Q.1 What is Computer? Explain its Characteristics and Limitations?
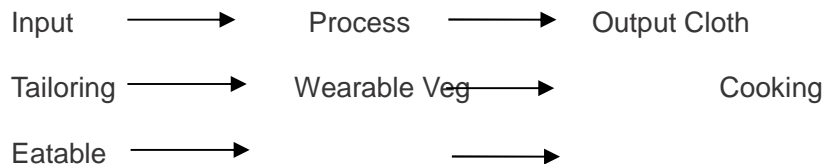
Ans. Definition :– A computer is a fast electronic device, processing the Input data according to the Instructions given by the Programmer/User and provides the desired information as an output.

The word 'Computer' is basically derived form the word 'computer', which means to calculate some thing. But in today's scenario if we told that computer is just a calculation machine, it is not true. We can do a lot more than calculation. Let's take few examples — Your Bio-Data, Examination Records, Admission Register, Airlines and Rail Reservation etc. In all these cases you will find apart form just calculation the computer is managing information and data. So, Computer is electronic devices (Machine) which accept our data, process them and gave output.

Input	⟶	Process	⟶	Output Cloth
Tailoring	⟶	Wearable Veg	⟶	Cooking
Eatable	⟶		⟶	

Terminology used in Definition of Computer :–

Ø Data :– Collection of facts or figures.
Ø Information :– Processed data is known Information. Data and
Ø Input :– instructions given to computer. Manipulation of
Ø Process :– data.
Ø Output :– Information obtained after processing of data

Characteristics of Computer:-

(1)   Speed: - A computer is very fast device. It can perform large amount of work in a few seconds. Where human being worked a particular work for whole day, computer does the same in very short time. Today, computers can perform 100 million computations in one second. The speed of computers are measured in terms of microseconds, Nano seconds and even in Pico seconds.

Where 1 second=10^{-6} micro second

$$=10^{-9} \text{ nano second}$$

$$=10^{-12} \text{ Pico second}$$

(**2**)   **Accuracy :–** The computer is 100% accurate and capable to perform arithmetical calculation and logic operations with the same accuracy. It can never make mistakes. All mistakes are done by users. The cause of errors may be due to inaccurate feeding data or due to wrong setting of the programmer. The accuracy of a computer is Illustrated well by the term GIGO; i.e. Garbage In Garbage Out, which means if faulty instruction are provided for processing the data, obviously wrong answer will be given.

(3)   Diligence :– A computer can operate twenty four hours continuously without taking any rest. It has no feelings or no emotions, if you work continuously for 3 hours, you feel lack of concentrate but a computer is free from these and you will get the result you
want with the same speed and same accuracy.

(4)   Versatility :– Versatility is one of the most wonderful features about the computer.
One moment, it is preparing the results of a particular examination, the next moment it is busy in preparing electricity bills, and in between it may be helping an office secretary to trace an important letter is seconds. It can do multiple works at a same time.   It also used in data processing jobs, weather fore casting, ticket reservation purpose, multimedia designing, animations, accountancy etc.

(5)   High Memory :– computer   has made more memory or storage capacity than human beings. It can store millions of data and instructions, which can be retrieved and recalled even after a number of years. This is not possible in case of human brain.

(6)   Automation :–   Computers are automatic in operation. It means once the data and instructions are fed to a computer, human interventions are not required. The computers manipulate the data according to the instructions and continue doing so till the last instruction is executed.

(**7**)   **Superiority of Manufacture :–**   Computer hardware is manufactured with the best materials by the most sophisticated processor. It has superiority of manufacture as compared to other machines.

(8)   Reduce the Paper Work :–

(9) **Solve Complete Problems :–** Computer solved those problems which are not solved by human being computer solved the computer solved the problems in seconds.

Limitations of Computer:-

The main limitations of computers are as follows :–

Dependency :– Fully Dependent upon human beings.

Lack of Intelligence :– Computers do not have their own Intelligence and hence cannot think for example, a computer can create music but cannot tell its quality. In other words, computer has no brain.

Lack of Detecting Errors :– Computer can detect only syntax error, it cannot detect flaw or error in logic.

Lack of Capability :– It has no Capability to take any decision by itself, like a human being, it cannot judge by itself for any valid or non-valid data.

No I.Q. :– A computer is not a magical device. It can only perform tasks that a human being can. The difference is that it performs these tasks with unthinkable speed and accuracy. It possesses no intelligence of its own. It I.Q. is zero, at least today. A computer cannot take its own decision in this regard.

No Feelings :– Computers have no feelings and no emotion because they are machine.

Lack of Creativity and imagination :– It does not have intuition and cannot draw

conclusion without going through all the intermediate steps.

Experience :– Computers don't learn form experience.

Q. 2 What is Computer? What are various Applications of Computer?

<div align="center">Or</div>

What is Computer? What is the scope or impact of computer in business application?

Ans. Definition :– A computer is a fast electronic device, processing the Input data

according to the Instructions given by the Programmer/User and provides the desired information as an output.

<div align="center">Or</div>

The word 'Computer' is basically derived form the word 'computer', which means to calculate some thing. But in today's scenario if we told that computer is just a calculation machine, it is not true. We can do a lot more than calculation. Let's take few examples — Your Bio-Data, Examination Records, Admission Register, Airlines and Rail Reservation etc. In all these cases yo will find apart form just calculation the computer is managing information and data. So, Computer is electronic devices (Machine) which accept our data, process them and gave output.

Application of Computer in Business

Computers have completely altered the structure of business. Large volumes of accounting and record keeping data can be manipulated, organized, stored, retrieved and used for specific purposes. Bills and statements can be processed and sent to customers in much less time and much less effort than would be required for doing the same process manually financial projections is made with greater ease. Planning and decision making thus be cover more efficient and accurate.

In manufacturing industries, Computers direct production, guide machine tools, control quality design parts and monitor inventory levels. Modern banking would be impossible without computers. In modern officer, word processing saver time for people at all levels in organization and helps ensure more accurate letters, reports and memos.

Scope of Computers in Business offices : – (1)   Personal

Management
- Manpower Planning
- Human Resource Development
- Selection and Recruitment
- Compensation and benefits
- Skill Inventory Management
- Establishment and Personnel records
- Placement Modules
- Training and development
- Career Planning/Promotion

(2)   Financial Management
- Invoicing, Sales Ledgers and Statements
- Stock Control and Evaluations
- Payroll, Pay slips, Tax Statement
- Purchase Ledger
- Credit Control
- Sales and Purchase Ledger Analysis
- Budgetary Control
- Cost accounting, Job costs, Standard costs, Work in Progress, Labors registers
- Asset Registers
- Hire Purchase Records

(3)   Office Management
- Budget

- · Annual Reports
- · Production Schedules
- · Loan Analysis
- · Graphic Trends
- · Managing Reports, Directories, Catalog's, Bulletins, Letters, Memos

(4) Material Management
- · To Minimize Inventories
- · Material Planning/Specifications

(5) Purchasing Management
- · Calling Tenders
- · Comparing Tenders
- · Supplies Evaluation
- · Placing Orders/Recorders

(6) Marketing Management
- · Demand forecasting
- · Sales Management
- · Consumer behavior
- · Channels of Distribution
- · Pricing decisions
- · Market Research
- · Transport Analysis
- · Advertising Strategies
- · Product Mix
- · Planning and Control of sales

Q.3 What is Computer? Describe the functioning of computer with its block diagram?

