g. Global Village: the use of the internet to access information from any part of the world.

h. Information and Communication Technology (ICT): The use of computers as a tool for information communication, for instance through e-mails, cell phones, etc. For companies that invest in ICT:

They should make sure that electricity is always available, faults in software may lead to loss of customers and employee morale, inadequate hardware may lead to a bottleneck in flow of information in the organisation, managers may be overloaded with information making decision making difficult.

Advantages of Networking

Expensive peripherals like printers and scanners can be shared between users. Messages can be sent easily and faster between users whether on WAN or LAN. Avoids duplication of information as users can access the same file on the network. Network software can be purchased cheaply than buying individual packages for each computer. It is possible to access data or programs from any terminal or workstation. Data and programs can be stored centrally making it easier to maintain and backup. Users can be easily prevented from accessing files not intended for them. Allows sharing of files, software and data held in computers. Allows emails to be send between users.

Disadvantages of Networking

Sophisticated equipment is needed, which may be expensive to buy. Security of data can be a problem due to hacking. Wiring can be expensive both to buy and to install; wiring can be sunk on the ground to avoid trailing cables. If a server breaks down, the whole network becomes unusable. Networks need experienced network managers, who will be highly paid to keep the network running.

TYPES OF NETWORKS

Computer networks are grouped into Local Area Networks (LAN) and Wide Area Networks (WAN) and these are described below.

1. LOCAL AREA NETWORKS (LAN)

This is the connection of computers over a very small geographical area, like in a single room. Other LANs can link different departments (e.g. Sales, Accounts, Warehousing, Despatch, etc) within an organisation's complex. However, if an organisation uses internet service within its restricted private Local Area Network, such a network is called an Intranet (private network).

NB: **Intranet** is a private organisation's network that uses internet technologies for the benefits of such an organisation.

   Extranet: an extension of the intranet giving authorized outsiders controlled access to the intranet.

REQUIREMENTS FOR A LAN CONNECTION

A. Hardware Requirements

1. Host computer / Server: This is the main computer that control and manage other computers on the network.

2. Terminals: These are computers that are on the network and are linked to the host computer. If the terminal has its own processing and storage capabilities, it is called an intelligent terminal. However, if the terminal does not have its own processing and storage facilities and relies on the host computer for it to work, it is called a dump terminal.

3. Network cables: These act as pathway for data from one computer to another. Cables can be coaxial, fibre optics, twisted pair, etc. However, some networks are now using wireless technology and these are called **Wireless Local Area Networks (WLAN).** WLAN uses radio signals and therefore no cabling is required**.**

4. Hub: a device used as a connection point for devices and computers on a Local Area Network.

5. Network cards for each computer/terminal:- a device that identifies computers to the network, where network cables are plugged on the computer
6. A bridge can also be connected to link your network to another network and is an optional requirement.
The diagram below shows the structure of a LAN that can be connected to another network.
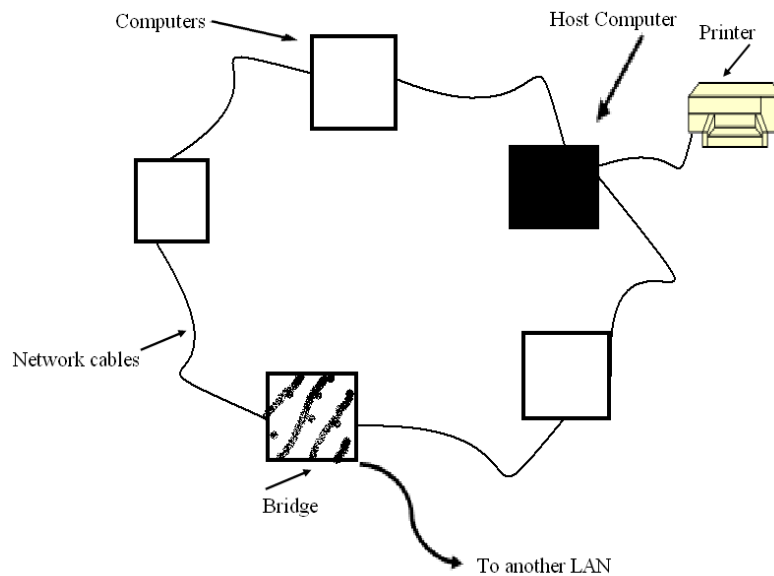

SOFTWARE REQUIREMENTS FOR A LAN CONNECTION
1. Communication software like TCP/IP – Transmission Control Protocol Internet Protocol. A protocol is a set of rules followed by devices when they are communicating.
- **2. Network operating system**: manages the network and network devices

NETWORK TOPOLOGY (CONFIGURATION)
This refers to the shape of the network. The common network topologies are:

1. Ring Network:
Computers are connected together to form a circle and uses a token when transferring data. Information travels in one direction only. Information moves around the ring in sequence from its source to its destination.
The diagram below illustrates the physical configuration of a ring network:
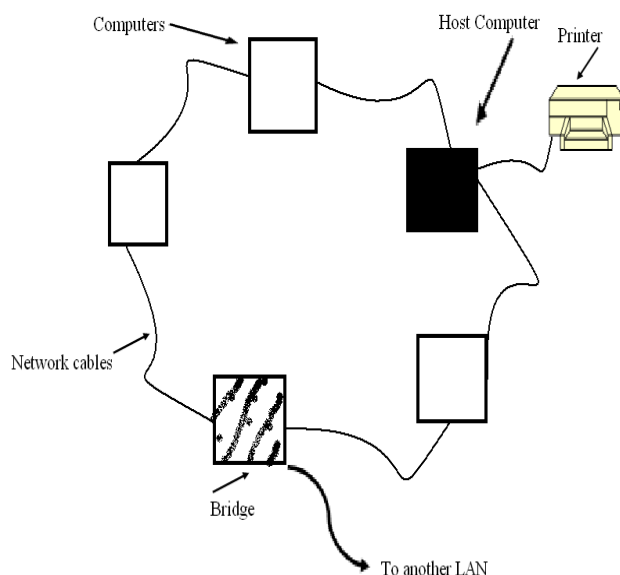
Advantages of Ring Network
- If one computer breaks down, others will remain working as they have their own processors and storage facilities.
- Data processing is faster as each computer processes its own processor.
- Has very high data transfer rates.
- Uses a token to avoid data collision or loss

Disadvantages of Ring Network
- If one computer breaks down, the whole network is disrupted.
- Its requirements are expensive, that is buying several computers with processors and storage facilities.
- It is difficult to link the computers together.
- Difficult to add another computer without disrupting the networking.
- One may not send data when another node (computer) is still sending its own data.

2. Star Network:
Computers form a star shape with host computer at the centre, as shown below:
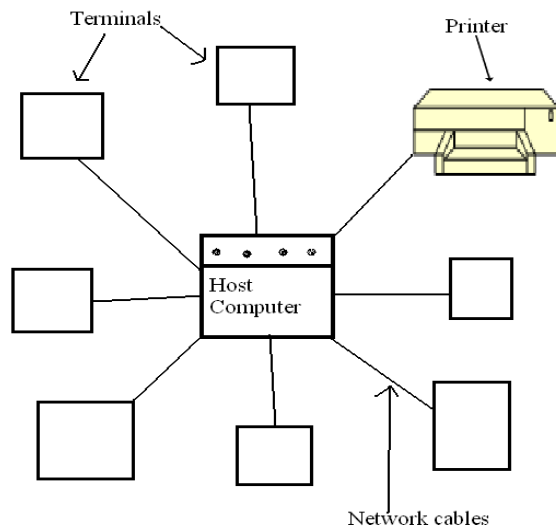
Advantages of Star Network
- If one terminal breaks down, the network is not affected.
- If one terminal breaks down, others will remain working.
- It is cheap in terms of requirements since only the host computer can have a processor and storage facility.
- It is very easy to install.
- Management of data is easier as this is done centrally.
- It is very fast to process data.
- Easier to add new workstation without disrupting the network.
- No problem of collision of data since each terminal has its own cable to the host computer.
- Gives consistent performance even when the network is heavily utilised.
- More secure than other network topologies

Disadvantages of a Star Network
If the host computer breaks down, the whole network will be affected. If the host computer is down, all the terminals will not work as they depend on the host for processing and storage. It requires a lot of cabling, which might be expensive.

3. Mesh Network
A network in which each computer serves as a relay point for directly sending information to any other computer on the network. No central device oversees a mesh network, and no set route is used to pass data back and forth between computers. Thus, if any one computer is damaged or temporarily unavailable, information is dynamically rerouted to other computers—a process known as *self-healing*
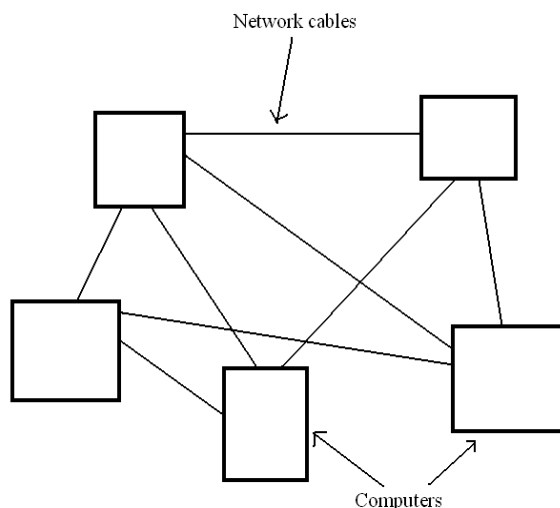
Advantages of Mesh Network
- If one computer breaks down, others will remain functional.
- If one computer breaks down, the network is not disturbed.
- Computers have their own storage and processing capabilities.

Disadvantages of Mesh Network
- Expensive to buy computers with their storage and processing facilities.
- Too much cabling is involved, which may be expensive.

4. Bus(Linear/Multi-drop) Network:
Computers are connected together through one main cable and all computers all signals transmitted by any computer connected to the network
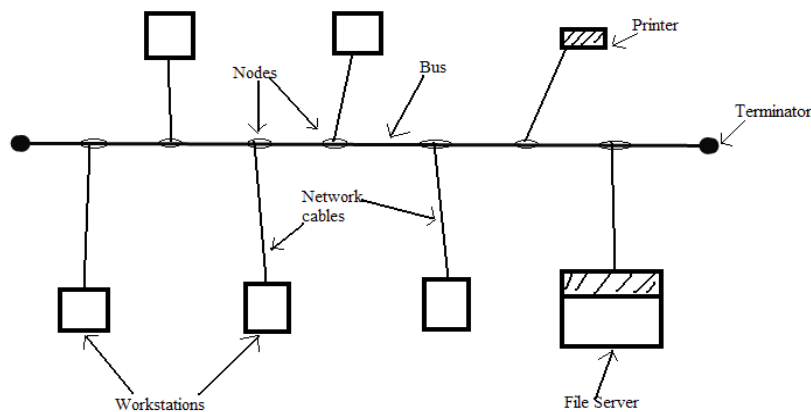
(a) **Bus**: the dedicated and main cable that connects all workstations and other computer devices like printers.
(b) **Nodes**: these are connection points for workstations and the bus.
(c) **Terminator**: devices that prevent data in the bus from bouncing back, causing noise and prevents data from getting lost.

Advantages of Bus network
If one workstation breaks down, others will remain functional. If one workstation breaks down, the network remains working. All computers have processing and storage capabilities. It is cheap to install due to less cabling. Easy to add workstation without disrupting the network.

Disadvantages of Bus Network
Computers cannot send data at the same time or while there is data being transferred in the bus. Can cause collision of data during transmission. It is slow in transferring data. Its requirements are expensive, that is computers with their own processors and storage facilities. The system will be down if the main cable (bus) is disrupted at any point. Less secure

5. Point – to-Point Connection
Point-to-point topology is the simplest, consisting of two connected computers
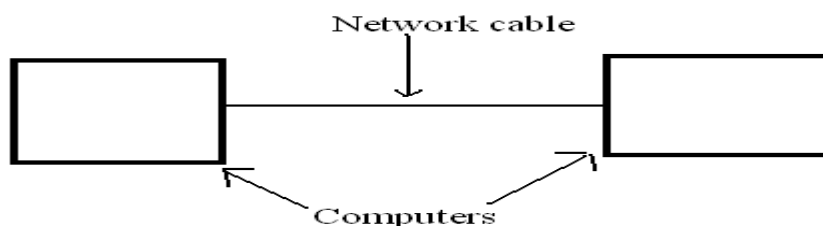
2. WIDE AREA NETWORK (WAN)
Refers to the connection of computers over a large geographical area, often over 1 km, e.g. covering the whole district or province. Internet is also part of WAN. WANs can also be wireless.

Hardware Requirements for a WAN
i. Modem (Modulator Demodulator):- a device that converts analogue data to digital form and vice versa, often for internet connection using a telephone line.
2. Communication link: Acts as a transmission media for data, e.g. telephone line, satellite transmission, etc.
3. Network cards for each computer:- a device that identifies computers to the network, where network cables are plugged on the computer

Software Requirements for a WAN
i. Communication Software like TCP/IP – Transmission Control Protocol Internet Protocol.
ii. Web Browser: refers to software used for opening web pages on the internet, for example Microsoft Internet Explorer, Netscape Navigator, Mozilla Firefox, etc.
iii. Search Engine: Software used for searching data and websites with needed data from the internet as per user request. Examples of search engines includes Yahoo, Google, etc
iv. Network operating system: manages the network and network devices.

THE INTERNET

It is a global connection of computer networks.

Hardware Requirements for an Internet Connection

1. Modem (Modulator Demodulator):- a device that converts analogue data to digital form and vice versa, often for internet connection using a telephone line. Alternatively one may acquire a GPRS (general packet radio service) modem

2. Communication link: Acts as a transmission media for data, e.g. telephone line, satellite transmission, etc.

3. Network cards for each computer:- a device that identifies computers to the network, where network cables are plugged on the computer

Software Requirements for an Internet Connection

1. Communication Software like TCP/IP – Transmission Control Protocol Internet Protocol.

2. Web Browser: refers to software used for opening web pages on the internet, for example Microsoft Internet Explorer, Netscape Navigator, Mozilla Firefox, etc.

3. Network operating system: manages the network.

Other requirements

1. An internet account: a unique personal identifier given by the Internet Service Provider (ISP). An ISP is an organisation that links users to the internet, for example, Mweb, Ecoweb, Africaonline, Yahoo and Google Inc. The internet has become a source of a wide range of information globally.

Advantages of the Internet as a Source of Information

Can be accessed from anywhere in the world. Information on the internet is up-to-date. Multimedia can be used. Huge amounts of information can be accessed; e.g., magazines, encyclopaedia, dictionaries, newspapers, textbooks, etc. Search engines are available to assist in finding information. Using emails you can access experts from all over the world on certain subjects.

Disadvantages of the Internet as a Source of Information

Equipment and connections needed are very expensive (computers, modems (ISDN adapters) ISP, telephone). One needs knowledge to perform searches effectively. Problem of hackers. Breaches of copyrights are very common. Rampant spread of rumours on the internet. Spread of pornography to young people. Leads to loss of privacy. Some people become internet addicted and tend to interact with computers more than with human beings. Credit card fraud is rampant.

Services Provided By the Internet

1. Electronic Mail (E-Mail): These are written messages send electronically over networked computers. In-order to send and receive e-mails, the following is needed.

(a) An internet connection

(b) An E-mail Address: This is a unique identifier of the storage location of a person's mailbox. An e-mail address is made up of two parts that are separated by the "@" symbol, for example, kapondenit@gmail.com. The first part (kapondenit) is the username and is used to identify the name of the person or organisation that has the mailbox. The username is unique. The second part (gmail) is the domain name and is used to identify the server where the person has a mailbox. The other part (the one after the dot (.) indicates the domain type e. g

      . com – commercial organisation

      . edu – educational organisation

      . org – non-profit making organisation, etc

An e-mail address should be known by many people so that they will know the address where to send the emails. Every mailbox is protected from illegal access by use of password. A **password** is a secret group of alphanumeric characters used to protect a document from unauthorised access.

NB. When creating an e-mail, one is requested to enter the password twice in order to verify if it is the one you intend to use.

Mailbox: - An electronic folder used to store electronic mails. It contains the inbox which contains incoming mails and the outbox, which is used to save outgoing messages.

When sending an email, the user first logs on to email address, compose the message and then send it by clicking on the send button. The computer processes involved after the user presses the **send button** are as follows:

The message is transmitted to the sender's ISP/central host computer. The message is stored on a central host computer. The message is transmitted to intermediate computers. The message is stored on the intermediate computers. The message is received by the addressee's host computer/ISP.

The addressee logs in to a local computer and receives the mail

Advantages of e-mails as compared to ordinary mails

It is very fast in sending messages (can be delivered promptly while ordinary mails can take days to reach their destination). It is very cheap to send e-mails since there is no need for envelopes, stamps, paper and pen, which are needed in conventional mail. They are reliable since e-mails rarely get lost. E-mails are time independent as they can be send any time of the day other than conventional mails which can be send during the normal working hours. E-mails allow multiple addressing, that is, one e-mail message can be send to several recipients simultaneously without having to retype it. E-mails can be saved for future use or reference. E-mails are more convenient to use as there is no need to travel to the post office or to shops to buy stamps and envelopes. In e-mails, attachments in form of reports, scanned documents, pictures and curriculum vitae can easily be attached to the e-mail.

Disadvantages of e-mail

Not everyone has equipment to send e-mails. Junk mail (spam) is a problem. You waste a lot of time looking through mails that are just adverts. E-mails are not as secure as traditional mails. The system relies on people checking their mails regularly. Old people feel left out as they consider themselves too old to learn. Equipment used to send and receive e-mails is very expensive as compared to traditional methods.

However, despite the increase in the use of e-mail, there has been a sharp increase in the amount of paper used. This is because: People print copies for meetings and then destroy them afterwards, but if needed again, print out another copy. Some people find it difficult reading large amounts of text on the screen. People often e-mail colleagues rather than use the phone who then print out the document.

2. Teleconferencing: A method of conducting discussion with several people in different locations using the telephone.

3. Video conferencing: Conducting meetings with several people in different locations and seeing each other on the screen of networked computers. Delegates do not need to leave their homes or work places. Video conferencing requires the following:

A computer with a codec. Video cameras. Microphone. Speakers. Large and high resolution monitor. An integrated Services Digital Network (ISDN) line with a high bandwidth to transmit video data at fast speed. Sound card. Video card

Advantages of tele and video conferencing

It cuts transport cost incurred in travelling to the venue of the meeting. Reduces costs involving paying hotel bills and meals for the delegates. Saves time spend in travelling to the venue of the meeting. It becomes safer for employees since no travelling is done (no travelling accidents). There is no need for delegates to leave home/office. It becomes easier for several delegates to take part simultaneously.

Disadvantages of video and tele-conferencing

Communication expenses are very high. Hardware and software requirements are expensive. People will lack personal contact and will socialize less.

