# COMPUTER SYSTEM OVERVIEW

➢ **What is computer?**

  ○ in today's era, computer is a necessity in everyone's life, we cannot imagine life without it.

  ○ *Computer* is an electronic device that manipulates(control), information or data according to the set of instructions. Set of instructions is called program.

  ○ *Computer* is the combination of hardware and software, which converts data into information.

  ○ *Hardware* means the physical electronic components of a computer.

    Eg. CPU, monitor, Keyboard etc.
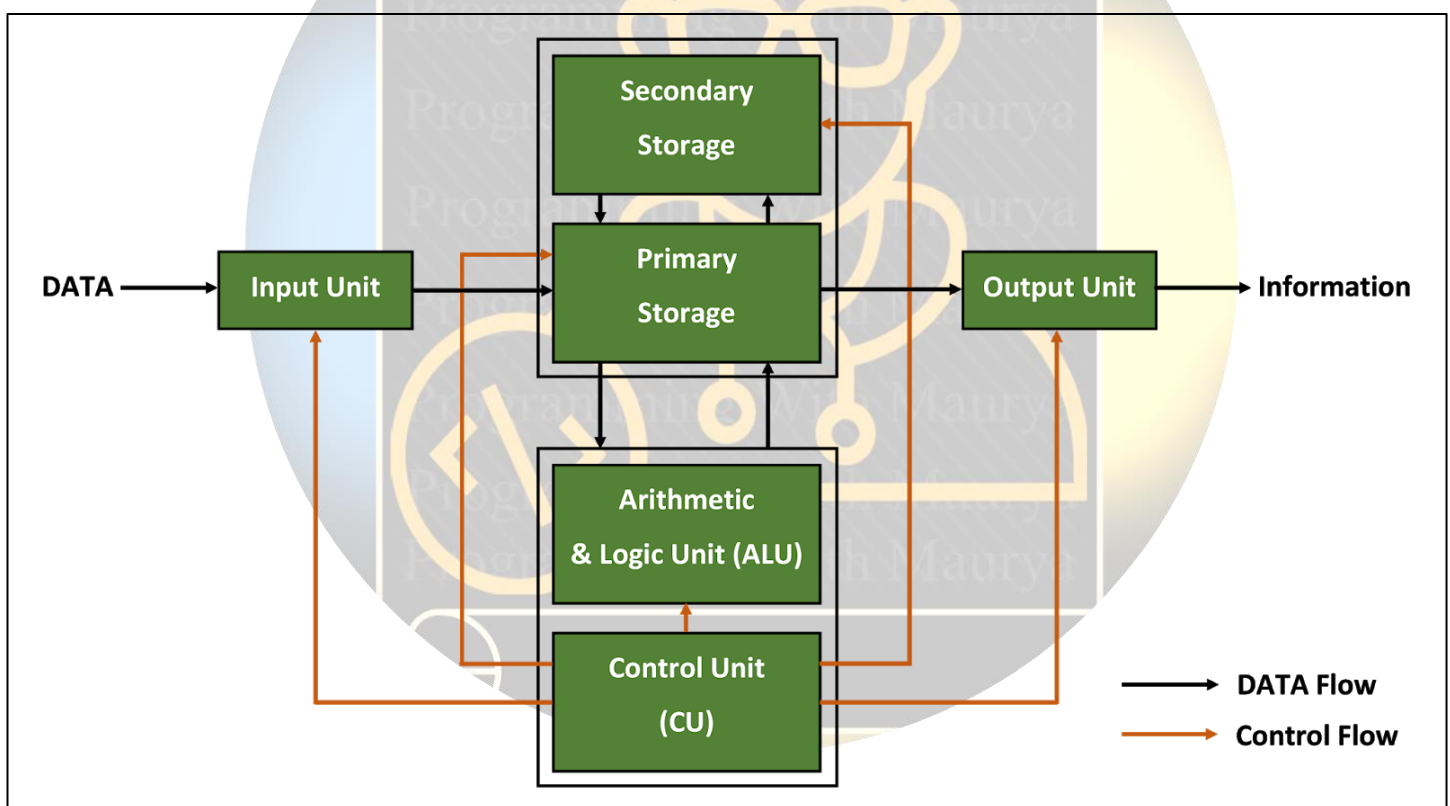
  ○ *Software* means the recorded instructions and programs that govern the working of a computer.

    Eg. Windows Vista, Ubuntu, Linux, Microsoft PowerPoint presentation

  ○ In this chapter we will see computer functioning by system organisation and types of software.

➢ **Basic computer Organization/Computer Processing/Basic architecture of a computer**

  ○ **Data** is a collection of facts, such as numbers, words, measurements, observations or just descriptions of things.

CPU

○ **Input unit** is defined as an input device, a piece of computer hardware apparatus used to supply a data processing system including a computer or information device with control and data signals. Eg. Keyboard, Mouse, Joystick, Camera etc.

○ **Output unit** is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as computer). Eg. Monitor, Earphones, Fax machine, Printer etc.