Ans. Definition :– A computer is a fast electronic device, processing the Input data according to the Instructions given by the Programmer/User and provides the desired information as an output.

Or

The word 'Computer' is basically derived from the word 'compute', which means to calculate some thing. But in today's scenario if we told that computer is just a calculation

machine, it is not true. We can do a lot more than calculation. Let's take few examples – Your Bio-Data, Examination Records, Admission Register, Airlines and Rail Reservation etc. In all these cases you will find apart from just calculation the computer is managing information and data. So, Computer is electronic devices (machine) which accept our data, process them and gave output.

A computer System is defined as a set of interacting elements, responding to inputs so as to produce outputs. The computer system also consist of the following elements.

- ∨ Hardware
  - Ø C.P.U (Central Processing Unit)
  - Ø Input Devices
  - Ø Output Devices
  - Ø Storage Devices
- ∨ Software
  - Ø System Software
  - Ø Application Software
  - Ø Utility Software
- ∨ Humanware
  - Ø Trained Computer Professionals

Hardware:- Hardware refers to all the physical parts and components of the computer.

Ø **Central Processing Unit :–** The Central Processing Unit (CPU) or Microprocessor is the heart of the computer, where all the processing of the data is carried out. The data and instructions that are entered into the computer system are fed into the CPU before the final results are displayed on the Output Unit. The CPU stores the data and instructions, does all the calculations and problem solving, and also controls the functions of all other units.

The components of the CPU are as follows:

(1) Memory Unit or Storage Unit

(2) Arithmetic & Logical Unit (ALU) (3) Control Unit

(1) Memory Unit or Storage Unit :– The data and instructions that are entered into the computer system through input units have to be stored inside the computer before the actual processing starts. Similarly, the results produced by the computer after processing must also be kept somewhere inside the computer system before being

passed on to the output units. It provides space for storing data and instructions, space

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for intermediate results, and also space for the final results.

In short, the specific functions of the storage unit are hold (store) :
1.	All the data to be processed and the instructions required for processing (received from input devices).
2.	Intermediate results of processing.
3.	Final result of processing these results are released to an output device.

**(2)	Arithmetic Logic Unit (A.L.U) :–**		This unit performs all the basic arithmetic

operations like addition, subtraction, multiplication, division and also logical operations such as comparison of numbers etc. The ALU is responsible for actual execution of instructions during processing operation. The data and instructions that are stored in memory unit are transferred into ALU for processing when needed and transferred back to memory when processing is over. After the completion of processing, the final results are stored in memory before sent to the output unit. ALU also consist a number of small storage locations termed as registers. This register is of very small capacity and contains the data and instructions which are to be executed next.

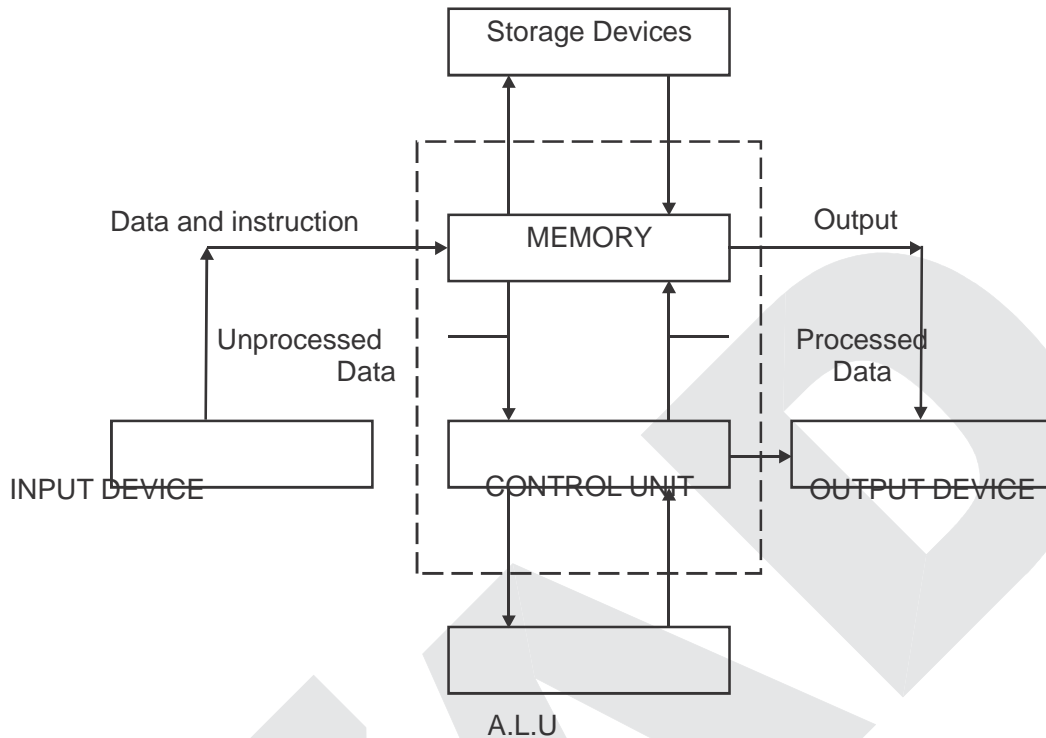**Following are the main functions of ALU :–**
(1)	It operates on data available in main memory.
(2)	It caries out all arithmetic operations like addition, subtraction, multiplication and division.
(3)	It caries out all logic operations like comparison, selection and merging of data
(4)	After processing the data, it sends back the processed data to main memory.

**(3)	Control Unit :–** The control Unit in every computer is the supervising element. It does not perform any processing but acts as a central control system for all other components of a computer system. This unit maintains the exact sequence in which the instructions are to be executed and directs the operations of the entire computer system. It co-ordinates all the activities of various elements of computer system skill. It is termed as heart of computer as in controls all hardware operation.

Functions of Control Unit are :–
(1)	It gives command to transfer data from the input device to memory and from memory to arithmetic & Logical Unit.
(2)	It transfers the results from memory to Output Unit.
(3)	It stores the program in memory, takes instruction one by one, interprets them and issue appropriate signals to the other units of computer to the other units of computer to execute them.

