Computer Organization

What is a computer?

- A computer is a programmable device that stores, retrieves, and processes data.
- A computer takes raw data (unprocessed) as an input from the user and processes it under the control of a set of instructions (program), produces a result (output) and saves it for future use.

Generations of Computers

First Generation (1940 - 1956)

- Vacuum tubes were used as main component.
- Vacuum tubes contain electrodes for controlling electron flow and were used in early computers as a switch or an amplifier.
- The were big in size and consumed more power
- Malfunctions occur due to overheat
- Machine language was used for programming
- ENIAC, EDVAC, UNIVAC 1 were first generation computers
- ENIAC weighed about 27 tons, size 8 ft x 100 ft x 3 ft and consumed 150 W of power

Generations of Computers

Second Generation (1956 - 1964)

- Transistors were used as main component.
- The transistor ("transfer resistance") is made up of semiconductors.
- Transistor is used to control the amount of current or voltage used for amplification/modulation of an electronic signal.
- Smaller compared to first generation.
- Generated less heat and consumed less power
- Punched cards also known as Hollerith cards are paper cards containing several punched or perforated holes that were punched by hand or machine to represent data.
- First Operating system was developed - Batch processing and multiprogramming OS
- Machine language and Assembly language were used for programming
- IBM 1401, IBM 1620, UNIVAC 1108 were second generation computers

Generations of Computers

Third Generation (1964 - 1971)

- Integrated Circuits (IC) were used as main components.
- IC is a package containing many circuits, pathways, transistors, and other electronic components all working together to perform a particular function or a series of functions.
- Computers were smaller, faster and more reliable
- Consumed less power
- High level languages were used.
- IBM 360 series, Honeywell 6000 series were third generation computers.

Generations of Computers

Fourth Generation (1971 - 1980)

- Microprocessors (Very Large Scale Integrated Circuits - VLSI) were used as main components.
- Smaller and faster
- IBM and APPLE microcomputers were developed
- Portable computers were introduced

Generations of Computers

Fifth Generation (1980 - till date)

- Ultra Large Scale Integration(ULSI) was used as main components.
- Parallel processing and superconductors
- Size was drastically reduced
- Can recognize images and graphics
- Introduction of Artificial Intelligence
- Able to solve complex problems including decision making and logical reasoning

Generations of Computers

Sixth Generation (In future)

- Based on Artificial Neural Networks
- Parallel and Distributed computing
- Computers have become smarter, faster and smaller
- Development of robotics
- Natural Language Processing(NLP)
- Development of Voice Recognition Software
- Ability to develop the computer program to understand human language

Types of Computers

1. Mainframe Computer
   - It is high capacity and costly computer.
   - Used by big organizations where many people can use it simultaneously.
2. Supercomputer
   - fastest and also very expensive.
   - Can solve up to ten trillion individual calculations per second.
3. Workstation Computer
   - High-end and expensive one.
   - Used for complex work purpose.
4. Mini Computer
   - Multi-user computer system, capable of supporting hundreds of users simultaneously.
5. Personal Computer (PC)
   - Low capacity computer developed for single users.
6. Laptop computer (notebook)
   - Computer that can be easily carried anywhere.
7. Tablet and Smartphone
   - Computers that are pocket-friendly.

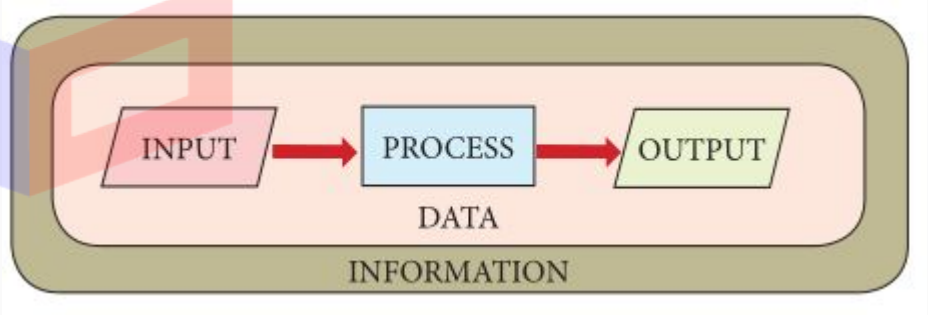
Data and Information

Data

- Unprocessed collection of raw facts, suitable for communication, interpretation or processing

Information

- Collection of facts from which conclusions may be drawn
- Data is the raw facts processed to give meaningful, ordered or structured information.
- Conversion of data into information is data processing



Number System

- Computer handles data in the form of ‘0’(Zero) and ‘1’ (One).
- Any kind of data like number, alphabet, special character should be converted to ‘0’ or ‘1’ which can be understood by the Computer.
- ‘0’ and ‘1’ that the Computer can understand is called Machine language.
- ‘0’ or ‘1’ are called ‘Binary Digits’(BIT).

Bit and Nibble

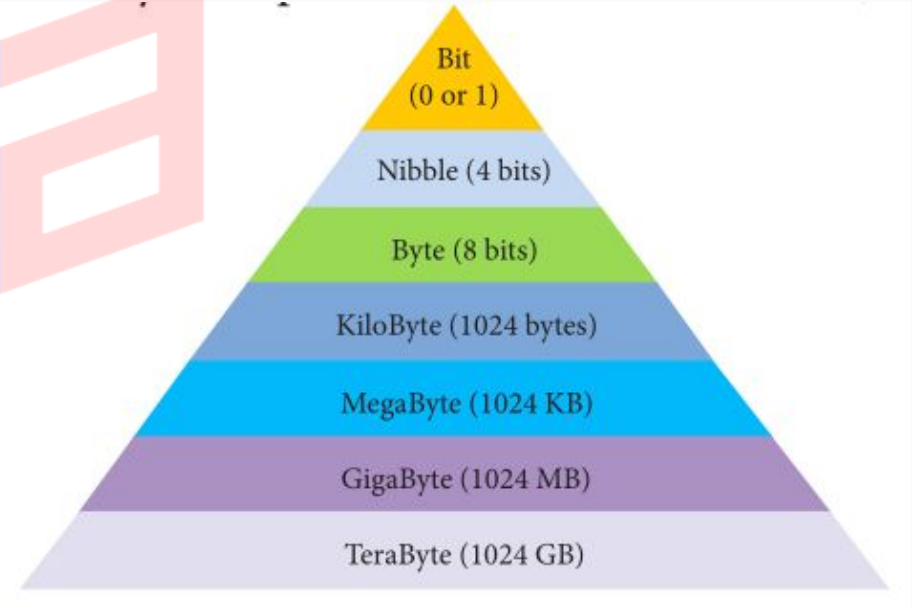
- A bit is the short form of Binary digit which can be ‘0’ or ‘1’.
- Bit is the basic unit of data in computers.
- A nibble is a collection of 4 bits.