○ **CPU**

- Main Control Centre
- Processing Unit
- Brain of the computer
  - Guides the Computer
  - Controls the Computer
  - Governs the Performance of Computer
- **Arithmetic Logical Unit (*ALU*)**
  - performs all the arithmetic and logical operations
    - when we add two numbers
      - numbers are sent from memory to the ALU which adds the numbers.
      - then the results are sent back in the memory.
    - In logical operations,
      - the numbers to be compared are sent from memory to ALU and the result for the comparison.
      - returns to memory, the result can be either True or False.
      - This helps in decision making.
- **Control unit**
  - Controls and guides the flow and manipulation of all data and information.
  - sends control signals until the operation complete by ALU and memory.
  - program execution
    - carrying out all the instruction stored in a program.
  - get program instructions and executes(performs) them one after the other.

- instructions is decoded and interpreted.
- control unit controls the flow of data from input devices to memory and from memory to output devices.
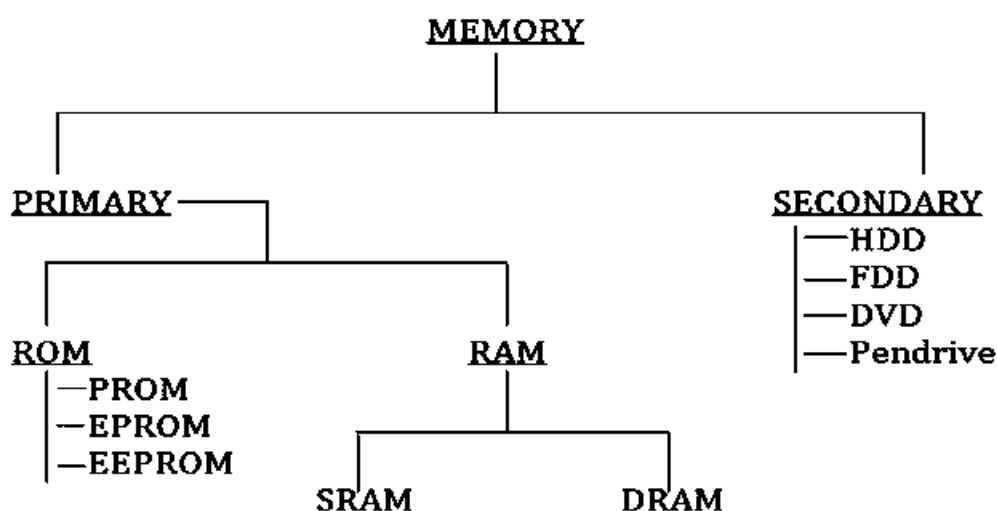
■ **Registers**

- is a quickly accessible location available to a computer's processor.
- small units of holding data places.
- temporarily hold some important processing information during the time of execution.
- it may store data, memory address or instructions.
- is a fast memory used immediately by the CPU.

➢ **Memory**

○ **Main memory/Primary Memory**

■ temporary(volatile), after switched off it'll lost our all data.
■ temporarily keeps information and data to facilitate(easier) its performance.
■ each memory location has its unique address.
■ after execution, it clears its memory and then space is available for next task.
■ if system switched off, all the data stored in that memory will be lost.
■ The **memory cell** is the fundamental building block of **computer memory**.

PROGRAMMING WITH MAURYA

```
                          MEMORY
                             |
          _____
         |                                           |
      PRIMARY----------                          SECONDARY
         |              |                          |—HDD
      _____       |                          |—FDD
     |           |      |                          |—DVD
    ROM         RAM                                |—Pendrive
    |—PROM        |
    |—EPROM     _____
    |—EEPROM   |             |
             SRAM          DRAM
```

- cell is broken into smaller parts called as bits.

■ bit includes binary digit i.e.; bits get together to store data instructions by their combination.

■ A bit is an elementary unit of memory.

■ 8 bits together form a byte.

■ 1 byte is the smallest unit which can represent a data item or character.

■ Amount of time taken to produce data required from memory, from the start of access until the availability of data, is called memory access time.

1024 bytes	= 1 KB	KB	=	Kilobyte
1024 KB	= 1 MB	MB	=	Megabyte
1024 MB	= 1 GB	GB	=	Gigabyte
1024 GB	= 1 TB	TB	=	Terabyte
1024 TB	= 1 PB	PB	=	Petabyte

■ **RAM**

- **Random Access Memory**
- RAM is a volatile memory
- is the internal memory of the CPU for storing data, program, and program result.
- a read/write memory (which means the information can be written to it as well as read from it.)
- The benefit of loading data into RAM is that reading data from the RAM is much faster than reading from the hard drive.
- the unnecessary data on the RAM is deleted when it fills up, and is replaced with new data from the hard disk which is required for the current operations.
- computer's performance mainly depends on the size or storage capacity of the RAM.
- **DRAM (Dynamic RAM)**
  - consists of transistors and capacitor
  - capacitor either contains no charge (0 bit) or hold a charge (1 bit)
  - today's DRAM chips have access times ranging from 20 to 70 nanoseconds.
  - DRAM chips are available with tens to hundreds Gigabit densities.

