



Future Star Series  
1st Edition  
2016

# MCQS IN COMPUTER SCIENCE

*A quick Approach to Computer technologies.*

**FOR  
PPSC,NTS & FPSC  
PAKISTAN**

**THEORY + MCQS**

- *Computer Fundamentals*
- *Operating Systems*
- *Databases and SQL*
- *Data Structures and Algos*
- *Computer Networks*
- *Object Oriented Programming*
- *Artificial Intelligence*



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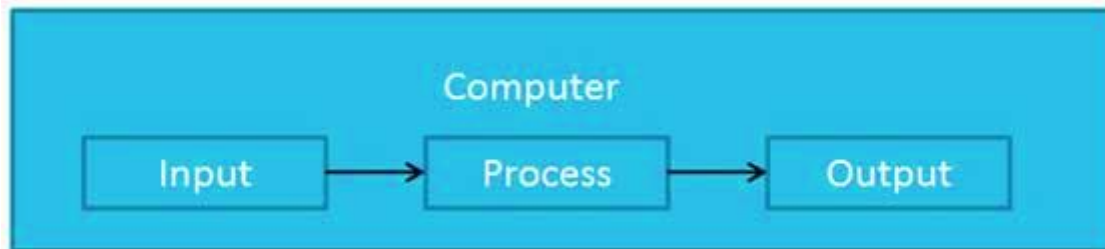
# FUNDAMENTALS OF COMPUTERS:

Today's world is an information-rich world and it has become a necessity for everyone to know about computers. Purpose of this tutorial is to introduce you about computer and its fundamentals.

## FUNCTIONALITIES OF A COMPUTER

Any digital computer carries out five functions in gross terms:

- Takes data as input.
- Stores the data/instructions in its memory and use them when required.
- Processes the data and converts it into useful information.
- Generates the output
- Controls all the above four steps.



## DEFINITION

Computer is an electronic data processing device which

- accepts and stores data input,
- processes the data input, and
- Generates the output in a required format.

## ADVANTAGES

Following list demonstrates the advantages of computers in today's arena.

### I. High Speed

- Computer is a very fast device.
- It is capable of performing calculation of very large amount of data.
- The computer has units of speed in microsecond, nanosecond, and even the picosecond.
- It can perform millions of calculations in a few seconds as compared to man who will spend many months for doing the same task.

### II. Accuracy

- In addition to being very fast, computers are very accurate.
- The calculations are 100% error free.

- Computers perform all jobs with 100% accuracy provided that correct input has been given.

### III. Storage Capability

- Memory is a very important characteristic of computers.
- A computer has much more storage capacity than human beings.
- It can store large amount of data.
- It can store any type of data such as images, videos, text, audio and many others.

### IV. Diligence

- Unlike human beings, a computer is free from monotony, tiredness and lack of concentration.
- It can work continuously without any error and boredom.
- It can do repeated work with same speed and accuracy.

### V. Versatility

- A computer is a very versatile machine.
- A computer is very flexible in performing the jobs to be done.
- This machine can be used to solve the problems related to various fields.
- At one instance, it may be solving a complex scientific problem and the very next moment it may be playing a card game.

### VI. Reliability

- A computer is a reliable machine.
- Modern electronic components have long lives.
- Computers are designed to make maintenance easy.

### VII. Automation

- Computer is an automatic machine.
- Automation means ability to perform the given task automatically.
- Once a program is given to computer i.e., stored in computer memory, the program and instruction can control the program execution without human interaction.

### VIII. Reduction in Paper Work

- The use of computers for data processing in an organization leads to reduction in paper work and results in speeding up a process.
- As data in electronic files can be retrieved as and when required, the problem of maintenance of large number of paper files gets reduced.

### IX. Reduction in Cost

- Though the initial investment for installing a computer is high but it substantially reduces the cost of each of its transaction.

## DISADVANTAGES

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Following list demonstrates the disadvantages of computers in today's arena

### *NO I.Q*

- A computer is a machine that has no intelligence to perform any task.
- Each instruction has to be given to computer.
- A computer cannot take any decision on its own.

### *DEPENDENCY*

- It functions as per a user's instruction, so it is fully dependent on human being

### *ENVIRONMENT*

- The operating environment of computer should be dust free and suitable.

### *NO FEELING*

- Computers have no feelings or emotions.
- It cannot make judgement based on feeling, taste, experience, and knowledge unlike a human being.

## COMPUTER – APPLICATIONS AND USES

### *I. BUSINESS*

A computer has high speed of calculation, diligence, accuracy, reliability, or versatility which made it an integrated part in all business organizations.

Computer is used in business organizations for:

- Payroll calculations
- Budgeting
- Sales analysis
- Financial forecasting
- Managing employees database
- Maintenance of stocks etc.



## *II. BANKING:*

Today banking is almost totally dependent on computer.

Banks provide following facilities:

- Banks provide online accounting facility, which includes current balances, deposits, overdrafts, interest charges, shares, and trustee records.
- ATM machines are making it even easier for customers to deal with banks.



## *III. INSURANCE:*

Insurance companies are keeping all records up-to-date with the help of computers. The insurance companies, finance houses and stock broking firms are widely using computers for their concerns.

Insurance companies are maintaining a database of all clients with information showing

- procedure to continue with policies
- starting date of the policies
- next due installment of a policy
- maturity date
- interests due
- survival benefits
- bonus





#### IV. EDUCATION:

The computer has provided a lot of facilities in the education system.

- The computer provides a tool in the education system known as CBE (Computer Based Education).
- CBE involves control, delivery, and evaluation of learning.
- The computer education is rapidly increasing the graph of number of computer students.
- There are number of methods in which educational institutions can use computer to educate the students.
- It is used to prepare a database about performance of a student and analysis is carried out on this basis.



#### V. MARKETING:

In marketing, uses of computer are following:

- **Advertising** - With computers, advertising professionals create art and graphics, write and revise copy, and print and disseminate ads with the goal of selling more products.
- **At Home Shopping** - Home shopping has been made possible through use of computerized catalogues that provide access to product information and permit direct entry of orders to be filled by the customers.



## VI. HEALTH CARE:

Computers have become an important part in hospitals, labs, and dispensaries. The computers are being used in hospitals to keep the record of patients and medicines. It is also used in scanning and diagnosing different diseases. ECG, EEG, Ultrasounds and CT Scans etc., are also done by computerized machines.

Some major fields of health care in which computers are used are:

- **Diagnostic System** - Computers are used to collect data and identify cause of illness.
- **Lab-diagnostic System** - All tests can be done and reports are prepared by computer.
- **Patient Monitoring System** - These are used to check patient's signs for abnormality such as in Cardiac Arrest, ECG etc.
- **Pharma Information System** - Computer checks Drug-Labels, Expiry dates, harmful drug's side effects etc.
- **Surgery:** Nowadays, computers are also used in performing surgery.



## VII. ENGINEERING DESIGN

Computers are widely used in engineering purpose.

One of major areas is CAD (Computer aided design). That provides creation and modification of images. Some fields are:

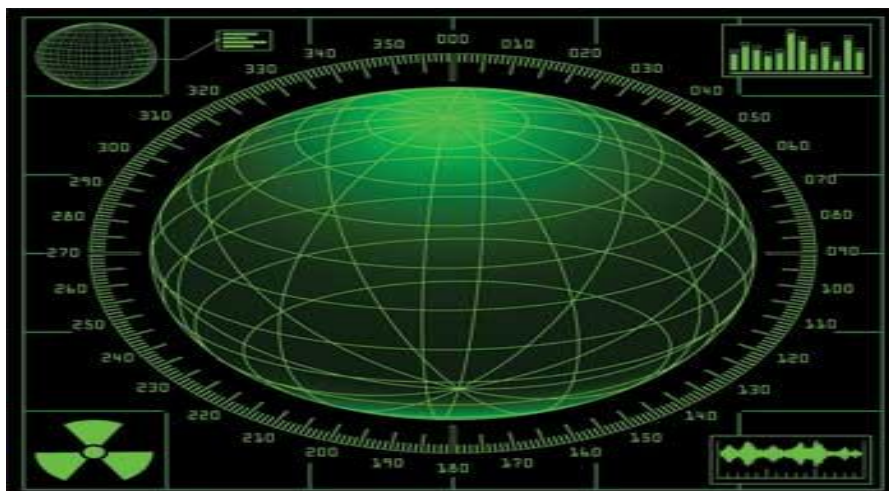
- **Structural Engineering** - Requires stress and strain analysis for design of Ships, Buildings, Budgets, and Airplanes etc.
- **Industrial Engineering** - Computers deal with design, implementation and improvement of integrated systems of people, materials and equipment's.
- **Architectural Engineering** - Computers help in planning towns, designing buildings, determining a range of buildings on a site using both 2D and 3D drawings.



#### VIII. **MILITARY**

Computers are largely used in defense. Modern tanks, missiles, weapons etc. Military also employs computerized control systems. Some military areas where a computer has been used are:

- Missile Control
- Military Communication
- Military Operation and Planning
- Smart Weapons





## *IX. COMMUNICATION*

Communication means to convey a message, an idea, a picture or speech that is received and understood clearly and correctly by the person for whom it is meant for. Some main areas in this category are:

- E-mail
- Chatting
- Usenet
- FTP
- Telnet
- Video-conferencing



## *X. GOVERNMENT*

Computers play an important role in government. Some major fields in this category are:

- Budgets
- Sales tax department
- Income tax department
- Male/Female ratio
- Computerization of voters lists
- Computerization of driving licensing system
- Computerization of PAN card
- Weather forecasting



## COMPUTER GENERATIONS

Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. But nowadays, generation includes both hardware and software, which together make up an entire computer system.