Block Diagram of Computer

```
                    ┌─────────────────────┐
                    │   Storage Devices   │
                    └──────────▲──────────┘
                               │
        ┌ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ┐
Data and instruction  │  ┌──────────▼──────────┐  │   Output
  ──────────────────► │  │       MEMORY        │  ─────────────►
        │             │  └──────────┬──────────┘  │
        │        Unprocessed │      │      │  Processed
        │          Data      │      │      │    Data
  ┌─────┴───────┐       │    │      │    ┌─┴─────────────┐
  │             │       │    │      │    │               │
  │ INPUT DEVICE│    ┌──▼────▼──────▼─┐  │ OUTPUT DEVICE │
  └─────────────┘    │  CONTROL UNIT  ├─►└───────────────┘
        └ ─ ─ ─ ─ ─ ─│─ ─ ─ ─│─ ─ ─ ─ ┘
                     └────┬───┘
                     ┌────▼────────────┐
                     │     A.L.U       │
                     └─────────────────┘
```

- **INPUT DEVICES:** - In a computerized system, before any processing takes place, the data and instructions must be fed. This is achieved through the **Input Devices,** which provide a communication medium between the user and the machine.

The most common of Input devices keyboard, which resembles a typewriter. The help of a keyboard, the user types data and instruction. The other commonly Input devices are mouse, magnetic ink character reader, magnetic tape, magnetic disk, optical mark reader and optical character reader.

Input devices are divided into two categories
1) Text Input Devices
2) Cursor Control Devices
   - In text input devices the mainly used keyboard.
   - Cursor control devices are mouse, joystick, scanner etc.

In brief, the following functions are performed by the input unit:-
- It accepts (reads) data from user.
- It converts the instructions and data into computer acceptable form.
- It passes the converted instructions and data to the computer for processing.

- **Output Devices :-** When Processing is complete in the CPU, the information produced is stored in the Memory in a computer understandable format. This information has to be transcribed into a form that can be read by the user, which is achieved by **Output Devices.** The most commonly used Output Devices are VDU (Visual Display Unit), Printer, Plotter etc.

There are two types of outputs produced by these devices:
(1) Hard Copy
(2) Soft Copy

Hard Copy: - An output produced on a printer or a plotter.

Soft Copy:- An output on the VDU or stored on magnetic media (Disks and Tapes).

In brief, the functions of the Output units are:-
- To accept the results processed by CPU which is in coded form?
- To convert coded results to human acceptable form.
- To produce the results to users.

- **Storage Devices :-** As we aware, that whenever data or instruction is fed to the computer, it is stored within it. Computers store data, instruction and the output of a process in a storage device.

    Storage devices are categorized as:
    - Primary Storage Devices
    - Secondary Storage Devices

    Primary Storage Devices:- Primary storage device often referred to as the main memory is the work area within the computer, where the data and instructions are stored. These devices are made up of Capacitors, Transistors and Silicon Chips. This makes access of data and instructions from these devices very efficient. The different kind of primary storage devices available are listed below:
    - RAM (Random Access Memory)
    - ROM (Read Only Memory)

    Secondary Storage Devices:- The secondary storage device is a storage medium used for storing data, instruction and output for archival purposes, so that whenever any data or instruction is required in the future. Different kind of secondary storage devices available are Floppy Disk, Hard Disk, Optical Disk etc.

Software :– The non-tangible components of the computer system are referred as **Software.**

Humanware :– The personnel involved in using and maintaining the computer system form the Humanware. They are the trained computer professionals and can be a:

- **Hardware Engineer:** Who takes care of the various components of the computer.
- **Software Engineer:** Who manages and handles the software loaded onto the computer.

- **Programmer:** Who designs various types of the software required to work on the computer.
- **User:** Who is the actual user of the computer.
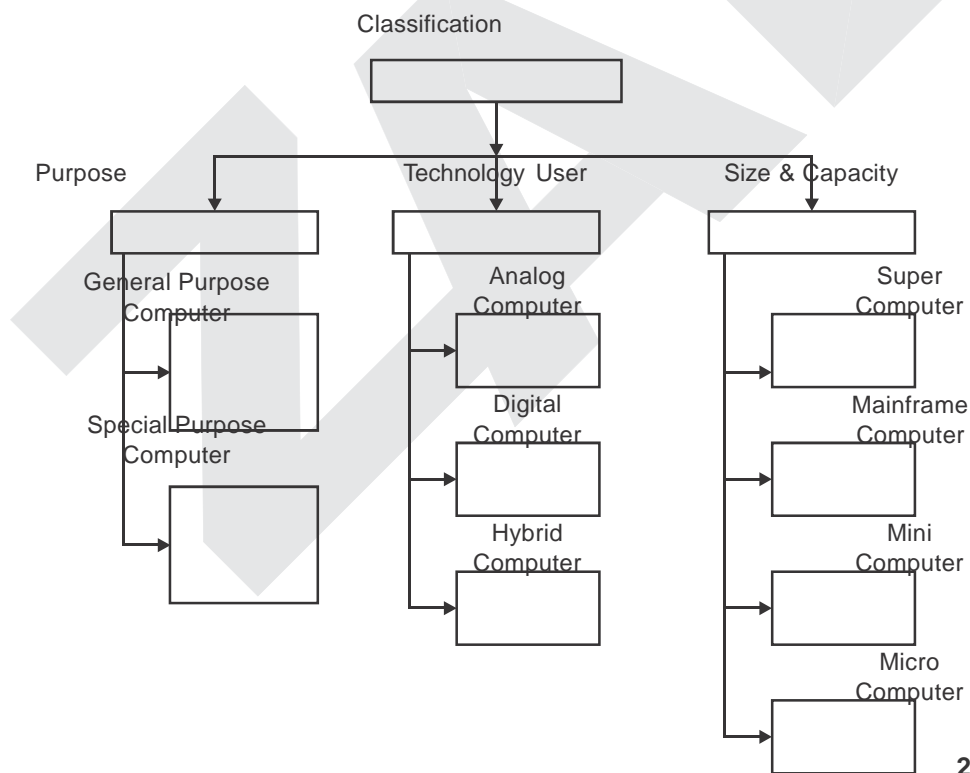
Q.4 Describe the classification of Computer?

<center>**Or**</center>

Write a short note on the following.
i)   Analog, digital, Hybrid Computers
ii)   Super, Mainframe, Micro, Mini Computers iii)
General, Special Purpose Computers

Ans.   Classification of Computers

The classification of computers is based on the following three categories:- (1)
          According to Purpose
(2)   According to technology used
(3)   According to size and capacity.