- ○ DRAM helps in the memory controller needs, to refresh the memory contents as many as thousand times a second, which is called memory refreshing.
  - Short Data lifetime
  - needs to be refreshed continuously
  - Slower as compared as SRAM
  - used as RAM
  - smaller in size
  - less expensive
  - less power consumption
- **SRAM (Static RAM)**
  - ○ no need to refresh several times to retain the stored data.
  - ○ contains flip-flop to store binary information
  - ○ A binary cell capable of storing one bit of information.
  - ○ contains 6 transistors and no capacitors.
  - ○ SRAM need not be refreshed on a regular basis.
  - ○ long life
  - ○ no need to refresh
  - ○ faster
  - ○ used as cache memory
  - ○ large size
  - ○ expensive
  - ○ high power consumption

- **ROM**
  - **Read Only Memory**
  - read operations only
  - permanent binary in formatted stored during hardware production of the unit
  - non-volatile

- can't reprogram, rewrite, or erase its content later

- The BIOS program, which is also present in the computer memory (ROM) is used by the microprocessor of the computer to start the computer during the booting process. It allows you to open the computer and connects the computer with the operating system.

- ROM is also used to store Firmware, which is a software program which remains attached to the hardware or programmed on a hardware device like a keyboard, hard drive, video cards, etc. It is stored in the flash ROM of a hardware device. It provides instructions to the device to communicate and interact with other devices.

- **Programmable Read Only Memory (PROM)**
  - a blank version of ROM
  - program it once using a special tool called a programmer.
  - used to record information using a facility as PROM programmer.
  - recorded information cannot be changed.
  - used in cell phones, video game consoles, medical devices, RFID tags, and more.

- **Erasable Programmable Read Only Memory (EPROM)**
  - can record different information using a special PROM-program facility.
  - can be erased.
  - it is done by exposing the chip to ultraviolet light.
  - while using EPROM, information can only be read and cannot be erased.
  - used in some micro-controllers to store program, e.g., some versions of Intel 8048 and the Freescale 68HC11.

- **Electrically Erasable Programmable Read Only Memory (EEPROM)**
  - can be programmed and erased by electric signals.
  - information can be retained for many years without any power supplied.
  - it can backup to RAM memory whose contents are lost in a power failure.
  - when power is returned, EEPROM memory can be used to replace the lost contents of the RAM memory and the microcomputer can continue working just as if nothing has happened.

○ Even newer devices are combining RAM and EEPROM memory in a single integrated circuit.

➢ **Storage Unit**

  ○ Store large amount of data permanently

  ○ Can be measured in KB, MB, GB, TB, PB etc.

  ○ **Hard Disks**

    ▪ Non-volatile

    ▪ Random access digital data storage device.

    ▪ Used for storing and retrieving digital information using rotating disks(platters) coated with magnetic material.

    ▪ All programs of a computer are installed in hard disk within a particular drive.

    ▪ It consists of a spindle that hold non-magnetic flat circular disks called platters, which hold the recorded data.

    ▪ Each platter requires two read/write heads, that is used to write and read the information from a platter.

    ▪ All the read/write heads are attached to a single access are so that they cannot move independently.

    ▪ The information is recorded in bands, each band of information is called a track.

    ▪ Each platter has the same number of tracks and a track location that cuts across all platters is called a cylinder.

    ▪ The tracks are divided into pie-shaped sections known as sectors.

    ▪ The minimum quantity of information which can be transferred is a sector.

    ▪ A motor rotates the disk at a rapid speed. Data are recorded on the tracks of a spinning disk surface and read from the surface by one or more read/write heads.

  ○ **Compact Disk**

    ▪ Optical media

    ▪ Cheap and storage capacity up to 700mb

    ▪ **CD-ROM**

- Used only to store information not data

- Compact Disk – Read Only Memory

- To record information including text, graphics or audio.

  - Eg. Encyclopaedia, software, games etc.

- Optical disks are available today in speed range of 48x to 75x(x=150kbps)

- **CD-R**

  - Compact Disk- Recordable

  - Data can be recorded only once.

  - One part of the disk one time and another part at a later time.

  - Disk can't be erased.

- **CD-RW (Compact Disk-Rewritable)**

  - Can be erased and recorded several times

  - It is more like floppy's or hard disks

- **DVDs**

  - Digital Video Disk

  - Optical storage device

  - 20 times fast and 15 times more data can be stored than compact disks

  - Also called as Super Density disk (CD)

  - **DVD-ROM**

    - Digital Video Disk-Read Only Memory

    - Can store from 4.7 GB to 17 GB.

    - Eg. Store a telephone book containing every resident in the US.

    - Originally developed for the movie industry.

    - Can read audio CD's, CD-ROM's, CD-R's and CD-RW's

  - **DVD-R(DVD-Recordable)**

    - Similar as CD-R

    - Store only one time and readable many times.

  - **DVD-RW(Rewritable)**

- Erase and read many times.

- **Pen/Thumb Drives- Flash memories**
    - Also called as USB memory, Key memory
    - Can be used in cell-phones using USB connector.
    - Solid state memory (no movement of any part)
    - Works in similar way as RAM but data is retained in Flash memory even when the power is switched off
    - Ranges from 256MB to 512GB.