4. View data (videotext) systems: These are interactive systems on which users view data when they access specialized databases like Prestel. The requirements include the telephone line or cable TV, specialized keyboard and a Television set. Information on the database is provided by companies that advertise their products like news, weather reports, and so on. View data systems have the advantage that they are interactive and the service is provided for free to the public. However, its requirements are expensive.

5. Teletext: It is a broadcast service that comes as a television transmission. It is cheaper than the internet service. However, it is non-interactive.

6. Facsimile (Fax): A method whereby output from a scanned document is send over telephone line and reproduce on a fax machine on the receiving end. Fax method has the following advantages:

It is very cheap to send messages. It is very easy to use. It is a very fast method of sending messages.

However, it has the following disadvantages:

Its requirements are expensive (fax machine). There must be a person at the receiving end to attend to the fax when receiving messages.

The use of fax, e-mail, view data, teletext, teleconferencing and video conferencing in an office brings about an electronic (paperless) office. An electronic office is an office in which the storage and processing of data as well as communication are done electronically. An electronic office is efficient because: Communication is easier and faster. Less paperwork is involved. Current and up-to-date information is provided. Ensures a clean office environment.

However, it is very expensive to setup and maintain an electronic office.

__NB__- The use of computers to perform all clerical and office duties is called Office Automation.

Tele and video conferencing as well as networking bring about **tele-commuting** (tele-working). Tele-commuting is carrying out work without leaving home. Communication is done through networked computers. Requirements for telecommuting includes: modem, very fast communication links (for example telephone line), computers, internet services, etc.

Benefits of telecommuting

Easier to concentrate on work in a quiet environment than in a noisy office. It saves time spent in travelling to the work place thereby increasing productivity. It cut costs involved in travelling to work place. The employer saves costs of office space and overheads like water and electricity. People can be recruited from a wide geographical area. People with disabilities like the handicapped can be employed. People in different locations can work as a team.

Disadvantages of tele-commuting

Workforce not in office is difficult to control. Workers would not understand corporate goals and will not be loyal to the organisation. Employees feel isolated and miss the environment of an office full of colleagues. People may find it difficult to work in teams. It is difficult to separate work from home duties while at home. Unions find it difficult to mobilise workers for demonstrations and strike.

OTHER INTERNET ACCESS SOFTWARE AND SERVICES

1. Web browser – software used to download and view web pages from the World Wide Web (www). A web page is a site on the internet that provides information about an organisation. The World Wide Web (www) is a group of websites on the internet. Web pages can be created using any of the following software: HTML (editor), word processing, desktop publishing software, web publishing software, presentation software. The web developing software should have the following features:

Feature for changing the background colour or background image on a page. Feature for formatting text (size, font, colour, bold, italic, underline etc.) or frames. Able to work with tables. Features for inserting graphics/pictures/sound clip/video clip/animations. Features for working with links/creating buttons/list box. Features for switching to a browser to check the appearance of a page. Use templates. Use auto tags.

__NB__. **Hyperlink** :- an HTML page on the World Wide Web. The websites must be stored on a server provided by the Internet Service Provider (ISP)

2. File Transfer Protocol (FTP): program that allows users to transfer files from host computers on the internet to their personal computers.

3. News groups: a global electronic bulletin board system in which users exchange information on different topics.

4. Entertainment: the internet provides an option for users to download and listen to music, newspapers, radio stations, etc.

5. Internet Shopping: (Internet buying, electronic commerce, online shopping): The internet provides a facility for customers to purchase products from the internet without visiting shops. Credit cards are used in internet buying.

Advantages of buying from the internet
To the customers

Programs are available to search for the cheapest products on offer. Customers have more time to choose. Shopping is done any time of the day, thus providing a 24 hour service. A wide choice of products is available. Shopping can be done by setting up a file. It is very convenient to use as customers do not leave their homes for shopping. It cut travelling costs to the shops. Customers do shopping without being jostled by crowds. There are less cases of impulse buying. Product reviews are obtainable before purchase. Goods and services usually cheaper on the internet. Customer need not to go to shop and therefore save travelling time.

To businesses/shop managers

Business is carried out any time of the day (provides a 24 hour shopping service). Increases sales due to greater number of customers from all over the world. No wastage space for goods is involved. Ensures huge saving on overheads like rent, warehousing, employee facilities. More goods can be made available. It is cheaper to use as there are no leaflets, pamphlets, etc. Can reduce the number of shops on the streets. Organisations can employ fewer workers thereby cutting labour costs. No need to travel to the shop as business can be run from home.

Disadvantages of buying from the internet

To customers

There are chances of losing money through credit card fraud and hacking. Customers lack interaction with others. Customers fear of rogue companies (customers may not receive the goods). Customers cannot physically see the goods before purchasing. Not everyone has a computer and is connected to the internet. Not everyone has credit cards. Problem of spam (Unwanted e-mail, usually of a commercial nature sent out in bulk). Customers cannot have the goods immediately.

To businesses

Increase in cases of industrial espionage. **Industrial espionage** involves selling of company secrets by employees to rival companies and the use of destructive methods by competitors to destroy other organisations.

EFFECTS OF E-COMMERCE TO THE COMMUNITY

Loss of jobs as some traditional shops and banks close. Lower profits for companies that do not engage in e-commerce. Decline in leisure shopping as goods are bought on-line. City centres become deserted as shops and banks close down. The gap between the rich and the poor widens as the rich get savings from shopping on-line. More people choose to interact with computers rather than with other people. Increase in small businesses. Less pollution. Less travelling

THE CASHLESS SOCIETY

This refers to the use of electronic commerce thereby reducing handling of hard cash amongst individuals. However, it seems impossible to completely have a complete cashless society. A cashless society has the following benefits:

More convenient to pay bills, mortgage loans, gas, phone and electricity bills since these are paid automatically. Customers no longer need to carry large sums of money thereby reducing cases of robbery. Customers no longer need to queue on banks to get cash.

However, a cashless society will have the following problems:

Credit is normally given only to those who are working and have a steady source of income. People will spend more than they can afford thereby getting into debt. Wrong information about individuals is kept as more information about people is kept in computers for their credit rating. It is difficult for individuals to track how much they spent.

DATA COMMUNICATION

This deals with the means of sending and receiving data on networked computers. Transmitted data can be in analogue or in digital form.

Digital Data: Data is in discrete value, that is, in ones and zeros.

**Analogue Data**: Data is in continuously varying form, e.g. human voice.

Synchronous and asynchronous Transmission

Synchronous Transmission: This is whereby data is sent in blocks (packets) at any given time. This method is faster in transmitting data.

Asynchronous Transmission: This is whereby data is send character by character over a transmission channel. This is much slower as compared to synchronous transmission.

Transmission Modes

Transmission modes include Simplex, Duplex (Full duplex) and Half Duplex

Simplex Transmission Mode
Diagram A

Half Duplex Transmission Mode
B

Duplex Transmission Mode
C
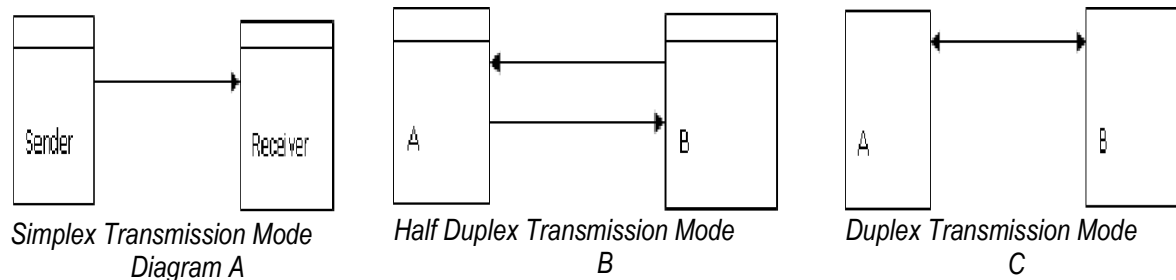
Simplex Mode: This is a mode of data transmission in which data travels only in one direction. Thus one computer acts as the sender and the other as a receiver. See diagram A, above.

Half Duplex: This is a transmission mode in which data travels in both directions but not simultaneously. See diagram B above. The receiver waits until the sender has finished sending data in order for him to respond.

Duplex/Full Duplex: This is a transmission mode in which transmission is possible in both directions simultaneously. See diagram B above. There is no need for one to wait until the channel is free from data.

Transmission impairments

This refers to change in signal form as it propagates through the transmission channel. Transmission impairments include:

Attenuation: The loss of signal power as it moves through the transmission channel.

Noise: Occurs when an unwanted signal from other sources than the transmitter enters the transmission channel.

Multiplexing

This is a method of allowing multiple signals to share the same channel, reducing too much cabling, as shown below:

A multiplexer is used in multiplexing. A multiplexer is a device that joins two or more channels into one channel while the de-multiplexer is responsible for splitting a channel into a number of them for easy transmission to the intended destination.
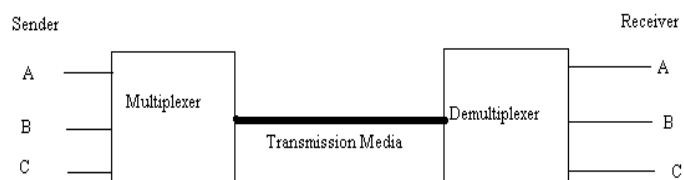
Bandwidth

Refers to the caring capacity of a transmission channel (measured in bits per second: bps). It determines the amount of data a channel can transmit at a given period of time.

Transmission Media

Refers to forms of media through which data is transferred from one point to another. These include:

1. Twisted Pair: These are cables with two copper wires of about 1 millimetre thick. The wires are twisted to avoid crosstalk. Twisted pair is very cheap to buy and offer good performance over short distances.

Disadvantages of twisted pair: Twisted pair is very cheap to buy. Has big attenuation. Has low bandwidth

2. Coaxial cable: It is a stiff copper wire surrounded by an insulating material. It has less attenuation than twisted pair, has high bandwidth and has low error rates. However, coaxial cable is expensive to buy and is stiff, making it difficult to handle.

3. Fibre optics: A media that uses light to transmit data. It has less attenuation, has very high bandwidth and cannot corrode (not affected by corrosion), it is thin and therefore has less weight. However, fibre optics is very expensive to buy and is uni-directional (travels in one direction only)

4. Infra-red waves: Refers to data transmission in form of waves as through some remote controls of televisions. It has enormous bandwidth. However, infrared waves do not travel through obstacles like buildings, they only work for very short distances, affect eyes and consume a lot of power.

5. Satellite transmission: These include earth stations which communicate with geostationary satellites (36 000 to 80 000 km above the earth. These have high bandwidth and support very long distance communication. However, they have big attenuation and are slow in sending messages.

WIRELESS COMMUNICATION
This is a method of networking computers and computer devices without the use of cabling, e.g. using blue tooth, radio, optical, satellite, infra-red, microwave, etc. The devices that are used in wireless technology include: 3G (Wireless Application Protocol (WAP)) mobile phones /cell phone/remote key pad/remote control/ remote keyboard. infra-red mouse. Multimedia mobile handsets and notebooks. GPRS (general packet radio service) modems. Wireless LAN(or Wi-Fi –Wireless Fidelity: A local area network that uses high frequency radio signals to transmit and receive data over distances of a few hundred feet; uses Ethernet protocol). PDAs (personal digital assistants).
GPS - A navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on earth by computing the time difference for signals from different satellites to reach the receiver

Advantages of wireless communication include: Cheaper as no wires are needed for networking. Ensures fast wireless Internet access. Wireless LAN is faster than a modem or mobile. Wireless LAN enables working at home. Users can create and send multimedia messages to mobiles or e-mail while in transit. Users can send greetings from mobiles to mobiles/PCs. Ensures instant transmission. Users can download e-mail and file attachments while on mobile. Users can watch live web cast on mobile. Users can listen to streaming video on mobile. Users can watch news, weather, sport, games while on the move. Users can access information from mobile anytime. Users can send, receive, delete e-mail while on the move. Users can view business appointments while out of office on mobile. Users can send corporate e-mail while out of office - even behind a firewall on mobile. Users can use wireless internet connection from chat rooms for discussions with colleagues while on the move.
Disadvantages of Wireless Technology: Wireless LAN speeds are slower than Net access at work due to narrow bandwidth. Any one within the Wireless LAN nodes range with an appropriate device can use your Wireless LAN and broad band link. Any one who walks past your house or WLAN linked into a corporate system can access sensitive information like credit card details. 3G phones are not compatible with 2G phones. Blue tooth has limited range. Signals can be blocked, distorted or will be weak. Can lead to health problems from microwaves

COMPUTER VIRUSES

A computer virus is a program which replicates itself, damages or corrupts files and memory of the computer, for example, a Trojan horse. By replication, it means that the virus can multiply itself (produces several similar copies of itself) when it enters the computer system.

Signs and symptoms of virus attack on a computer:

Reduced system performance (reduced speed of operation). The computer displays nasty messages on the screen. The computer displays a blank screen. The computer system produces wrong results of a process. Unexplained and frequent lose of data held in the computer. The hard disk becomes inaccessible (the user cannot access data held in the computer). The computer fails to boot.

Effects of computer viruses:

Memory of a computer will be used up, slows down computer. Alters system settings. Erases and corrupts files and data on the computer. Infects other computers on network. Leads to production loss. Leads to financial loss. The hard disk becomes inaccessible (the user cannot access data held in the computer). The computer fails to boot. The computer system produces wrong results of a process.

Methods by which viruses spread from one computer to another

By sharing diskettes, compact disks, hard disks, memory sticks, memory cards, Video compact disks, Digital Versatile Disks, etc, with external users. Through networked computers, that is on a LAN, WAN or the internet. Can come as e-mail attachments. Can come with downloads from bulletin boards

Methods of preventing virus attack on the computer

Avoiding sharing external diskettes, compact disks, hard disks, memory sticks, memory cards, Video compact disks, Digital Versatile Disk. Stay offline (not connected to any computer or the internet). Install the latest antivirus program on the computer and upgrade it frequently. Scan the computer with the latest antivirus frequently. Avoid software distributed as shareware (freeware) (*software produced for distribution free of charge and can be distributed to others free of charge, e.g. computer games*). Avoiding downloading software from bulletin boards. Installing firewall (*software used to protect networked private computer systems from unauthorised access.*). Use disk free work stations. Do not open file attachments from unknown sources or download doubtful software from the Internet. Do not use files that come from unknown sources. Buy original software and do not buy pirated software. Disable able compact disk drives, diskette drives and USB ports of the computer.

Antivirus programs

These are programs that detect computer viruses and reduce the risk of computers being attacked by viruses for example Norton Antivirus, MacAfee, Avira, Avast, AVG, etc.

TYPES OF COMPUTER VIRUSES

1. Boot sector Viruses

These viruses affect the booting sector on the hard disk so that the computer fails to boot.

2. Time bomb

Virus attack and destroys computer files at a specific date and time

3. Logic bombs

A type of virus that attacks the computer when a specific event occurs and destroys everything on the computer disk like the Friday the 13th

4. Trojan Horse virus

These are viruses that appears as programs useful to the user with the intention of soliciting information like user accounts and passwords or damaging computer system files.

5. WORM viruses

A program capable of reproducing itself and spread from one computer to the next over a network and damage computer files.

6. File sector Viruses

These viruses destroy files that are created by users on the computer.

HUMAN – COMPUTER INTERFACES

Interface: A form of communication between the user and the computer, for example Graphical User Interface. A program that is easy to learn and to use is said to be **user friendly.** A user friendly interface has the following **features**:

It is easy for a user to start using the system. The system should be self-contained so that users are not forced to access manuals. Minimum effort must be used for the user to complete required tasks. It should have minimum errors and unexpected results. Thus must be reliable. It should be logical and consistent, allowing the user to learn it faster. It is intuitive to use. Help is available. Can use menus, wizards, sound and colour to assist the user.

User friendly programs usually display windows, icons, menus, pointers and dialogue boxes.

Window: - A rectangular area on the screen which displays text or images.

Windows Administrator : a person responsible for setting up and managing domain controllers or local computers and their user and group accounts, assigning passwords and permissions, and helping users with networking problems.

Icon: - Small image on the screen that represent a file, folder, command or any object that can be manipulated by the user, like the **My Computer** icon on the desktop.

Menu: - a list of options from which the user could select one.

Pointer: - Arrow appearing on the screen that is moved by moving the mouse to point, select or open an icon.

Static Menu: - Menu that appear on the screen most of the time, for example File, Edit, View, etc which are found in Microsoft Word.

Pull Down Menu: - a list of options that are listed going downwards.

Pop-up menu: - A list of options that appear which you right click on an empty space on the screen.

Dialogue box: - A rectangular area with many windows that prompts the user to provide data.

Prompt: - a screen display that allows the user to enter a command by typing as in MS-DOS mode. A prompt may appear as C:>-

Cursor: - a blinking arrow that shows an insertion point on the screen showing where text will appear when typing as in Microsoft Word.

Scroll bar: - A vertical or horizontal bar that is moved up and down or left and right respectively, to view text on the screen.

Text box: - In a dialog box, a box in which you type information needed to carry out a command. The text box may be blank or may contain text when the dialog box opens.

TYPES OF USER INTERFACES

1. Graphical User Interface (GUI): It is a way of communication between the user and the computer by use of Windows, Icons, Menus and Pointers (WIMP) as supported by Microsoft Windows XP operating system. Programs that provide a graphical user interface include Microsoft Word 2003, Windows XP. The user moves a mouse and point on required options and then click. It has commands in form of icons which have the name of the command or file below the icon. The mouse is the most used device in this system.

Advantages of GUI: It is faster to give commands by just clicking. It is easier for a novice (beginner) to use the system right away. It is user friendly (this is an interface that is easy to learn, understand and to use). There is no need for users to remember commands of the language. It avoids typing errors since no typing is involved. It is easier and faster for user to switch between programs and files. A novice can use the system right away.

Disadvantages of GUI: The icons occupy a lot of disk storage space that might be used for storage of data. Occupy more main memory than command driven interfaces. Run slowly in complex graphics and when many windows are open. Irritate to use for simple tasks due to a greater number of operations needed.

2. Command Driven Interface: This is an interface which allows the user to type the command to be carried out by the computer through the keyboard as supported by MS-DOS. The user has to remember the commands to be typed when performing a specific task. An example of a program that uses command driven interface is Microsoft Disk Operating System (MS-DOS). The commands are abbreviated and short e.g. Del (for delete), copy, print, etc.

Advantages of Command Driven Interface: It saves disk storage space since there are no icons involved. It is very fast in executing the commands given once the user mastered the commands. It saves time if the user knows the commands by heart.

Disadvantages of Command Driven Interface: It takes too long for the user to master all the commands by heart. It is less user friendly. More suited to experienced users like programmers. Commands for different software packages are rarely the same and this will lead to mix-up of commands by the user.