Byte

- A collection of 8 bits is called Byte.
- A byte is considered as the basic unit of measuring the memory size in the computer.

Word Length

- Word length refers to the number of bits processed by a Computer's CPU.
- For example, a word length can have 8 bits, 16 bits, 32 bits and 64 bits (Present day Computers use 32 bits or 64 bits)



Computer Memory

- Computer memory (Main Memory and Secondary Storage) is normally represented in terms of KiloByte (KB) or MegaByte (MB).
- 1 KiloByte represents 1024 bytes that is 2^{10}
- Bytes are used to represent characters in a text.
- Different types of coding schemes are used to represent the character set and numbers.
- The most commonly used coding scheme is the American Standard Code for Information Interchange (ASCII).
- Each binary value between 0 and 127 is used to represent a specific character.
- The ASCII value for (blank space) is 32 and the ASCII value of numeric 0 is 48.
- The range of ASCII values for lowercase alphabets is from 97 to 122
- The range of ASCII values for the upper case alphabets is 65 to 90.

Memory Sizes

Name	Abbr.	Size
Kilo	K	2^10 = 1,024
Mega	M	2^20 = 1,048,576
Giga	G	2^30 = 1,073,741,824
Tera	T	2^40 = 1,099,511,627,776
Peta	P	2^50 = 1,125,899,906,842,624
Exa	E	2^60 = 1,152,921,504,606,846,976
Zetta	Z	2^70 = 1,180,591,620,717,411,303,424
Yotta	Y	2^80 = 1,208,925,819,614,629,174,706,173

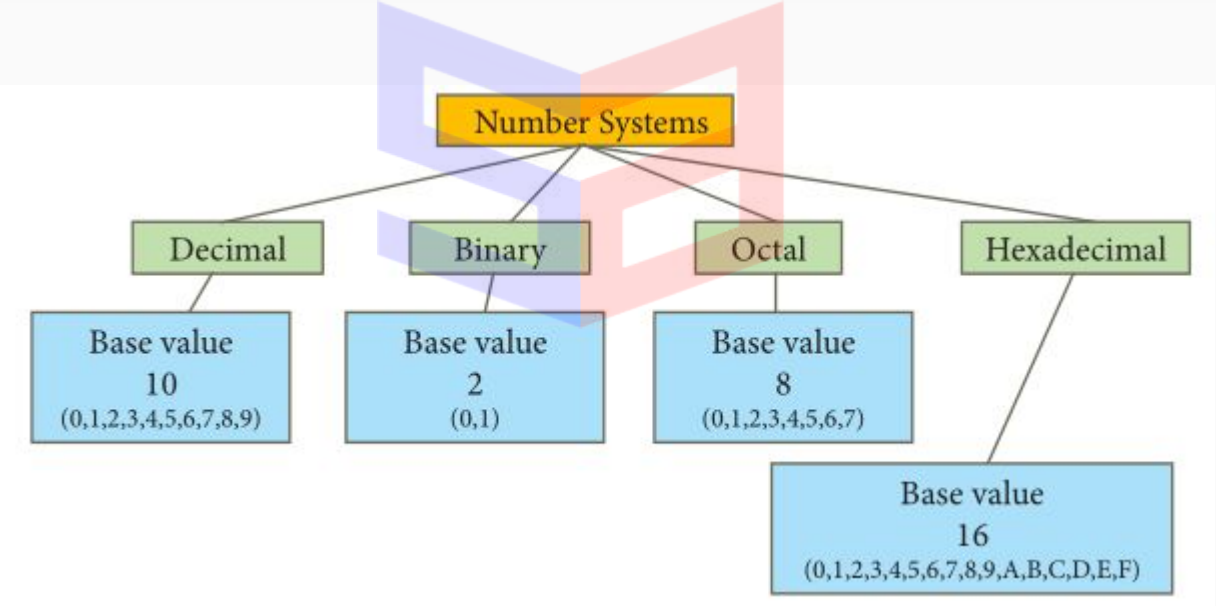
Processing Speed

- The speed of a computer depends on the number of bits it can process at once.
- For example, a 64- bit computer can process 64-bit numbers in one operation
- A 32-bit computer break 64-bit numbers down into smaller pieces, making it slower

Number System

- A numbering system is a way of representing numbers.
- The most commonly used numbering system in real life is Decimal number system.
- Other number systems are Binary, Octal, Hexadecimal number system.
- Each number system is uniquely identified by its base value or radix.
- Radix or base is the count of number of digits in each number system.
- Radix or base is the general idea behind positional numbering system

Number System

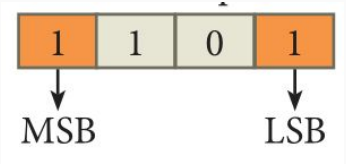


Decimal Number System

- It consists of 0,1,2,3,4,5,6,7,8,9(10 digits).
- It is the oldest and most popular number system used in our day to day life

Binary Number System

- There are only two digits in the Binary system, namely, 0 and 1.
- The numbers in the binary system are represented to the base 2 and the positional multipliers are the powers of 2.
- The leftmost bit in the binary number is called as the Most Significant Bit (MSB) and it has the largest positional weight.
- The right most bit is the Least Significant Bit (LSB) and has the smallest positional weight.