- **Blu-Ray disk**
    - Developed by Blu-Ray Disc Association (BDA).

      (including Apple, Dell, Hitachi, HP, JVC, LG, Mitsubishi etc)

- Developed to enable recording, rewriting and playback of high-definition (HD) video
    - Can hold up to 25/50 GB on a single layer disc and 50/100 GB on a dual-layer disc.
    - Optical disc storage media format.
    - Disc has the same dimensions as a standard DVD or CD.
    - Current optical disk technology relies on a red laser to read and write data, the new format uses a blue-violet laser instead, hence the name Blue-Ray.
    - Blue-violet laser have shorter wavelength than a red-laser which helps in focusing the laser spot with even greater precision.
    - which takes less place, data are tightly packed.
    - Used in recording media, video game and music companies.
    - Major movie studios
    - Capable of storing up to 128GB of data

- **System Bus**
    - Electronic pathway composed of connecting cables and that connects the major components of a computer system.
    - Data and instructions are passed among the computer system components.
    - Data carrying part of system is called database.

- The control instruction carrying part of system bus is called control bus.

- Memory address carrying part of system is called Address bus.

- The input, output, and other external devices to the system is connected by I/O bus.

➢ **Mobile System Organization**

   ○ **Mobile Processor**

      - Brain of the smartphone

      - Receives commands, make instant calculations, plays audio/video, stores information and sends signals throughout the device.

   ○ **Communication Processing Unit**

      - Responsible for making and receiving phone calls on a mobile handset.
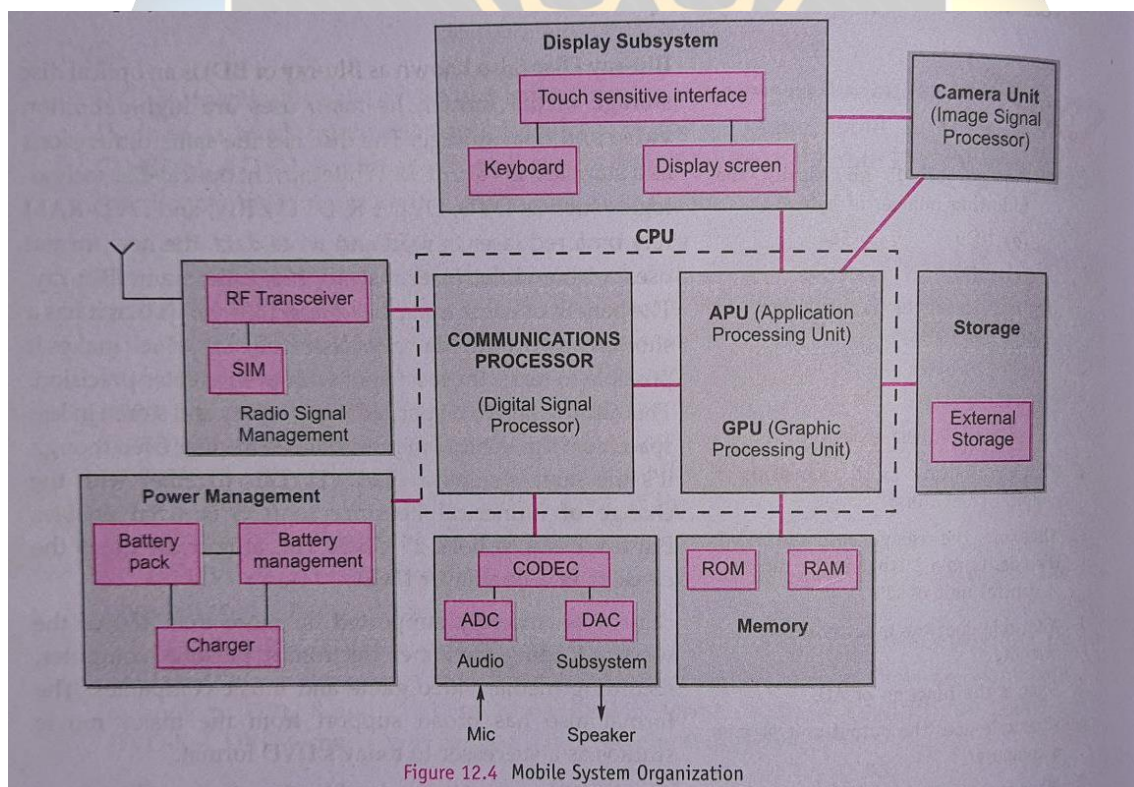
- Digital signal processor that helps it work with RF transceiver and the Audio subsystem.

Figure 12.4 Mobile System Organization

- Radio Signal Management Unit

      • For connecting SIM to the base stations through radio signals(2G/3G/4G)

      - Audio Subsystem

         • Responsible for converting the voice signals to digital signals and vice-versa.

         • DAC

            ○ Digital to Analog Converter

            ○ Produces digital output to analog audio form(Speaker).