Classification

Purpose	Technology User	Size & Capacity
General Purpose Computer	Analog Computer	Super Computer
Special Purpose Computer	Digital Computer	Mainframe Computer
	Hybrid Computer	Mini Computer
		Micro Computer

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(1)   <u>**According to Purpose :**</u> **–** According to the utilization of compute for different uses, computers are of following two types:-

       (i)   **General Purpose Computers :–** Computers that follow instructions for general requirement such as sales analysis, financial accounting, invoicing, inventory, management information etc are called general purpose computers. Almost all computers used in offices for commercial, educational and other applications are general purpose computers.

       (ii)   **Special purpose computers :–** Computers designed from scratch to perform special tasks like scientific applications and research, weather forecasting, medical diagnostic etc are called special purpose computers.

(2)   **According to technology used :–** according to the technology used, computes are of following three types :–

       (i)   <u>**Analog computers**</u> **:–** Analog computers are special purpose computers that represent and store data in continuously verifying physical quantities such as current, voltage or frequency. These computers are programmed for measuring physical quantities like temperature, speed etc and to perform computations on these measurements. Analog computers are mainly used for scientific and engineering applications. Some of the examples of analog computers are given below:–

     a)   **Thermometer :–**   It is a simple analog computer used to measure temperature.

     b)   **Speedometer :–** Car's speedometer is another example of analog computer. Where the position of the needle on dial represents the speed of the car.

Digital Computers   **:–** Digital computers are mainly general purpose computers that

represent and store data in discrete quantities or numbers. In these computers, all processing is done in terms of numeric representation (Binary digits) of data and information. Although the user enters data in decimal or character form, it is converted into binary digits (O's and I's). Almost all the computers used now days are digital computers.

Difference between Analog and Digital Computers

Analog Computers	Digital Computers
Analog Computer accepts, processes and generates continuous data (Air, Water, Distance)	The Digital Computer accepts, processes and produce discrete data (AIr, Prices, Incomes etc)
Computation of Physical quantity	Computation of Numerical Digits
Accuracy of Computation is quite limited	Accuracy of Computation is more

Slow Systems	Fast Systems
Used in limited number of applications	Used in Unlimited number of applications
Outputs is Continuous	Output is obtained after complete computation is carried out.
Measure & Answer (How much)	Counts & Answer (How much)

Hybrid Computers :– Hybrid computers combine the technology of both analog and digital computers. These computers store and process analog signals which have been converted into discrete numbers using analog-to-digital converters. They can also convert the digital numbers into analog signals or physical properties using digital to analog converters. Hybrid computers are faster than analog computers but much slower than digital computers. It finds applications are special areas.

For example :– In a hospital, analog devices measure the heart functions, temperature and other vital signs of the patients. These measurements are converted into numbers and supplied to a digital computer. This is used to monitor the patient's vital signs and it gives an immediately signal if any abnormal reading is detected.

According to size and capacity :–

According to size and memory/storage capacity, computers are of following four types :–

Super Computers :– Super computers are the biggest and fastest computer, which is mainly designed for complex scientific applications. It has many CPUs (central processing units- main part of computer) which operate in parallel to make it as a fastest computer. These computers are very expensive and more powerful than mainframe computers. It is typically used fall the following applications:-

- Weather forecasting
- Petroleum Exploration and production
- Energy Mgt
- Defense
- Nuclear Energy Research
- Weapons research and development
- Earthquake prediction (seismology)

PARAM and ANURAG are Super Computers produced by India. CRAY 3, CRAY-XMP 14, NEC 500, are the another example of super computers.

Mainframe Computer :– Mainframe computers are very large and fast computers but smaller and slower the super computers. These are used in a centralized location where

many terminals (Input/Output devices) are connected with one CPU and thus, allow different users to share the single CPU. They have a very high memory (several hundred megabytes) and can support thousands of users. These computers are faster and more powerful than minicomputers. They are mainly used for following applications:-

- · Railway and Airline Reservations
- · **Banking** Applications
- · **Commercial** Applications of large industries/companies

Some examples of Mainframe Computers are- MEDHA Series, DEC, IBM 3090, IBM 4381, IBM 4300 and IBM ES-9000.

Mini Computer: - Minicomputers are medium scale, smaller and generally slower than mainframe computers. Like Mainframes, they have many terminals which are connected with one CPU and can support many users. The cost of minicomputer is very less as compared to mainframe. These computers are faster and more powerful than microcomputers. These computers are suitable for medium class organizations, banks, data processing centers etc.

Some of the examples of minicomputers are PDP-1, IBM AS/400, and DEC MICRO VAX, IBM AS/400 is actually a midi computer (computer with performance between a mainframe and minicomputer) is becoming very popular among minicomputers.

Micro Computers :– It is a low cost small digital computer. This type of compute contains a microprocessor as its CPU, a memory Unit, Input and Output device. These are also called personal computer system. Maximum speed of micro computers is up to 1 million bytes per second. These types of computers can be used to play games, teach children math, make a painting, create net musical sounds etc.

They are very inexpensive families or home business can afford to buy a small system to use at home.

Micro-Computers can be classified into the following tow categories:-

- · Desktop Micro Computes
- · Portable Micro Computers

Desktop Micro Computers :– Common type of Micro Computes, which can easily be accommodated on the top of a desk, is called desktop computers. The usage of such computers is quite common is offices, markets, homes etc.

Portable Micro Computers :– These Computes are small is size and looks like a briefcase o a notebook. They are very light in weight and easy to carry from one place to another. They use batteries or electronic current.

Examples of these computers are :–

- · Laptop Computers
- · Notebook Computers

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Laptop Computers sometimes called briefcase computes, can be used on your lap and are very portable. Like a desktop computers, laptop computers have a full typewriter keyboard. Laptop computers can be connected to larger peripherals. For example- A regular size printer or a large monitor etc.

Notebook Computes are smaller is size than laptop computers. These computers are idle for user who has to wok away from their offices. The users of these computers might be a student, a journalist and a salesman etc. Example- IBM ThinkPad.

Q.4 Describe Operating System. What are various types and functions of Operating System?

Or

"Operating System as resource manager." Describe.

Ans. Operating System :– Operating system is a program that acts as an interface between the users and computes hardware and controls the execution of all kinds of programs. It is the most important program in the computer System. It is one program that executes all the time always as the computer is operational and it exit only when the computer is shut down. OS are the programs that makes the computer work hence the name OS. It takes instructions in the form of commands from user and translates into machine understandable instructions. It gets the instructions executed by the CPU and translates the result back into user understandable form.

Definition: - **"An operating system is a set of programs, which are used to manage the overall operations of a computer, in order to achieve maximum efficiency of the computer system."** In other words, an operating system is a large collection of software, which manages resources of the computer system, such as memory, processor, file system and input/output devices. It is the program with in a computer system which helps users to run their applications.