Octal Number System

- Octal number system uses digits 0,1,2,3,4,5,6 and 7 (8 digits).
- Each octal digit has its own positional value or weight as a power of 8

Hexadecimal Number System

- A hexadecimal number is represented using base 16.
- Hexadecimal or Hex numbers are used as a shorthand form of binary sequence.
- This system is used to represent data in a more compact manner.
- Since 16 symbols are used, 0 to F, the notation is called hexadecimal.
- The first 10 symbols are the same as in the decimal system, 0 to 9 and the remaining 6 symbols are taken from the first 6 letters of the alphabet sequence, A to F, where A represents 10, B is 11, C is 12, D is 13, E is 14 and F is 15.

Binary, Octal, Hexadecimal equivalent of Decimal Numbers

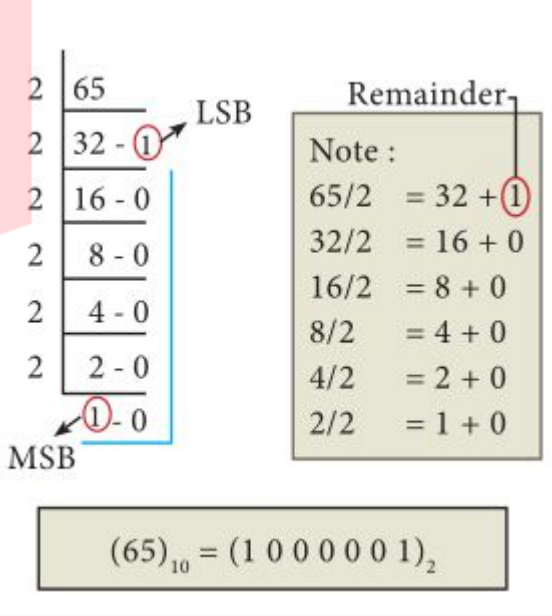
Decimal	Binary	Octal	Hexadecimal
0	0000	000	0000
1	0001	001	0001
2	0010	002	0002
3	0011	003	0003
4	0100	004	0004
5	0101	005	0005
6	0110	006	0006
7	0111	007	0007
8	1000	010	0008
9	1001	011	0009
10	1010	012	A
11	1011	013	B
12	1100	014	C
13	1101	015	D
14	1110	016	E
15	1111	017	F

Decimal to Binary Conversion

- “Repeated Division by 2” method can be used.
- Any Decimal number divided by 2 will leave a remainder of 0 or 1.
- Repeated division by 2 will leave a sequence of 0s and 1s that become the binary equivalent of the decimal number.
- Suppose it is required to convert the decimal number N into binary form, dividing N by 2 in the decimal system, we will obtain a quotient
- N1 and a remainder R1, where R1 can have a value of either 0 or 1.
- The process is repeated until the quotient becomes 0 or 1.
- When the quotient is ‘0’ or ‘1’, it is the final remainder value. Write the final answer starting from final remainder value obtained to the first remainder value obtained.

Decimal to Binary Conversion

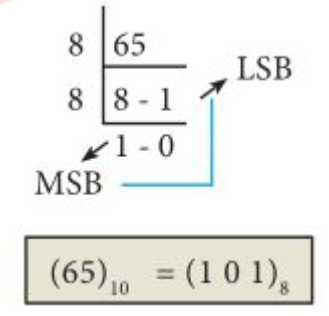
Example:
Convert $(65)_{10}$ into its equivalent binary number



Decimal to Octal Conversion

- “Repeated Division by 8” method can be used.
- The method is the same we have learnt in decimal to binary, but in this method, we have to divide the given number by 8 instead of 2.

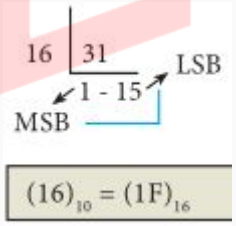
Example: Convert $(65)_{10}$ into its equivalent Octal number



Decimal to Hexadecimal Conversion

- “Repeated Division by 8” method can be used.
- The method is the same we have learnt in decimal to binary, but in this method, we have to divide the given number by 16 instead of 2.

Convert $(31)_{10}$ into its equivalent hexadecimal number.



Binary to Decimal Conversion

- Write down the Binary digits and list the powers of 2 from right to left (Positional Notation)
- For each positional notation written for the digit, now write the equivalent weight.
- Multiply each digit with its corresponding weight
- Add all the values.

Positional Notation	Weight	Positional Notation	Weight
2^0	1	2^6	64
2^1	2	2^7	128
2^2	4	2^8	256
2^3	8	2^9	512
2^4	16	2^{10}	1024
2^5	32		

Binary to Decimal Conversion

Example:
Convert $(111011)_2$ into its equivalent decimal number.

$$32+16+8+0+2+1 = (59)_{10}$$
$$(111011)_2 = (59)_{10}$$

Binary to Octal Conversion

- Group the given binary number into 3 bits from right to left.
- You can add preceding 0 to make a group of 3 bits if the leftmost group has less than 3 bits.
- Convert equivalent octal value using "2's power positional weight method"

Octal	Binary Equivalent
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Binary to Octal Conversion

Convert $(11010110)_2$ into octal equivalent number

: Group the given number into 3 bits from right to left.

011 010 110

The left most groups have less than 3 bits, so 0 is added to its left to make a group of 3 bits.

: Find Octal equivalent of each group

011	010	110
3	2	6

$(11010110)_2 = (326)_8$

Binary to Hexadecimal Conversion

- Group the given number into 4 bits from right to left.
- You can add preceding 0's to make a group of 4 bits if the leftmost group has less than 4 bits.
- Convert equivalent Hexadecimal value using "2's power positional weight method"

Example

Convert $(1111010110)_2$ into Hexadecimal number

Step 1: Group the given number into 4 bits from right to left.