- ADC
    - Analog to Digital Converter
    - Receives audio input and convert it into digital form so that mobile system can work on it (Mic)

- **Application Processing Unit (APU)**
    - Responsible for governing, controlling all types of operations taking place on a mobile system.
    - Responsible for calculations, playing music, browsing net, streaming videos, saving data and so on.
    - For visuals and other graphically rich applications, GPU assists the CPU.
    - GPU handles all the graphics-related chores of a mobile CPU.
    - Applications Processing Unit is connected with all other sub systems of a mobile system such as display subsystem, camera subsystem, memory, storage, connectivity subsystem etc.

- **System on a Chip (SoC)**
    - All major components of a mobile system are integrated on a single chip called system on a chip (SoC).
    - GPU, modem (SIM), display processor, video processor and other
    - Made of Silicon
    - Consume less power than other alternatives

- **Display Subsystem**
    - Provide display facilities and touch sensitive interface.
    - Display Screen
        - Amoled based display screens form a major part of this subsystem.
    - Touch sensitive interface
        - Activates the touch sensors of the mobile system screen and recognizes instructions given through it.
    - Touch sensitive keyboards
        - Allows to type letters and numbers through touch.

- **Camera Subsystem**

- Designed to deliver a tightly bound image processing package and enable an improved overall picture and video experiences.
- Integrated image signal processor
  - Instant image capture
  - High-resolution support, image stabilisation and other image enhancements.

○ **Mobile System Memory**

- RAM
  - When we run installed mobile apps, it is first loaded in the RAM and then executed.
  - When we don't use it longer, they are shifted to background.
  - More RAM $\rightarrow$ better performance $\rightarrow$ faster phone
  - RAM does not store information once the device is turned off.
- ROM
  - Part of mobile system's internal storage
  - Not accessible for users to write on.
  - It is basically EEPROM or Flash memory
  - It includes pre-installed apps
  - That's why we don't get full internal memory as advertised on the box.

○ **Storage**

- External storage/ expandable storage
- In the form of SD cards, or micro-SD cards etc.
- Can be removed easily.
- Can be used for storing pictures, music, videos and the likes.
- But may or may not be able to able to install applications on it.
- Cloud storage can also be categorized as external storage.

○ **Power Management Systems**

- Responsible for providing power to mobile
- Works on a limited power depending on the battery unit.

- Works with a battery charger and a battery unit, and provide power to mobile system in required form.
- Contains a collection of different functions that include battery charging, monitoring and supplying many different voltages these systems require.
- Also contain software-controlled turn-on and turn-off feature.

➢ Software

- **Hardware**
  - Hardware represents the physical and tangible components of the computer.
  - Eg. CPU, printer, mouse, keyboard, etc.
- **Software**
  - Software represents the set of programs that govern the operation of a computer system and make the hardware run.
  - System Software
  - Application Software
- **System Software**
  - The software that controls internal computer operations that is reading data from input devices, transmitting system processed information to the output devices, checking system components, converting data/instructions to computer understandable form etc.
  - Operating system
  - Language Processor
- **Operating System (OS)**
  - Make the computer system convenient to use
  - A program which acts as an interface between a user and the hardware (i.e., all computer resources).
  - Use computer hardware in an efficient manner
  - Major component of a computer system to control other computer system components are: -
  - Hardware
    - Which provides basic computing resources

- ○ Application program
  - ▪ The way in which these resources to be used to solve computing problems of the user.
- ○ Operating system
  - ▪ Controls and coordinates the use of the hardware among the various application programs for the various users.
  - ▪ Types of operating system
    - Single user OS (Eg. MS-DOS etc.)
    - Multiuser OS (Eg. Windows Vista, windows xp, etc.)
    - Time-sharing OS (Eg. Linux, Unix etc.)
    - Real-time OS (Eg. Traffic Control System etc.)
    - Multiprocessing OS (Eg. IOS etc.)
    - Distributed OS (Eg. Ubuntu, distrix etc.)
- ○ **Language Processor**
  - ▪ Special type of a computer software that can translate the source code into an object code or machine code.
  - ▪ Source code-
    - Program code written by a programmer in a high-level language such as C, JAVA, C++ etc.
  - ▪ Object code-
    - Code in machine language or binary code which is easily understandable by computer.
  - ▪ Assembler
    - This language processor converts the program in assembly language into machine language
  - ▪ Interpreter
    - An interpreter is a type of system software that translates and executes instructions written in a computer program line-by-line, unit-by-unit etc.

- Compiler
  - A compiler is another type of system software that translates and executes instruction written in a program in one go.