3. Menu Driven Interface: This type of interface displays a list of options / commands from which the user has to choose one by use of the mouse or keyboard. Below is an illustration of a menu driven type of interface:

1. PRINT RECORD
2. DISPLAY RECORD
3. DELETE RECORD
4. EDIT RECORD
5. MY OPTION IS: __

The user has to enter 1, 2, 3 or 4 and then press enter on the keyboard.

Advantages of Menu Driven Interface: It is fast in carrying out task. The user does not need to remember the commands by heart. It is very easy to learn

Disadvantages of Menu Driven Interface: The user is restricted to those few options available and thus is not flexible to use.

4. Direct Manipulation Interface: The user is given a list of options and the effect of carrying out an option is displayed on the screen. The options are often represented by an icon as shown below:
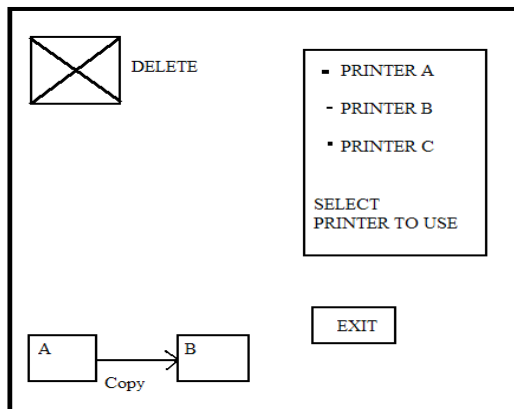
This type of an interface requires the mouse, keyboard and bit-mapped screens. A **bitmap** is a computer memory representing a graphical image in form of pixels. A **pixel** is the smallest discrete component of an image.

Advantages of Direct Manipulation Interface are:
Very easy to learn. Very easy to use. Very fast in carrying out task by just clicking on required option.

Disadvantages of Direct Manipulation Interface
Users have limited options to choose.

PERIPHERAL DEVICES CONTROL

A **peripheral** is any hardware connected to the central processing unit, e.g. mouse, printer, etc. Peripherals can be controlled in a number of ways that will provide continuous job processing sequence. These include:

1. Buffers: This is a temporary memory store for data awaiting processing or output, compensating speed at which devices operate, for example printer buffer. Buffering is appropriate where an output device processes data slower than the processor. For example, the processor sends data to the printer, which prints much slower and the printer does not need to wait for the printer to finish printing in order for it to carry out the next task. It therefore saves the data in a buffer where it will be retrieved by the printer. Buffering usually match devices that work at different speeds, e.g. processor and disk.
Reasons for using printer buffers: Stores data or information being sent to the printer temporarily. Compensates for difference in speed of CPU and printer. Allows CPU to carry out other tasks whilst printer is printing.
Benefits of increasing size of buffer in a printer: Reduces the number of data transfers to the printer. Ensures a more efficient use of the CPU. Larger files can be sent to the printer without problems

2. Interrupts: An interrupts is a signal send to the processor by a peripheral for attention to be turned to that peripheral, thereby causing a break in the execution of a program, e.g. printer out of paper. Examples of interrupts include:
Input / output interrupt e.g. disk full, printer out of paper, etc. **Arithmetic and Logic Unit error**. **Clock** (happens normally in time sharing systems where the clock transfers control from one computer to another.)

3. Polling: A process whereby the processor interrogates peripherals to determine if they are in a certain condition (or are present). Polling can take place during booting, where the processor checks the connected devices like keyboard, mouse, hard disks, etc. It also occurs in time-sharing systems where the processor checks if the terminal has anything that needs processing.

4. Spooling (Simultaneous Peripheral Operating On-line)
A process of transferring data from processor into temporary and faster access storage awaiting release to a slow output device, for example to a printer. Jobs from different users can be queued until the printer is ready to print.

5. Handshaking: It is the exchanging of signals to establish communication link between two devices/computers, for example modem and computer. It is a protocol for establishment of a link between two communicating devices. This controls movement of data between the computer devices, e.g. modems. The device engages in something like a dialogue to acknowledge receipt of data.

6. Scheduling: This is whereby the processor decides the loading and execution of programs to provide continuous job processing sequence. Scheduling can do this by giving time slices to each computer or by queuing jobs. Scheduling generally ensures that:
No resource is heavily under-utilised or over-utilised. The maximum number of interactive users get a reasonable response time. Making sure that no job is pushed to the back of a queue. Getting maximum number of jobs done in the minimum amount of time.

*NB: Directory: - a folder used to store other folders and files in a hierarchical structure. Directories are usually created in MS-DOS systems.

COMPUTER APPLICATION
1. COMPUTER APPLICATION IN HOSPITALS:
Uses of computers in hospitals include:

Storage of patient, supplier, asset and employee records. **Monitoring** patients and alerting the doctors / nurses when a problem occurs. **Taking** measurements on patients, for instance: blood pressure, temperature level, weight, etc. This relieves nurses of some duties that will be boring, making them faster and more reliable. Used to **aid medical** researches by analysing data produced from experiments. Used to **aid diagnosis** (used to answer patient problems). Used to **hold data** for children's immunisation processes. Used in **medical diagnosis**, whereby the computers are used to identify patient problems and the therapy (treatment). **Monitoring** of patients during surgery as they control body scanners and sensors.

There are however some hospital tasks that are more suitable for human beings to perform than computers. These include dressing patients, bathing patients, etc. Control systems are also used to monitor patients. Computers also act as expert systems. Computers have the following advantages in hospitals:

Precise 'tests' and medical examinations. Faster medical alerts, which are more accurate time-wise. Enhanced data about a patient's medical history. Accuracy in diagnosis. Accuracy in billing. Automated updating of medical history

EXPERT SYSTEMS
An expert system is a program that mimic human reasoning in a specific field, for example in medical diagnosis, mineral prospecting, engineering, coding games like chess, tax/financial calculations, weather forecasting, fault diagnostics, criminology/forensic science, career choices, etc. Expert systems are programs that make decisions or solves problems in a particular field, such as finance or medicine.

An expert system contains the following:

i. A knowledge Base: a representation of facts (data) in a particular field (e.g. diseases, symptoms, treatments, etc)

ii. Inference procedure (engine): contains reasoning methods used to arrive at a conclusion using information in the knowledge base. It contains interrogation technique/questions and answers.

Additional tools for expert systems are:
iii. User interfaces: these enable people to form queries, provide information, and otherwise interact with the system.

iv. Explanation facilities: enable the systems to explain or justify their conclusions, and they also enable developers to check on the operation of the system themselves.

Advantages of expert systems:
Ensure fast identification of solutions to problems by quickly analysing data. They produce reliable and accurate results. There is no need for an expert to be present since they can act as a prompt to an expert. They can deal with complex situations much faster than humans. They could be used in hazardous areas (e.g. Oil prospecting). They are less likely to make an error. They do not forget as humans do. Many copies can be made at a low cost. Knowledge of several experts is combined. Save costs on wages and salaries for staff.

However, expert systems have the following drawbacks:
They are expensive to develop and to setup. They lack common sense as human beings do. They lack creativity. They are unable to learn outside the system. They lack sensory experience. They take time and are difficult to develop. They need to be constantly updated to keep pace with recent developments in the field they are applied. This may be difficult and time consuming. Data is entered by humans who may make mistakes in doing so.

Steps needed to produce an expert system are:
Gather information from experts in the field. Design the knowledge base. Input data into knowledge base. Design the rule base. Design inference engine (questions and answers, interrogation techniques). Design display of results and appropriate user interface

An expert system can be improved by: Frequently carrying out researches and making updates. Quickly inputting new data into the knowledge base. Assigning its control to a number of highly experienced personnel who will monitor and make updates as soon as possible.

Artificial Intelligence

Artificial Intelligence(AI) is the science of developing computer systems that have the ability to learn from experience and mimic human reasoning in specific areas, as in medical diagnosis, mineral prospecting, etc. Expert systems are a branch of Artificial Intelligence.

2. SIMULATION

It is the studying of the behaviour of a system by using models to predict future real life events, like population growth, flight simulator, etc. In simulation, past and present data, as well as models are analysed in order to predict the future. A model is a pictorial representation of a real object, e.g. a bridge, house, etc. The use of real things has the following disadvantages in simulation other than use of models:

Too dangerous to test with. Too large a time scale is required. It involves wastage of materials. Takes much longer to build the real thing.

Simulation in Population Growth: Data needed include birth rate for the country, death rate, previous growth rate for the previous 5-10 years, present population size, etc. Cognisance can also be taken of natural disasters like floods, war, earthquakes, which may distort the figures.

Simulation can also be used in **Virtual Reality**; which is the creation of simulated multi-dimensional representation of real things, e.g. armies fighting against each other, in chemical plants. Virtual reality needs devices like goggles (headsets), gloves, special suits fitted in sensors, motors that provide movement, etc. Virtual reality ensures safety other than using real objects, can perform real tasks without risks, can be used in dangerous areas, and can store data and results on the computer.

- Simulation can be applied to games like <u>chess</u>, where the opponent's moves can be analysed.

3. COMPUTER APPLICATION IN BUSINESS

i. Order Processing Systems: These are responsible for receiving orders from clients and processing them. A typical order file contains some of the following fields: Supplier / Customer Name, Quantity ordered, item name, date, unit price, total price, etc.

ii. Stock Control Systems: Stock refers to goods purchased for resale. A computer system can be used by managers to manage their stock in an efficient way in order to provide efficient service to customers. Managers shall avoid overstocking and under-stocking as this will have a negative effect in business. Typical records may have the following:

Quantity in stock, item name, serial number, supplier name, minimum re-order level, etc.

If the quantity in stock reaches the minimum re-order level, an order should be placed for more items. Computerised stock control systems are used to monitor stock levels in an organisation. Computerised stock control can be done when goods are purchased at the Point of Sale Terminal (POS) or as goods are moved from the warehouse. The computer at the POS will be connected to the server in the manager's office. As the items are bought, the number of quantity in stock is automatically reduced by the number of goods purchased. If the quantity in stock reaches or becomes lower than the minimum re-order level, the computer alerts the manager. This helps the manager as he is freed from the task of manually counting the stock items and placing some orders.

At the POS terminal, the hardware required includes:
(a) **Input Hardware**: barcode reader (automatically enter details of goods purchased into the computer), keyboard (manually typing in product code if the barcode reader fails to do so), mouse (selecting item by clicking)
(b) **Output Devices**: printer (producing receipts), VDU - monitor (displays item details and items that are being purchased by the client, amount paid and change)
(c) **Network Cables**: connecting the VDU to the main computer.

The POS terminals can also be connected to the main server in banks like CABS, Barclays, etc. This enables customers to purchase goods electronically without the burden of carrying cash around. This is called **Electronic Funds Transfer at Point of Sale (EFTPOS).** Customers can also be given cash back at the EFTPOS after purchasing goods using debit cards.

After purchasing the goods, a receipt is produced. The receipt will have the following details: date of purchase, time purchased, shop attendant, item (s) bought, quantity bought, unit price, total price, amount tendered, change, etc.

Advantages of Using Electronic POS terminal to supermarket managers
It is automatic and more accurate to control stock. Automatic updating of stock file is ensured. Automatic reordering of stock items is involved. Less staff and wages needed. Sales statistics are always available.

Faster throughput is ensured. Itemised receipts are produced quickly. The system records every transaction. The system records staff work rates. Less pilfering by staff as it is easier to identify pilfering. Fewer errors are produced. Faster calculations are made. There is no need to remember prices of goods.

NB. The system updates the master file when an item is sold. It first searches the master file. Using the barcode number (or product code) it decrease the number in stock and increase the quantity sold

*NB:
POS –Point of Sale terminal: the point where customers pay for goods purchased in shops, either by cash or otherwise.
Difference between Electronic Point Of Sale (EPOS) and Electronic Funds Transfer at Point Of Sale (EFTPOS).
EPOS terminal only involves scanning of goods electronically by use of barcodes and by keyboard entry.
EFTPOS involves electronic scanning of goods at point of sale by use of scanners and barcodes (and use of keyboard) and has an added feature of allowing customers to transfer money from one account to another, usually to the account of the shop where the goods are being bought. Customers can also get cash-back at the EFTPOS terminal in shops.

iii. Payroll Processing Systems: These are batch processing systems used to process employee wages and produce payslips at the end. Data is first put in batches, e.g. number of hours worked for each employee per day. Processing is later on done at month-end or every Friday by compiling all the hours worked each day. A typical payroll processing system will have the following details:
Employee name, employment number, national identification number, net salary, gross salary, deductions (aids levy, NSSA, PAYE, Pension, etc) number of hours worked, salary grade, bank name, account number, etc.

iv. Accounting Systems: These deal with handling of company's finances and could be accounts receivables or accounts payables. Special accounting packages like Pastel Accounting are used in financial systems. Calculations could be done automatically.

4. COMPUTER APPLICATION IN BANKS
Uses of computers in banks:
i. Used for **storage** of client account details like, account name, account number, address, sex, date of birth, national identification number, balance, withdrawal, deposit, overdraft, interest, etc.

ii. Used for **cash disbursement** at the *Automated Teller Machine (ATM).* An ATM is a computerised, special purpose cash disbursement machine outside banking halls used even when banks are closed. Services offered at the ATM include: Balance enquiry, mini-bank statement, facility to change PIN code, cash withdrawal, cash deposit, etc.
PIN (Personal Identification Number) - a secret number used by individual account holders to access his bank account and get service at the ATM. The account holder needs a debit card for him/her to access bank services at the ATM.
The Account holder inserts the debit card into the hole on the ATM, which in turn request the user's PIN. The user enters the PIN and then presses enter. The ATM validates the PIN, and if it is correct, allows the user to select service required from the list of options available. If the user enters the wrong PIN for three consecutive attempts, the ATM would not eject the debit card, assuming that you are not the owner of the card and no service shall be given.

iii. Clearance of cheques: The main branch receives cheques from other branches and processes them using the batch processing method. MICR is used to read data from the cheques into the computer.

iv. Electronic Funds Transfer at Point of Sale (EFTPOS): This is a method of transferring money from one account to another electronically without handling of cash at the Point of Sale terminal in shops. The Point of Sale terminals will be online the bank's database, enabling the shop to deduct cash from the customer's account and transfer it to the shop's account. For this to occur the customer is supposed to produce the debit card, which is wiped on the card reader which in turn requests the client to enter the PIN. Some cash back is available at the POS.

Electronic banking (e-banking): the process of carrying out all bank transactions electronically on the internet (internet banking) and by use of cell phones. This is almost similar to tele-banking.

For **Internet banking**, credit cards are required for clients to get access to the bank accounts. Data about credit cards is stored on the magnet strip and this includes: Date of issue, Bank code, Branch code, Account number, Card number and Expiry date. Information entered by a client to access banking services from home includes: Account Number, Account name and password.

In **home banking**, users can stop a cheque, enquire their account balances, transfer money between accounts, pay bills, order a cheque book, look at account transactions for a given period, request a change of pin or password, amend or create standing orders/direct debits, print statements and change personal details. It is impossible to withdraw cash or pay in cash.

In home banking, the following advantages are realised by customers:
Do not have to waste time travelling long distances to banks. Do not have to spend money on travelling expenses travelling long distances to banks. No embarrassment of having to ask for loans face to face. Can do bank transactions even when banks are closed. Do not have to waste time waiting for a response to telephone banking.

However, home banking has the following disadvantages:
Less personal touch is involved hence no socialisation with friends and neighbours. More expensive phone bills are to be paid. Lack of exercises as user just sits on the computer. Hackers can access personal details and transfer money to their accounts. You have to have a computer and an Internet access of which less people can afford. Users are unable to withdraw cash

When purchasing the goods, the supermarkets and any other shops check the following on the credit card:
Check if the card is valid. Check if credit limit is not exceeded. Check if credit card is not reported as stolen. Check if expiry date has not been exceeded.

The introduction of ATMs, EFT and electronic banking, including internet banking has the following advantages and disadvantages.
Advantages to Bank workers
Their workload is reduced, for instance the burden of counting cash and service many clients can be done the ATM. Reduction in mistakes, for instance counting cash and updating wrong accounts as the computers validate details during entry. Reduction in working hours. Increased salaries. Better working conditions

Disadvantages to Bank Workers
Some lose their jobs due to computerisation. Leads to de-skilling where some jobs are taken as redundant, for example clerical jobs. Some workers will be transferred

Advantages to Bank clients
Customers get faster service as they are served quickly. Customers save time spend in travelling to banking halls by use of cell phones and internet bank. Customers no longer carry around large amounts of cash as all payments are done electronically and this reduces robbery cases. Clients get bank services at ATMs even during public holidays, weekends and after hours. Customers are provided with 24 hour services. Customers save money used to pay travelling expenses to banks.

Disadvantages to Bank clients
Customers can lose money through credit card fraud. Customers may forget their PIN and fail to get service at ATM. Debit cards and credit cards can be stolen and used illegally thereby customers will lose their money. There are cases of phantom withdrawals: unexplained cash withdrawals from bank accounts.

5. COMPUTER APPLICATION IN EDUCATION
i. The use Internet allows unlimited access of information on all subjects

ii. Distance learning made easier through chartrooms, digital interactive television, CD-ROM (storage of encyclopaedia, learning materials (content)). Learning materials like the encyclopaedia can be stored on the CD ROM as it will have the following **advantages** as compared to a printed (manual) encyclopaedia:
Cannot write to it so cannot be changed. Can use sound, text as well as video for students to understand better. Search of data is quicker. Can printout data conveniently. It takes up less space. Is more portable.

However, the electronic encyclopaedia has the following **disadvantages** as compared to a manual one:
Users need a suitable multimedia computer for them to use it. The computer could crash and access to data will not be possible. Can lead to electricity expenses. Cannot be read in awkward locations. Takes time to start up the computer. The disk can be stolen easily. You can't add notes to a Recordable Compact Disk

iii. People with communication difficulties like the blind and deaf are assisted, e.g. in voice recognition systems.

iv. Computers can be used to **organise** events in schools, for example, parents' visits, timetable, etc.

v. Used to store students data, exams, teachers records, etc.

vi. Used as teaching aids in all subjects. Enables interactive teaching

vii. For marking multiple choice examinations on scanner sheets

viii. For storage of student data pertaining to subjects, teachers and subjects taken.

ix. Used as a subject for student to learn, e.g. Computer Science, Information Technology, etc.

x. Used for carrying out researches and experiments which may be dangerous for human beings to do.

xi. Computers can also be used in Computer Aided Learning (CAL) and Computer Aided Instruction (CAI).

CAI: a teaching system that operates on drill and practice principle, for instance, in teaching computers, a student is presented with a word and its meaning. The student studies it and will be asked its meaning at a later stage.