There are totally five computer generations known till date. Each generation has been discussed in detail along with their time period and characteristics. Here approximate dates against each generations have been mentioned which are normally accepted.

Following are the main five generations of computers

Sr. No.	Generation & Description
1	<b>First Generation</b> The period of first generation: 1946-1959. Vacuum tube based.
2	<b>Second Generation</b> The period of second generation: 1959-1965. Transistor based.
3	<b>Third Generation</b> The period of third generation: 1965-1971. Integrated Circuit based.
4	<b>Fourth Generation</b> The period of fourth generation: 1971-1980. VLSI microprocessor based.

5	<b>Fifth Generation</b> The period of fifth generation: 1980-onwards. ULSI microprocessor based
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## COMPUTER - TYPES

Computers can be broadly classified by their speed and computing power.

Sr. No.	Type	Specifications
1	<b>PC (Personal Computer)</b>	It is a single user computer system having moderately powerful microprocessor
2	<b>WorkStation</b>	It is also a single user computer system which is similar to personal computer but have more powerful microprocessor.
3	<b>Mini Computer</b>	It is a multi-user computer system which is capable of supporting hundreds of users simultaneously.
4	<b>Main Frame</b>	It is a multi-user computer system which is capable of supporting hundreds of users simultaneously. Software technology is different from minicomputer.
5	<b>Supercomputer</b>	It is an extremely fast computer which can execute hundreds of millions of instructions per second.

### PC (PERSONAL COMPUTER)

A PC can be defined as a small, relatively inexpensive computer designed for an individual user. PCs are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. At home, the most popular use for personal computers is playing games and surfing Internet.

Although personal computers are designed as single-user systems, these systems are normally linked together to form a network. In terms of power, now-a-days High-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and Dell.



## WORKSTATION

Workstation is a computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other such types of applications which require a moderate amount of computing power and relatively high quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, large amount of RAM, inbuilt network support, and a graphical user interface. Most workstations also have a mass storage device such as a disk drive, but a special type of workstation, called a diskless workstation, comes without a disk drive.

Common operating systems for workstations are UNIX and Windows NT. Like PC, Workstations are also single-user computers like PC but are typically linked together to form a local-area network, although they can also be used as stand-alone systems.



## MINICOMPUTER

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously.



## MAINFRAME

Mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports many simultaneous execution of programs



## SUPERCOMPUTER

Supercomputers are one of the fastest computers currently available. Supercomputers are very expensive and are employed for specialized applications that require immense amount of mathematical calculations (number crunching). For example, weather forecasting, scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting).

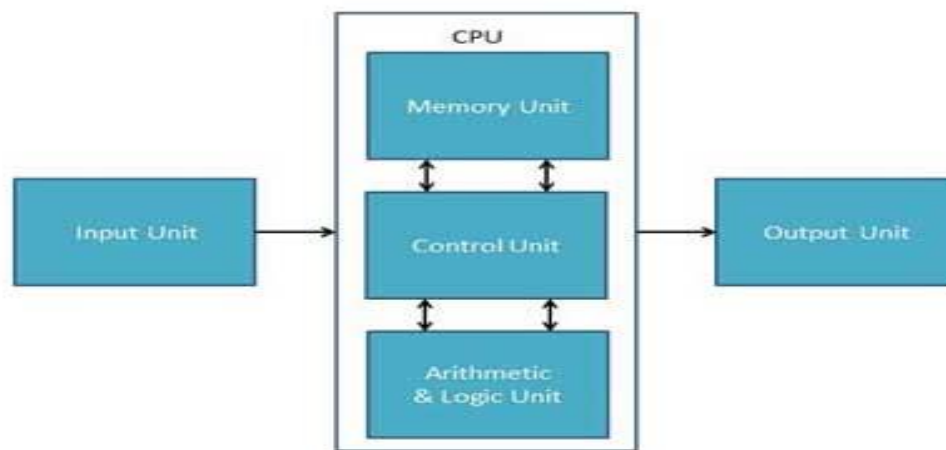
## COMPUTER - COMPONENTS

All types of computers follow a same basic logical structure and perform the following five basic operations for converting raw input data into information useful to their users.

Sr. No.	Operation	Description
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1	Take Input	The process of entering data and instructions into the computer system
2	Store Data	Saving data and instructions so that they are available for processing as and when required.
3	Processing Data	Performing arithmetic, and logical operations on data in order to convert them into useful information.
4	Output Information	The process of producing useful information or results for the user, such as a printed report or visual display.
5	Control the workflow	Directs the manner and sequence in which all of the above operations are performed.



## INPUT UNIT

This unit contains devices with the help of which we enter data into computer. This unit makes link between user and computer. The input devices translate the information into the form understandable by computer.

## CPU (CENTRAL PROCESSING UNIT)

CPU is considered as the brain of the computer. CPU performs all types of data processing operations. It stores data, intermediate results and instructions (program). It controls the operation of all parts of computer.

CPU itself has following three components

- ALU(Arithmetic Logic Unit)
- Memory Unit
- Control Unit

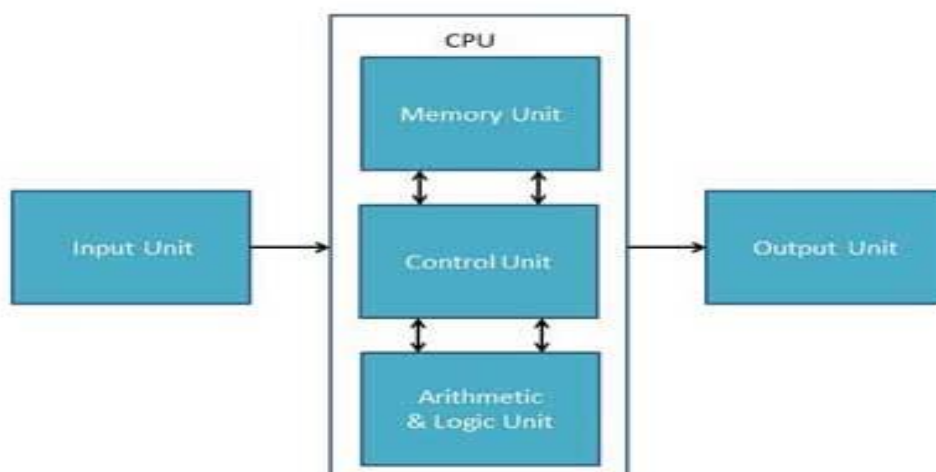
## OUTPUT UNIT

## COMPUTER - CPU (CENTRAL PROCESSING UNIT)

- CPU is considered as the brain of the computer.
- CPU performs all types of data processing operations.
- It stores data, intermediate results and instructions (program).
- It controls the operation of all parts of computer.



- Memory or Storage Unit
- Control Unit
- ALU(Arithmetic Logic Unit)



This unit can store instructions, data and intermediate results. This unit supplies information to the other units of the computer when needed. It is also known as internal storage unit or main memory or primary storage or Random access memory (RAM).

Its size affects speed, power and capability. Primary memory and secondary memory are two types of memories in the computer. Functions of memory unit are:

- It stores all the data and the instructions required for processing.
- It stores intermediate results of processing.
- It stores final results of processing before these results are released to an output device.
- All inputs and outputs are transmitted through main memory.

### *CONTROL UNIT*

This unit controls the operations of all parts of computer but does not carry out any actual data processing operations.

Functions of this unit are:

- It is responsible for controlling the transfer of data and instructions among other units of a computer.
- It manages and coordinates all the units of the computer.
- It obtains the instructions from the memory, interprets them, and directs the operation of the computer.
- It communicates with Input/output devices for transfer of data or results from storage.
- It does not process or store data.

### *ALU (ARITHMETIC LOGIC UNIT)*

This unit consists of two subsections namely

- Arithmetic section
- Logic Section

### *ARITHMETIC SECTION*

Function of arithmetic section is to perform arithmetic operations like addition, subtraction, multiplication and division. All complex operations are done by making repetitive use of above operations.

### *LOGIC SECTION*

Function of logic section is to perform logic operations such as comparing, selecting, matching and merging of data.

## COMPUTER - INPUT DEVICES

Following are few of the important input devices which are used in a computer:

- Keyboard
- Mouse

- Joy Stick
- Light pen
- Track Ball
- Scanner
- Graphic Tablet
- Microphone
- Magnetic Ink Card Reader (MICR)
- Optical Character Reader(OCR)
- Bar Code Reader
- Optical Mark Reader(OMR)

## KEYBOARD

Keyboard is the most common and very popular input device which helps in inputting data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.

Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

The keys on the keyboard are as follows:

Sr. No	Keys	Description
1	Typing Keys	These keys include the letter keys (A-Z) and digit keys (0-9) which generally give same layout as that of typewriters.
2	Numeric Keypad	It is used to enter numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
3	Function Keys	The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has unique meaning and is used for some specific purpose.
4	Control keys	These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
5	Special Purpose Keys	Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.



## MOUSE

Mouse is most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base which senses the movement of mouse and sends corresponding signals to CPU when the mouse buttons are pressed.

Generally it has two buttons called left and right button and a wheel is present between the buttons. Mouse can be used to control the position of cursor on screen, but it cannot be used to enter text into the computer.

## ADVANTAGES

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of keyboard.



## JOYSTICK



Joystick is also a pointing device which is used to move cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.

The function of joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.



### *LIGHT PEN*

Light pen is a pointing device which is similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube. When the tip of a light pen is moved over the monitor screen and pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.



### *TRACK BALL*

Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on ball, pointer can be moved. Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button and a square.



## SCANNER

Scanner is an input device which works more like a photocopy machine. It is used when some information is available on a paper and it is to be transferred to the hard disc of the computer for further manipulation. Scanner captures images from the source which are then converted into the digital form that can be stored on the disc. These images can be edited before they are printed.