- **Application Software**
  - Programs written by programmers to perform a specific task such as processing words, calculation, financial and accounting, billing etc.
  - **Packages**
    - Some general software are designed that maybe used by individual users in the manner it suits their needs and requirements. Such general-application software are known as Packages.
    - Some major and most common categories of general application software(packages) are:
      - Word Processing software
      - Spreadsheets
      - DBMS
      - Desktop Publishing Software
      - Graphics, multimedia and presentation application
  - **Utilities**
    - Application programs that assist the computer by performing housekeeping functions like backing up disk or scanning/cleaning viruses or arranging information etc.
    - Some utilities are as follows:
      - Text editor
        - Used for creating, editing text files.
      - Backup utility
        - Facilitates the backing-up of disk
        - Duplicating the disk information so that in case of any damage or data-loss, this backed up data may be used.
      - Compression utility

- Compress large files so that they take less storage data
  - Disk fragmentor
    - A file is fragmented when it becomes too large for your computer to store in a single location on a disk.
    - This splits up the computer and stores it in pieces. We can use fragmented files, but it takes your computer longer to access them.
    - Disk fragmentor utility program speeds up disk access by rearranging the files and free space on your computer, so that files are stored in contiguous units and free space is considered in one contiguous block.
  - Antivirus Software
    - Ensures virus free work environment.
    - Computer virus is a malicious computer program that disrupts the normal functioning of a computer
    - Scans disk for viruses and remove them.

- **Business Software**
  - Specifically created software according to a business requirement.
  - Examples of these software: -
    - Inventory management system, (for managing inventory details of a company), Payroll system (for handling payroll of a company's employees), financial Accounting, Hotel management and reservation system etc.
  - Customized software
    - As per the specific company requirements

- **Software Libraries**
  - The predefined sets of codes (functions, classes, scripts) for programmers to develop software and programs are called software libraries

- A software library is a predefined and available to sue, suite of data and programming code in the form of prewritten code/ functions/ scripts/ classes etc. that can be used in the development of new software programs and applications.
- Examples:
  - Numpy (Numerical Python)
    - Useful features and function for operation on numeric arrays and matrices in Python.
  - SciPy (scientific Python)
    - Contains modules for linear algebra, optimization, integration, and statistics
  - Panda library
    - Work with 'labelled' and relational data.
    - Designed for quick and easy data manipulation, aggregation, and visualization.

Data representation

- In digital systems like computers, the quantities are represented by symbols called digits.
- Decimal
- Binary
- Octal
- Hexadecimal
- **Decimal number system**
  - 10 numerals or symbols
  - 0,1,2,3,4,5,6,7,8,9
  - Base-10 system
  - Position value system
  - Value of digits depend upon the position

Carries the least weight, Least significant Digits (LSD)

Carries the most weight, Most significant Digits (MSD)

729	927
700	900
20	20

9	7

- ■
- ■ Decimal number system sequence
  - ● 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16…….
  - ● Eg.
    - ○ 52_{10}
    - ○ 52.79_{10}

So, every decimal number can be expressed as power of 10.

○ **Binary Number System**

- ■ Every digital use binary number system
- ■ Base-2
- ■ Two numbers or symbols 0 and 1.
- ■ Position-value system
- ■ Eg. 101101_2
- ■ the term binary digit is abbreviated to the term bit.
- ■ Leftmost bit carries the largest weight, Most significant Bit (MSB)
- ■ Rightmost bit carries the smallest weight, Least significant Bit (LSB)
- ■ 0,1,10,11,101,110,100,1000…

○ **Octal Number System**

- ■ Important in digital computer work
- ■ 8 numbers or symbols
- ■ 0,1,2,3,4,5,6,7
- ■ Positional-value system
- ■ Sequence: - 0,1,2,3,4,5,6,7,10,11,12,13,14,15,16,17,20….
- ■ Eg. 3721.2406_8

- ○ **Hexadecimal Number System**
    - ▪ Base-16
    - ▪ 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
    - ▪ Positional value system
    - ▪ 16 numbers or symbols
    - ▪ Each hexadecimal represents a group of 4 binary digits
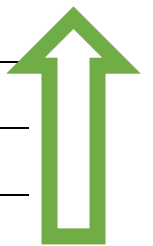
- ➢ **Number Conversions**

    - ○ Decimal to Binary conversion
        - ▪ 43_{10}

2	43	
2	21	1
2	10	1
2	5	0
2	2	1
2	1	0
2	0	1

101011_2

- 4545

2	4545	
2	2272	1
2	1136	0
2	568	0
2	284	0
2	142	0
2	71	0
2	35	0
2	17	1
2	8	1
2	4	1
2	2	0
2	1	0
2	0	1

- **1001110000001_2**

- Binary to decimal
  - 11101_2
    - $\mathbf{1} \times 2^4 + \mathbf{1} \times 2^3 + \mathbf{1} \times 2^2 + \mathbf{0} \times 2^1 + \mathbf{1} \times 2^0$
    - $16+8+4+0+1$
    - $24+5$
    - $\mathbf{29_{10}}$

-
  - 101011_2
    - $\mathbf{1} \times 2^5 + \mathbf{0} \times 2^4 + \mathbf{1} \times 2^3 + \mathbf{0} \times 2^2 + \mathbf{1} \times 2^1 + \mathbf{1} \times 2^0$
    - $32+0+8+0+2+1$
    - $42+1$
    - $\mathbf{43_{10}}$
- Decimal to octal
  - 266_{10}

8	266	
8	33	1
8	4	1
8	0	4
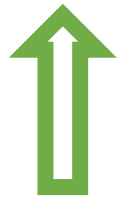
  - $\mathbf{412_8}$