CAL: This whereby a lesson is rehearsed before the computer and then played back to the class when the teacher is not physically present. The computer is thereby used to teach the pupil. For example, the computer present a topic just like a teacher does in a lesson. Pupils are asked questions. If they fail, the lesson is repeated; otherwise a new topic will be presented. CAL has the following **advantages**:

This system allows pupils to study at their own pace, repeating sections they do not understand. Material is presented in a consistent way making learning easier. Few teachers are required. Computers are endlessly patient and can repeat sections that pupils did not understand without hesitation.

xii. Used for typing and printing examination papers and keeping of student results.

Some schools have pupils who are either blind or partially sighted. Computers could be used to help these pupils to learn in the following ways:

Use of sound (voice) output and speech synthesiser. Use of speech (voice) input, recognition or microphones. Type using large characters (large font size) on the screen. Use of Braille keyboards, touch screens, touch pads. Use of bright colours to improve visibility. Use of scanners to input information and output speech. Use of printers which give output in Braille

6. COMPUTERS AND WEATHER FORECASTING

Computers can predict the state of the atmosphere for a given period of time; say for the next 4 days. Super computers are user in weather forecasting as they control satellites in orbit in the atmosphere. The procedure is as follows:

Data Collection: Using sensors, data loggers collect and store data such as temperature, wind speed, moisture content, wind direction, pressure, etc. These are the variables that the sensors can detect. The data collected by the data loggers will be in analogue form and the computer cannot read this. The ADC device converts this to discrete values (digital) for the computer to accept.

Processing: data from the data logger is retrieved by computers in offices. The data is analysed to simulate the weather condition. Calculations are made to produce expected minimum and maximum temperatures, pressure, moisture content, rainfall patterns, etc.

Output: Information obtained is displayed on the computer screen ready for presentation on televisions and on printed documents. Tables and graphs are produced as well as rainfall maps.

Advantages of this automatic weather forecasting system include:

Computer can take readings during weekends and public holidays without the presence of human beings. Computer readings are more accurate. Readings can be taken more frequently. Readings can be taken any time of day or night. Graphs can be produced more easily. Readings can be taken more reliably. Humans can be more productive if not collecting data.

7. COMPUTER APPLICATION IN INDUSTRY AND MANUFACTURING

Generally computes are used for:

i. Storage of data pertaining to their employees, sales, raw materials, etc

ii. Used for **Computer Aided Design (CAD).** This is whereby computers are used to design models of infrastructure like bridges and test for their strength before building actual structures on the ground. For example, designing of aeroplane wings. Models are tested on the computer. CAD is used in fields like engineering, architectural design, etc. **Features of the CAD software which are used to design electronic components are:**

Can draw geometrical shapes and use colour fill. Can zoom, rotate, scale, and crop images. Facility to use three dimensions. Ability to use simulations. can do calculations e.g. costing of components, stress, volumes. Can link to CAM (Computer Assisted Manufacturing). Can store and retrieve drawings and images. Has inbuilt library of components and templates. Have ability for labelling and adding text

Advantages of Computer Aided Design include:
Saves a lot of time spent in drawing and testing objects. Produces accurate scale diagrams. Images are easily manipulated on the screen. One can produce drawings in 3-dimensions as in buildings, gardens, bridges, etc. Images can be saved on the disk and retrieved at a later date. Drawings can be easily scaled up and down.

iii. Used for **industrial automation**: whereby computers take control of all production processes in industries. Computers ensure that products produced are of good quality and are standardised.

iv. Used for communication between departments and branches of an organisation.

v. Used for monitoring the production process (production control). Computer can monitor and control temperature level, pressure level, etc, that might be vital for production process. In this case, feedback is vital. If temperature becomes too high, the computer will switch off the power supply and switch it on when temperature becomes low.

vi. Computers also monitor robots in car assemblies, television production, computer manufacturing, etc. **A robot** is a computer controlled human-like device used in the production of goods in industries. It is a reprogrammable, multifunctional device designed to perform multiple tasks in industries, like spray painting, welding parts. The term **Robotics** therefore denotes the science of developing and the use of computer controlled devices to replace human beings in manufacturing. Robots are mostly used in the following areas:
Very dangerous areas for human beings work, e.g. fire fighting, nuclear power stations, underground mining, chemical, nuclear factories, deep in the ocean, in space
Areas where heavy items are to be lifted, e.g. for loading containers in ships, in production lines
Areas where the degree of accuracy is of utmost importance. Thus producing standardised goods.
Where work is repeatedly executed and boring, like at, road junctions

Features (parts) of a Robot
Robots have the following features:
Actuator (Manipulator): - A moving part which resembles a moving arm used for lifting and fitting items.
Sensors: capture information and data from the environment
Microprocessor: Processes data collected from sensors
Power supply: - Usually electricity through compressors or stepper motors.
Controlling Computers: - Connected through an interface to give instructions to the robot.
Have some form of interface

Advantages of Using Robots
Ensure reduced labour costs as they do not need paying. Quality of work produced is of high standard and consistent. Ensure reduced cost of goods due to reduced labour costs. Ensure improved speed of production. Ensures high degree of accuracy. Robots can operate in the dark thereby saving electricity costs. Robots do not take breaks and holidays as they do not get tired. Robots can work 24 hrs a day. Robots reduce accidents at traffic lights. Robots improve traffic flow. Robots can work in dangerous conditions. Create employment as the robots need to be serviced and installed. Eliminates human errors.

However errors still exists due to:
Loss of power to the robot. Fault in the software (wrongly programmed). Occurrences of hardware break down. Some robot components can be missing or misplaced.

Disadvantages of Using Robots
Use of robots means more people will become redundant and lose their jobs. Electricity expenses are very high.

8. COMPUTERISED TRAFFIC CONTROL SYSTEM

Input: Data is read from sensors and from camera images
Processing: Computers analyse data from sensors. Computers calculate average traffic flow and speed. Computer sends signals to adjust change of lights and timing
Output: Computers change lights at junction. Computers change timing plan

Advantages of using computerised traffic control systems
Ensures improved traffic flow control. Reduces traffic accidents. Keeps delays to a minimum. Reduces pollution. cars use less fuel
In case of an emergency, the computerised traffic system may perform any one of the following:
Give uninterrupted path through the system of linked traffic lights. Give green link – wave for all traffic to pass. Turn all lights to red. Activate emergency generator. Sound an alarm.

9. Microprocessor-controlled streetlights

Input: Sunset time and Sunrise time and then sending a signal **or**
- Light sensor sends measurement of light to microprocessor, ADC converts this to   digital
Processing: Compare sunrise time, sunset time and current time. If sunrise time = current time or higher, switch off lights, else, if signal equals sun set time, the switch on light. Also the amount of light is compared with preset value. If higher – nothing happens, If lower or equal sends signal to light
Output: Lights switched on or off

DATA LOGGING

The process of automatically collecting data from source at set intervals for use at a later stage. A device that automatically collects data from source at set intervals for use at a later stage is called a data logger. Data loggers have the following **features**:

They contain processor inside them. They have own storage facility. They contain sensors used for collecting data. They can be connected to small keyboards or other special reading attachments. They are connected to an Analogue to Digital Converter (ADC), which converts data signals in continuously varying form collected by sensors into discrete values that can be accepted by the computer.

Benefits of computerised data logging are:

Data loggers are a very fast method of data collection than manual methods. Data loggers are very accurate than humans in collecting data. Data loggers stored data for a very long period of time. Data loggers can work 24 hours a day.

Data loggers can be used to measure the pollution level in a dam or river, as shown below:
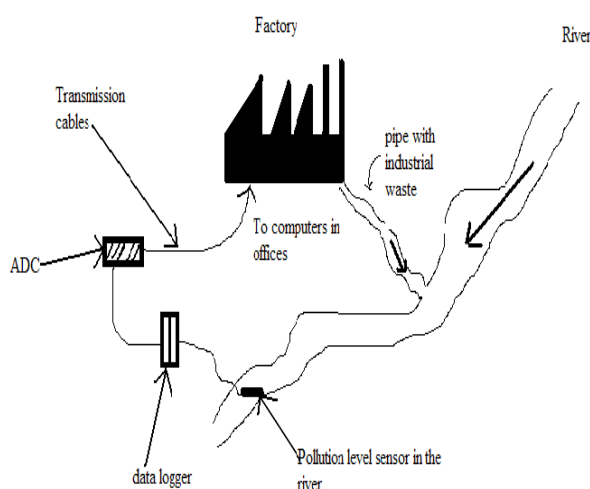
The pollution level sensor is placed downstream where pollution from the waste material from the factory can reach. The sensor detects the level of pollution and sends it to the data logger through the transmission cables connected to it in analogue form. The data logger stores the details for future retrieval. The ADC device converts the analogue data collected by the sensor into digital form which can be understood by the computer. The computer users in the factory get the data and analyse it on their computers. A signal (either by a siren) can be send by the microprocessor to alert the computer user if the pollution level becomes too high to affect humans and the organisms that rely on the water for survival.

In the above system, the types of sensor that can be used include: Ph (acidity/alkalinity) sensor, Temperature sensor, Light sensor, Radiation sensor, dissolved oxygen or Nitrate or Nitrite or Ammonia sensor.

Reasons why computers are used rather than manual methods for this pollution data logging

It takes more accurate readings. More readings can be taken in a short period of time. Results can be obtained more easily and quickly. Graphs are automatically produced. No chance of forgetting to record the temperature. Collects temperature over long periods continuously/automatically. Data can be automatically stored and used in other programs. The results of the system can be stored in a spreadsheet package or a database package for future reference.

A word processor or DTP package can then be used to produce reports of the results. The procedure will be as follows:

Spreadsheet file will be saved in suitable format. The template is created in DTP package. The Spreadsheet file is copied and pasted in to the DTP package. The Pictures are imported into DTP package. Text is typed in and formatted. Headings are formatted and then printed

*<u>**NB: Sensor**</u>: A sensor is an input device that automatically records data by sensing the environment it is supposed to record. Sensors receive a signal and respond to it in a distinctive manner. The type of sensor is derived from the type of information it is designed to collect. Some of the examples of sensors include: Optical sensors, light sensors, pressure sensors, temperature sensors, humidity level sensors, sound sensors, proximity sensors, position sensors, push switch, mercury tilt switch, pH sensor, weight sensors, air pressure sensor, conductivity sensor, distance sensor, motion sensor, oxygen sensor, ultra-violet irradiance sensor, radiation sensor, escaping gas sensor, etc. Sensors are mostly used in conjunction with Analogue to Digital Converter (ADC) – This is a device used to convert data in continuously varying form from the sensor into discrete value for entry into the computer. A device that will convert digital data into analogue for is called a Digital – Analogue Converter (DAC).

Nuclear Power Stations

The diagram below shows a nuclear reactor cooled by pumping gas around the core. The reactor is monitored and controlled by a computer.

Hot gas out under pressure

CORE

Cold gas IN under pressure
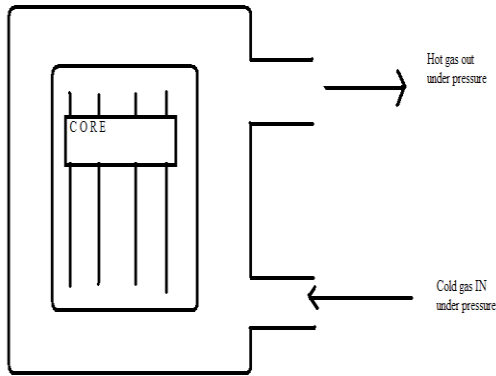
Sensors that are used to monitor the core include: pressure sensor, temperature sensor, radiation sensor and escaping gas sensor.

ADC (analogue to digital converter) is needed to enable the data from the sensor to be processed by the computer.

Use of feedback to control the reactor

As hot gas under pressure moves out, the processor allows appropriate amount of gas to move in. Thus output affects the input. Sensors detect this and the data from the sensors is sent to the computer. The data is compared with stored values. The computer sends information to valves to control gases. The system loops.

Advantages of using a computer system rather than a manual system to monitor and control the reactor

Can monitor process at a distance. It is a safer way of operation and is less dangerous to humans. Computer is faster at taking necessary action. Has the ability to automatically analyse data and produce graphs. There is less need for human intervention. It ensures a 24 hour monitoring while workers can get tired. It is a more accurate control mechanism.

DATA CAPTURING

It is the process of collecting and changing data from source into machine sensible form before processing is done. It involves getting data into a structure in which it can be processed by the computer. The following are some of the data capturing techniques/methods:

Key-to-disk – A way of inputting data directly into the computer and onto the disk using the keyboard. **Voice Recognition/input**, **OMR**, **OCR**, **MICR**, **Barcodes** , **Tags** (Kimball tags),

Turnaround Document: it is a document produced by the computer that can latter be used as an input document to the computer, e.g. water bills, telephone bills, etc.

CODING DATA

Data to be entered into the computer can be coded / written in a short way, for example:

In databases, a field for sex can be coded as follows: F for Female, M for Female. In this case the user just enters F or M and not the whole field as it is. The column for colour can also be coded as B for Black, R for Red, Y for Yellow, etc.

Reasons form coding data:

Codes are quicker to type in, both initially and subsequently. Reduces the size of files thereby saving disk storage space. Increases the speed of searching and any process performed on data

Features of Codes

Should be of the same length. Must be easy to use. Must not be too short in case you will run out of codes. Codes are often unique

IMPLICATIONS OF COMPUTER APPLICATION

The following are some of the effects of use of computers (computerisation):

Many people lose their jobs leading to high levels of unemployment. Huge profits are made by companies that engage in electronic commerce (*the advertising, buying and selling of goods and services on the internet*) and industrial automation. High productivity of high quality goods. Cheaper goods have been produced by companies. Cheaper, faster and more reliable means of communication have been realised. Creation of new jobs, e.g. computer programmers, computer technicians, etc. Companies lose a lot of money by re-training of their employees for them to catch up of software updates, software changes and hardware changes. **De-skilling**: - this is the replacement of skilled and semi-skilled labour by microprocessor controlled systems in manufacturing, for example in car assemblies. Most of the skills which were highly valued are taken to be useless by the introduction of computers. The ability of unions to maximise impact by selecting computing staff for strike action, etc.

*NB: - **Electronic scabbing**: a process whereby managers switch word-processing duties from striking workers in one country to none-striking workers in another country.

Improved working conditions and environments for employees. Misuse of personal data held in public offices like police stations, registry offices, etc. **The data can be misused by:**

Hackers may **read** the data and pass it on. Hackers may **delete** the data. Hackers may **amend** the data

Loss of data can be prevented by:

Use of Usernames and Passwords. Do not connect the computers to a network. If connected to a network use dedicated lines. **Physical security** - locks on computer room doors and employ guards. Install Firewall. Use Proxy server security. Data can be encrypted. Use iris and palm recognition systems. Use of swipe cards, finger print recognition systems. **Use of audit trail**: The process that tracks the activities of users by recording selected types of events in the security log of a server or a workstation.

Computers can create health problems, for example:

- Lack of exercises by computer users.
- **Repetitive Strain Injury (RSI):** - injury to muscles and tendons caused by continuous repetitive use of particular muscles, especially by using a keyboard, or working on an assembly line. Employees are advised to have frequent breaks to avoid RSI. They can also type with their fingers straight and flat on the keyboard.
- **Eye problems**: - itchiness of eyes caused by light reflected by computer screens. This can be solved by:
Wearing spectacles (glasses). Use of antiglare screens: these reduce the amount of light reflected by the screen. Adjusting screen settings so that it becomes darker. Very bright colours are dangerous for eyes.
- **Backbone problems**: sitting on the computer for a long period can cause this. This can be solved by:
Using a chair that is adjustable to fit the height suitable for each employee. Sitting up while using the computer.
- Increase in the amount of litter due to dumping of used and old computers
-
Children are being exposed to pornography, hate literature, racism and dangerous experiments like those for manufacturing bombs on the internet. **This can be solved by**:
Installing software that prevents children from accessing restricted sites on the internet like Net-Nanny, Surfwatch, Cybersitter, etc. This software blocks inappropriate sites and subject matter. Teachers and parents need to closely supervise students during internet access. Firewalls can also be installed as a security measure.

Protecting of data against accidental loss

Periodically backing up data that will be stored in a secure, fireproof safe. Training users to follow proper updating procedures. Avoid bringing in outside disks which transmit viruses. Load recent antivirus programs and update them frequently.

DATA SECURITY AND INTEGRITY

1. Data Security

Data security refers to the means of protecting data from unauthorised access and from deliberate or accidental loss. It includes the safety of data from any form of hazard like floods, theft of the computer, fire, etc. Data security can be achieved by:

Physical Security measures against hardware and data loss.

Locking the computer room. Employing security guards. Installing burglar bars on windows. Use of screen gates. Installing an electric fence around the computer room. Constructing a durawall around the computer room. Installing fire extinguishers inside the room. Building the computer room on higher grounds to avoid flooding. Installing a generator to avoid data loss through power cuts. Installing an **Uninterruptible Power Supply (UPS)** to prevent data loss through power cuts:

NB: a UPS is a device connected between a computer and a power source to ensure that electrical flow is not interrupted. UPS devices use batteries to keep the computer running for a period of time after a power failure. UPS devices usually provide protection against power surges and blackouts as well.

Measures against unauthorised access to data held in the computer:

Use of data encryption methods before sending (*data encryption is the scrambling of data before sending, for security reasons*). Use of passwords. Use of firewalls. Use of iris and palm recognition systems. Installing the latest anti-virus software. Log users for computer use. Use call back facility for incoming information. Check references of potential staff for employment purposes. Divide jobs between several people and then supervise the staff. Use physical locks like burglar bars, installing electric fences, etc.

2. Data integrity

This refers to the correctness and accurateness of data held in the computer. The issue of data integrity and security lead to the introduction of some data protection laws which govern how organisations holding public data must operate.

THE DATA PROTECTION ACT (1984)

This tries to regularise the use of automatically processed individual information by organisations. The Act outlines some of the following rules:

Organisations using personal data must be registered. Data about individuals must be obtained fairly and lawfully for the purpose collected for. Data must be used only for the specific purpose collected for and may only be disclosed in accordance with such a purpose. Data collected must not be excessive for the purpose collected for but must be adequate and relevant. Data collected must be accurate, up-to-date and kept no longer than necessary. Data must be protected from unauthorised access or loss. Individuals with collected data have the right to view it and make alterations where necessary.

DATABASES

A Database is a collection of related files. Databases enable addition, deletion and modification of data held in the computer.

Building Block of Computerised Databases

Bit → Byte → Field → Record → File → Database
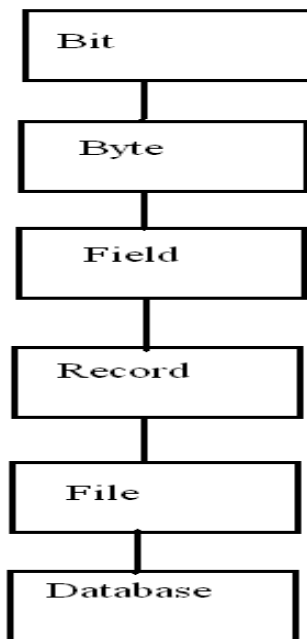
- **Bit**: A single binary digit like 0 or 1.