## DIGITIZER

Digitizer is an input device which converts analog information into digital form. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been pointed at. Digitizer is also known as Tablet or Graphics Tablet because it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for doing fine works of drawing and image manipulation applications.



### *MICROPHONE*

Microphone is an input device to input sound that is then stored in digital form. The microphone is used for various applications like adding sound to a multimedia presentation or for mixing music.



### *MAGNETIC INK CARD READER (MICR)*

MICR input device is generally used in banks because of a large number of cheques to be processed every day. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable. This reading process is called Magnetic Ink Character Recognition (MICR). The main advantages of MICR is that it is fast and less error prone.



### *OPTICAL CHARACTER READER(OCR)*

OCR is an input device used to read a printed text. OCR scans text optically character by character, converts them into a machine readable code and stores the text on the system memory.



### BAR CODE READERS

Bar Code Reader is a device used for reading bar coded data (data in form of light and dark lines). Bar coded data is generally used in labelling goods, numbering the books etc. It may be a hand held scanner or may be embedded in a stationary scanner. Bar Code Reader scans a bar code image, converts it into an alphanumeric value which is then fed to the computer to which bar code reader is connected.



### Optical Mark Reader (OMR)

OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil. It is used where one out of a few alternatives is to be selected and marked. It is specially used for checking the answer sheets of examinations having multiple choice questions.

## COMPUTER - OUTPUT DEVICES

Following are few of the important output devices which are used in a computer.

- Monitors
- Graphic Plotter
- Printer

### MONITORS

Monitors, commonly called as Visual Display Unit (VDU), are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat- Panel Display

### *CATHODE-RAY TUBE (CRT) MONITOR*

The CRT display is made up of small picture elements called pixels. The smaller the pixels, the better the image clarity, or resolution. It takes more than one illuminated pixel to form whole character, such as the letter 'e' in the word help.

A finite number of characters can be displayed on a screen at once. The screen can be divided into a series of character boxes - fixed location on the screen where a standard character can be placed. Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically. There are some disadvantages of CRT:

- Large in Size
- High power consumption



### *FLAT-PANEL DISPLAY MONITOR*

The flat-panel display refers to a class of video devices that have reduced volume, weight and power requirement in comparison to the CRT. You can hang them on walls or wear them on your wrists. Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, graphics display.

The flat-panel display is divided into two categories:

- **Emissive Displays** - The emissive displays are devices that convert electrical energy into light. Example are plasma panel and LED (Light-Emitting Diodes).



- **Non-Emissive Displays** - The Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. Example is LCD(Liquid-Crystal Device)



## **PRINTERS**

Printer is an output device, which is used to print information on paper.

There are two types of printers:

- Impact Printers
- Non-Impact Printers

### **IMPACT PRINTERS**

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The impact printers print the characters by striking them on the ribbon which is then pressed on the paper.

Characteristics of Impact Printers are the following:

- Very low consumable costs
- Very noisy
- Useful for bulk printing due to low cost
- There is physical contact with the paper to produce an image

These printers are of two types

- a. Character printers
- b. Line printers

#### **A. CHARACTER PRINTERS**

Character printers are the printers which print one character at a time.

These are further divided into two types:

- Dot Matrix Printer (DMP)
- Daisy Wheel

## DOT MATRIX PRINTER

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In the market one of the most popular printers is Dot Matrix Printer. These printers are popular because of their ease of printing and economical price. Each character printed is in form of pattern of dots and head consists of a Matrix of Pins of size (5\*7, 7\*9, 9\*7 or 9\*9) which come out to form a character that is why it is called Dot Matrix Printer.

### Advantages

- Inexpensive
- Widely Used
- Other language characters can be printed

### Disadvantages

- Slow Speed
- Poor Quality



## DAISY WHEEL

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Head is lying on a wheel and pins corresponding to characters are like petals of Daisy (flower name) that is why it is called Daisy Wheel Printer. These printers are generally used for word-processing in offices which require a few letters to be sent here and there with very nice quality.

### Advantages

- More reliable than DMP
- Better quality
- The fonts of character can be easily changed

### Disadvantages

- Slower than DMP
- Noisy
- More expensive than DMP



### Line Printers

Line printers are the printers which print one line at a time.



These are of further two types

- Drum Printer
- Chain Printer

**a. DRUM PRINTER:** This printer is like a drum in shape so it is called drum printer. The surface of drum is divided into number of tracks. Total tracks are equal to size of paper i.e. for a paper width of 132 characters, drum will have 132 tracks.

A character set is embossed on track. The different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line. Drum printers are fast in speed and can print 300 to 2000 lines per minute.

### Advantages

- Very high speed

#### Disadvantages

- Very expensive
- Characters fonts cannot be changed

#### b. CHAIN PRINTER

In this printer, chain of character sets are used so it is called Chain Printer. A standard character set may have 48, 64, or 96 characters.

#### Advantages

- Character fonts can easily be changed.
- Different languages can be used with the same printer.

#### Disadvantages

- Noisy

#### NON-IMPACT PRINTERS

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Non-impact printers print the characters without using ribbon. These printers print a complete page at a time so they are also called as Page Printers.

These printers are of two types

- Laser Printers
- Inkjet Printers

#### Characteristics of Non-impact Printers

- Faster than impact printers.
- They are not noisy.
- High quality.
- Support many fonts and different character size.

#### Laser Printers

These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page.

#### ADVANTAGES

- Very high speed
- Very high quality output
- Give good graphics quality
- Support many fonts and different character size

#### DISADVANTAGES

- Expensive.
- Cannot be used to produce multiple copies of a document in a single printing.



### Inkjet Printers

Inkjet printers are non-impact character printers based on a relatively new technology. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.

They make less noise because no hammering is done and these have many styles of printing modes available. Color printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

#### ADVANTAGES

- High quality printing
- More reliable

#### DISADVANTAGES

- Expensive as cost per page is high
- Slow as compared to laser printer

## COMPUTER - MEMORY

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in computer where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address which varies from zero to memory size minus one. For example if computer has 64k words, then this memory unit has  $64 * 1024 = 65536$  memory locations. The address of these locations varies from 0 to 65535.

Memory is primarily of three types



- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

## CACHE MEMORY

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Cache memory is a very high speed semiconductor memory which can speed up CPU. It acts as a buffer between the CPU and main memory. It is used to hold those parts of data and program which are most frequently used by CPU. The parts of data and programs are transferred from disk to cache memory by operating system, from where CPU can access them.

### Advantages

The advantages of cache memory are as follows:

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

### Disadvantages

The disadvantages of cache memory are as follows:

- Cache memory has limited capacity.
- It is very expensive.

## COMPUTER - RANDOM ACCESS MEMORY

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RAM (Random Access Memory) is the internal memory of the CPU for storing data, program and program result. It is read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.

Access time in RAM is independent of the address that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time. Data in the RAM can be accessed randomly but it is very expensive.

RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure. Hence a backup uninterruptible power system (UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.

RAM is of two types

- Static RAM (SRAM)
- Dynamic RAM (DRAM)



## STATIC RAM (SRAM)

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The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not have to be refreshed on a regular basis.

Because of the extra space in the matrix, SRAM uses more chips than DRAM for the same amount of storage space, thus making the manufacturing costs higher. So SRAM is used as cache memory and has very fast access.

### Characteristic of the Static RAM

- It has long life
- There is no need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

## DYNAMIC RAM (DRAM)

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DRAM, unlike SRAM, must be continually **refreshed** in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory because it is cheap and small. All DRAMs are made up of memory cells which are composed of one capacitor and one transistor.

### Characteristics of the Dynamic RAM

- It has short data lifetime
- Need to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM
- Lesser in size

- Less expensive
- Less power consumption

## COMPUTER - READ ONLY MEMORY

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## PRIMARY MEMORY (MAIN MEMORY)

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Primary memory holds only those data and instructions on which computer is currently working. It has limited capacity and data is lost when power is switched off. It is generally made up of semiconductor device. These memories are not as fast as registers. The data and instruction required to be processed reside in main memory. It is divided into two subcategories RAM and ROM.

### Characteristics of Main Memory

- These are semiconductor memories
- It is known as main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without primary memory.



## SECONDARY MEMORY

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This type of memory is also known as external memory or non-volatile. It is slower than main memory. These are used for storing data/Information permanently. CPU directly does not access these memories instead they are accessed via input-output routines. Contents of secondary memories are first transferred to main memory, and then CPU can access it. For example : disk, CD-ROM, DVD etc.

### Characteristic of Secondary Memory

- These are magnetic and optical memories
- It is known as backup memory.
- It is non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without secondary memory.
- Slower than primary memories.



### COMPUTER – MOTHERBOARD

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The motherboard serves as a single platform to connect all of the parts of a computer together. A motherboard connects CPU, memory, hard drives, optical drives, video card, sound card, and other ports and expansion cards directly or via cables. It can be considered as the backbone of a computer.



## Features of Motherboard

A motherboard comes with following features:

- Motherboard varies greatly in supporting various types of components.
- Normally a motherboard supports a single type of CPU and few types of memories.
- Video Cards, Hard disks, Sound Cards have to be compatible with motherboard to function properly
- Motherboards, cases and power supplies must be compatible to work properly together.

## Popular Manufacturers

- Intel
- ASUS
- A Open
- ABIT
- Biostar
- Gigabyte
- MSI

## Description of Motherboard

The motherboard is mounted inside the case and is securely attached via small screws through pre-drilled holes. Motherboard contains ports to connect all of the internal components. It provides a single socket for CPU whereas for memory, normally one or more slots are available. Motherboards provide ports to attach floppy drive, hard drive, and optical drives via ribbon cables. Motherboard carries fans and a special port designed for power supply.