The position of operating system in overall computer is following :–

<div align="center">
User

Application Program

Operating System
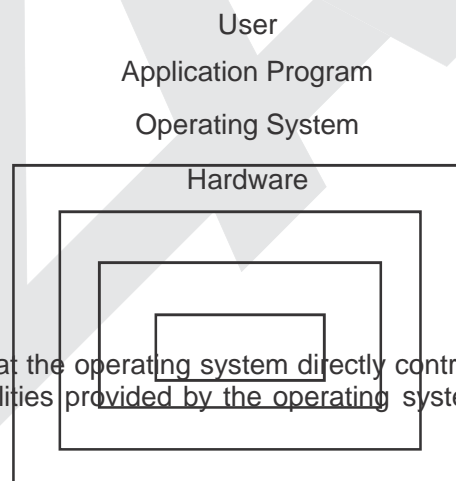
Hardware
</div>

The diagram clearly shows that the operating system directly controls computer hardware resources and other programs depend on the facilities provided by the operating system to gain access to computer system resources.

Types of Operating System

The operating systems are classified as-

1. Single program operating system.
2. Batch processing system.
3. Multiprogramming operating system.
4. Multiuse or Multi-access operating system.
5. Multiprocessing operating system.
6. Real Time operating system.
7. Network operating system.
8. Distributed operating system.

Single Program Operating System :– Single program operating system refers to single pertaining to single user for example-MS-DOS. It has a single processor runs a single program and interacts with a single use at a time.

Only one program resides in the computer memory and it remains these till it is executed. It is also called Unit Programmed operating system. It is the simplest operating system because-

· The whole memory space is allocated to one program so memory management is not very difficult.

· The CPU has to execute only one program at a time so the CPU management also does not have any problem.

Limitation of the Operating System

In single program operating system, the CPU remains idle most of the time because as compared to CPU speed, the speed of I/O devices is quite slow.

Batch Operating System :– Jobs with similar requirements were batched together and run through the computer as a group.The operating system handling a batch of programs known as Batch or Concurrent operating system.This operating system relieves the user from the difficult task of loading the next program after the execution o a previous program is completed. It must be remembered that a batch program operating system is a single program system because at a time only one program is being executed by the CPU.

In this operating system :–

· Memory is usually divided into two parts. One part is fixed for containing operating parts. One part is fixed for containing operating system and the other part contains use programs to be executed. When one program is executed, another program is loaded into same memory area.

· The CPU has to execute only one program at a time, so the CPU management also does not have problem.

Disadvantages

· Non-Interactive Environment :– Batch operating system allows on interaction between users and

executing programs.

- · High Turn around Time :– The turn around time taken between Job submission and completion is very high.

- · Off-Line debugging :– This means that a programmer can not correct bugs the moment it occurs.

Multi Programming Operating System **:–** Multiprogramming operating systems as

compared to batch operating system are fairly better but sophisticated. Multiprogramming increases CPU utilization y organizing a number of jobs such that CPU always has one to execute.

Different forms of multiprogramming operating system are :–

- Multitasking or Multiprocessing operating system
- Time sharing operating system.

Multitasking operating system :– A running state of a program is called a process or a task. A multitasking operating system supports more than one active process simultaneously with a single CPU. It is also called serial multitasking or context switching which implies stopping one temporarily to work on another.

In these operating systems, CPU switches from one task to another so quickly that it gives the illusion to the use of executing all the tasks at the same ties example- windows 95/98, windows NT etc.

Time-Sharing Operating System :– Time Sharing is a special case of multiprogramming operating system with a quick response time. It allows many users to simultaneously share the computer resources. It provides each user with a small portion of a time-shared computer. In a time shared system since each action or command take a very small fraction of time, only a little CPU time is needed for each user.

As the CPU switches rapidly from one user to another user, each user is given impression that he has his own computer, whereas actually one computer is being shared among many users.

Multi user of multi-access operating system :– Multi user operating system allows simultaneous access to a computer system through two or more terminals.

Example: - Railway Reservation System & Airline reservation system support hundreds of active terminals under control of a single program. Although it is associated with multiprogramming multitasking operating system does not imply multiprogramming or multitasking.

Multiprocessing (Parallel) operating system :– In multiprocessing operating system, multiple, CPUs perform more than one job at one time it differs from the time-sharing operating system in the manner that it refers to utilization of multiple CPUs.

In it the resources are allocated comfortable to the competing processes in a manner which results in a high throughput e.g.: - UNIX, MVS etc. Some mainframe and Supermini computers have multiple CPUs, each of which can handle several jobs.

Real Time operating system: - Real Time system is a special purpose operating system. It is used in those environments, are accepted and processed in a short time, or within a specified time. Real time operating system has well defined, fixed time constraints. Its main characteristics are:-

- Fast response time
- Feedback mechanism
- Reliability

It has to handle a process within the specified time limit otherwise the system fails, resulting in a disaster

many a times. Such applications include- Scientific experiments, flight control, few military applications, industrial control etc.

Network Operating System :– a network operating system is a collection of S/W and associated protocols that allow a set of computers which are interconnected by a computer network to be used together. In a network operating system the uses are aware of existence of multiple computers.

Capabilities of network operating system :–

- · Allowing users to access the various resources of the network nodes.

- · Allowing the users to copy files from one machine to another machine.

- · Controlling access to ensure that only users in the proper authorization access particular resources.

Distributed Operating System :– A distributed operating system looks like an ordinary centralized operating system that runs on multiple independent CPUs. It is collection of processors that do not share memory. Each processor has its own local memory.

The use of multiple processors is invisible to the user i.e. the users are not aware of where their programs are being run or where there files are residing. These are handled automatically and efficiently by the operating system.

Advantages :–

·   Resource Sharing

·   Powerful and cheap microprocessor technology

Reliable :–

·   Better services to users

·   Communication and information sharing

Functions of Operating System

Operating System as Resource Manager

1. **Process Management :–** a process is an executable program. During execution, a process requires certain resources like CPU Time, Memory Space, and I/O Devices. At a particular instance of time, a computer system normally consists of a collection of processes. The process Management module of the operating system takes care of the creation and deletion of processes, scheduling of various resources to the different processes requesting them, and providing mechanisms for synchronization and communication among processes.

2. **Memory Management :–** To execute a program, it must be loaded; together with the data is accesses, in the main memory. To improve CPU utilization and to provide better response time to its user, a computer system keeps several programs in main memory. The memory management module of an operating system takes care of the allocation and de-allocation of memory space to the various programs in need of the resource.

3. **File Management :–** All computer systems are used for storage, retrieval and sharing of information. A computer normally stores such information in units called files. Processes can read the information from the files and can create new files for storing the new information in the files. The file management module of an operating system takes care of file related activities such as organizing, storing, retrieval, naming, sharing and protection of files.

4. **Device Management**   **:–** A computer system consists of various I/O devices as terminals, printers, disks and tapes. The device management module of the operating system takes care of controlling all the computer's I/O devices.

5. **Security :–** Computer system stores a large amount of information, some of which is highly sensitive and valuable for their user. User can trust the system and rely on it only if the various resources and information of a computer system are protected against unauthorized access. The security module of the operating system ensures it.