- **Byte**: A group of eight bits representing a character for example 10010110

- **Field**: A specific category of information in a table (database), for example Surname, Date of Birth, etc

- **Record**: A collection of related fields describing an entity, e.g patient.

- **File**: A collection of related records

- **Database**: A collection of related files

A database system (elements) is made up of stored data, software to maintain the database and the person working with the database.

Database Management System (DBMS)

It is a layer of software used to maintain the database and provides interface between the database and application programs. It allocates storage to data. The DBMS maintains data by: adding new records, deleting unwanted records, amending records.

Data in databases can be accessed using different programming languages.

DBMS facilities: Processing of files in serial or sequential order. Processing of records. Retrieval of records

DBMS provides security to data in the database by:

Protecting data against unauthorised access using passwords.

Safeguarding data against corruption.

All transaction between the database and the user are done through the DBMS.

Communicating with the database

Some databases have their own computer languages. For all the data in databases, data descriptions must be provided. Data Description Languages (DDL) are provided as well as the Data Manipulation Language (DML)

*NB: **DDL**- Refers to data about data (data used to describe data).

             DML: Language used to retrieve data from databases.

A combination of the DDL and the DML is called a Data Sub-Language (DSL) or a Query Language. The most common DSL is the Structured Query Language (SQL)

The Database Administrator (DBA)

This is a person appointed to manage the database and ensures that the database meets the needs of the organisation. The DBA is supposed to have software and managerial skills. The **responsibilities** of the **DBA** are:

Ensuring that the database meets the needs of the organisation. Setting up the database. Control, manage and maintain the database. Define, implement and control database storage. Ensure that policies and procedures are established. Guarantee effective production, control and use of data. Define the strategy of backup storage and recovering from system breakdown. Supervise amendments to the database. Ensures that the data is secure from unauthorised access.

TYPES OF DATABASES

These includes relational, hierarchical and network databases

1. Relational databases: These are database that organises data in a table format, consisting of related data in another file, allowing users to link the files. Each column represents an attribute (characteristic or field). Each row represents a record, as shown below.

Student Number	Surname	First Name	Date of Birth
0001/00	Kapondeni	Tungamirai	07/02/78
0028/05	Moyo	Cosmas	02/05/88
1255/05	Turugari	Tendai	04/06/97

Relational databases organise data in a flexible manner. They are also simple to construct and are easy to use. However, it may be difficult to come up with relationships.

From the above database structure, it can be noticed that:

- There are three records for Kapondeni, Turugari and Moyo. A record is also called a **tupple**.
- There are four fields: Student Number, Surname, First Name and Date of Birth.
- The student Number is used as a Primary Key (Key field) because it gives a unique(one) record. **A primary key** is a field that is used to identify a unique record from a database. All other fields from the above database are not appropriate for a key field because they can identify more than one record. That is surnames can be similar for 2 or more people as well as date of birth.

*NB: **Concatenated key**: the combination of two or more fields in a database in order to identify a unique record, e.g. using the Surname, First Name and Date of Birth in search of one record.

*NB: **Secondary Key**: A field used to identify more than one record at a time, e.g. a surname.

*NB: **Attribute**: A characteristic of a record, e.g. its surname, date of birth.

Entity: any object or event about which data can be collected, e.g. a patient, student, football match, etc.

Data types for fields can be:

- **Numeric**: consists of digits 0-9 only (negative or positive), 12, 900, -50, etc
- **Alphabetic**: Consists of letters of the alphabet (a-z, lowercase or uppercase) only, for example a person's name, like **Tungamirai**.
- **Alphanumeric**: Combination of digits and letters of the alphabet, eg. National Identification Number, like 27-134575-C-27
- **Text**: Combination of digits and letters of the alphabet.
- **String**: Combination of digits and letters of the alphabet
- **Currency**: in monetary value, e.g. $10.00
- **Date/time**: shows date and time, e.g. 27/01/1997
- **Array:** An array is a series of elements of the same type placed in contiguous memory locations that can be individually referenced by adding an index to a unique identifier.

2. Network Databases
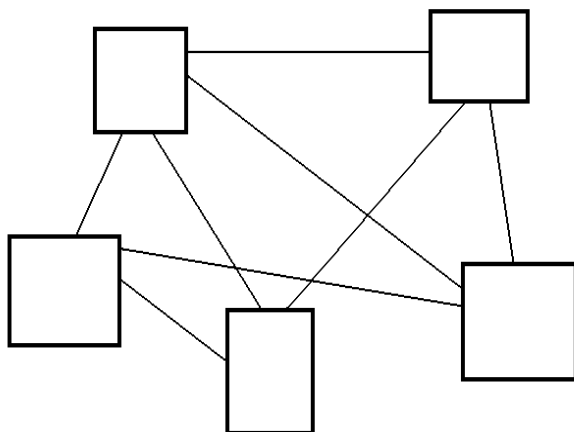
These databases have links that are used to express relationships between different data items.

Data is maintained by a single input.

There is little duplication of data.

There is no duplication of inputs. Linkages are more flexible.

Many to many relationships to records are limited

3. Hierarchical database: These are databases in which records are subordinates to other records in a tree structure of database. It promotes grandfather, father, and son relationship of records as illustrated below..
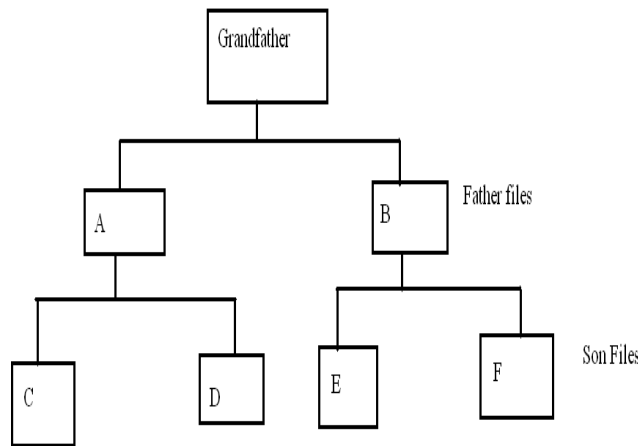
Each father file has one or more son files.

Each son file has only one father file.

There are no cross linkages of file records.

It is difficult to access all the files at one time.

A lot of duplication exists in this type of database structure

DBMS components

i. Data Dictionary: this contains names and descriptions of every data element in the database. Descriptions are on how data elements are related to each other. The Data Dictionary (DD) stores data in a consistent memory, reducing data redundancy.

ii. Data Languages: a Special language used to describe the characteristics of a data element placed into the DD. This language is called the DDL

iii. Security Software: provides tools used to shield the database from unauthorised access.

iv. Recovery and archiving system: these allow data to be copied onto backups in case of disaster.

v. Report writers: these are programs used to design output reports without writing an algorithm in any programming language.

vi. Teleprocessing monitors: Software that manages communication between the database and remote terminals.

Advantages of Databases

Validation checks are made on data during entry thereby reducing data entry errors. Searching and retrieval of data is very fast. Less likelihood of data getting lost. Record structure can be easily modified if the need arises. Files can be linked together making file updating easier and faster. Avoids data redundancy. Data can be secured from unauthorised access by use of passwords. Users can share data if the database is networked. Duplication of records is eliminated. Ad hoc reports can be created easily. Sorting of records in any order is very fast

Disadvantages of databases

If the computer breaks down, you may not be able to access the data. It is costly to initially setup the database. Computer data can be easily copied illegally and therefore should be password protected. Takes time and costs to train users of the systems. Expensive to employ a database administrator who will manage the database

Advantages of computer based systems as compared to manual filing systems.

Work can be done anywhere, even at offices in different countries. It is quicker to transfer files to other offices. Fewer staff is employed thereby saving expenses on wages. There are less chances of files getting lost. Less paperwork and storage requirements are needed. It is quicker to search needed records. It is quicker to sort records in any order using any field. It is quicker to cross reference files. It is quicker and easier to insert sections of files into reports

However, the introduction of the computer systems means that staff would need new skills, can lead to unemployment, people are likely to work from home, could lead to de-skilling and some health problems will suffice.

Sample Question

A database stores details about cars in a showroom: The database information can be amended, deleted or new ones inserted due to:

Amended: information in the databases is incorrect. Price of vehicle needs to be changed (e.g. sales). Change of vehicle colour.

Deleted (record deleted): Vehicle is sold or Vehicle is scrapped

Inserted/ added: new vehicle arrived. More information about current vehicle becomes known.

FILE HANDLING
Types of files
1. Master File: It is a relatively permanent file that is kept up-to-date by applying transactions that occur during business operations. It contains permanent and semi-permanent data. Static (permanent) data stored in database files can include Surname, First names, Date of birth, etc.

2. Transaction Files: These are files that contain data that can change regularly, e.g. on daily bases and it is used to update the master file. This includes sales per day, student mark in a weekly test, etc. Transaction files are used to update master files.

3. Reference files: These are files that contain permanent data which is required for reference purposes only. This includes data on tax bands, formulae, etc. No changes to files are done.

4. Data file: A set of related records (either written or electronic) kept together.

a. FIXED LENGTH RECORDS
These are records that allocate a specific amount of space for data, mostly a specific number of characters. For instance, a school keeps student records in a fixed length file. The student number has 6 characters, Surname was assigned 10 characters, First Name is given 10 characters, Date of Birth has 6 characters, sex has one character and class has 2 characters only in that order in the computer database file. In total, the length of each record is 35 characters.

The following student details are to be entered into the computer:

Student Number: *012999,* **Surname**: *Kapondeni,* **First Name**: *Tungamirirai*
Date of Birth: *7th of February 1978,* **Sex:** *Male,* **Class**: *Form 4A*

When entered into the database, the record will appear as follows:

Student Number	Surname	First Name	Date of Birth	Sex	Class
0 1 2 9 9 9	K a p o n d e n i	T u n g a m i r i r	0 7 0 2 7 8	M	4 A

From the table above, it can be noticed that:
- The Sex field is coded to accommodate only the letters *M* or *F*. This is shorter and therefore faster to enter data into the computer and to search records than entering the words Male or Female.
- The Surname *Kapondeni* is shorter than the allocated 10 spaces. The other spaces will remain idle.
- The First Name *Tungamirirai* is too long than the allocated spaces and therefore extra characters will be cut.

Fixed length records have the following advantages:
Entering data is faster as records are shorter and less typing is required. less memory is required. Less data entry errors are encountered. It is faster to carry out searches. Faster to do validation checks and procedures. They are easier for programmers to work with than variable length records. They allow an accurate estimate of disk storage requirements. Thus disk storage space can be easily managed as records occupy a specific number of characters. They are very easy to update

However, fixed length records have the following disadvantages:
Can lead to wastage if disk storage space if used to store variable length data. For example, not all surnames are of the same length. Some spaces may lie idle as data entered will be shorter than the space allocated. Some data to be entered may be too long for the space allocated and therefore will be cut.

b. VARIABLE LENGTH RECORDS
These are records that allow data to occupy the amount of space that it needs. They allow data with varying (different) number of characters or sizes. They usually show where the field or record starts and ends, for example:

0 1 2 9 9 9 * K a p o n d e n i * T u n g a m i r i r a i * 0 7 0 2 7 8 * M * 4 A ≈

NB:- * *Indicates the end of field marker, and the* ≈ *indicates the end of record marker*

Variable length records have the following advantages:
They are more economical in terms of usage of disk storage space as they do not allow spaces to lie idle. Data entered will not be cut but appears as entered no matter how long it is.

However, variable length records have the following disadvantages:
End of field and end of record markers occupy disk storage space that might be used to store data. These records are difficult to update as the transaction and master files might have different lengths.

FILE ORGANISATION

Refers to the way in which records in a file are stored, retrieved and updated. This affects the number of records stored, access speed and updating speed. The most common methods of file organisation are: Serial **File Organisation, Sequential File organisation, indexed – sequential file organisation and random (direct**) file organisation.

1. Serial File Organisation: This is whereby data is recorded one after another as they occur, without any definite order as on magnetic tapes. Data is read from the first record until the needed data is found, as on magnetic tapes. New records are added to the end of the file. Serial file organisation is not appropriate for master files since records are not sorted and therefore are difficult to access and to update. Suitable for temporary transaction files since records are not sorted.

2. Sequential File Organisation: This is whereby records are sorted into a key sequence, that is, in ascending or descending order of a given key filed as on magnetic tapes. Sequential files organisation is appropriate for files with a high hit rate like payroll processing. They are suitable for master files since they are ordered. However, it takes too long to access required data since the records are accessed by reading from the first record until the required data is found. Adding of new records is difficult as this is done by re-entering the data and the new record is inserted at its right position. It time consuming to update such records. Suitable for master files since records are sorted. This is used where all records need processing

3. Indexed-Sequential Files: This is whereby records are ordered in sequence based on the value of the index or disk address as supported by hard disks. This is used for storing master files records since the records are ordered. It is also suitable for real time processing applications like stock control as it is fast in accessing records and in updating them. It provides direct access to data as on hard disks, diskettes and compact disks.

4. Random (Direct) File Organisation: This is whereby records are stored in no order but accessed according to their disk address or relative position, as supported by hard disks and compact disks. It is appropriate where extremely fast access to data is required as in airline reservation. Updating of records is in situ, very simple and very fast. Hard disk, compact disks and diskettes promotes random file organisation.

FILE PROCESSING

Refers to any form of activity that can be done using files. This includes: file referencing, sorting, maintenance and updating.

1. File Referencing/Interrogation: This involves searching of record and displaying it on the screen in order to gain certain information, leaving it unchanged. The record can also be printed.

2. Sorting: Refers to a process of arranging (organising) records in a specific ordered sequence, like in ascending or descending order of the key field.

3. Merging Files : This is the process of combining two or more records into one. Below is an example of how records can be merged:

Record A (sorted)

12	34	71	78	101

Record B (unsorted)

103	67	3	90	12

Record C (Merged and sorted for records A and Record B)

3	12	34	67	71	78	90	101	103

4. File maintenance: This is the process of reorganising the structure of records and changing (adding or removing or editing) fields. This can be due to changes due to addition or deletion of records.

5. File Updating: Updating is the process of making necessary changes to files and records, entering recent information. Only master files are updated and they must be up-to-date. **For updating to occur, any one of the following must have occurred:**

A new record has been entered. Deletion of an unwanted record. An amendment (change) to the existing data has been made, e.g. change in date of birth only.

The most common methods of file updating are:
Updating **in situ** and Updating **by copying**.

a. Updating by copying
This happens in sequential file updating. This is done through the following steps:
- A record is read from master file into memory. A record is then read from transaction file into memory. Record keys from each file are compared. If record keys are the same, the master file is updated by moving fields form transaction file to the master file.

In sequential file updating, it is recommended to keep at least three master file versions that will be used for data recovery in case of a system failure or accidental loss of data. The first master file is called the

Grandfather file, the second master file is called the father file and the third master file is the son file. This relationship is called the grandfather-father-son version of files. The process of keeping three versions of master files (grandfather-father-son) as a result of sequential file updating is called **File Generations**. Thus the first master file (grandfather file) is called the first generation file, the second master file (father file) is called the second generation file and the third master file (son file) is the third generation file. The following diagram illustrates the sequential file updating process:
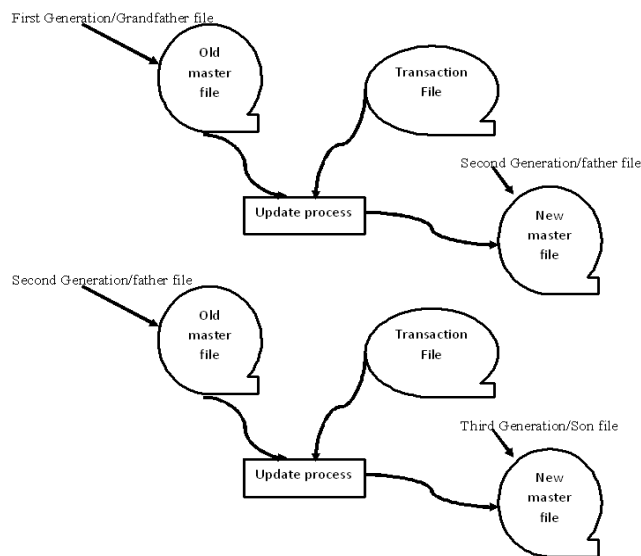
*NB: - Always create data backups on compact disk or hard disks and re-run the old master file with the transaction file if the computer system fails or if data is lost. This is a data recovery method that works well.

*NB:- A backup is a copy of file(s) on an alternative medium like CD-ROM in case the original file is damaged or lost and will be used for recovery purposes. The original files could be deleted accidentally, deleted by hackers, corrupted by system failure or could be corrupted by hackers.

b. Updating by overlay (in situ):
In this case, record is accessed directly, read into memory, updated and written back to its original position (in situ). This occurs in random and indexed-sequential files, thus on devices like hard discs and memory sticks.

PROGRAMMING CONCEPTS

Definition of terms:

- **Program**: a set of detailed and unambiguous instructions that instructs a computer to perform a specific task, for example, to add a set of numbers.
- **Programming**: A process of designing, coding and testing computer programs
- **Programmer**: A person who specialises in designing, coding and testing computer programs
- **Problem**: any question or matter involving difficulty or uncertainty and is proposed for solution.

PROGRAMMING LANGUAGES

A programming language is a set of symbols in computer language that are used in coding computer programs. Programming languages are of the following types:

1. Low Level Languages (LLL): These are programming languages used to write programs in machine code, that is in zeros and ones or in mneumonic codes. Low level language is in two forms: **Machine Language** and **Assembly Language**.

a. Machine code (language) is the language used to write programs in binary form (zeros and ones). Machine language has the following **advantages**:
(i) Programs run faster since they are already in computer language. There is no need for conversion as programs are in machine language. (ii) Programs occupy very small disc storage space by storing just 1s and 0s.

Disadvantages of Machine language:
They are very difficult to learn. They are difficult to understand. Very difficult to use and takes too long to find an error in a program. It takes too long too develop working programs. They are machine dependent (they can only work on type of computer designed for and not work on other computers)

b. Assembly Language: These are programming languages that use mneumonic codes in coding programs. Mneumonic codes are abbreviations used in coding assembly language programs, for example, LDA for Load, ADD for Addition, etc. Mneumonic codes are very close to machine code, hence are low level language assembly language codes

Advantages of Assembly language:
One assembly language instruction corresponds to one machine code instruction and therefore translation is easier and faster. Programs run faster since they are close to machine code. They occupy very small disk storage space hence are economical to use. Easier for a programmer to use than machine language.

Disadvantages of Assembly Language
They are very difficult to learn. They are very difficult to understand. Takes too long to develop working programs. They can be machine dependent.