There is a peripheral card slot in front of the motherboard using which video cards, sound cards and other expansion cards can be connected to motherboard.

On the left side, motherboards carry a number of ports to connect monitor, printer, mouse, keyboard, speaker, and network cables. Motherboards also provide USB ports which allow compatible devices to be connected in plug-in/plug-out fashion for example, pen drive, digital cameras etc.

## COMPUTER - MEMORY UNITS

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Memory unit is:

- The amount of data that can be stored in the storage unit.
- That in which storage capacity is expressed in terms of Bytes.

Following are the main memory storage units:

Sr. No.	Unit	Description
1	Bit (Binary Digit)	A binary digit is logical 0 and 1 representing a passive or an active state of a component in an electric circuit.
2	Nibble	A group of 4 bits is called nibble.
3	Byte	A group of 8 bits is called byte. A byte is the smallest unit which can represent a data item or a character.
4	Word	<p>A computer word, like a byte, is a group of fixed number of bits processed as a unit which varies from computer to computer but is fixed for each computer.</p> <p>The length of a computer word is called word-size or word length and it may be as small as 8 bits or may be as long as 96 bits. A computer stores the information in the form of computer words.</p>



Few higher storage units are following



Sr. No.	Unit	Description
1	Kilobyte (KB)	1 KB = 1024 Bytes
2	Megabyte (MB)	1 MB = 1024 KB
3	Giga Byte (GB)	1 GB = 1024 MB
4	Tera Byte (TB)	1 TB = 1024 GB
5	Peta Byte (PB)	1 PB = 1024 TB

## COMPUTER - PORTS

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### What is a Port?

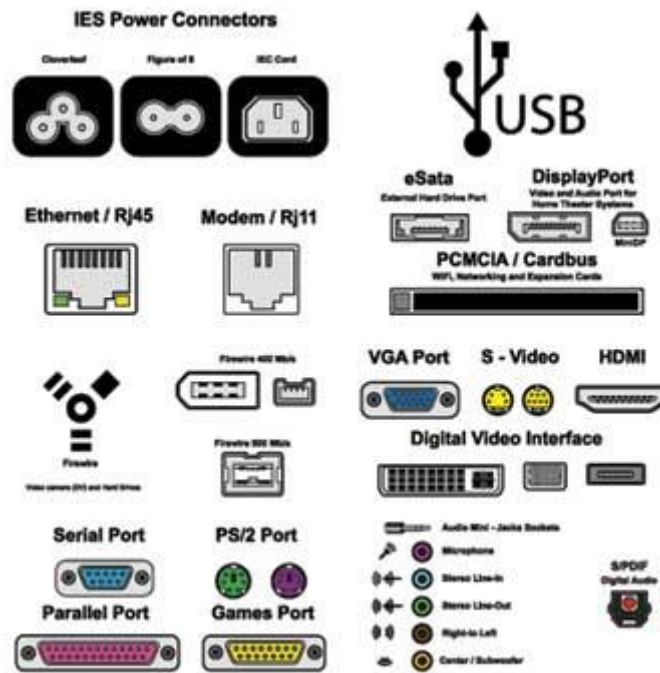
A port:

- Is a physical docking point using which an external device can be connected to the computer.
- Can also be programmatic docking point through which information flows from a program to computer or over the internet.

### Characteristics

A port has the following characteristics:

- External devices are connected to a computer using cables and ports.
- Ports are slots on the motherboard into which a cable of external device is plugged in.
- Examples of external devices attached via ports are mouse, keyboard, monitor, microphone, speakers etc.



Following are few important types of ports:

### Serial Port

- Used for external modems and older computer mouse
- Two versions : 9 pin, 25 pin model
- Data travels at 115 kilobits per second

### Parallel Port

- Used for scanners and printers
- Also called printer port
- 25 pin model
- Also known as IEEE 1284-compliant Centronics port

### PS/2 Port

- Used for old computer keyboard and mouse
- Also called mouse port
- Most of the old computers provide two PS/2 port, each for mouse and keyboard
- Also known as IEEE 1284-compliant Centronics port

### Universal Serial Bus (or USB) Port

- It can connect all kinds of external USB devices such as external hard disk, printer, scanner, mouse, keyboard etc.
- It was introduced in 1997.
- Most of the computers provide two USB ports as minimum.
- Data travels at 12 megabits per seconds

- USB compliant devices can get power from a USB port

### VGA Port

- Connects monitor to a computer's video card.
- Has 15 holes.
- Similar to serial port connector but serial port connector has pins, it has holes.

### Power Connector

- Three-pronged plug
- Connects to the computer's power cable that plugs into a power bar or wall socket

### Firewire Port

- Transfers large amount of data at very fast speed.
- Connects camcorders and video equipments to the computer
- Data travels at 400 to 800 megabits per seconds
- Invented by Apple
- Three variants : 4-Pin FireWire 400 connector, 6-Pin FireWire 400 connector and 9-Pin FireWire 800 connector

### Modem Port

Connects a PC's modem to the telephone network

### Ethernet Port

- Connects to a network and high speed Internet.
- Connect network cable to a computer.
- This port resides on an Ethernet Card.
- Data travels at 10 megabits to 1000 megabits per seconds depending upon the network bandwidth.

### Game Port

- Connect a joystick to a PC
- Now replaced by USB.

### Digital Video Interface, DVI port

- Connects Flat panel LCD monitor to the computer's high end video graphic cards.
- Very popular among video card manufacturers.

### Sockets

Connect microphone, speakers to sound card of the computer

Hardware represents the physical and tangible components of a computer i.e. the components that can be seen and touched.

Examples of Hardware are following:

- **Input devices** -- keyboard, mouse etc.
- **Output devices** -- printer, monitor etc.
- **Secondary storage devices** -- Hard disk, CD, DVD etc.
- **Internal components** -- CPU, motherboard, RAM etc.



## RELATIONSHIP BETWEEN HARDWARE AND SOFTWARE

- Hardware and software are mutually dependent on each other. Both of them must work together to make a computer produce a useful output.
- Software cannot be utilized without supporting hardware.
- Hardware without set of programs to operate upon cannot be utilized and is useless.
- To get a particular job done on the computer, relevant software should be loaded into the hardware
- Hardware is a one-time expense.
- Software development is very expensive and is a continuing expense.
- Different software applications can be loaded on a hardware to run different jobs.
- A software acts as an interface between the user and the hardware.
- If hardware is the 'heart' of a computer system, then software is its 'soul'. Both are complimentary to each other.

## COMPUTER - SOFTWARE

Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a particular problem.

There are two types of software

- System Software
- Application Software

## SYSTEM SOFTWARE

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The system software is collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. System software are generally prepared by computer manufactures. These software products comprise of programs written in low-level languages which interact with the hardware at a very basic level. System software serves as the interface between hardware and the end users.

Some examples of system software are Operating System, Compilers, Interpreter, and Assemblers etc.



Features of system software are as follows:

- Close to system
- Fast in speed
- Difficult to design
- Difficult to understand
- Less interactive
- Smaller in size
- Difficult to manipulate
- Generally written in low-level language

## APPLICATION SOFTWARE

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Application software products are designed to satisfy a particular need of a particular environment. All software applications prepared in the computer lab can come under the category of Application software.

Application software may consist of a single program, such as a Microsoft's notepad for writing and editing simple text. It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as a spreadsheet package.

Examples of Application software are following:

- Payroll Software
- Student Record Software

- Inventory Management Software
- Income Tax Software
- Railways Reservation Software
- Microsoft Office Suite Software
- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint



Features of application software are as follows:

- Close to user
- Easy to design
- More interactive
- Slow in speed
- Generally written in high-level language
- Easy to understand
- Easy to manipulate and use
- Bigger in size and requires large storage space

## COMPUTER - NUMBER SYSTEM

When we type some letters or words, the computer translates them in numbers as computers can understand only numbers. A computer can understand positional number system where there are only a few symbols called digits and these symbols represent different values depending on the position they occupy in the number.

A value of each digit in a number can be determined using

- The digit
- The position of the digit in the number
- The base of the number system (where base is defined as the total number of digits available in the number system).

## DECIMAL NUMBER SYSTEM

The number system that we use in our day-to-day life is the decimal number system. Decimal number system has base 10 as it uses 10 digits from 0 to 9. In decimal number

system, the successive positions to the left of the decimal point represent units, tens, hundreds, thousands and so on.

Each position represents a specific power of the base (10). For example, the decimal number 1234 consists of the digit 4 in the units position, 3 in the tens position, 2 in the hundreds position, and 1 in the thousands position, and its value can be written as

$$(1 \times 1000) + (2 \times 100) + (3 \times 10) + (4 \times 1)$$

$$(1 \times 10^3) + (2 \times 10^2) + (3 \times 10^1) + (4 \times 10^0)$$

$$1000 + 200 + 30 + 4$$

$$1234$$

As a computer programmer or an IT professional, you should understand the following number systems which are frequently used in computers.

S.N.	Number System and Description
1	<b>Binary Number System</b> Base 2. Digits used : 0, 1
2	<b>Octal Number System</b> Base 8. Digits used : 0 to 7
3	<b>Hexa Decimal Number System</b> Base 16. Digits used : 0 to 9, Letters used : A- F

## BINARY NUMBER SYSTEM

Characteristics of binary number system are as follows:

- Uses two digits, 0 and 1.
- Also called base 2 number system
- Each position in a binary number represents a 0 power of the base (2). Example  $2^0$
- Last position in a binary number represents a x power of the base (2). Example  $2^x$  where x represents the last position - 1.