0011	1101	0110

Note: 0's are added to the left most group to make it a group of 4 bits

0011	1101	0110
3	D	6

$(1111010110)_2 = (3D6)_{16}$

Octal to Decimal Conversion

- Write down the Octal digits and list the powers of 8 from right to left(Positional Notation)
- For each positional notation of the digit write the equivalent weight.
- Multiply each digit with its corresponding weight
- Add all the values

Octal to Decimal Conversion

- Convert $(1265)_8$ to equivalent Decimal number

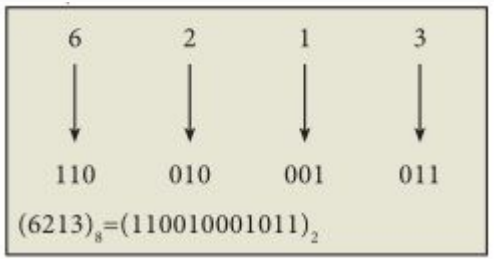
Weight	512	64	8	1
Positional Notation	8^3	8^2	8^1	8^0
Given number	1	2	6	5

$$(1265)_8 = 512 \times 1 + 64 \times 2 + 8 \times 6 + 1 \times 5$$
$$= 512 + 128 + 48 + 5$$
$$(1265)_8 = (693)_{10}$$

Octal to Binary Conversion

For each Octal digit in the given number write its 3 digits binary equivalent using positional notation

Example: Convert $(6213)_8$ to equivalent Binary number



Hexadecimal To Decimal Conversion

- Write down the Hexadecimal digits and list the powers of 16 from right to left(Positional Notation)
- For each positional notation written for the digit, now write the equivalent weight.
- Multiply each digit with its corresponding weight
- Add all the values to get one final value.

Convert $(25F)_{16}$ into its equivalent Decimal number.

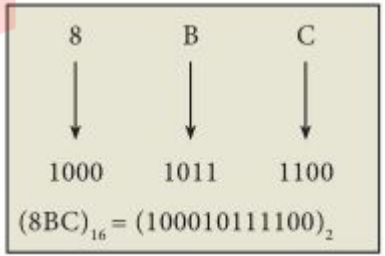
Weight	256	16	1
Positional Notation	16^2	16^1	16^0
Given number	2	5	F(15)

$(25F)_{16} = 2\times256 + 5\times16 + 15\times1$
$= 512 + 80 + 15$
$(25F)_{16} = (607)_{10}$

Hexadecimal to Binary Conversion

- Write 4 bits Binary equivalent for each Hexadecimal digit for the given number using positional notation method.

Example:
Convert $(8BC)_{16}$ into equivalent Binary number

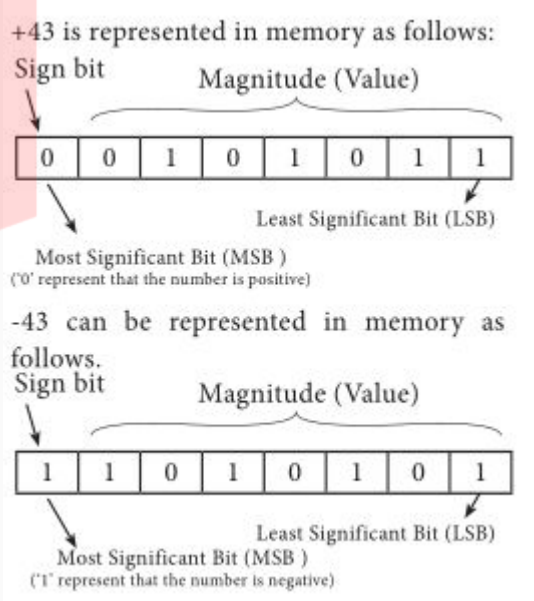


Binary Representation for Signed Numbers

- Computers can handle both positive (unsigned) and negative (signed) numbers.
- The simplest method to represent negative binary numbers is called Signed Magnitude.
- In signed magnitude method, the leftmost bit is Most Significant Bit (MSB), is called sign bit or parity bit.
- The numbers are represented in computers in different ways:
    1. Signed Magnitude representation
    2. 1's Complement
    3. 2's Complement

Signed Magnitude representation

- In signed binary representation, the leftmost bit is considered as sign bit.
- If this bit is 0, it is a positive number and if it 1, it is a negative number.
- Therefore a signed binary number has 8 bits, only 7 bits used for storing values (magnitude) and the 1 bit is used for sign.



1’s Complement representation

- 1’s Complement is for negative numbers only i.e. the number whose MSB is 1.
- Finding 1’s Complement of a number
  1. Convert given Decimal number into Binary
  2. Check if the binary number contains 8 bits , if less add 0 at the left most bit, to make it as 8 bits.
  3. Invert all bits (i.e. Change 1 as 0 and 0 as 1)

Eg: Find 1’s complement for $(-24)_{10}$

Given Number	Binary Number	1’s Compliment
$(-24)_{10}$	00011000	11100111

2’s Complement representation

- Finding 2’s Complement
  1. Invert all the bits in the binary sequence (i.e., change every 0 to 1 and every 1 to 0 ie.,1’s complement)
  2. Add 1 to the result to the Least Significant Bit (LSB).

2’s Complement represent of $(-24)_{10}$

Binary equivalent of +24:	11000
8bit format:	00011000
1’s complement:	11100111
Add 1 to LSB:	+1
2’s complement of -24:	**11101000**

Binary Addition

The following table is useful when adding two binary numbers.

A	B	SUM (A + B)	Carry
0	0	0	-
0	1	1	-
1	0	1	-
1	1	0	1

- In 1 + 1 = 10, is considered as sum 0 and the 1 as carry bit.
- This carry bit is added with the previous position of the bit pattern.