NB. Assemblers: These are programs used to convert assembly language instructions into machine language. Other uses of assemblers include:
They generate machine code that is equivalent to assembly language. They are used to check the validity of instructions, that is, checking for syntax errors in an instruction. They also assign memory locations to variables.

2. High Level Languages (HLL): These are programming languages that use English-like statements in coding programs, for example COBOL, Pascal, BASIC, etc. There are so many high level languages because each language is designed for a specific problem to be solved in our daily lives. For example BASIC was designed for learning purposes, COBOL for business applications, FORTRAN for scientific purposes, etc. Below is an example of a BASIC program that accepts two numbers entered through the keyboard, adds them and display the result on the screen:

```
INPUT "ENTER FIRST NUMBER.", A
INPUT "ENTER SECOND NUMBER.", B
SUM = A + B
PRINT SUM
END
```

Programs written in High Level Language are first converted to machine code before running.

Advantages of High Level Languages:
They are easier to understand since they are written in English-like statements which are more readable. They are easier to learn. It is easier to work with, that is to correct errors and to test programs. They are problem oriented and therefore can be used on any computer (not machine dependent)

Disadvantages of HLL
Takes long to run since they need to be first converted to machine code. They occupy a lot of disk storage space as compared to low level languages.

Factors to consider when choosing a programming language
Nature of the application. Availability of needed facilities in the programming language for system implementation. Availability of compatible hardware. Availability of expertise of the programmers.

TRANSLATORS
These are programs used to convert High level Language programs into machine code, and are in two types, which are **interpreters and compilers**, which are further explained below:

Interpreters
These are programs that convert and run one instruction of a program at a time until the end of the program, e.g. the BASIC interpreter. They do not produce the machine code version of a program; hence conversion is repeated when you run the program again.
Functions of Interpreters
They check syntax error in a program statement. They translate an instruction into machine language and run it. Allocates storage space to variables.
Advantages of interpreters
It is easy to find and correct syntax errors in interpreted programs. It is very fast to run programs for the first time. It is very fast to run small programs.
Disadvantages of interpreters
They are very slow in running very large programs. They do not produce an object code of a source code and hence difficult to use.

Compilers
These are programs that convert a high level language program into its machine code equivalent at one go and then run it, e.g. the COBOL compiler. Once compiled, the program no longer needs conversion since the machine code version is the one that will be run, until some changes are made to the program code.
Functions of Compilers
They check syntax errors in program statements. They allocate storage space to variables. Translate the whole program into machine code at one go. Run an object code of the program. Produces a program listing which indicates position of errors in a program.
Advantages of Compilers
Compiled programs runs faster since the object code is run. Compilers indicate the line numbers with syntax errors and therefore assist programmers in debugging programs. They are appropriate even for very large programs.
Disadvantages of Compilers
Slower than interpreters for running programs for the first time. They can cause the computer to crash. Difficult to find errors in compiled program.

*__NB__: __Source Code__ refers to the program written in English-like statements (High Level Language) by the programmer.
__Object Code__ refers to a machine code version of a source code. All programs written in source code must be converted to object code for the computer to understand them.

Difference between High Level Languages and Low Level Languages

	High Level Language	Low Level Language
1	Written in English like statements	Written in 1s and 0s (machine code) or in mneumonic codes.
2	Easier to work with	Difficult to work with
3	Easier to understand	Difficult to understand
4	Are problem oriented and can be used on any computer	Machine oriented
5	Slower in execution since they need to be first converted to machine code before running	Faster in execution since they are in machine code already.
6	Occupy large disk storage space on the computer	Occupy small disk storage space on the computer
7	They are machine independent	They are machine dependent

3. Very High Level Languages (VHLL) – 4GLs: These only specify the desired end result and do not indicate steps that the computer needs to take to make the calculation, e.g. SQL used in relational databases. 4GLs are flexible and easy to use since no coding is required.

4. Natural Language – Artificial Intelligence and expert systems: These are programs that mimic human reasoning and learn from experiences.

Programming Language Generations

1. First Generation Languages (1951-58) – Machine language: These used binary form to code programs. This is the Machine language version. Programming was tedious to do.

2. Second Generation Languages (1959-64) – Assembly Language: Assemblers, compilers and interpreter became available to represent machine code. This generation saw the use of assembly language. Programming was simpler and less tedious.

3. Third Generation Languages (1965-70)- High Level Languages: This saw the development of High Level Languages like BASIC, COBOL, FORTRAN, etc

4. Fourth Generation Languages (1971) – Very High Level Languages (4GLs): This saw the development of non-procedural languages like SQL, PARADOX, etc

5. Fifth Generation Languages(1981) - Natural Language, artificial intelligence, expert systems like PROLOG, LISP.

Procedural Languages: These languages give a precise definition of the steps to be followed by the computer in order to perform a specific task. Most High Level Languages are procedural languages.

Object Oriented Languages (non-procedural). These languages just specify the constraint and objects to be produced and do not specify the steps to be followed to perform a task. Very High Level Programming Languages are procedural languages, e.g. SQL

TOP-DOWN PROGRAM DESIGN
Refers to the splitting of a program into simpler subtasks called modules which will be easier to solve. For example, a program can be split into modules to Accept Number, Add, Divide, Subtract and to Display Results. Modules are also called procedures, routines, sub-routines or functions. The splitting of a problem into a series of self-contained modules is called modularisation (modular programming).

Advantages of modularisation (modular programming)
Programmer can concentrate at one task at a time. Modules are simpler and easier to understand and to solve. Modules are easier to test and to debug. Program modification is easier since changes are isolated with specific modules. More experienced programmers can be assigned complex modules. It saves programming time by sharing tasks. A large project will be easier to monitor. It is easier to update (modify) modules
However, it may be difficult to link the modules together.

*NB: Library programs: this refers to a collection of standard programs and subroutines that are stored and available for immediate use by other modules in the system. Library programs are referenced by most modules in the systems.

*NB: Stepwise refinement: a technique used in developing the internal working of a module.

ALGORITHMS
A set of instructions describing the steps followed in performing a specific task, for example, calculating change. Algorithms can be illustrated using the following:
Descriptions, Flowcharts, Pseudocodes, Structure diagrams

a. Descriptions: These are general statements that are followed in order to complete a specific task. They are not governed by any programming language. An example is as follows:

> *Enter temperature in ^oC*
> *Store the value in box C*
> *Calculate the equivalent temperature in ^oF*
> *Store the value in box F*
> *Print the value of box C and F*
> *End the program.*

b. Pseudocodes: These are English-like statements, closer to programming language that indicate steps followed in performing a specific task. They are however independent of any programming language. An example is as follows:

> *Enter centigrade temperature, C*
> *If C = 0, then stop.*
> *Set F to 32 + (9C/5)*
> *Print C and F*
> *End*

A number of control structures are used in designing Pseudocodes. These includes: simple sequence, selection and iteration.

i. Simple sequence: This is whereby instructions are executed in the order they appear in a program without jumping any one of them up to the end of the program. Statements are executed one after another in the order they are. It is simple and avoids confusion. Example:

> *Enter first number, A*
> *Enter second number, B*
> *C = A + B*
> *Print C*
> *Stop*

ii. Selection Structure:
This allows one to choose the route to follow in order to accomplish a specific task. Selection is written using the IF ....THEN...ELSE statement or the CASE statement.

IF...THEN ...ELSE statement: A programming structure that allows the user to choose one from at least two routes of solving a problem. The following Pseudocodes compares two numbers entered through the keyboard and determines the bigger one.

A	B	C

Enter first Number, A
Enter second number, B
IF A>B THEN
　　Print A is bigger
ELSE
　IF A<B THEN
　　Print B is bigger
ELSE
　　Print Numbers are equal
ENDIF
ENDIF
END
	Enter first Number, A
	Enter second number, B
	IF A > B THEN
	　　Print A is bigger
	ENDIF
	　IF A < B THEN
	　　Print B is bigger
	ENDIF
	IF A = B THEN
	　　Print Numbers are equal
	ENDIF
	END
		Enter first Number, A
		Enter second number, B
		IF A>B THEN Print A is bigger
		IF A<B THEN Print B is bigger
		IF A=B THEN Print Numbers are equal
		END

The above 3 Pseudocodes produces the same result.

CASE Statement: This is an alternative to the IF...THEN...ELSE statement and is shorter. For example:
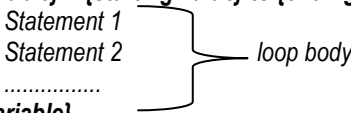
> *Enter first Number, A*
> *Enter second number, B*
> *Enter operand (+, -, * /)*
> *CASE operand of:*
> 　　*"+": C = A + B*
> 　　*"-": C = A-B*
> 　　*"*": C = A*B*
> 　　*"/": C = A/B*
> *ENDCASE*
> *Print C*
> *END*

iii. Repetition/Iteration/looping:

A control structure that repeatedly executes part of a program or the whole program until a certain condition is satisfied. Iteration is in the following forms: FOR...NEXT LOOP, REPEAT... UNTIL Loop and the WHILE...ENDWHILE Loop.

a. For...Next Loop: A looping structure that repeatedly executes the loop body for a specified number of times. The syntax of the For...Next loop is as follows:

> *FOR {variable} = {starting value} to {ending value} DO*
> > *Statement 1*
> > *Statement 2* ——— *loop body*
> > *................*
> *NEXT {variable}*

A group of statements between the looping structures is called the **loop body** and is the one that is repeatedly executed.
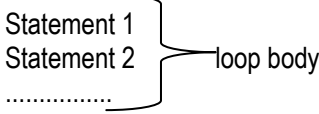
The **For...Next** loop is appropriate when the number of repetitions is known well in advance, e.g. five times. An example of a program that uses the **For...Next** loop is as follows:

> *Sum, Average = 0*
> *FOR I = 1 to 5 DO*
> > *Enter Number*
> > *Sum = Sum + number*
> *NEXT I*
> *Average = Sum/5*
> *Display Sum, Average*
> *End*

b. Repeat...Until Structure: This is a looping structure that repeatedly executes the loop body when the condition set is FALSE until it becomes TRUE. The number of repetitions may not be known in advance and the loop body is executed at least once. The syntax is as follows:

> **Repeat**
> > Statement 1
> > Statement 2 } loop body
> > ....
> **Until {Condition}**

For example

> *Sum, Average, Count = 0*
> *Repeat*
> *Enter Number (999 to end)*
> *Sum = Sum + Number*
> *Count = count + 1*
> *Until Number = 999*
> *Average = Sum / count*
> *Print Sum, count, Average*
> *End*

In the above program:
- **Count** records the number of times the loop body executes.
- 999 is used to stop further data entry through the keyboard and thereby ending the loop. Such a value that stops further data entry through the keyboard thereby terminating a loop is called a **Rogue value or sentinel**.
- The condition here is {**Number = 999**}. The loop exits when the number 999 is entered. If 999 is part of the number to be entered in this program, then the user has to split it into two numbers, that is 999 = 990 + 9, therefore can be entered separately as 990 and 9.
- A flag is also used to control the loop. In this case 999 is also a flag.

NB. As for the Repeat...Until loop, the condition is tested after the loop body has been run at least once, even when the condition is true from start. This is rather misleading.

c. While ... Do Statement: A looping structure in which the loop body is repeatedly executed when the condition set is TRUE until it becomes FALSE. It is used when the number of repetitions is not known in advance. The condition set is tested first before execution of the loop body. Therefore the loop body may not be executed at all if the condition set is FALSE from start. The syntax of the WHILE…ENDWHILE structure is as follows:

WHILE {condition}

Statement 1
Statement 2 } loop body
....
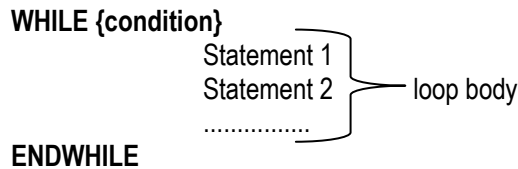
ENDWHILE

An example of the program is as follows:

Sum, Count, Average = 0
WHILE Count < 6 DO
Enter Number
Sum = Sum + number
Count = count + 1
ENDWHILE
Average = Sum/count
Display sum, count, average
END
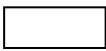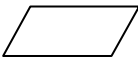
The word **WEND** can be used to replace the word **ENDWHILE** in some structures and therefore is acceptable. The word **Do, after the condition** is optional.

<u>**Differences between the Repeat...Until and the While…ENDWHILE structures**</u>

	Repeat Until Loop	**While Endwhile Loop**
1	Loop body is executed when the condition set is FALSE until it becomes TRUE	Loop body is executed when the condition set is TRUE until it becomes FALSE
2	Loop body is executed at least once	Loop body may not be executed at all
3	Condition is tested well after execution of loop body	Condition is tested before execution of loop body

<u>**c. Flowcharts**</u>

It is a diagram used to give details on how programs and procedures are executed. Flowcharts are drawn using specific symbols, each with its own meaning, as given below:

Symbol	**Explanation**
Process Symbol	- Indicates where some form of processing occur
Arrow ⟶	-Shows directional flow of data (data flow symbol)
Input /output	- Parallelogram in shape. Indicates where data is entered and output form, either screen display or printout.
Terminal	- Oval in shape. Indicate the start and stop of a program. Therefore it is written either Start/Begin/Stop/End.
Connector	- Circular in shape. Denotes the start and end of a subroutine. Nothing should be written inside it.
Pre-defined process	Indicates a module/subprogram/procedure inside another program
Decision	Represents a selection stage. Often used where a condition is, especially in repetition and selection structures.

Illustrations of flowcharts for programs
1. Using Simple Sequence Structure

Flowchart equivalent to the pseudocode on the right
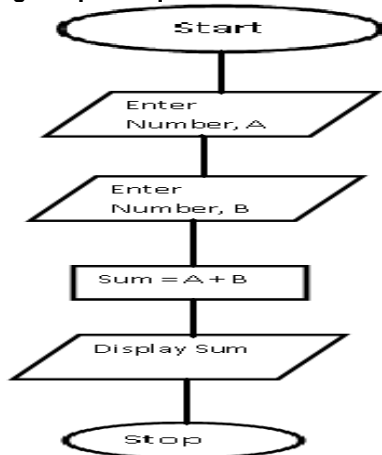
Start

Enter number, A

Enter number, B

Sum = A + B

Display Sum

Stop

Pseudocode for the flowchart on the left:

2. Using Selection Structure
Flowchart
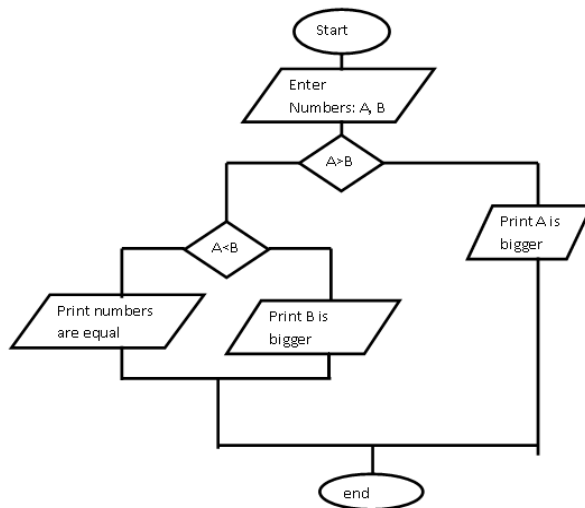
Pseudocode equivalent

Enter first Number, A
Enter second number, B
IF A>B THEN
    Print A is bigger
ELSE
IF A<B THEN
    Print B is bigger
ELSE
    Print Numbers are equal
ENDIF
ENDIF
END

3. Using Iteration
(a) Repeat ... Until Structure
Flowchart
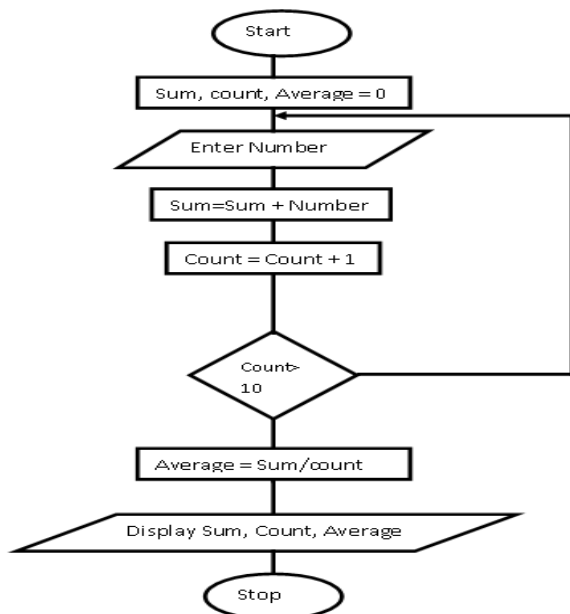
Pseudocode equivalent
Sum, Average, Count = 0

Repeat

Enter Number

Sum = Sum + Number

Count = count + 1

Until Count > 10

Average = Sum / count

Display Sum, count, Average

End

b) WHILE...WEND Structure and the FOR...TO...NEXT Loop

Flowchart	**Pseudocode equivalent**

Sum, Average, Count = 0

WHILE *Count <=10*

Enter Number

Sum = Sum + Number

Count = count + 1

WEND

Average = Sum / count

Display Sum, count, Average

END
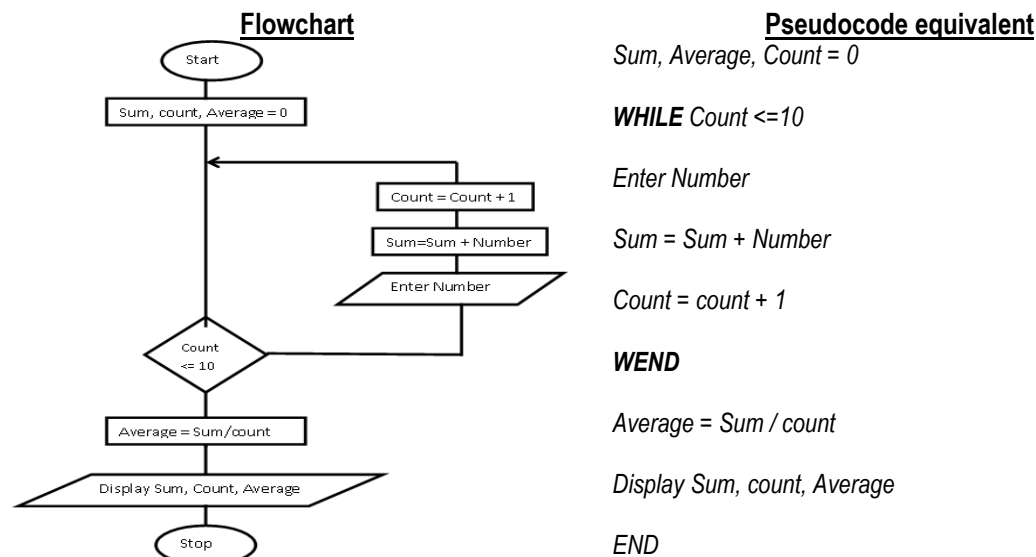
Use of the Pre-defined Symbol and the connector

This is used when drawing flowcharts of subprograms as given below.