6. **I/O Management :–** Operating system also manages input output devices. The function of input output devices are controlled by the operating system.

7. **Scheduling :–** Operating system is responsible for the scheduling of the input output device

5

Computer numbering systems

5.1 Binary numbers

The system of numbers in everyday use is the **denary** or **decimal** system of numbers, using the digits 0 to 9. It has ten different digits $(0, 1, 2, 3, 4, 5, 6, 7, 8 \text{ and } 9)$ and is said to have a **radix** or **base** of 10.

The **binary** system of numbers has a radix of 2 and uses only the digits 0 and 1.

5.2 Conversion of binary to denary

The denary number 234.5 is equivalent to

$$2 \times 10^2 + 3 \times 10^1 + 4 \times 10^0 + 5 \times 10^{-1}$$

i.e. is the sum of terms comprising: (a digit) multiplied by (the base raised to some power).

In the binary system of numbers, the base is 2, so 1101.1 is equivalent to:

$$1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1}$$

Thus the denary number equivalent to the binary number 1101.1 is

$$8 + 4 + 0 + 1 + \frac{1}{2}, \text{ that is } 13.5$$

i.e. $\mathbf{1101.1_2 = 13.5_{10}}$, the suffixes 2 and 10 denoting binary and denary systems of numbers respectively.

Problem 1. Convert 11011_2 to a denary number.

From above: $11011_2 = 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2$
$$+ 1 \times 2^1 + 1 \times 2^0$$
$$= 16 + 8 + 0 + 2 + 1$$
$$= \mathbf{27_{10}}$$

Problem 2. Convert 0.1011_2 to a decimal fraction.

$$0.1011_2 = 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-4}$$
$$= 1 \times \frac{1}{2} + 0 \times \frac{1}{2^2} + 1 \times \frac{1}{2^3} + 1 \times \frac{1}{2^4}$$
$$= \frac{1}{2} + \frac{1}{8} + \frac{1}{16}$$
$$= 0.5 + 0.125 + 0.0625$$
$$= \mathbf{0.6875_{10}}$$

Problem 3. Convert 101.0101_2 to a denary number.

$$101.0101_2 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 0 \times 2^{-1}$$
$$+ 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4}$$
$$= 4 + 0 + 1 + 0 + 0.25 + 0 + 0.0625$$
$$= \mathbf{5.3125_{10}}$$

Now try the following exercise

Exercise 17 Further problems on conversion of binary to denary numbers (Answers on page 272)

In Problems 1 to 4, convert the binary numbers given to denary numbers.

1. (a) 110   (b) 1011   (c) 1110   (d) 1001

2. (a) 10101   (b) 11001   (c) 101101   (d) 110011

3. (a) 0.1101 (b) 0.11001 (c) 0.00111 (d) 0.01011

4. (a) 11010.11 (b) 10111.011

   (c) 110101.0111 (d) 11010101.10111

5.3 Conversion of denary to binary

An integer denary number can be converted to a corresponding binary number by repeatedly dividing by 2 and noting the remainder at each stage, as shown below for 39_{10}

```
2 |39   Remainder
2 |19    1
2 |9     1
2 |4     1
2 |2     0
2 |1     0
   0     1
```

(most significant bit)→1 0 0 1 1 1 ←(least significant bit)

The result is obtained by writing the top digit of the remainder as the least significant bit, (a bit is a **b**inary dig**it** and the least significant bit is the one on the right). The bottom bit of the remainder is the most significant bit, i.e. the bit on the left.

Thus $39_{10} = 100111_2$

The fractional part of a denary number can be converted to a binary number by repeatedly multiplying by 2, as shown below for the fraction 0.625

```
 0.625   × 2 =          1. |250|
|0.250| × 2 =           0. |500|
|0.500| × 2 =           1.  000
```

(most significant bit). 1   0   1 (least significant bit)

For fractions, the most significant bit of the result is the top bit obtained from the integer part of multiplication by 2. The least significant bit of the result is the bottom bit obtained from the integer part of multiplication by 2.

Thus $0.625_{10} = 0.101_2$

Problem 4. Convert 47_{10} to a binary number.

From above, repeatedly dividing by 2 and noting the remainder gives:

```
2 |47   Remainder
2 |23    1
2 |11    1
2 |5     1
2 |2     1
2 |1     0
   0     1
```

         1   0   1   1   1   1

Thus $47_{10} = 101111_2$

Problem 5. Convert 0.40625_{10} to a binary number.

From above, repeatedly multiplying by 2 gives:

```
 0.40625 × 2 =              0. |8125|
|0.8125| × 2 =              1. |625|
|0.625|  × 2 =              1. |25|
|0.25|   × 2 =              0. |5|
|0.5|    × 2 =              1.  0
```

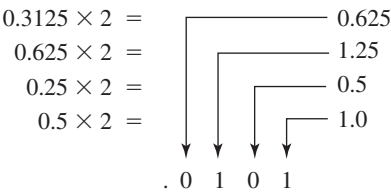   0   1   1   0   1

i.e. **$0.40625_{10} = 0.01101_2$**

Problem 6. Convert 58.3125_{10} to a binary number.

The integer part is repeatedly divided by 2, giving:

```
2 |58   Remainder
2 |29    0
2 |14    1
2 |7     0
2 |3     1
2 |1     1
   0     1
```

         1   1   1   0   1   0

The fractional part is repeatedly multiplied by 2 giving:

$$0.3125 \times 2 = \qquad 0.625$$
$$0.625 \times 2 = \qquad 1.25$$
$$0.25 \times 2 = \qquad 0.5$$
$$0.5 \times 2 = \qquad 1.0$$
$$. \ 0 \quad 1 \quad 0 \quad 1$$

Thus $58.3125_{10} = 111010.0101_2$

Now try the following exercise

Exercise 18   Further problems on conversion of denary to binary numbers (Answers on page 272)

In Problems 1 to 4, convert the denary numbers given to binary numbers.