Example Perform Binary addition for the following: $23_{10} + 12_{10}$

Step 1: Convert 23 and 12 into binary form

23_{10}

2's power	16	8	4	2	1
Binary Number	1	0	1	1	1

$23_{10} = 00010111_2$

12_{10}

2's power	8	4	2	1
Binary Number	1	1	0	0

$12_{10} = 00001100_2$

Step 2: Binary addition of 23 and 12:

Carry Bit →			1	1	1		
$23_{10} = 0$	0	0	1	0	1	1	1
$12_{10} = 0$	0	0	0	1	1	0	0
$35_{10} = 0$	**0**	**1**	**0**	**0**	**0**	**1**	**1**

Binary Subtraction

The table for Binary Subtraction is as follows:

A	B	Difference (A-B)	Borrow
0	0	0	0
1	0	1	0
1	1	0	0
0	1	1	1

- When subtracting 1 from 0, borrow 1 from the next Most Significant Bit, when borrowing from the next Most Significant Bit, if it is 1, replace it with 0.

- If the next Most Significant Bit is 0, you must borrow from a more significant bit that contains 1 and replace it with 0 and 0s upto that point become 1s.

Example Substract $1001010_2 - 10100_2$

	0	1	10	0	10		
	~~1~~	~~0~~	0	~~1~~	0	1	0
(-)			1	0	1	0	0
		1	1	0	1	1	0

Representing Characters in Memory

- In general, 26 uppercase letters, 26 lowercase letters, 0 to 9 digits and special characters are used in a computer, which is called character set.
- All these character set are denoted through numbers only.
- All Characters in the character set needs a common encoding system.

Encoding Systems

1. BCD – Binary Coded Decimal
2. EBCDIC – Extended Binary Coded Decimal Interchange Code
3. ASCII – American Standard Code for Information Interchange
4. Unicode
5. ISCII - Indian Standard Code for Information Interchange

Representing Characters in Memory

Binary Encoded Decimal (BCD)

- This encoding system is not in the practice right now.
- This is 26 bit encoding system.
- This can handle 26 = 64 characters only.

American Standard Code for Information Interchange (ASCII)

- This is the most popular encoding system recognized by United States.
- Most of the computers use this system.
- This encoding system can handle English characters only.
- This can handle 27 bit which means 128 characters.
- The new edition (version) ASCII -8, has 28 bits and can handle 256 characters are represented from 0 to 255 unique numbers.

Representing Characters in Memory

Extended Binary Coded Decimal Interchange Code (EBCDIC)

- This is similar to ASCII Code with 8 bit representation.
- This coding system is formulated by International Business Machine(IBM).
- The coding system can handle 256 characters.
- The input code in ASCII can be converted to EBCDIC system and vice - versa.

Indian Standard Code for Information Interchange (ISCII)

- ISCII is the system of handling the character of Indian local languages.
- This as a 8-bit coding system.
- It can handle 256 (28) characters.
- This system is formulated by the department of Electronics in India in the year 1986-88 and recognized by Bureau of Indian Standards (BIS).

Representing Characters in Memory

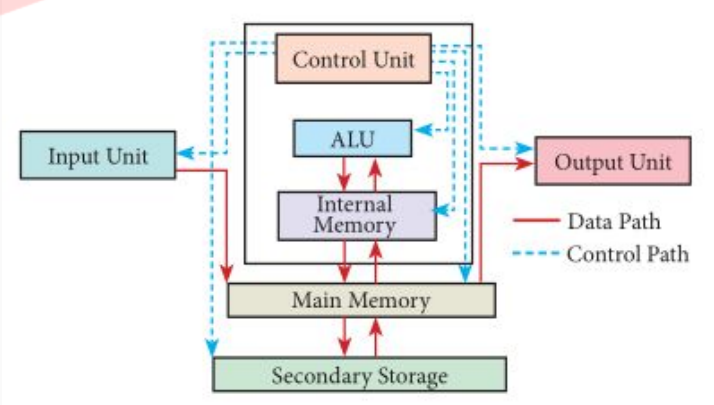
Unicode

- This coding system is used in most of the modern computers.
- ASCII can represent only 256 characters.
- Therefore English and European Languages alone can be handled by ASCII.
- Hence, the Unicode was generated to handle all the coding system of Universal languages.
- This is 16 bit code and can handle 65536 characters.
- Unicode scheme is denoted by hexadecimal numbers.

Components of a Computer

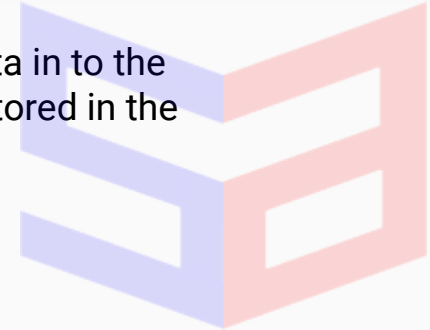
- A computer is the combination of hardware and software
- Hardware is the physical component of a computer like motherboard, memory devices, monitor, keyboard etc.
- Software is the set of programs or instructions.
- Both hardware and software together make the computer system to function.
- Every task given to a computer follows Input - Process - Output Cycle (IPO Cycle)

- Input unit takes the input, central processing unit does the processing of data, memory holds the data and instructions during the processing and output unit produces the output



Input Unit

- It is used to input any form of data in to the computer which can be further stored in the memory unit
- Example: Keyboard, Mouse, etc

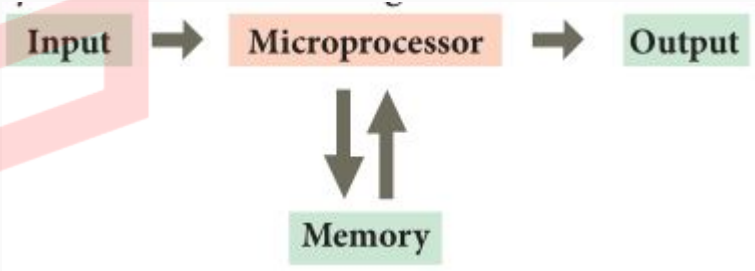


Central Processing Unit (CPU)

- CPU interprets and executes software instructions.
- It controls the operation of all other components such as memory, input and output units.
- It accepts binary data as input, process the data according to the instructions and provide the result as output.