### Example

Binary Number:  $10101_2$

Calculating Decimal Equivalent:



Step	Binary Number	Decimal Number
Step 1	10101 <sub>2</sub>	$((1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0))_{10}$
Step 2	10101 <sub>2</sub>	$(16 + 0 + 4 + 0 + 1)_{10}$
Step 3	10101 <sub>2</sub>	21 <sub>10</sub>

**Note:** 10101<sub>2</sub> is normally written as 10101.

## OCTAL NUMBER SYSTEM

Characteristics of octal number system are as follows:

- Uses eight digits, 0,1,2,3,4,5,6,7.
- Also called base 8 number system
- Each position in an octal number represents a o power of the base (8). Example 8<sup>o</sup>
- Last position in an octal number represents a x power of the base (8). Example 8<sup>x</sup>where x represents the last position - 1.

### Example

Octal Number: 12570<sub>8</sub>

Calculating Decimal Equivalent:

Step	Octal Number	Decimal Number
Step 1	12570 <sub>8</sub>	$((1 \times 8^4) + (2 \times 8^3) + (5 \times 8^2) + (7 \times 8^1) + (0 \times 8^0))_{10}$
Step 2	12570 <sub>8</sub>	$(4096 + 1024 + 320 + 56 + 0)_{10}$
Step 3	12570 <sub>8</sub>	5496 <sub>10</sub>

**Note:** 12570<sub>8</sub> is normally written as 12570.

## HEXADECIMAL NUMBER SYSTEM

Characteristics of hexadecimal number system are as follows:

- Uses 16 digits and 6 letters, 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F.
- Letters represents numbers starting from 10. A = 10, B = 11, C = 12, D = 13, E = 14, F = 15.
- Also called base 16 number system
- Each position in a hexadecimal number represents a power of the base (16).  
Example  $16^0$
- Last position in a hexadecimal number represents a power of the base (16).  
Example  $16^x$  where x represents the last position - 1.

### Example

Hexadecimal Number:  $19FDE_{16}$

Calculating Decimal Equivalent:

Step	Binary Number	Decimal Number
Step 1	$19FDE_{16}$	$((1 \times 16^4) + (9 \times 16^3) + (F \times 16^2) + (D \times 16^1) + (E \times 16^0))_{10}$
Step 2	$19FDE_{16}$	$((1 \times 16^4) + (9 \times 16^3) + (15 \times 16^2) + (13 \times 16^1) + (14 \times 16^0))_{10}$
Step 3	$19FDE_{16}$	$(65536 + 36864 + 3840 + 208 + 14)_{10}$
Step 4	$19FDE_{16}$	$106462_{10}$

**Note :**  $19FDE_{16}$  is normally written as 19FDE.

## COMPUTER - DATA AND INFORMATION

### What is data?

Data can be defined as a representation of facts, concepts or instructions in a formalized manner which should be suitable for communication, interpretation, or processing by human or electronic machine.



## What is Information?

Information is organized or classified data which has some meaningful values for the receiver.

Information is the processed data on which decisions and actions are based.

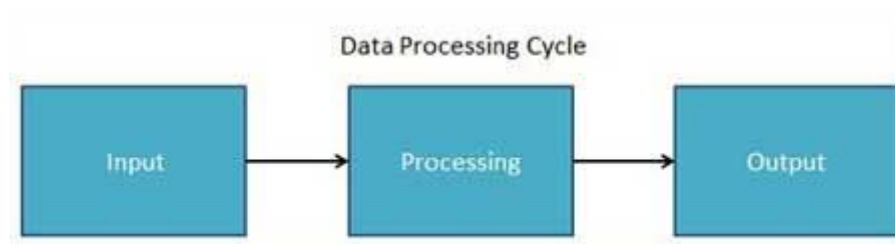
For the decision to be meaningful, the processed data must qualify for the following characteristics:

- **Timely** - Information should be available when required.
- **Accuracy** - Information should be accurate.
- **Completeness** - Information should be complete.



## DATA PROCESSING CYCLE

Data processing is the re-structuring or re-ordering of data by people or machine to increase their usefulness and add values for particular purpose. Data processing consists of basic steps input, processing and output. These three steps constitute the data processing cycle.



- **Input** - In this step the input data is prepared in some convenient form for processing. The form will depend on the processing machine. For example, when electronic computers are used, the input data could be recorded on any one of several types of input medium, such as magnetic disks, tapes and so on.
- **Processing** - In this step input data is changed to produce data in a more useful form. For example, pay-checks may be calculated from the time cards, or a summary of sales for the month may be calculated from the sales orders.
- **Output** - Here the result of the proceeding processing step are collected. The particular form of the output data depends on the use of the data. For example, output data may be pay-checks for employees.



## COMPUTER - NETWORKING

### WHAT IS A COMPUTER NETWORK?

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A computer network is a system in which multiple computers are connected to each other to share information and resources.



## Characteristics of a computer network

- Share Resources from one computer to another
- Create files and store them in one computer, access those files from the other computer(s) connected over the network
- Connect a printer, scanner, or a fax machine to one computer within the network and let other computers of the network use the machines available over network.

Following is the list of hardware's required to setup a computer network.

- Network Cables
- Distributors
- Routers
- Internal Network Cards
- External Network Cards

## NETWORK CABLES

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Network cables are used to connect computers. The most commonly used cable is Category 5 cable RJ-45.



## Distributors

A computer can be connected to another one via a serial port but if we need to connect many computers to produce a network, this serial connection will not work. The solution is to use a central body to which other computers, printers, scanners etc. can be connected and then this body will manage or distribute network traffic.



## Router

A router is a type of device which acts as the central point among computers and other devices that are part of a network. A router is equipped with holes called ports and computers and other devices are connected to a router using network cables. Now-a-days router comes in wireless modes using which computers can be connected without any physical cable.



## Network Card

Network card is a necessary component of a computer without which a computer cannot be connected over a network. It is also known as network adapter or Network Interface Card (NIC). Most branded computers have network card pre-installed. Network cards are of two types : Internal and External Network Cards.

## INTERNAL NETWORK CARDS

Motherboard has a slot for internal network card where it is to be inserted. Internal network cards are of two types in which first type uses Peripheral Component Interconnect (PCI) connection while the second type uses Industry Standard Architecture (ISA). Network cables are required to provide network access.



## EXTERNAL NETWORK CARDS

External network cards come in two flavors: Wireless and USB based. Wireless network card need to be inserted into the motherboard but no network cable is required to connect to network



## Universal Serial Bus (USB)

USB card are easy to use and connect via USB port. Computers automatically detect USB card and can install the drivers required to support the USB network card automatically.





## COMPUTER - OPERATING SYSTEM

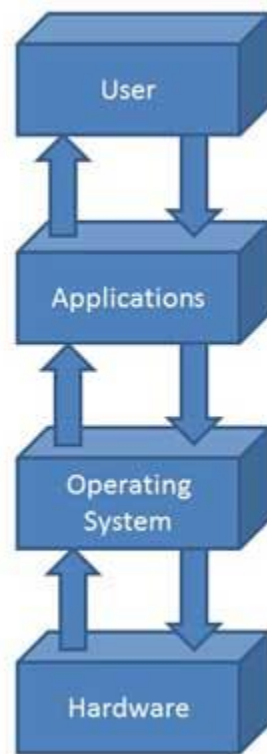
It is a program with following features:

- An operating system is a program that acts as an interface between the software and the computer hardware.
- It is an integrated set of specialized programs that are used to manage overall resources and operations of the computer.
- It is specialized software that controls and monitors the execution of all other programs that reside in the computer, including application programs and other system software.

### OBJECTIVES OF OPERATING SYSTEM

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- To make a computer system convenient to use in an efficient manner
- To hide the details of the hardware resources from the users
- To provide users a convenient interface to use the computer system
- To act as an intermediary between the hardware and its users and making it easier for the users to access and use other resources
- To manage the resources of a computer system
- To keep track of who is using which resource, granting resource requests, according for resource using and mediating conflicting requests from different programs and users
- To provide efficient and fair sharing of resources among users and programs



## CHARACTERISTICS OF OPERATING SYSTEM

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- **Memory Management** -- keeps tracks of primary memory i.e. what part of it is in use by whom, what part is not in use etc. and allocates the memory when a process or program requests it.
- **Processor Management** -- allocates the processor(CPU) to a process and deallocates processor when it is no longer required.
- **Device Management** -- keeps track of all devices. This is also called I/O controller that decides which process gets the device, when, and for how much time.
- **File Management** -- allocates and de-allocates the resources and decides who gets the resources.
- **Security** -- prevents unauthorized access to programs and data by means of passwords and similar other techniques.
- **Job accounting** -- keeps track of time and resources used by various jobs and/or users.
- **Control over system performance** -- records delays between request for a service and from the system.
- **Interaction with the operators** -- The interaction may take place via the console of the computer in the form of instructions. Operating System acknowledges the same, does the corresponding action and informs the operation by a display screen.
- **Error-detecting aids** -- Production of dumps, traces, error messages and other debugging and error-detecting methods.

- **Coordination between other software and users** -- Coordination and assignment of compilers, interpreters, assemblers and other software to the various users of the computer systems.

## COMPUTER - INTERNET AND INTRANET

### INTERNET

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It is a worldwide system which has the following characteristics:

- Internet is a world-wide / global system of interconnected computer networks.
- Internet uses the standard Internet Protocol (TCP/IP)
- Every computer in internet is identified by a unique IP address.
- IP Address is a unique set of numbers (such as 110.22.33.114) which identifies a computer's location.
- A special computer DNS (Domain Name Server) is used to give name to the IP Address so that user can locate a computer by a name.
- For example, a DNS server will resolve a name **<http://www.tutorialspoint.com>** to a particular IP address to uniquely identify the computer on which this website is hosted.
- Internet is accessible to every user all over the world.