Start Module Accept Numbers

Enter First Number, A

Enter Second Number, B

Enter Third Number, C

End Module

a. Flowchart for whole program	*b. Flowchart for module Accept Numbers*	*c. Pseudocode for module Accept Numbers*
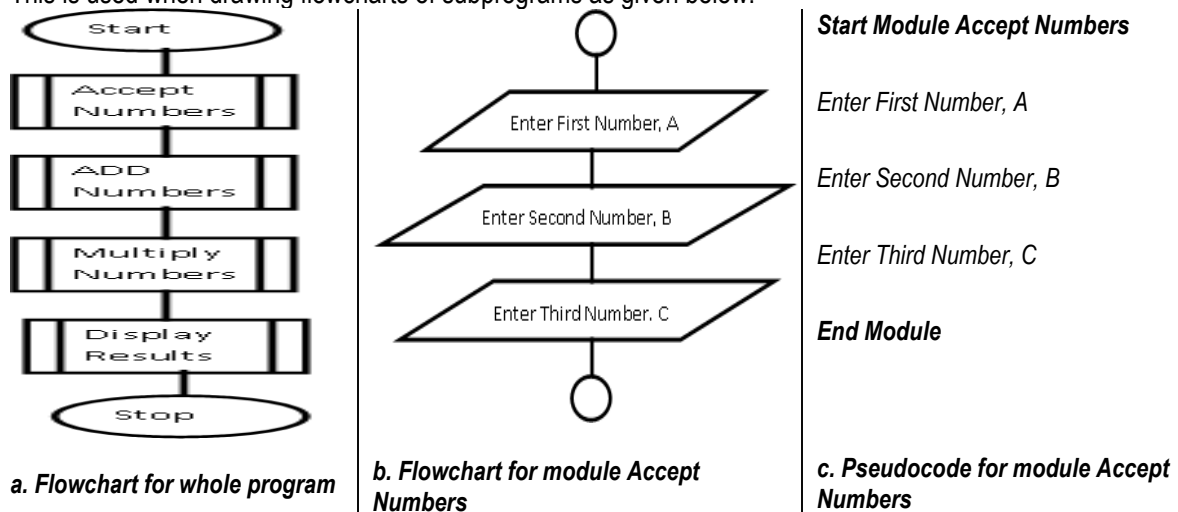
Flowchart (a) above indicates modules named Accept Numbers, Add numbers Multiply Numbers and Display Results. Flowcharts for individual modules can then be designed as given in diagram (b) above, only the first module is indicated. **Can you do the rest**?

d. Structure Diagrams: These are diagrams that show relationships between different modules as given below.

Start

Sum, Product = 0

Enter First Number, A

Enter Second Number, B

Sum = A + B

*Product = A * B*

Display Sum, Product

End
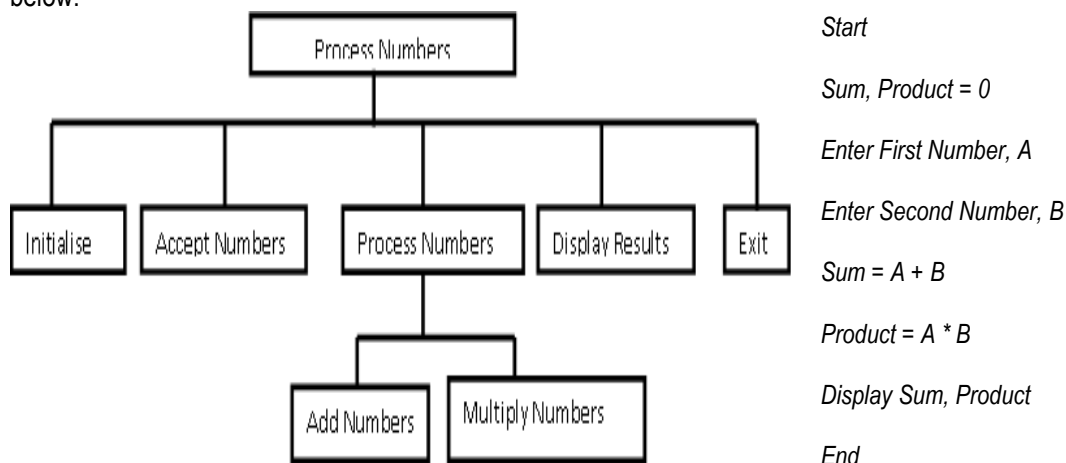
The structure diagram above indicates five sub-programs of the program Process Numbers, namely Initialise, Accept Numbers, Process Numbers, Display Results and Exit. The module Process Numbers has its own sub-programs, which are Add Numbers and Multiply Numbers. Modules are appropriate for very large programs. Can you write pseudocode for individual modules? The program can be written as a continuous single program as indicated on the right side of the diagram.

INTERPRETING AND TESTING PROGRAMS

Dry running (desk checking): the process of manually testing the logic of a program on paper before coding on the computer. Dry running is done to determine the logic of a program (to check if it gives intended results.)

Debugging: The process of finding and correcting errors in a program. Bugs are errors in a program. A debugger is a program used in aiding the finding and removal of errors in a program.

PROGRAMMING ERRORS

Programming errors are grouped into:

i. Syntax error: this is an error of violating the grammatical rules governing sentence construction in a certain programming language, for example, leaving a semi-colon at the end of each line in Pascal. Syntax errors are detected by the computer. A program cannot run with syntax errors.

ii. Logic error (Semantic error): refers to an error in the sequencing of instructions, modules and specifying wrong formulae that will produce undesirable results. For example, instructing the computer to display result before any processing has been done. Logic errors cannot be detected by the computer. The user just finds wrong and unintended results of a process. It is also an error generated by entering the wrong data type during program execution, for example, entering a text value where a numeric value is needed.

iii. Runtime (execution) error: These are errors that occur during program execution and can be generated when the computer tries to read past an end of file marker or by dividing a number by zero.

DATA TESTING

After a program has been coded, it must be tested with different data types to determine if intended results are produced. The types of test data that can be used include:

i. Extreme Data: Refers to the minimum and the maximum values in a given range. For example, a computer program requires the user to enter any number from (between) 1 to 20. 1 and 20 are extreme data and the computer must accept these. Thus extreme data is accepted by the computer.

ii. Standard (normal) Data: This refers to data that lies within (in-between) a given range. In our example above, the numbers from 2 to 19 are standard data and are accepted by the computer.

iii. Abnormal Data: This refers to data outside a given range. As to our example above, the number 0, -1, -50 and all number from 21 and above are abnormal data.

iv. Valid data: refers to data of the correct data type. Invalid data is data of the wrong data type. Thus if the user enter the value "Tungamirai" instead of a number, this is referred to as a wrong (invalid) data type. Only numbers are needed, not text.

PROGRAM TESTING

A very large program must be tested using the following types of tests:

Unit testing: the process of testing each program unit singly to determine if it produces expected results.

System testing: the testing of the whole program after joining the modules to determine if it runs perfectly.

Integration Testing: testing to see if modules can combine with each other.

User acceptance testing: determining if users of the new system are prepared to use it.

SYSTEMS ANALYSIS AND DESIGN

This is a process of identifying problems of an existing system and finding the best solution to such a problem.

System: A groups of elements working together to achieve a common goal. Systems are of two types:

Physical system: refers to tangible systems like schools, firm, shop, etc

Conceptual systems: these exist in mind or paper and cannot be touched. They just represent a physical system.

This chapter is concerned with the development and maintenance of system like stock control, patient monitoring, banking and payroll which are part of physical systems.

The systems analyst

This is a person who identifies problems of the existing system and recommends the best solution to such a problem. The duties of a systems analyst are:

Identifies the problems of the current system. Liaises with system users and determine their requirements. Finds out facts important to the design of the new system. Determines the human and computer procedures that will make up the system. Participates in the process of system implementation.

By performing such duties the systems analyst acts as:
   i.   **A consultant**: can be called or hired to identify problems in a system
   ii. **A supporting expert**: draws together professional expertise concerning computer hardware and software and their uses in business.
   iii. **An agent of change**: bring new ideas into the organisation

Qualities of a systems analyst

Must have good oral and written communication skills for all managerial levels of an organisation. Must be able to work as a team. Must be well educated, with at least a degree. Must be well experienced in computers and at top managerial levels. Must have good managerial skills. Must be a problem solver and see problems as challenges. Must be self motivated. Must be well disciplined. Must be able to work under pressure and meet deadlines.

INITIATION (ORIGINATION) OF SYSTEMS ANALYSIS

Changes to a system can be triggered by many factors, some of which are:

i. System users: they may be dissatisfied with the current system since they are the ones who operate it. They will the sent requests to have a new system or some modification to the existing one.

ii. Top management: they may issue directives in order to meet new organisational objectives. It can also be due to change in management (new manager), new requirements, etc.

iii. The need for improved operating efficiency: Errors in the existing systems may be intolerable, especially to customers.

iv. Changes in technology: new hardware and software may force organisations to change their ways of operation.

v. Change of government policies: new government laws and policies can force organisations to change their systems

vi. The user can change his mind

SYSTEMS DEVELOPMENT LIFE CYCLE (SDLC)

This refers to the stages through which a system develops from 'birth' to 'death'. That is from the moment the system is incepted until it is modified or replaced with a new one. The stages, in their order, include Problem identification, feasibility study, analysis, design, implementation, conversion and then maintenance. Below is a diagram that indicates the SDLC stages.
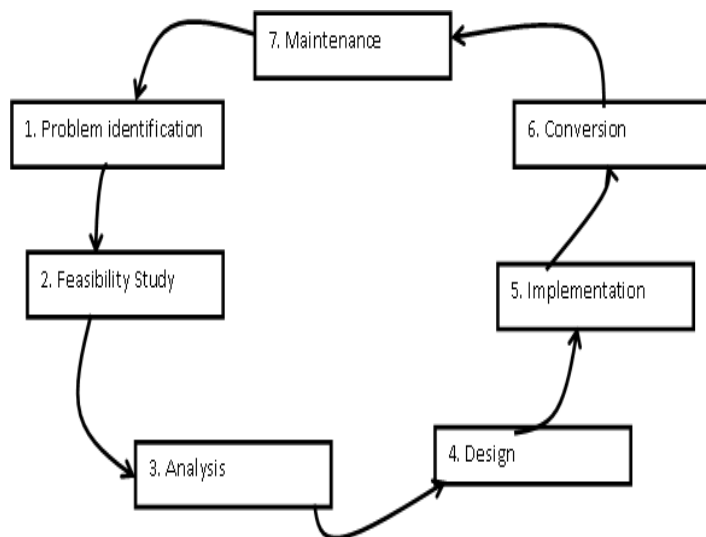
The diagram on the left shows seven stages can be compressed to give five stages, which are:

1. Investigation,

2. Analysis,

3. Design,

4. Conversion,

5. Maintenance (review / evaluation)

Below is an explanation of each of the stages listed above:

1. Problem identification/Recognition/Definition/Realisation:
This refers to the realisation of the need for a new system by managers or users. This includes the general statement of the problems being experienced by they system.

2. Feasibility Study:
This is a preliminary investigation conducted to determine if there is need for a new system or modification of the existing one. It involves evaluation of systems requests from users and to determine if it is feasible to construct a new one. Feasibility can be measured by its:

Economic feasibility: determining whether the benefits of the new system will out-weigh the estimated cost involved in developing, purchasing, installing and maintenance of the new system. The cost benefits analysis is important. Benefits can be tangible and quantifiable, e.g. profits in terms of monetary values, fewer processing errors, increased production, increased response time, etc. Other benefits are intangible, e.g. improved customer goodwill, employee moral, job satisfaction, better service to the community, etc.

Technical feasibility: determines if the organisation can obtain software, equipment and personnel to develop, install and operate the system.

Social feasibility: a measure of the system's acceptance by the general public; if it will not violet the norms and values of the society.

After carrying out the feasibility study, a feasibility study report must be produced and it contains the following information:

A brief description of the business. Advantages and problems of the existing system. Objectives of the new system. Evaluation of the alternative solutions. Development timetable. Management summary. Terms of reference. Contents page. Title page. Proposed solution. Appendices.

Data Collection Procedures
Systems investigation is also carried out to find information on the system. The fact finding methods that can be used include: interviews, record inspection, questionnaire, observations, etc. Terms used in data gathering include:

a. Interviewer: The person who asks questions in order to solicit information

b. Interviewee (respondent): interviewee is a person who is asked questions and is expected to give information to the interviewer.

c. Population: The average number of people in an area where a research is to be carried out.

d. Sample: Fraction of the population who actually take part in the research.

i. Interview:
This refers to the face-to-face communication between two or more people in order to obtain information. Interviews can also be done over the phone but the most common ones are face to face. Interviews are done when you want to collect information from a very small population sample.

Advantages of Interviews
The researcher can ask for clarification on some points that may not be clear. Encourages good rapport between the researcher and the respondent. Non-verbal gestures like facial expressions can help the researcher to determine if the respondent is telling the truth. Information can be collected even from the

illiterate since the respondent's language could be used. First hand information is collected. The researcher can probe to get more information.

Disadvantages of Interviews

It is expensive since the researcher has to travel to the interview venue. It is time consuming as more time is spent travelling and carrying out the interview. Good interview techniques are required as failure may lead to disappointments. Biased information can be given since the respondent may not tell the truth.

ii. Record inspection:

A fact finding method which involves scrutinising system documents in order to solicit information. Record inspection has the following advantages:

Accurate information is collected from system records. First hand information is obtained

Disadvantages of record inspection

It is time consuming to go through all system records. Manual files can be tiresome to go through and some of the data may be illegible. Confidential files are not given to the researcher

iii. Questionnaire:

A document with carefully crafted questions to be answered by the respondent by filling on the spaces provided. Questionnaires are used when collecting information from a widely spaced population sample and when collecting information from many people. A questionnaire contains open-ended and closed questions. Open-ended questions are gap filling questions which require the respondent to express his or her own view. Closed questions are guided questions where the respondent just chooses Yes or No, True or False, or by just putting a tick on given options. Questionnaires can be distributed personally or by post.

Advantages of questionnaires

Questions are very simple to answer. It saves time as questionnaires can be distributes and then collected later. Respondents can fill questionnaires at their own pace. Give guarantees confidential of information, thereby encouraging respondents to give accurate information. They are cheap to use as travel expense can be low

Disadvantages of questionnaires

Some questions are left blank. Some questionnaires may not be returned. Biased information can be collected. Respondents usually do not fill the correct information. It is difficult to analyse information collect using questionnaires. They are expensive to use if the postal system is used. Abusive information can be filled by respondents.

iv. Observations:

It is a fact finding method that involves viewing the actual system in operation by the researcher. The researcher can even take part in operating the system. It is used when the researcher wants to see for himself how the system operates.

Advantages of observations

First hand information is collected. Accurate information can be obtained. Areas of interest can be observed. The researcher can take part in operating the system thereby getting insight on how the system operates.

Disadvantages of observations
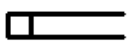
People work differently if they feel that they are being observed, therefore inaccurate information can be collected. The researcher may not understand some of the activities being observed. It is time consuming to collect the required information. The researcher may interrupt some of the activities being done.

3. The analysis stage:

This is the in-depth study of the system to determine how data flows within the system. It involves use of flowcharts, data flow diagrams, structure diagrams and others, to describe the operations of the system. The analysis stage determines whether computerisation will take place or not. The analysis stage also specifies the hardware and software requirements.

Dataflow Diagrams

These are diagrams that show how data moves between external sources, through processes and data stores of a particular system. Dataflow diagrams use the following symbols:

Symbol		Explanation
Process Symbol		- Indicates where some form of processing occur
File Storage		- Shows data storage in a file
Arrow		-Shows directional flow of data
Entity		- Shows an external source or destination of data for the system
Predefined Process		- Shows a predefined process, like sorting of data.

4. Design Stage:

This stage is concerned with the development of the new computer based solution as specified by the analysis stage. Design stage involves:

Input Design: includes designing of data entry forms, input methods (e.g. by filling forms, use of barcodes, etc) and the user interface.

Output Design: Includes design of reports, data output formats, screen displays and other printed documents like receipts, etc

File design: Involves designing tables/files, records and validation rules. It also involves determining how data is to be stored and accessed, the media to be used for storage and the mode of file organisation. Fields in each files ca be designed, their length and data type, e.g.

> **File Name**: Student File
> **Storage Location**: Hard Disk
> **Mode of Access**: Direct/Random

File Structure:

Field name	Data type	Length	Example
Surname	Alphabetic	20	Kapondeni
First name	Alphabetic	20	Tungamirai
Date of birth	Date	8	07/02/78
Class	Text	2	3A
Student number	String	7	0098/99

It also involves specifying how data is to be sorted and updated.

Program Design: Involves design of systems flowcharts, structure diagrams, dataflow diagrams, algorithms, etc. **Selection of appropriate hardware**: Specify the input hardware, output hardware, processing hardware and speed, storage media, RAM size, etc. **Selection of appropriate software**: specifying the type of operating system, programming language or database package and other application packages to be used. Design of test plan and strategy, Design of the user manual, Design of the technical documentation

5. Implementation Stage:

This involves the construction and assembling of the technical components that are needed for the new system to operate. This includes preparation of the computer room environment, coding of the computer program using a specific programming language, testing of the coded program, user training (users are trained on how to enter data, search records, edit fields, produce reports, etc), etc.

Ergonomics: the design and functionality of the computer environment and includes furniture setup, ventilation, security, space, noise, etc. some of the ergonomic concerns include:
Incorrect positioning of the computer facing the window can lead to eyestrain from screen glare. Incorrect sitting positioning can lead to backache. Constant typing with inadequate breaks can lead to RSI. Printer noise can lead to stress. Badly designed software can cause stress. Trailing electricity cables are a safety hazard.

6. Conversion (Installation/Changeover) Stage:

This involves putting the new computer system into operation, that is, changing from the old system to the new one. It involves file conversion, which is the changing of old data files into the current format. Different changeover methods can be used, and these include:

a. Parallel Run: This involves using of both the old and new system concurrently until the new system proves to be efficient. It involves operating the new and old systems simultaneously until management is confident that the new system will perform satisfactorily. Other workers will be using the old system while others use the old system but doing the same type of job.

Advantages of parallel run

Results for both systems are compared for accuracy and consistency. If the new system develops problems, it will be easier to revert to the old one. There is enough time given to determine if the new system produces expected results. Employees have enough time to familiarise with the new system.

Disadvantages of Parallel run

Running two systems at the same time is very expensive. Running two systems simultaneously is demanding to employees. It may be difficult to reach a decision when comparing the two systems. There is duplication of tasks which in turn stresses employees

ii. Abrupt (Direct) changeover: Involves stopping using the old system on a certain day and the new system takes over on the next morning. This is suitable for control systems like in chemical plants and for traffic lights.