Microprocessor

- CPU performs its tasks using microprocessor which is an Integrated Circuit
- The first general purpose microprocessor, 4004 was developed by Intel Inc in 1971
- The microprocessor is a programmable multipurpose silicon chip.
- It is driven by clock pulses.
- It accepts input as a binary data and after processing, it provides the output data as per the instructions stored in the memory.



Microprocessor

Components of a Microprocessor

1. Arithmetic and Logic Unit (ALU)
2. Control Unit
3. Registers

Characteristics of Microprocessors

- Performance depends on
  1. Clock speed
  2. Instruction set
  3. Word size

Clock Speed

- Internal clock of a microprocessor regulates the speed at which it executes instructions.
- The speed at which a microprocessor executes instructions is called clock speed
- Unit of clock speed is hertz (Hz) and is measured in MHz(Mega Hertz) or in GHz(Giga Hertz)

Instruction Set

- Instruction is a command given to a computer to perform an operation on a data.
- Basic set of machine level instructions that a microprocessor is designed to execute is called as an instruction set

- Operations carried out by Instruction Set
  1. Data transfer
  2. Arithmetic operations
  3. Logical Operations
  4. Control flow
  5. Input / Output

Word Size

- Number of bits that can be processed by a microprocessor in a single instruction is called its word size.
- Word size determines the amount of RAM that can be accessed by a microprocessor

Communication between data and memory

- The Central Processing Unit(CPU) has a Memory Data Register (MDR) and a Memory Address Register (MAR).
- The Memory Data Register (MDR) keeps the data which is transferred between the Memory and the CPU.
- The Program Counter (PC) is a special register in the CPU which always keeps the address of the next instruction to be executed.
- The Arithmetic and Logic unit of CPU places the address of the memory to be fetched, into the Memory Address Register.
- A bus is a collection of wires used for communication between the internal components of a computer.

Communication between data and memory

- The word in the RAM has the same size (no. of bits) as the Memory Data Register (MDR).
- If the processor is an 8-bit processor like Intel 8085, its MDR and the word in the RAM both have 8 bits.
- The read operation transfers the data(bits) from word to Memory Data Register.
- The write operation transfers the data(bits) from Memory Data Register to word.

Microprocessor Types based on Width of Data

- 8-bit microprocessor
- 16-bit microprocessor
- 32-bit microprocessor
- 64-bit microprocessor

Microprocessor Types based on Instruction Set

1. Reduced Instruction Set Computers (RISC)
    - Eg: Pentium IV, Intel P6, AMD K6 and K7
2. Complex Instruction Set Computers (CISC)
    - Eg: Intel 386 and 486, Pentium II and III, Motorola 68000

Arithmetic and Logic Unit (ALU)

- Computing functions are performed on data by ALU
- Arithmetic operations such as addition, subtraction, multiplication, division and logical operations are performed
- Result of an operation is stored in internal memory of CPU

Control Unit

- Controls the flow of data between CPU, memory and I/O devices
- Controls the entire operation of a computer

Memory Unit

- Memory unit is used to store data and instructions in a computer.
- Types of Memory
  1. Primary or Internal Memory
  2. Secondary Memory
- Methods to Access
  1. Sequential Access
  2. Random Access

Primary Memory

- Primary Memory or Internal Memory or Main Memory or **Random Access Memory (RAM)** is used to store I/O data and program instructions temporarily during the processing by CPU.
- Primary memory is volatile which means data is lost when power supply is switched off.
- Operating System, Application Programs and data in current us are kept temporarily in the RAM so that they can be accessed by the computer's processor

Types of RAM

1. Dynamic RAM (DRAM)
   - Need to be refreshed frequently
   - Slower than static RAM
   - Inexpensive than static RAM
2. Static RAM (SRAM)
   - Need to be refreshed less often
   - Faster than dynamic RAM
   - Expensive than dynamic RAM

Types of RAM

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Read Only Memory (ROM)

- ROM is a special memory in a computer with pre-recorded data at manufacturing time.
- The stored programs that start the computer and perform diagnostics are available in ROMs.
- ROM stores critical programs such as the program that boots the computer.
- Once the data has been written onto a ROM chip, it cannot be modified or removed and can only be read.
- ROM retains its contents even when the computer is turned off. So ROM is called as a non-volatile memory.

Programmable Read Only Memory (PROM)

- Programmable read only memory is a non-volatile memory on which data can be written only once.
- Once a program has been written onto a PROM, it remains there forever.
- Unlike the main memory, PROMs retain their contents even when the computer is turned off.
- The PROM differs from ROM in a way that PROM is manufactured as a blank memory, whereas a ROM is programmed during the manufacturing process itself.
- PROM programmer or a PROM burner is used to write data to a PROM chip.
- The process of programming a PROM is called burning the PROM.

Erasable Programmable Read Only Memory (EPROM)

- Erasable Programmable Read Only Memory is a special type of memory which serves as a PROM, but the content can be erased using ultraviolet rays.
- EPROM retains its contents until it is exposed to ultraviolet light.
- The ultraviolet light clears its contents, making it possible to reprogram the memory.
- EPROMs are used widely in personal computers because they enable the manufacturer to change the contents of the PROM to replace with updated versions or erase the contents before the computer is delivered.

Electrically Erasable Programmable Read Only Memory (EPROM)

- Electrically Erasable Programmable Read Only Memory is a special type of PROM that can be erased by exposing it to an electrical charge.
- EEPROM retains its contents even when the power is turned off.
- EEPROM is slower in performance.

Cache Memory

- The cache memory is a very high speed and expensive memory, which is used to speed
- up the memory retrieval process.
- Due to its higher cost, the CPU comes with a smaller size of cache memory compared with the size of the main memory.
- Without cache memory, every time the CPU requests the data, it has to be fetched from the main memory which will consume more time.
- The idea of introducing a cache is that, this extremely fast memory would store data that is frequently accessed and if possible, the data that is closer to it.
- This helps to achieve the fast response time, where response Time, (Access Time) refers to how quickly the memory can respond to a read / write request.