### INTRANET

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- Intranet is system in which multiple PCs are connected to each other.
- PCs in intranet are not available to the world outside the intranet.
- Usually each company or organization has their own Intranet network and members/employees of that company can access the computers in their intranet.
- Each computer in Intranet is also identified by an IP Address which is unique among the computers in that Intranet.



### **SIMILARITIES IN INTERNET AND INTRANET**

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- Intranet uses the internet protocols such as TCP/IP and FTP.
- Intranet sites are accessible via web browser in similar way as websites in internet. But only members of Intranet network can access intranet hosted sites.
- In Intranet, own instant messengers can be used as similar to yahoo messenger/ talk over the internet.

### **DIFFERENCES IN INTERNET AND INTRANET**

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- Internet is general to PCs all over the world whereas Intranet is specific to few PCs.
- Internet has wider access and provides a better access to websites to large population whereas Intranet is restricted.
- Internet is not as safe as Intranet as Intranet can be safely privatized as per the need.

## MCQS BASICS OF COMPUTER SCIENCE

**1. UNIVAC is**

- A) Universal Automatic Computer
- B) Universal Array Computer
- C) Unique Automatic Computer
- D) Unvalued Automatic Computer

**2. The basic operations performed by a computer are**

- A) Arithmetic operation
- B) Logical operation
- C) Storage and relative
- D) All the above

**3. The two major types of computer chips are**

- A) External memory chip
- B) Primary memory chip
- C) Microprocessor chip
- D) Both b and c

**4. Microprocessors as switching devices are for which generation computers**

- A) First Generation
- B) Second Generation
- C) Third Generation
- D) Fourth Generation

**5. What is the main difference between a mainframe and a super computer?**

- A) Super computer is much larger than mainframe computers
- B) Super computers are much smaller than mainframe computers
- C) Supercomputers are focused to execute few programs as fast as possible while mainframe uses its power to execute as many programs concurrently
- D) Supercomputers are focused to execute as many programs as possible while mainframe uses its power to execute few programs as fast as possible.

**6. ASCII and EBCDIC are the popular character coding systems.**

**What does EBCDIC stand for?**

- A) Extended Binary Coded Decimal Interchange Code
- B) Extended Bit Code Decimal Interchange Code
- C) Extended Bit Case Decimal Interchange Code
- D) Extended Binary Case Decimal Interchange Code

**7. The brain of any computer system is**

- A) ALU
- B) Memory
- C) CPU
- D) Control unit

**8. Storage capacity of magnetic disk depends on**

- A) tracks per inch of surface
- B) bits per inch of tracks
- C) disk pack in disk surface
- D) All of above

**9. The two kinds of main memory are:**

- A) Primary and secondary
- B) Random and sequential
- C) ROM and RAM
- D) All of above

**10. A storage area used to store data to a compensate for the difference in speed at which the different units can handle data is**

- A) Memory
- B) Buffer
- C) Accumulator
- D) Address

**11. Computer is free from tiresome and boardroom. We call it**

- A) Accuracy
- B) Reliability
- C) Diligence
- D) Versatility

**12. Integrated Circuits (ICs) are related to which generation of computers?**

- A) First generation

- B) Second generation
- C) Third generation
- D) Fourth generation

**13. CD-ROM is a**

- A) Semiconductor memory
- B) Memory register
- C) Magnetic memory
- D) none of above

**14. A hybrid computer**

- A) Resembles digital computer
- B) Resembles analogue computer
- C) Resembles both a digital and analogue computer
- D) None of the above

**15. Which type of computers uses the 8-bit code called EBCDIC?**

- A) Minicomputers
- B) Microcomputers
- C) Mainframe computers
- D) Super computer

**16. The ALU of a computer responds to the commands coming from**

- A) Primary memory
- B) Control section
- C) External memory
- D) Cache memory

**17. Chief component of first generation computer was**

- A) Transistors
- B) Vacuum Tubes and Valves
- C) Integrated Circuits
- D) None of above

**18. To produce high quality graphics (hardcopy) in color, you would want to use a/n**

- A) RGB monitor
- B) Plotter
- C) Ink-jet printer
- D) Laser printer

**19. What are the stages in the compilation process?**

- A) Feasibility study, system design and

testing

- B) Implementation and documentation
- C) Lexical Analysis, syntax analysis, and code generation
- D) None of the above

**20. Which of the following IC was used in third generation of computers?**

- A) SSI
- B) MSI
- C) LSI
- D) Both a and b

**21. The main electronic component used in first generation computers was**

- A) Transistors
- B) Vacuum Tubes and Valves
- C) Integrated Circuits
- D) None of above

**22. A dumb terminal has**

- A) an embedded microprocessor
- B) extensive memory
- C) independent processing capability
- D) a keyboard and screen

**23. One millisecond is**

- A) 1 second
- B) 10th of a seconds
- C) 1000th of a seconds
- D) 10000th of a seconds

**24. The output quality of a printer is measured by**

- A) Dot per sq. inch
- B) Dot per inch
- C) Dots printed per unit time
- D) All of the above

**25. Which of the following was a special purpose computer?**

- A) ABC
- B) ENIAC
- C) EDVAC
- D) All of the above

**26. What was the computer invented by Attanasoff and Clifford?**



- A) Mark I
- B) ABC
- C) Z3

D) None of above

**27. Which of the following storage devices can store maximum amount of data?**

- A) Floppy Disk
- B) Hard Disk
- C) Compact Disk
- D) Magneto Optic Disk

**28. Which computer was considered the first electronic computer until 1973 when court invalidated the patent?**

- A) ENIAC
- B) MARK I
- C) Z3
- D) ABC

**29. A physical connection between the microprocessor memory and other parts of the microcomputer is known as**

- A) Path
- B) Address bus
- C) Route
- D) All of the above

**30. High density double sided floppy disks could store \_\_\_\_ of data**

- A) 1.40 MB
- B) 1.44 GB
- C) 1.40 GB
- D) 1.44 MB

**31. A high quality CAD system uses the following for printing drawing and graphs**

- A) Dot matrix printer
- B) Digital plotter
- C) Line printer
- D) All of the above

**32. Which of the following is not an input device?**

- A) OCR
- B) Optical scanners

- C) Voice recognition device
- D) COM (Computer Output to Microfilm)

**33. The accuracy of the floating-point numbers representable in two 16-bit words of a computer is approximately**

- A) 16 digits
- B) 6 digits
- C) 9 digits
- D) All of above

**34. In most of the IBM PCs, the CPU, the device drivers, memory, expansion slots and active components are mounted on a single board. What is the name of the board?**

- A) Motherboard
- B) Daughterboard
- C) Breadboard
- D) Fatherboard

**35. In most IBM PCs, the CPU, the device drives, memory expansion slots and active components are mounted on a single board. What is the name of this board?**

- A) Motherboard
- B) Breadboard
- C) Daughter board
- D) Grandmother board

**36. Magnetic disks are the most popular medium for**

- A) Direct access
- B) Sequential access
- C) Both of above
- D) None of above

**37. A technique used by codes to convert an analog signal into a digital bit stream is known as**

- A) Pulse code modulation
- B) Pulse stretcher
- C) Query processing
- D) Queue management

**38. Regarding a VDU, Which**

*statement is more correct?*

- A) It is an output device
- B) It is an input device
- C) It is a peripheral device
- D) It is hardware item

**39. A modern electronic computer is a machine that is meant for**

- A) Doing quick mathematical calculations
- B) Input, storage, manipulation and outputting of data
- C) Electronic data processing
- D) Performing repetitive tasks accurately

**40. When was vacuum tube invented?**

- A) 1900
- B) 1906
- C) 1910
- D) 1880

**41. Which of the following produces the best quality graphics reproduction?**

- A) Laser printer
- B) Ink jet printer
- C) Plotter
- D) Dot matrix printer

**42. Computers with 80286 microprocessor is**

- A) XT computer
- B) AT computers
- C) PS/2 computer
- D) None of above

**43. An application suitable for sequential processing is**

- A) Processing of grades
- B) Payroll processing
- C) Both a and b
- D) All of above

**44. Which of the following is not processing?**

- A) arranging
- B) manipulating
- C) calculating
- D) gathering

**45. The digital computer was**

**developed primarily in**

- A) USSR
- B) Japan
- C) USA
- D) UK

**46. Software in computer**

- A) Enhances the capabilities of the hardware machine
- B) Increase the speed of central processing unit
- C) Both of above
- D) None of above

**47. Today's computer giant IBM was earlier known by different name which was changes in 1924. What was that name?**

- A) Tabulator Machine Co.
- B) Computing Tabulating Recording Co.
- C) The Tabulator Ltd.
- D) International Computer Ltd.