1. (a) 5   (b) 15   (c) 19   (d) 29

2. (a) 31   (b) 42   (c) 57   (d) 63

3. (a) 0.25   (b) 0.21875   (c) 0.28125   (d) 0.59375

4. (a) 47.40625   (b) 30.8125

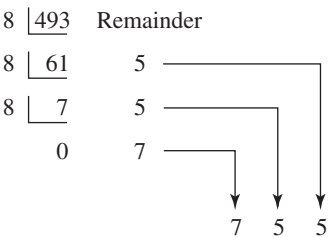   (c) 53.90625   (d) 61.65625

5.4   Conversion of denary to binary via octal

For denary integers containing several digits, repeatedly dividing by 2 can be a lengthy process. In this case, it is usually easier to convert a denary number to a binary number via the octal system of numbers. This system has a radix of 8, using the digits 0, 1, 2, 3, 4, 5, 6 and 7. The denary number equivalent to the octal number 4317_8 is

$$4 \times 8^3 + 3 \times 8^2 + 1 \times 8^1 + 7 \times 8^0$$
i.e. $4 \times 512 + 3 \times 64 + 1 \times 8 + 7 \times 1$ or 2255_{10}

An integer denary number can be converted to a corresponding octal number by repeatedly dividing by 8 and noting the remainder at each stage, as shown below for 493_{10}

$$
\begin{array}{ll}
8 \ \underline{|493} & \text{Remainder} \\
8 \ \underline{|\ 61} & 5 \\
8 \ \underline{|\ \ 7} & 5 \\
\quad \ \ 0 & 7 \\
& \qquad 7 \quad 5 \quad 5
\end{array}
$$

Thus $493_{10} = 755_8$

The fractional part of a denary number can be converted to an octal number by repeatedly multiplying by 8, as shown below for the fraction 0.4375_{10}

$$0.4375 \times 8 = 3 . \boxed{5}$$
$$\boxed{0.5} \times 8 = 4 . 0$$
$$. 3 \quad 4$$
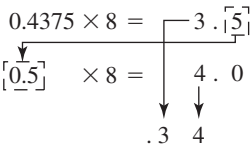
For fractions, the most significant bit is the top integer obtained by multiplication of the denary fraction by 8, thus

$$0.4375_{10} = 0.34_8$$

The natural binary code for digits 0 to 7 is shown in Table 5.1, and an octal number can be converted to a binary number by writing down the three bits corresponding to the octal digit.

Table 5.1

Octal digit	Natural binary number
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Thus $437_8 = 100\,011\,111_2$

and $26.35_8 = 010\,110.011\,101_2$

The '0' on the extreme left does not signify anything, thus $26.35_8 = 10\,110.011\,101_2$

Conversion of denary to binary via octal is demonstrated in the following worked problems.

Problem 7.   Convert 3714_{10} to a binary number, via octal.

Dividing repeatedly by 8, and noting the remainder gives:

$$
\begin{array}{ll}
8 \ \underline{|3714} & \text{Remainder} \\
8 \ \underline{|\ 464} & 2 \\
8 \ \underline{|\ \ 58} & 0 \\
8 \ \underline{|\ \ \ 7} & 2 \\
\quad \ \ \ 0 & 7 \\
& \qquad 7 \quad 2 \quad 0 \quad 2
\end{array}
$$

From Table 5.1, $7202_8 = 111\,010\,000\,010_2$

i.e. $\mathbf{3714_{10} = 111\,010\,000\,010_2}$

Problem 8. Convert 0.59375_{10} to a binary number, via octal.

Multiplying repeatedly by 8, and noting the integer values, gives:

$$0.59375 \times 8 = \quad 4.75$$
$$0.75 \times 8 = \quad 6.00$$
$$\qquad\qquad .\ 4\ 6$$

Thus $0.59375_{10} = 0.46_8$

From Table 5.1, $0.46_8 = 0.100\,110_2$

i.e. $\mathbf{0.59375_{10} = 0.100\,11_2}$

Problem 9. Convert 5613.90625_{10} to a binary number, via octal.

The integer part is repeatedly divided by 8, noting the remainder, giving:

8	5613	Remainder
8	701	5
8	87	5
8	10	7
8	1	2
	0	1

$$1\ 2\ 7\ 5\ 5$$

This octal number is converted to a binary number, (see Table 5.1)

$$12755_8 = 001\,010\,111\,101\,101_2$$

i.e. $5613_{10} = 1\,010\,111\,101\,101_2$

The fractional part is repeatedly multiplied by 8, and noting the integer part, giving:

$$0.90625 \times 8 = \quad 7.25$$
$$0.25 \times 8 = \quad 2.00$$
$$\qquad\qquad .\ 7\ 2$$

This octal fraction is converted to a binary number, (see Table 5.1)

$$0.72_8 = 0.111\,010_2$$

i.e. $0.90625_{10} = 0.111\,01_2$

Thus, $5613.90625_{10} = 1\,010\,111\,101\,101.111\,01_2$

Problem 10. Convert $11\,110\,011.100\,01_2$ to a denary number via octal.

Grouping the binary number in three's from the binary point gives: $011\,110\,011.100\,010_2$

Using Table 5.1 to convert this binary number to an octal number gives: 363.42_8 and

$$363.42_8 = 3 \times 8^2 + 6 \times 8^1 + 3 \times 8^0 + 4 \times 8^{-1} + 2 \times 8^{-2}$$
$$= 192 + 48 + 3 + 0.5 + 0.03125$$
$$= \mathbf{243.53125_{10}}$$

Now try the following exercise

Exercise 19   Further problems on conversion between denary and binary numbers via octal (Answers on page 272)

In Problems 1 to 3, convert the denary numbers given to binary numbers, via octal.

1. (a) 343   (b) 572   (c) 1265

2. (a) 0.46875   (b) 0.6875   (c) 0.71875

3. (a) 247.09375   (b) 514.4375   (c) 1716.78125

4. Convert the following binary numbers to denary numbers via octal:

5. (a) 111.011 1   (b) 101 001.01

   (c) 1 110 011 011 010.001 1

5.5 Hexadecimal numbers

The complexity of computers requires higher order numbering systems such as octal (base 8) and hexadecimal (base 16) which are merely extensions of the binary system. A **hexadecimal numbering system** has a radix of 16 and uses the following 16 distinct digits:

$$0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E \text{ and } F$$

'A' corresponds to 10 in the denary system, B to 11, C to 12, and so on.

To convert from hexadecimal to decimal:

For example $1A_{16} = 1 \times 16^1 + A \times 16^0$
$$= 1 \times 16^1 + 10 \times 1 = 16 + 10 = 26$$

i.e. $\mathbf{1A_{16} = 26_{10}}$

Similarly, $\mathbf{2E_{16}} = 2 \times 16^1 + E \times 16^0$
$$= 2 \times 16^1 + 14 \times 16^0 = 32 + 14 = \mathbf{46_{10}}$$

and $\mathbf{1BF_{16}} = 1 \times 16^2 + B \times 16^1 + F \times 16^0$

$= 1 \times 16^2 + 11 \times 16^1 + 15 \times 16^0$

$= 256 + 176 + 15 = \mathbf{447_{10}}$

Table 5.2 compares decimal, binary, octal and hexadecimal numbers and shows, for example, that

$23_{10} = 10111_2 = 27_8 = 17_{16}$

Table 5.2

Decimal	Binary	Octal	Hexadecimal
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14
21	10101	25	15
22	10110	26	16
23	10111	27	17
24	11000	30	18
25	11001	31	19
26	11010	32	1A
27	11011	33	1B
28	11100	34	1C
29	11101	35	1D
30	11110	36	1E
31	11111	37	1F
32	100000	40	20