  - 589_{10}

8	589	
8	73	5
8	9	1
8	1	1
	0	1

  - $\mathbf{1115_8}$

- Octal to Decimal
  - 412_8
    - $\mathbf{4} \times 8^2 + \mathbf{1} \times 8^1 + \mathbf{2} \times 8^0$
    - $4 \times 64 + 8+2$
    - $256+10$

- **266_{10}**

  - 1115_8
    - $1 \times 8^3 + 1 \times 8^2 + 1 \times 8^1 + 5 \times 8^0$
    - 512+64+8+5
    - 512+77
    - **589_{10}**

- Decimal to Hexadecimal

  - 423_{10}

16	423		
16	26	7	7
16	1	10	A
	0	1	1

    - **$1A7_{16}$**

  - 854_{10}

16	854	
16	53	6
16	3	5
	0	3

    - **356_{16}**

- Hexadecimal to decimal
  - $1A7_{16}$
    - $1 \times 16^2 + 10 \times 16^1 + 7 \times 16^0$
    - 256+160+7
    - **423_{10}**
  - 356_{16}

- **3** x 16^2 +**5** x 16^1 + **6**x 16^0

- 256 x 3 + 80 + 6

- 768+86

- **854_{10}**

○ **Binary to hexadecimal**

  ■ Step-1 Binary to decimal

  ■ Step-2 Decimal to hexadecimal

○ **Hexadecimal to binary**

  ■ Step-1 hexadecimal to decimal

  ■ Step-2 Decimal to binary

○ **Binary to octal**

  ■ Step-1 Binary to decimal

  ■ Step-2 Decimal to Octal

○ **Octal to Binary**

  ■ Step-1 Octal to decimal

  ■ Step-2 Decimal to Binary

○ **Binary addition**

  ■ 0 + 0 = 0

  ■ 0 + 1 = 1

  ■ 1 + 0 = 1

  ■ 1 + 1 = 0 with carry 1

  ■ 1 + 1 + 1=11 with carry 1

  ■ Eg.

ASCII control characters

00	NULL	(Null character)
01	SOH	(Start of Header)
02	STX	(Start of Text)
03	ETX	(End of Text)
04	EOT	(End of Trans.)
05	ENQ	(Enquiry)
06	ACK	(Acknowledgement)
07	BEL	(Bell)
08	BS	(Backspace)
09	HT	(Horizontal Tab)
10	LF	(Line feed)
11	VT	(Vertical Tab)
12	FF	(Form feed)
13	CR	(Carriage return)
14	SO	(Shift Out)
15	SI	(Shift In)
16	DLE	(Data link escape)
17	DC1	(Device control 1)
18	DC2	(Device control 2)
19	DC3	(Device control 3)
20	DC4	(Device control 4)
21	NAK	(Negative acknowl.)
22	SYN	(Synchronous idle)
23	ETB	(End of trans. block)
24	CAN	(Cancel)
25	EM	(End of medium)
26	SUB	(Substitute)
27	ESC	(Escape)
28	FS	(File separator)
29	GS	(Group separator)
30	RS	(Record separator)
31	US	(Unit separator)
127	DEL	(Delete)

ASCII printable characters

32	space	64	@	96	`
33	!	65	A	97	a
34	"	66	B	98	b
35	#	67	C	99	c
36	$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	'	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44	,	76	L	108	l
45	-	77	M	109	m
46	.	78	N	110	n
47	/	79	O	111	o
48	0	80	P	112	p
49	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58	:	90	Z	122	z
59	;	91	[	123	{
60	<	92	\	124		
61	=	93	]	125	}
62	>	94	^	126	~
63	?	95	_		

Extended ASCII characters

128	Ç	160	á	192	└	224	Ó
129	ü	161	í	193	┴	225	ß
130	é	162	ó	194	┬	226	Ô
131	â	163	ú	195	├	227	Ò
132	ä	164	ñ	196	─	228	õ
133	à	165	Ñ	197	┼	229	Õ
134	å	166	ª	198	ã	230	µ
135	ç	167	º	199	Ã	231	þ
136	ê	168	¿	200	╚	232	Þ
137	ë	169	®	201	╔	233	Ú
138	è	170	¬	202	╩	234	Û
139	ï	171	½	203	╦	235	Ù
140	î	172	¼	204	╠	236	ý
141	ì	173	¡	205	=	237	Ý
142	Ä	174	«	206	╬	238	¯
143	Å	175	»	207	¤	239	´
144	É	176	░	208	ð	240	≡
145	æ	177	▒	209	Ð	241	±
146	Æ	178	▓	210	Ê	242	
147	ô	179	│	211	Ë	243	¾
148	ö	180	┤	212	È	244	¶
149	ò	181	Á	213	ı	245	§
150	û	182	Â	214	Í	246	÷
151	ù	183	À	215	Î	247	¸
152	ÿ	184	©	216	Ï	248	°
153	Ö	185	╣	217	┘	249	¨
154	Ü	186	║	218	┌	250	·
155	ø	187	╗	219	█	251	¹
156	£	188	╝	220	▄	252	³
157	Ø	189	¢	221	¦	253	²
158	×	190	¥	222	Ì	254	■
159	ƒ	191	┐	223	▀	255	nbsp