**48. Before a disk drive can access any sector record, a computer program has to provide the record's disk address. What information does this address specify?**

- A) Track number
- B) Sector number
- C) Surface number
- D) All of above

**49. The arranging of data in a logical sequence is called**

- A) Sorting
- B) Classifying
- C) Reproducing
- D) Summarizing

**50. What is the responsibility of the logical unit in the CPU of a computer?**

- A) To produce result
- B) To compare numbers
- C) To control flow of information
- D) To do math's works

**51. Abacus was the first**

- A) electronic computer
- B) mechanical computer
- C) electronic calculator
- D) mechanical calculator

**52. If in a computer, 16 bits are used to specify address in a RAM, the number of addresses will be**

- A) 216
- B) 65,536
- C) 64K
- D) Any of the above

**53. Instructions and memory address are represented by**

- A) Character code
- B) Binary codes
- C) Binary word
- D) Parity bit

**54. The terminal device that functions as a cash register, computer terminal, and OCR reader is the:**

- A) Data collection terminal
- B) OCR register terminal
- C) Video Display terminal
- D) POS terminal

**55. A set of flip flops integrated together is called \_\_\_\_**

- A) Counter
- B) Adder
- C) Register
- D) None of the above

**56. People often call \_\_\_\_ as the brain of computer system**

- A) Control Unit
- B) Arithmetic Logic Unit
- C) Central Processing Unit
- D) Storage Unit

**57. Which is used for manufacturing chips?**

- A) Bus
- B) Control unit
- C) Semiconductors
- D) A and b only

**58. The value of each bead in heaven is**

- A) 1
- B) 3
- C) 5
- D) 7

**59. The first computer introduced in Nepal was**

- A) IBM 1400
- B) IBM 1401
- C) IBM 1402
- D) IBM1402

**60. Mnemonic a memory trick is used in which of the following language?**

- A) Machine language
- B) Assembly language
- C) High level language
- D) None of above

**61. Instruction in computer languages consists of**

- A) OPCODE
- B) OPERAND
- C) Both of above
- D) None of above

**62. Which generation of computer is still under development**

- A) Fourth Generation
- B) Fifth Generation
- C) Sixth Generation
- D) Seventh Generation

**63. A register organized to allow to move left or right operations is called a \_\_\_\_**

- A) Counter
- B) Loader
- C) Adder
- D) Shift register

**64. Which was the most popular first generation computer?**

- A) IBM 650
- B) IBM 360
- C) IBM 1130
- D) IBM 2700

**65. Which is considered a direct entry input device?**

- A) Optical scanner
- B) Mouse and digitizer
- C) Light pen
- D) All of the above

**66. A set of information that defines the status of resources allocated to a process is**

- A) Process control
- B) ALU
- C) Register Unit
- D) Process description

**67. Each set of Napier's bones consisted of \_\_\_\_ rods.**

- A) 5
- B) 9
- C) 11
- D) 13

**68. BCD is**

- A) Binary Coded Decimal
- B) Bit Coded Decimal
- C) Binary Coded Digit
- D) Bit Coded Digit

**69. When was the world's first laptop computer introduced in the market and by whom?**

- A) Hewlett-Packard, 1980
- B) Epson, 1981
- C) Laplink Traveling Software Inc, 1982
- D) Tandy Model-200, 1985

**70. From which generation operating systems were developed?**

- A) First
- B) Second
- C) Third
- D) Fourth

**71. The first firm to mass-market a microcomputer as a personal computer was**

- A) IBM
- B) Super UNIVAC
- C) Radio Shaks
- D) Data General Corporation

**72. How many address lines are**

**needed to address each machine location in a 2048 x 4 memory chip?**

- A) 10
- B) 11
- C) 8
- D) 12

**73. Properly arranged data is called**

- A) Field
- B) Words
- C) Information
- D) File

**74. A computer consists of**

- A) A central processing unit
- B) A memory
- C) Input and output unit
- D) All of the above

**75. Why are vacuum tubes also called valves?**

- A) Because they can amplify the weak signals and make them strong
- B) Because they can stop or allow the flow of current
- C) Both of above
- D) None of above

**76. John Napier invented Logarithm in**

- A) 1614
- B) 1617
- C) 1620
- D) None of above

**77. An integrated circuit is**

- A) A complicated circuit
- B) An integrating device
- C) Much costlier than a single transistor
- D) Fabricated on a tiny silicon chip

**78. What type of control pins are needed in a microprocessor to regulate traffic on the bus, in order to prevent two devices from trying to use it at the same time?**

- A) Bus control
- B) Interrupts
- C) Bus arbitration
- D) Status

**79. Where as a computer mouse moves over the table surface, the trackball is**

- A) Stationary
- B) Difficult to move
- C) Dragged
- D) Moved in small steps

**80. Which of the following is used as a primary storage device?**

- A) Magnetic drum
- B) Hard Disks
- C) Floppy
- D) All of above

**81. Multi user systems provided cost savings for small business because they use a single processing unit to link several**

- A) Personal computers
- B) Workstations
- C) Dumb terminals
- D) Mainframes

**82. What are the three decisions making operations performed by the ALU of a computer?**

- A) Greater than
- B) Less than
- C) Equal to
- D) All of the above

**83. The word processing task associated with changing the appearance of a document is**

- A) Editing
- B) Writing
- C) Formatting
- D) All of above

**84. Nepal brought a computer for census of 2028 BS. This computer was of**

- A) first generation
- B) second generation
- C) third generation
- D) fourth generation

**85. Algorithm and Flow chart help us to**

- A) Know the memory capacity
- B) Identify the base of a number system
- C) Direct the output to a printer
- D) Specify the problem completely and clearly

**86. Which statement is valid about computer program?**

- A) It is understood by a computer
- B) It is understood by programmer
- C) It is understood user
- D) Both a & b

**87. The difference between memory and storage is that memory is \_\_\_\_ and storage is \_\_**

- A) Temporary, permanent
- B) Permanent, temporary
- C) Slow, fast
- D) All of above

**88. When was Pascaline invented?**

- A) 1617
- B) 1620
- C) 1642
- D) 1837

**89. Which of the following statement is valid?**

- A) Lady Augusta is the first programmer
- B) Ada is the daughter of Lord Byron, a famous English poet
- C) ADA is a programming language developed by US Defense
- D) All of above

**90. A compiler is a translating program which**

- A) Translates instruction of a high level language into machine language
- B) Translates entire source program into machine language program
- C) It is not involved in program's execution
- D) All of above

**91. What is required when more than one person uses a central**

***computer at the same time?***

- A) Light pen
- B) Mouse
- C) Digitizer
- D) Terminal

***92. Which of the following is the first computer to use Stored Program Concept?***

- A) UNIVAC
- B) ENIAC
- C) EDSAC
- D) None of above

***93. The term gigabyte refers to***

- A) 1024 bytes
- B) 1024 kilobytes
- C) 1024 megabytes
- D) 1024 gigabyte

***94. in which year was UK's premier computing event started?***

- A) 1980
- B) 1985
- C) 1986
- D) 1987

***95. Once you load the suitable program and provide required data, computer does not need human intervention. This feature is known as***

- A) Accuracy
- B) Reliability
- C) Versatility
- D) Automatic

***96. What is a brand?***

- A) The name of companies that made computers
- B) The name of product a company gives to identify its product in market
- C) A name of class to indicate all similar products from different companies
- D) All of above

***97. Machine language is***

- A) Machine dependent
- B) Difficult to program
- C) Error prone
- D) All of above

***98. A byte consists of***

- A) One bit
- B) Four bits
- C) Eight bits
- D) Sixteen bits

***99. Modern Computers are very reliable but they are not***

- A) Fast
- B) Powerful
- C) Infallible
- D) Cheap

***100. What is the date when Babbage conceived Analytical engine***

- A) 1642
- B) 1837
- C) 1880
- D) 1850

***101. What was the expected feature of fifth generation computers when Japan started FGCS?***

- A) Operating Systems
- B) Parallel Processing
- C) ULSI
- D) None of above

***102. Which of the following memory medium is not used as main memory system?***

- A) Magnetic core
- B) Semiconductor
- C) Magnetic tape
- D) Both semiconductor and magnetic tape

***103. The storage subsystem in a microcomputer consists mainly of \_\_ or \_\_ media with varying capacities***

- A) Memory or video
- B) Magnetic or optical
- C) Optical or memory
- D) Video or magnetic

***104. Programs designed to perform specific tasks is known as***

- A) system software
- B) application software
- C) utility programs
- D) operating system

**105. Computer operators**

- A) writes computer programs for specific problems
- B) operate the device which input and output data from the computer
- C) normally require a college degree in computer science
- D) all of the above

**106. Which of the following is not anti-viruses software?**

- A) NAV
- B) F-Prot
- C) Oracle
- D) McAfee

**107. What is a compiler?**

- A) A compiler does a conversion line by line as the program is run
- B) A compiler converts the whole of a higher level program code into machine code in one step
- C) A compiler is a general purpose language providing very efficient execution
- D) None of the above

**108. \_\_\_\_\_ computers are also called personal computers**

- A) Mainframe Computer
- B) Mini Computers
- C) Micro Computers
- D) Super Computers

**109. Which of the following is not input unit device?**

- A) scanner
- B) camera
- C) plotter
- D) digitizer

**110. Identify the correct statement**

- A) IBM PCs used RISC CPU designs

- B) Macintosh used CISC CPU design
- C) IBM used CISC CPU design
- D) None of above is true

**111. Which of the following statement is false?**

- A) Mechanical analog computers have existed for thousands of years
- B) There are mechanical analog computers and electronic analog computers.
- C) All electronic computers are digital computers
- D) All of above are false

**112. Which of the following require large computers memory?**

- A) Imaging
- B) Graphics
- C) Voice
- D) All of Above

**113. Which of the following is machine independence program?**

- A) High level language
- B) Low level language
- C) Assembly language
- D) Machine language

**114. When was the first electro-mechanical computer developed?**

- A) 1880
- B) 1990
- C) 1944
- D) None of above

**115. The first machine to successfully perform a long series of arithmetic and logical operations was:**

- A) ENIAC
- B) Mark-I
- C) Analytic Engine
- D) UNIVAC-1

**116. Which one is the largest space?**

- A) kilobyte
- B) petabyte
- C) terabyte



D) gigabyte

**117. FORTRAN programming language is more suitable for \_\_\_\_**

- A) Business Applications
- B) Marketing Applications
- C) Scientific Applications
- D) None of the above

**118. The brain of any computer system is**

- A) Control Unit
- B) Arithmetic Logic Unit
- C) Central Processing Unit
- D) Storage Unit

**119. Analog computer works on the supply of**

- A) Continuous electrical pulses
- B) Electrical pulses but not continuous
- C) Magnetic strength
- D) None of the above