Advantages of Direct Changeover

Reduces cost as of running two systems at the same time. Faster and more efficient to implement. There is minimum duplication of tasks. Enough resources can be allocated to make sure that the new system operates successfully.

Disadvantages of Direct Changeover

It will be difficult to revert to the old system if the new system fails.

iii. Phased / Partial conversion: This is whereby the old system is gradually removed while the new system is gradually moved in at the same time. This can be done by computerising only one department in an organisation this month, then the next department in two months time, and so on until the whole system is computerised.

Advantages of phased conversion

Avoids the risk of system failure. Saves costs since the new system is applied in phases. It could be easier to revert to the old system if the new system fails since only one department will be affected.

Disadvantages of phased conversion

It could be very expensive since the organisation will be running two systems but in different departments.

iv. Pilot conversion: This is whereby a program is tested in one organisation (or department), and is applied to the whole organisation if it passes the pilot stage. It serves as a model for other departments. A pilot program can then be applied in phases, directly or using the parallel run method.

7. Maintenance/review/evaluation Stage:

This stage is concerned with making upgrades and repairs to an already existing system. Certain sections of the system will be modified with time.

Employee resistance: When a new system is introduced, some employees may resist the change and this could be catastrophic if not handled appropriately. Some fear losing their jobs, of being demoted or being transferred and change of their job description. Resistance can be in the following forms:

Through strikes and demonstrations. Giving false information during system investigation. Entering wrong and inappropriate data so that wrong results are produces, etc

User training:

Once a new system is put in place, existing employees are trained on how to operate the new system, otherwise new employees are recruited. User training can be in the following forms:

i. On the job training: Users are trained at their organisation by hired trainers. This has the following advantages:

Learners practice with actual equipment and the environment of the job. Learners can engage in productive practices while on training. This is cheaper for the organisation. Enough practice is gained on how to operate the system.

Disadvantages of on the job training

Distractions occur in a noisy office. Instructional methods are often poor. The need to keep up output may lead to hasty teaching

ii. Classroom training: Users are send to other colleges and institutions which offer courses on the subject matter. This could be expensive to organisations since employees take study leave while being paid at the same time. Employees can also be trained on aspects that they will not apply when they finish the course. The gap between what is learnt and what is needed at the job may be too wide.

SYSTEM DOCUMENTATION
Documentation refers to the careful and disciplined recording of information on the development, operation and maintenance of a system. Documentation is in two main types: user documentation and technical documentation

(a) User Documentation: It is a manual that guides system users on how to load, operate, navigate and exit a program (system). User documentation contains the following:
System/program name. Storage location. System password. Instruction on how to install the program.
instruction on how to operate the system: loading, searching data, adding new records, deleting unwanted records, modifying existing records, saving data, backup procedures, etc. How to quit the program

(b) Technical Documentation: This is a manual for programmers which aid them in modifying the system and in correcting program errors. The following are found in technical documentation:
Algorithms of the program, Program testing procedures and test data, Sample of expected system results, Program structure showing modules and their relationships, System flowcharts, Programming language used, Program code, program listings, File structures.

DATA ENTRY ERRORS

Data can be entered incorrectly into the computer and this can have the following effects:

- A company can be prosecuted under the Data Protection Act if incorrect information causes a person or organisation some loss.
- Wrong decisions can be made by managers due to wrong information given.
- Customers may be angry if they are sent wrong bills.

Types Of Errors

1. Transcription Errors: These are mistakes due to misreading or mistyping of data, e.g., confusing the number 5 with the letter S, 0 (zero) instead of the letter O, etc. This can also be caused by bad handwriting.

2. Transposition Errors: These are mistakes caused by swapping 2 letters or digits, e.g. typing 'ot' instead of 'to', 5721 instead of 7521. Transposition errors occur mostly when typing at very high speeds.

Avoiding Data Entry Errors

The following procedures can be used to avoid / reduce data entry errors:

1. Verification: Involves checking that what is in the computer is similar to what is on the input document (Proof reading). Verification is done manually by the user of the computer. Verification is carried out to determine errors that cannot be detected by the computer.

2. Validation: A process of detecting if data entered is valid, correct, complete, sensible and reasonable. For instance the height of a person entered as 12 metres is incorrect, not sensible, neither is it reasonable, and therefore the computer should reject this. Validation is done by the computer.

Types Of Validation Checks On Data

(a) Character type (Data type) checks: A validation check for detecting if the correct characters have been entered, for example can detect and reject alphabetic letters where numbers are needed. Data types include numbers, bytes, dates, text, alphabetic, alphanumeric, etc and each is to be entered where appropriate.

(b) Range Checks: Are validation checks performed on numbers to make sure they lie in a specified range. For example, you are required to enter a number between 5 and 20, and you enter 51, the computer should automatically reject this since it lies outside the required range.

(c) Presence checks: These are validation checks for determining if certain key data items have been entered in databases, for example, fields that should not be left without data like Surname for student databases. The computer does not allow the user to continue until an entry has been made.

(d) Length checks: These are validation checks used to determine if data entered is of the required number of characters. For example, if a student number has 5 digits, the computer should reject if a number with 4 or less digits or even more digits is entered.

(e) Spell Checkers: These are validation checks that determine if accurate text has been entered especially in word processing. Spell checkers use custom dictionaries to check spelling mistakes in documents. If a word is typed in, it is checked if it is in the custom dictionary, if not, it is treated as an error. Spell checkers cannot be used in case of names of people, places, computer jargon, new slang words, etc.

(f) Check Sum: A validation check of adding together the bits in a byte to give a number that will be transmitted together with the data. It is used to check whether errors have occurred in transmission or storage.

(g) Parity Bits: A parity bit is an extra bit (1 or 0) that is used in checking for errors in a group of bits transferred within or between computers. Parity bits are appended to the left of a byte to make it even or odd depending on the method of parity checking. Parity bits are also used to determine if a block of data has been correctly transmitted over a communication channel. It works in the following way:

Using Odd Parity: The letter C is transmitted as **1000011**. Since there are three 1s in this byte, a 0 is added to the left so that the total for 1s is odd, thus making it **01000011.** The first 0 (underlined) is used as the parity bit.

Using even parity: In even parity, a 1 would be appended to the left of the byte so that the total number of ones is even, thus making it **1 1000011**

(h) Check Digits: A check digit is an extra figure added to the end of an original number for error checking purposes. It s calculated from the original number.

*NB: - Check digits are used where data entered automatically as in using barcode readers.

Calculating Check Digits

Using the Modulus 11 method: Suppose a product number has been entered as: **1512113239**; the following procedures will be used.

The computer removes the last digit, 9, so that it is left with the number **151211323**.

We now have 9 digits. Working from the right, the first digit is multiplied by 2, second number by 3, third number by 4 and so on. The results are added together, e.g.
(1x10) + (5x9) + (1x8) + (2x7) + (1x6) + (1x5) + (3x4) + (2x3) + (3x2) = 112
The total (112) is divided by 11 and the remainder is noted; e.g., 112 divided by 11 = 10 remainder 2.
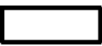The remainder is subtracted from 11 to give the check digit: 11 – 2 = 9
Therefore the number will be transmitted as **1512113239**
*NB: -   (1) If the check digit found is 10, an X is used as the check digit.
**(2) Check digits are used to detect where digits have been swapped.**
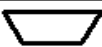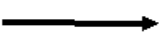
SYSTEMS FLOWCHARTS
A systems flowchart is a diagram used to show the flow of data in a program. It shows the overview of the system, tasks carried out by the system, whether manual or computer, devices, output media and files used. Common symbols for designing systems flowcharts are as follows:

Symbol	Explanation
Process Symbol	- Indicates where some form of processing occur
Document	- Indicates a printed document
Display	- Indicates screen display
Manual input	- Indicates a manual input method, for example through keyboard
Manual Operation	- Indicates where manual operations occur
Offline storage	- Indicates where data is stored offline
Magnetic Tape	- Indicates file storage on a magnetic tape
Disk Storage	- Shows data storage on a magnetic disk, like hard disk.
Arrow	-Shows directional flow of data
Sorting	- Indicates a stage where data is being sorted
Punched tape	- Indicates storage on a punched tape
Internal Storage	- Indicates data storage on internal storage, e.g. RAM or ROM
Multi-document	- Indicates where a number of documents are involved
Card	- Shows data on card
Direct Storage	- Shows data storage on any direct storage device
Communication line	- Indicates communication line like telephone, wireless communications, etc
Data	- Indicates where data is entered.

*NB: Meanings of these symbols are not universal and mean a different thing to others. Some symbols are borrowed from program flowcharts.

Below is a systems flowchart for a payroll processing system that uses batch processing
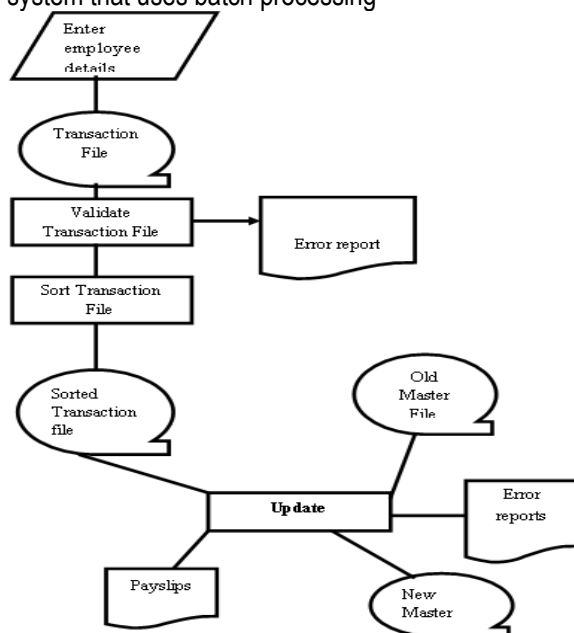
Below is a systems flowchart that is used to update a stock master file when stock items are purchased.
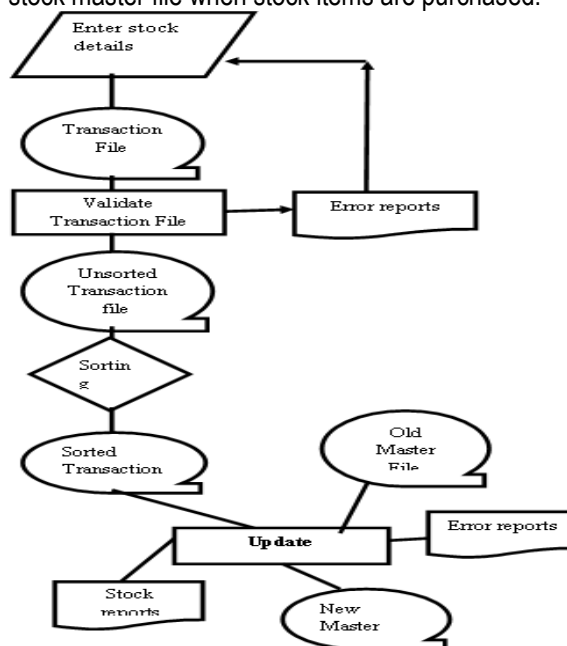
PAPER 2 (PROJECTS)

1. Statement of the problem: Limitations of the existing manual solution should be considered. These must be realistic and should justify computerisation. At least six problems should be cited. Each problem must be expanded or must be clear and should be solved using the computer. The problem can just be listed and then briefly explained how it affects the current solution. If the system is said to be expensive to run, pupils are supposed to give the statistics of the costs of running the system over a given period of time. If the system is slow to serve clients or to run, the number of minutes or hours must be specified so as to give clarity. Pupils should avoid vague points like "too slow, expensive to run, slow to update records, difficult to update records" etc. These problems must be clear, qualified, quantified and justifiable.

2. Aims and objectives: Good objectives must be cited and these must be achievable and measurable. A list of the desired outcomes of the proposed solution is needed: what will the proposed computer system be able to do? For instance; what should it be able to enter, what will have to be processed, what will need to be updated (that is addition, deletions and editing of which records), what form of reports will need printing? The objectives must link with the above stated problems. Include at least 6 objectives.

3. Data flow in existing solution: What data items are used in the existing solution? Identify all the data items for each file used in the system. Pupils can just give a file and the data items found in it. For example:
Client File: Client Surname, Client First Name, Client ID Number, Client Address, Item Bought, Quantity bought, Unit price, Total Price, Date of purchase, etc.
All data items in each file must be exhausted.

4. Description of the existing Solution: A broad description of the processes that take place in the existing system must be given. Pupils must describe how the system works, taking into consideration the data items cited in 3 above. Explain how each file is processed and what it is used for. At least 6 files must be described. There is no need of drawing data flow diagrams if the pupil can describe the processes involved. Pupils can even attach system forms of the current system being investigated and put them in appendices.

5. Evaluation of the existing solution: A good evaluation should assess both sides, the weaknesses and the strengths, and not just one side. Pupils should give 6 advantages and more disadvantages for the existing solution. A good evaluation should be able to qualify and quantify the limitations and strengths. Statements like: "it is too slow", "it is expensive", "it is inefficient" are not enough. Pupils must specify how slow is being too slow, how expensive is expensive, how inefficient is being inefficient. For instance they could specify the number of minutes, amount of expensiveness in $ amount, etc, so as to clarify the point.

6. Evaluation of the alternative solution: An alternative solution is the one that can be used to solve current problems. This could not be the current solution nor the candidate's proposed solution but other solutions. At least two solutions must be given and evaluated. Pupils are expected to list the alternative solution, briefly describe how it will be operated before giving it weaknesses and strengths. At least 6 advantages and more disadvantages are to be cited and clarified for each solution.

7. Overall Plan: This is the candidate's plan to realise the proposed computer solution. Normally a modular approach in a top-down structure is considered. The problem is split into modules in a tree structure. Tables (files) or forms could be taken as the modules. Pupils are supposed to indicate files. This can be given as shown below:
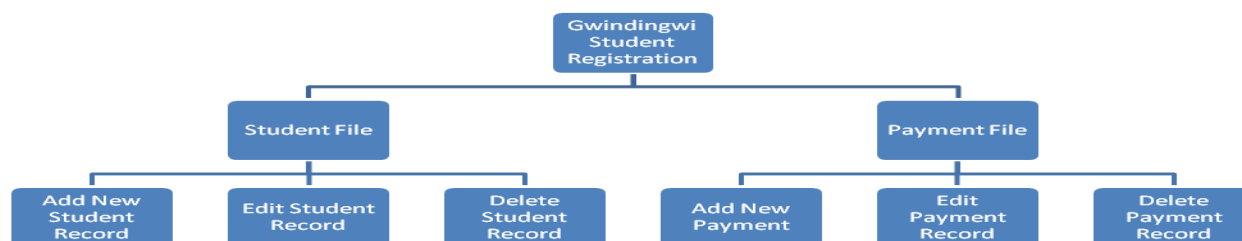
*NB: The above is just a sample and is incomplete. All files in the system must be included in the hierarchy chart. After the hierarchy chart given above, a systems flowchart will suffice.

8. Modules: Student should identify the modules to be used in the system. And give a valid linkage in the system. This can be obtained from the overall plan. This can be given as shown below:
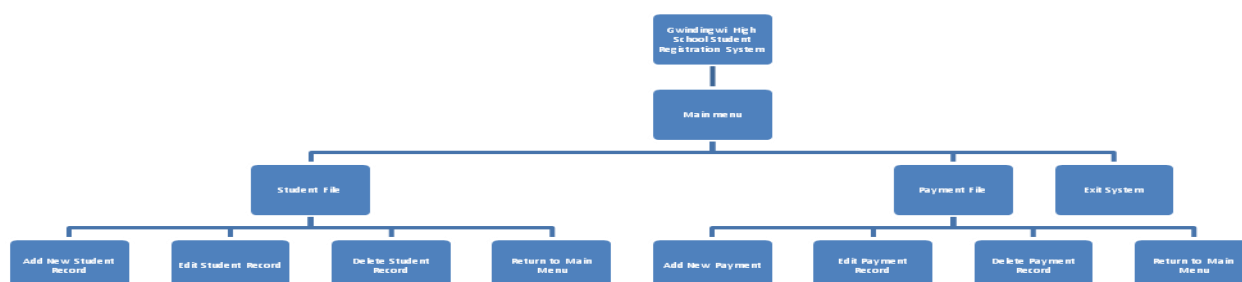
Linkages within the system must be clear. Instead of given a diagram as above, the modules can be given as below:
Module Name: Student File Module
Module Purpose:……..
Modules Called:…….
Modules Called from: ……
9. Algorithms: Annotated flowchart and Pseudocodes are acceptable. Good algorithms should be valid, clear, logical and plausible. Each algorithm should be clearly related to the system requirements. An explanation of the purpose of each module should be given first before the algorithm is written. For example:
Algorithm Name: Add New Student Record
Purpose: Responsible for accepting new student details for students who are joining the school
Algorithm:…….
At least six modules and their algorithms should be cited and explained.

10. Hardware Requirements: A list of at least 2 hardware requirements should be cited for each of the following categories:
   - Input Hardware, Processing hardware, Storage device, Output hardware
Explain the use of each device in relation to the system being designed, what it will be used for. The listed devices should be in the scope of the project and student capability. For storage devices, pupil could further include the storage capacity and what it will be used to store in the system. Lastly, pupils should select the processor type appropriate and the reason why such a processor type and speed is needed.

11. Testing for standard and extreme data: Use a table format for this. Pupils can also include sample runs produced by the system. Avoid screen dumps but actual reports produced by the system. Only numeric data and dates is acceptable.

12. Test for Abnormal Data: Again a table format can be used to illustrate the abnormal data being tested. Actual data being entered in the system is considered, NOT menus and keystrokes. Error messages produced by the system must be included in the project.

13. User Documentation: This documentation should enable a novice to start-up the candidate's solution and to navigate through without further assistance. Include how to install the program, software compatible, etc.

14. Sample runs: A lot of sample runs (reports) produced from different files must be printed and attached. Screen dumps are not acceptable. At least 6 report generated from different files are needed.

15. Technical Documentation: This includes program listing, algorithms, modules, data dictionary, program comments and file structures. At least four items of the above listed should be included.

16. Evaluation of the solution: The weaknesses and strengths of the newly designed computer solution must be cited. At least eight strengths and six weaknesses must be given. The strengths must be able to solve the problems cited in the earlier stages (stage 1). More advantages must be given other than the disadvantages.

17. Opportunities for development: Possible improvements to the system must be given and clarified. These improvements must be in the scope of the system and the student's capability. Do not entertain fancy ideas that are beyond the student's capability.

*NB:

1. The documented project for the student must be accompanied by a working disk that is virus free.

2. Your system should have the following features:

      - Should have menus

      - Should be able to sort records

      - Should be able to search records (queries and filters are acceptable)