Secondary Memory

- Secondary memory is used to store data permanently.
- It can be used to store large amounts of data.
- It is inexpensive compared to Primary memory.
- It is also known as Backup storage.
- Secondary memory is non-volatile which means data stored is available even when the power is switched off.
- Eg: Hard Disk, USB drive(Pen drive), CD-ROM, DVD ROM, etc

Hard Disk

- Hard disk is a magnetic disk on which you can store data.
- The hard disk has the stacked arrangement of disks accessed by a pair of heads for each of the disks.
- The hard disks come with a single or double sided disk.

Compact Disc (CD)

- A CD or CD-ROM is made from 1.2 mm thick, polycarbonate plastic material.
- A thin layer of aluminium or gold is applied to the surface.
- CD data is represented as tiny indentations known as "pits", encoded in a spiral track moulded into the top of the polycarbonate layer.
- The areas between pits are known as "lands".
- A motor within the CD player rotates the disk.
- The capacity of an ordinary CD-ROM is 700MB.

Digital Versatile Disc (DVD)

- A DVD (Digital Versatile Disc or Digital Video Disc) is an optical disc capable of storing up to 4.7 GB of data, more than six times what a CD can hold.
- DVDs are often used to store movies at a better quality.
- Like CDs, DVDs are read with a laser.
- The disc can have one or two sides, and one or two layers of data per side; the number of sides and layers determines how much it can hold.
- Double-layered sides are usually gold-coloured, while single-layered sides are usually silver-coloured, like a CD

Flash Memory Devices

- Flash memory is an electronic (solid-state) non-volatile computer storage medium that can be electrically erased and reprogrammed.
- They are either EEPROM or EPROM. Examples for Flash memories are pendrives, memory cards etc.
- Flash memories can be used in personal computers, Personal Digital Assistants (PDA), digital audio players, digital cameras and mobile phones.

- Flash memory offers fast access times.
- The time taken to read or write a character in memory is called access time.
- The capacity of the flash memories vary from 1 Gigabytes (GB) to 2 Terabytes (TB).

Blu-Ray Disc

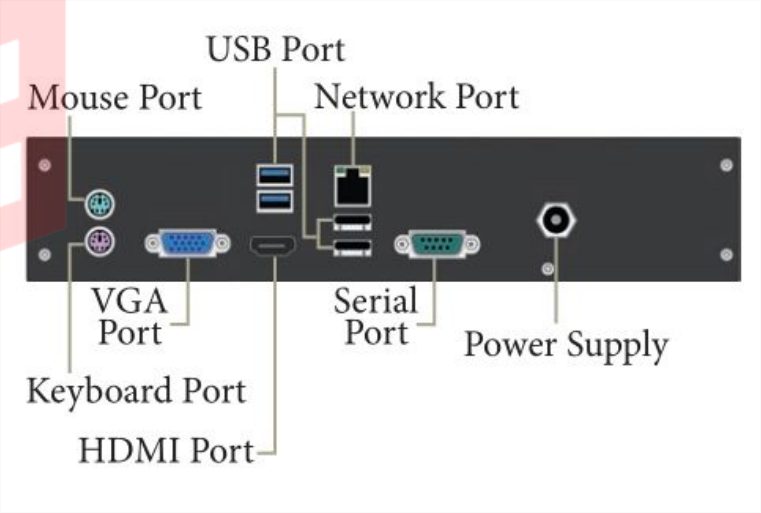
- Blu-Ray Disc is a high-density optical disc similar to DVD.
- Blu-ray is the type of disc used for PlayStation games and for playing High-Definition (HD) movies.
- A double-layer Blu-Ray disc can store up to 50GB (gigabytes) of data.
- Blu-ray uses a blue-violet laser to write.

Output Unit

- Output Unit is any hardware that conveys information to users in a understandable form
- Example: Monitor, Printer

Ports and Interfaces

- Motherboard of a computer has many I/O sockets that are connected to the ports and interfaces on the rear side of a computer
- External devices such as mouse, keyboard, speaker, headphones, USB drives, etc can be connected



Types of Ports

- Serial Port
  - It is used in old computers to connect external devices
- Parallel Port
  - It is used in old computers to connect printers
- VGA Connector
  - To connect a monitor or LCD Projector
- PS/2 Port
  - To connect mouse and keyboard to PC
- Audio Plugs
  - To connect speakers, mic, headphones
- USB Ports
  - It is used to connect cameras, scanners, mobile phones, external hard disks, printers
  - USB 3.0 is the 3rd major version of Universal Serial Bus(USB)
  - IT can transfer data up to 5 Giga bytes / second
- High Definition Multimedia Interface(HDMI)
  - Audio/Video interface which transfers uncompressed video and audio data from Monitor, Projector, TV

Input and Output Devices

- Input devices are used to get the input data from the user into a computer.
- Output devices are used to display output data from the computer.

Input Devices

1. Keyboard
2. Mouse
3. Scanner
4. Fingerprint Scanner
5. Track ball
6. Retinal Scanner
7. Light Pen
8. Optical Character Reader
9. Barcode / QR Code Reader
10. Voice Input (Microphone)
11. Digital Camera
12. Touch Screen
13. Keyer

Keyboard

- A keyboard is used to input characters into a computer by typing.
- A keyboard can be wired, wireless or virtual.
- Keyboard layout is derived from typewriter.

Types of Keys in a Keyboard

- Character Keys
  1. Letters
  2. Numbers
  3. Special Characters
- Function Keys
  1. F1 to F12
- Navigation Keys
  1. Arrow Keys
- Numeric Keypad
- Lock Keys
  1. Caps lock, Num lock, Scroll lock
- Modifier Keys
  1. Alt, Shift, Ctrl Keys
- Enter and Editing Keys
  1. Enter, Backspace, Delete, Insert keys

Mouse

- A mouse is a pointing device to control the movement of the cursor in the monitor.
- It can be wired or wireless
- It is used to select icons, menus, command buttons
- Mouse was invented by Douglas Engelbart during 1960s.