- 11011+1111=1011

- 11100+11010=110110

➢ **ASCII code** (Askee)

  ○ American Standard cod for information Interchange

  ○ Most microcomputer, minicomputer, many mainframes

  ○ 7-bit code
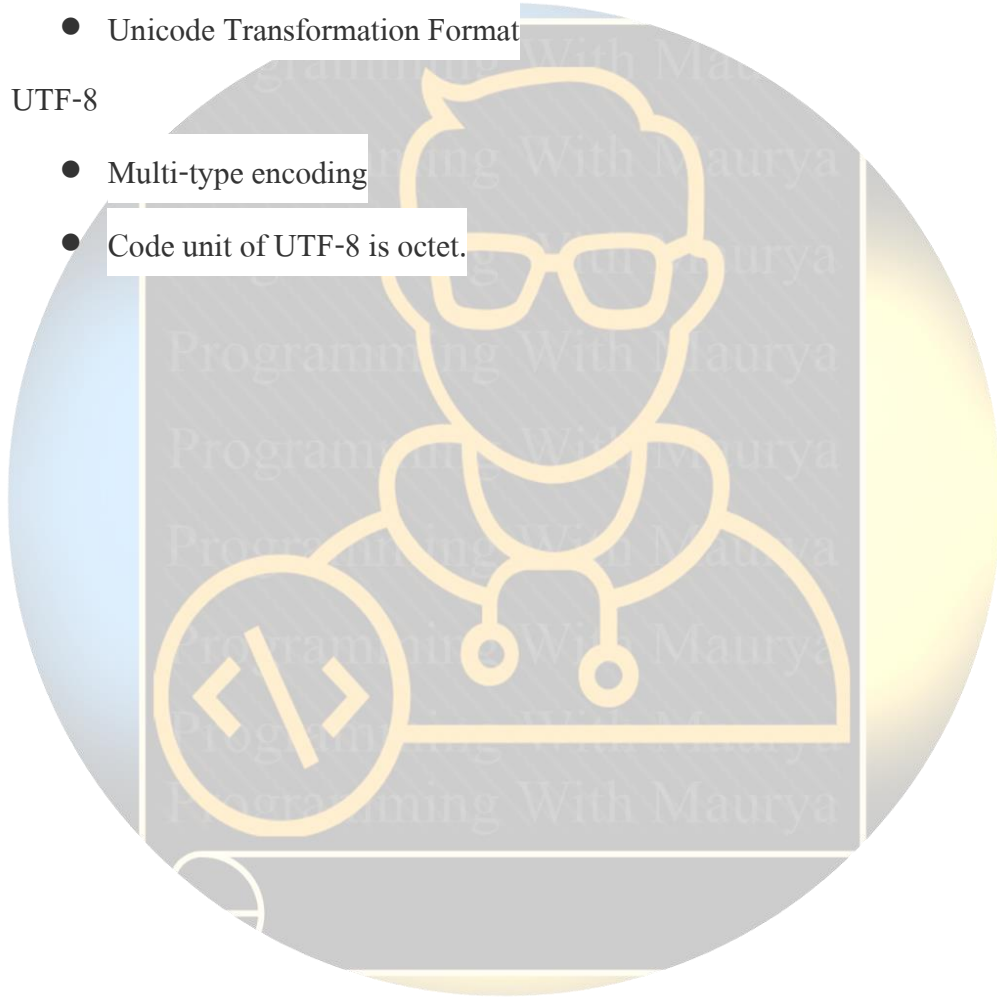
  ○ 2^7 ➔ 128 possible groups

➢ **ISCII code**

  ○ Indian Standard code for Information Interchange

  ○ In 1991.

- 8-bit code
- $2^8 \rightarrow$ 256 possible groups
- Also called Indian scripts code
- Used by IBM for PC-DOS
    - Apple for ILK
- Tamil, Kannada, Telgu, Bengal, Assmaese, Oriya, Gujrati, Gurumukhi, Devanagri

➤ Unicode

- Universal character set
    - To define all the characters needed for writing the majority of known languages
    - Use on computers in one place.
    - To be a superset of all other character set
- Terms related to encoding
    - Encoding scheme: -
        - Converting information
        - Character-by-character
        - Machine intelligible code
        - Same character may be represented through different encoding schemes.
    - Code Space: -
        - All the codes that an encoding scheme used to represent character.
        - ASCII has code space from 0 to 127
    - Code point
        - Code that represents a single character from the character set represented by an encodings scheme.
        - Eg. 0x31 is one code point of ASCII that represents character ''A".
        - Represents position of a character in the coded character set.
        - ASCII has 128 code point
        - Unicode has 1,112,064 code point.
    - Code Unit

- Unit of storage (no. of bits used)

- Used to represent one encoded code point

- UTF-8 encoding scheme uses 8-bits units to represent characters.

- It may take up to 8 bits for single character also, like for snowmen, it requires 24 bits it means 3UTF-8

- UTF

  - Unicode Transformation Format

- UTF-8

  - Multi-type encoding

  - Code unit of UTF-8 is octet.