Problem 11.   Convert the following hexadecimal numbers into their decimal equivalents: (a) $7A_{16}$ (b) $3F_{16}$

(a) $7A_{16} = 7 \times 16^1 + A \times 16^0 = 7 \times 16 + 10 \times 1$

$= 112 + 10 = 122$

Thus $7A_{16} = 122_{10}$

(b) $3F_{16} = 3 \times 16^1 + F \times 16^0 = 3 \times 16 + 15 \times 1$

$= 48 + 15 = 63$

Thus $3F_{16} = 63_{10}$

Problem 12.   Convert the following hexadecimal numbers into their decimal equivalents: (a) $C9_{16}$ (b) BD_{16}

(a) $C9_{16} = C \times 16^1 + 9 \times 16^0 = 12 \times 16 + 9 \times 1$

$= 192 + 9 = 201$

Thus $C9_{16} = 201_{10}$

(b) $BD_{16} = B \times 16^1 + D \times 16^0 = 11 \times 16 + 13 \times 1$

$= 176 + 13 = 189$

Thus $BD_{16} = 189_{10}$

Problem 13.   Convert $1A4E_{16}$ into a denary number.

$1A4E_{16} = 1 \times 16^3 + A \times 16^2 + 4 \times 16^1 + E \times 16^0$

$= 1 \times 16^3 + 10 \times 16^2 + 4 \times 16^1 + 14 \times 16^0$

$= 1 \times 4096 + 10 \times 256 + 4 \times 16 + 14 \times 1$

$= 4096 + 2560 + 64 + 14 = 6734$

Thus $1A4E_{16} = 6734_{10}$

To convert from decimal to hexadecimal:

This is achieved by repeatedly dividing by 16 and noting the remainder at each stage, as shown below for 26_{10}

```
16 | 26   Remainder
16 |  1   10 ≡ A₁₆
      0    1 ≡ 1₁₆
```

most significant bit → 1   A ← least significant bit

Hence $26_{10} = 1A_{16}$

Similarly, for 447_{10}

```
16 | 447   Remainder
16 |  27      15 ≡ F₁₆
16 |   1      11 ≡ B₁₆
       0       1 ≡ 1₁₆
                    1 B F
```

Thus $447_{10} = 1BF_{16}$

Problem 14. Convert the following decimal numbers into their hexadecimal equivalents: (a) 37_{10} (b) 108_{10}

(a) 16 | 37   Remainder

     16 | 2 $5 = 5_{16}$

        0        $2 = 2_{16}$

most significant bit $\rightarrow$ 2   5 $\leftarrow$ least significant bit

Hence $37_{10} = 25_{16}$

(b) 16 | 108   Remainder

     16 | 6 $12 = C_{16}$

        0        $6 = 6_{16}$

                6   C

Hence $108_{10} = 6C_{16}$

Problem 15. Convert the following decimal numbers into their hexadecimal equivalents: (a) 162_{10} (b) 239_{10}

(a) 16 | 162   Remainder

     16 | 10 $2 = 2_{16}$

        0        $10 = A_{16}$

                A   2

Hence $162_{10} = A2_{16}$

(b) 16 | 239   Remainder

     16 | 14 $15 = F_{16}$

        0        $14 = E_{16}$

                E   F

Hence $239_{10} = EF_{16}$

To convert from binary to hexadecimal:

The binary bits are arranged in groups of four, starting from right to left, and a hexadecimal symbol is assigned to each group. For example, the binary number 1110011110101001

is initially grouped in fours as: 1110 0111 1010 1001

and a hexadecimal symbol assigned   E   7   A   9

to each group   from Table 5.2

Hence **$1110011110101001_2 = E7A9_{16}$**

To convert from hexadecimal to binary:

The above procedure is reversed, thus, for example,

       $6CF3_{16} = 0110\ 1100\ 1111\ 0011$ from Table 5.2

i.e. **$6CF3_{16} = 110110011110011_2$**

Problem 16. Convert the following binary numbers into their hexadecimal equivalents:

(a) 11010110_2 (b) 1100111_2

(a) Grouping bits in fours from the

                right gives: 0101   0110

and assigning hexadecimal symbols

           to each group gives: D   6

                         from Table 5.2

Thus, $11010110_2 = D6_{16}$

(b) Grouping bits in fours from the

                right gives: 0110   0111

and assigning hexadecimal symbols

           to each group gives: 6   7

                         from Table 5.2

Thus, $1100111_2 = 67_{16}$

Problem 17. Convert the following binary numbers into their hexadecimal equivalents:

(a) 11001111_2 (b) 110011110_2

(a) Grouping bits in fours from the

                right gives: 1100   1111

and assigning hexadecimal symbols

           to each group gives: C   F

                         from Table 5.2

Thus, $11001111_2 = CF_{16}$

(b) Grouping bits in fours from the

                right gives: 0001   1001   1110

and assigning hexadecimal symbols

           to each group gives: 1   9   E

                    from Table 5.2

Thus, $110011110_2 = 19E_{16}$

Problem 18. Convert the following hexadecimal numbers into their binary equivalents: (a) $3F_{16}$ (b) $A6_{16}$

(a) Spacing out hexadecimal digits gives: 3   F

    and converting each into binary gives: 0011   1111

                            from Table 5.2

Thus, $3F_{16} = 111111_2$

(b) Spacing out hexadecimal digits gives: A   6
and converting each into binary gives: 1010   0110
from Table 5.2

Thus, $A6_{16} = 10100110_2$

Problem 19.   Convert the following hexadecimal numbers into their binary equivalents: (a) $7B_{16}$ (b) $17D_{16}$

(a) Spacing out hexadecimal digits gives: 7   B
and converting each into binary gives: 0111   1011
from Table 5.2

Thus, $7B_{16} = 1111011_2$

(b) Spacing out hexadecimal digits gives: 1   7   D
and converting each into binary gives:

0001   0111   1101
from Table 5.2

Thus, $17D_{16} = 101111101_2$

Now try the following exercise

In Problems 1 to 4, convert the given hexadecimal numbers into their decimal equivalents.

1. $E7_{16}$ 2. $2C_{16}$ 3. 98_{16} 4. $2F1_{16}$

In Problems 5 to 8, convert the given decimal numbers into their hexadecimal equivalents.

5. 54_{10} 6. 200_{10} 7. 91_{10} 8. 238_{10}

In Problems 9 to 12, convert the given binary numbers into their hexadecimal equivalents.

9. 11010111_2 10. 11101010_2

11. 10001011_2 12. 10100101_2

In Problems 13 to 16, convert the given hexadecimal numbers into their binary equivalents.

13. 37_{16} 14. ED_{16} 15. $9F_{16}$ 16. $A21_{16}$