Mouse

Mouse Actions

1. Move
2. Click
3. Double Click
4. Right Click
5. Drag and drop

Type of Mouse

1. Mechanical Mouse
2. Optical Mouse
3. Laser Mouse
4. Air Mouse
5. 3D Mouse
6. Tactile Mouse
7. Ergonomic Mouse
8. Gaming Mouse

Scanner

- A scanner is used to convert any printed information to digital format.
- It is used to scan photos or printed documents.
- A scanner enters the scanned information directly into the computer memory

Fingerprint Scanner

- A fingerprint scanner is a device used to recognize fingerprints.
- It uses biometric technology for scanning
- Fingerprint Scanner is a safer and secure device than using passwords

Trackball

- A trackball is similar to a mouse but the design is upside down.
- The user moves the ball while the device is stationary.
- The ball is moved in various directions to navigate the screen movements

Retinal Scanner

- A retinal scanner is used to scan the blood vessels in the retina of the eye.
- It uses biometric technology.

Light Pen

- A light pen is a pointing device shaped like a pen and connected with the monitor.
- The light-sensitive tip of the pen detects light from the monitor to identify the location is the pointer in the screen
- They can be used to draw on the screen but will be hard to do.
- Light pens are not accurate

Optical Character Reader

- It is a device which detects characters printed or written on a paper.
- It uses OCR(Optical Character Recognition) technology to detect characters.
- The scanned document can then be edited using a word processor

Barcode / QR Code Reader

- A barcode is a pattern of lines printed in different thickness.
- The barcode reader scans the bar codes and transmits the information in to the computer.
- QR(Quick Response) Code is a 2-dimensional barcode which can be read by a camera to interpret the information contained in it

Voice Input (Microphone)

- A microphone is used to input voice into the computer.
- A speech recognition software combined with voice input can be used to convert voice to text.

Digital Camera

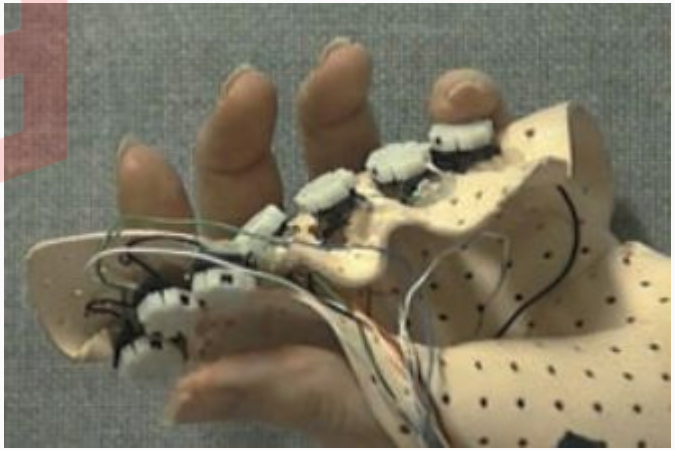
- It captures photos and videos in digital form.
- Captured photos and videos can be transferred in to a computer for further processing.
- It uses CCD(Charge Coupled Device) electronic chip.
- When light falls on the CCD through the lens, it converts light rays to digital form

Touch Screen

- It is a device which allows user to interact with a computer using the finger.
- They are used in tablets, monitors, cash registers, kiosks, ATMs.
- Some touch screens used Infra Red beams to sense the presence of a finger instead of touch input.

Keyer

- It is a device for signaling by hand where one or more switches are pressed.
- Normally there will be 4 to 50 switches



Output Devices

1. Monitor
2. Plotter
3. Printers
4. Speakers
5. Multimedia Projectors

Monitor

- A monitor is used to display digital information.
- A monitor displays picture elements called pixels
- Monitors may either be monochrome(black and white) or color(millions of colors).

Monitors

- Types of monitors
  1. CRT(Cathode Ray Tube)
  2. LCD(Liquid Crystal Display)
  3. LED(Light Emitting Diodes)
- 1st monitor was part of Xerox Alto Computer released in March 1, 1973
- Monitor works with VGA(Video Graphics Array) card which helps the keyboard communicate with the monitor.
- Recent motherboards include a built-in video card.

Plotter

- A plotter is a device used to produce graphical output on papers.
- It uses single color or multi color pens to draw pictures
- They are used in Computer-aided drawing, scientific and line art applications.

Printer

- Printers are used to print information on papers
- Types
  1. Impact Printers
  2. Non Impact Printers

Impact Printers

- Striking hammers or pins on ribbon are used for the printing operation
- They can print on multi-part(using carbon papers) by applying mechanical pressures
- Types
    1. Dot Matrix printers
    2. Line matrix printers

Dot Matrix Printer

- Prints using fixed number of pins or wires.
- It prints one line of text at a time.
- The printing speed of these printers varies from 30 to 1550 CPS(Characters Per Second)

Line Matrix Printer

- A fixed print head is used for printing.
- It prints a page-wide line of dots which eventually builds up a line of dots.
- They print 1000 Lines Per Minute which results in thousands of pages per hour.

Non-Impact Printers

- They use electrostatic or laser technology for printing.
- Quality and speed of the printers are better than impact printers
- Types
  1. Laser printer
  2. Inkjet printer

Laser Printers

- A laser beam scans back and forth across a drum and forms a pattern which gets printed.
- It can produce very high quality of prints
- Printing resolution range is around 1200 DPI(Dots per Inch).
- It can print around 100 pages per minute

Inkjet Printers

- Ionised inks are sprayed at the paper.
- Color cartridges which combine Magenta, Yellow and Cyan inks to form color tones are used.
- Black cartridge is used for monochrome output.
- Speed of Inkjet printers are 1-20 PPM(Page Per Minute)

Speakers

- They produce voice output(audio)
- Speakers can be used with speech synthesis software to give voice output. They are used in airlines, schools, banks, railway stations

Multimedia Projectors

- They are used to produce computer output on a big screen.
- They are used to display presentations in meeting halls or in classrooms