**120. An error in software or hardware is called a bug. What is the alternative computer jargon for it?**

- A) Leech
- B) Squid
- C) Slug
- D) Glitch

**121. The advantage of COM are its \_\_ and \_\_**

- A) Compact size; speed readability
- B) Compact size, speed
- C) Readability; speed
- D) Low cost; readability

**122. The BIOS is the abbreviation of \_\_\_\_.**

- A) Basic Input Output System
- B) Best Input Output System
- C) Basic Input Output Symbol
- D) Base Input Output System

**123. Which printer is very commonly used for desktop publishing?**

- A) Laser printer
- B) Inkjet printer
- C) Daisywheel printer

D) Dot matrix printer

**124. IBM 1401 is**

- A) First Generation Computer
- B) Second Generation Computer
- C) Third Generation Computer
- D) Fourth Generation Computer

**125. Most of the first generation computers were**

- A) Special purpose computers
- B) General purpose computers
- C) Both of above
- D) None of above

**126. Floppy disks typically in diameter**

- A) 3
- B) 5.25
- C) 8
- D) All of above

**127. The output quality of a printer is measured by**

- A) Dot per inch
- B) Dot per sq. inch
- C) Dots printed per unit time
- D) All of above

**128. On a PC, how much memory is available to application software?**

- A) 1024 KB
- B) 760 KB
- C) 640 KB
- D) 560 KB

**129. In a computer \_\_\_\_ is capable to store single binary bit.**

- A) Capacitor
- B) Flip flop
- C) Register
- D) Inductor

**130. What does DMA stand for?**

- A) Distinct Memory Access
- B) Direct Memory Access
- C) Direct Module Access
- D) Direct Memory Allocation

**131. Who invented Integrated Circuits?**

- A) Jack Kilby
- B) Robert Noyce
- C) Both of above
- D) None of above

**132. Operating system, editors, and debuggers comes under?**

- A) System Software
- B) Application Software
- C) Utilities
- D) None of the above

**133. One computer that is not considered a portable is**

- A) Minicomputer
- B) Laptop computer
- C) Notebook computer
- D) All of above

**134. Which of the following is not an electronic computer?**

- A) ENIAC
- B) ABC
- C) UNIVAC
- D) EDVAC

**135. What is the name of the display feature that highlights are of the screen which requires operator attention?**

- A) Pixel
- B) Reverse video
- C) Touch screen
- D) Cursor

**136. Which is the largest computer?**

- A) Mainframe Computer
- B) Mini Computers
- C) Micro Computers
- D) Super Computers

**137. Which of the following are the best units of data on an external storage device?**

- A) Bits
- B) Bytes
- C) Hertz
- D) Clock cycles

**138. The personal computer industry was started by**

- A) IBM
- B) Apple
- C) Compaq
- D) HCL

**139. What is meant by a dedicated computer?**

- A) Which is used by one person only
- B) Which is assigned one and only one task
- C) Which uses one kind of software
- D) Which is meant for application software

**140. Which programming languages are classified as low level languages?**

- A) Basic, COBOL, FORTRAN
- B) Prolog 2, Expert Systems
- C) Knowledge based Systems
- D) Assembly Languages

**141. What was the main disadvantage of vacuum tubes?**

- A) They were larger in size
- B) They consumed a lot of electricity
- C) They produced heat and often burned out
- D) The operation cost was high

**142. Registers, which are partially visible to users and used to hold conditional, are known as**

- A) PC
- B) Memory address registers
- C) General purpose register
- D) Flags

**143. Which is not a computer of first generation?**

- A) ENIAC
- B) UNIVAC
- C) IBM 360
- D) IBM 1401

**144. Registers which are partially visible to users and used to hold conditional codes (bits set by the CPU hardware as the result**

*of operations), are known as*

- A) PC
- B) Flags
- C) Memory Address Registers
- D) General Purpose Registers

**145. Who invented vacuum tubes?**

- A) John Bardeen
- B) William Shockley
- C) Lee de Forest
- D) All of above

**146. An approach that permits the computer to work on several programs instead of one is**

- A) On-line thesaurus
- B) Multiprogramming
- C) Over lapped processing
- D) Outline processor

**147. Who suggested Stored Program Concept**

- A) John Mauchley
- B) J.P. Eckert
- C) John Neumann
- D) Joseph Jacquard

**148. The central processing unit (CPU) consists of**

- A) Input, output and processing
- B) Control unit, primary storage, and secondary storage
- C) Control unit, arithmetic-logic unit and primary storage
- D) Control unit, processing, and primary storage

**149. The notable features like keyboards, monitors, GUI were developed in**

- A) First generation
- B) Second generation
- C) Third generation
- D) Fourth generation

**150. UNIVAC is**

- A) Universal Automatic Computer
- B) Universal Array Computer
- C) Unique Automatic Computer

D) Unvalued Automatic Computer

**151. Which is the highest form?**

- A) Data
- B) Information
- C) Knowledge
- D) All of above

**152. Who is credited with the idea of using punch cards to control patterns in a waving machine?**

- A) Pascal
- B) Hollerith
- C) Babbage
- D) Jacquard

**153. What is an interpreter?**

A) An interpreter does the conversion line by line as the program is run

B) An interpreter is the representation of the system being designed

C) An interpreter is a general purpose language providing very efficient execution

D) None of the above

**154. Which is a semi conductor memory?**

- A) Dynamic
- B) Static
- C) Bubble
- D) Both a & b

**155. RJ45 UTP cable has \_\_\_\_\_ Cables.**

- A) 2 pair
- B) 3 pair
- C) 4 pair
- D) 5 pair

**156. Which of the following is not a valid size of a Floppy Disk?**

- A) 8?
- B) 5 ¼?
- C) 3 ½?
- D) 5 ½?

**157. The earliest calculating devices are**

- A) Abacus

- B) Clock
- C) Difference Engine
- D) None of these

**158. Word length of a Personal Computer is \_\_**

- A) 4 bits
- B) 8 bits
- C) 16 bits
- D) 64 bits

**159. What was the first computer to perform all calculation using electronics rather than wheels, ratchets, or mechanical switches?**

- A) Mark I
- B) ABC
- C) Z3
- D) None of above

**160. A directly accessible appointment calendar is feature of a \_\_ resident package**

- A) CPU
- B) Memory
- C) Buffer
- D) ALU

**161. Which unit converts computer data into human readable form?**

- A) Input unit
- B) Output unit
- C) ALU
- D) Control Unit

**162. The full form of ALU is**

- A) Arithmetic Logic Unit
- B) Array Logic Unit
- C) Application Logic Unit
- D) None of above

**163. What produces useful information out of data?**

- A) Computer
- B) Processing
- C) Programming
- D) none of above

**164. Which of the following device was**

**not invented by Babbage?**

- A) Pascaline
- B) Difference Engine
- C) Analytical Engine
- D) None of above

**165. A digital computer did not score over an analog computer in terms of**

- A) Speed
- B) Accuracy
- C) Reliability
- D) Cost

**166. Which number system is usually followed in a typical 32-bit computer?**

- A) Binary
- B) Decimal
- C) Hexadecimal
- D) Octal

**167. A computer has very low failure rate because it uses electronic components. It produces very consistent results. This is highlighted by which of the feature of computer?**

- A) Accuracy
- B) Reliability
- C) Versatility
- D) Automatic

**168. A paper printout of a document is known as**

- A) Softcopy output
- B) Hardcopy output
- C) Permanent Output
- D) All of above

**169. Which electronic component was made out of semiconductor material?**

- A) Vacuum tubes
- B) Transistors
- C) ICs
- D) All of above

**170. The act of retrieving existing**

*data from memory is called*

- A) Read-out
- B) Read from
- C) Read
- D) All of above

*171. Which part of the computer is used for calculating and comparing?*

- A) Disk unit
- B) Control unit
- C) ALU
- D) Modem

*172. ABC is a*

- A) Special purpose computer
- B) General purpose computer
- C) All Purpose Computer
- D) None of above

*173. The computer code for the interchange of information between terminals is*

- A) ASCII
- B) BCD
- C) EBCDIC
- D) All of above

*174. When was the X window system born?*

- A) 1984
- B) 1989
- C) 1988
- D) 1990

*175. What is the first stage in software development?*

- A) Specification and design
- B) Testing
- C) System Analysis
- D) Maintenance

*176. Which of the following is valid statement?*

- A) Data in itself is useless unless it is processed
- B) The data that is processed is called a program
- C) The data which is not yet processed is

information

- D) Information is processed by computer to generate data.

*177. The Second Generation Computer was based on \_\_\_\_\_.*

- A) Vacuum Tube
- B) Silicon Chips
- C) Transistor
- D) Bio Chips

*178. EBCDIC stands for*

- A) Extended Binary Coded Decimal Interchange Code
- B) Extended Bit Code Decimal Interchange Code
- C) Extended Bit Case Decimal Interchange Code
- D) Extended Binary Case Decimal Interchange Code

*179. Personnel who design, program, operates and maintains computer equipment refers to*

- A) Console-operator
- B) Programmer
- C) Peopleware
- D) System Analyst

*180. IBM System/360 is*

- A) Mainframe Computer
- B) Mini Computers
- C) Micro Computers
- D) None of above

*181. A system is*

- A) an integration of different units so as to achieve an objective
- B) input unit
- C) input and output unit
- D) input, output and storage units

*182. Which of the following programming language started from second generation?*

- A) Cobol
- B) BASIC
- C) C
- D) LISP

**183. The translator program used in assembly language is called**

- A) Compiler
- B) Interpreter
- C) Assembler
- D) Translator

**184. EEPROM stands for**

- A) Electrically Erasable Programmable Read Only Memory
- B) Easily Erasable Programmable Read Only Memory
- C) Electronic Erasable Programmable Read Only Memory
- D) None of the above

**185. Regarding data, computers are very good at**

- A) store
- B) Processing
- C) retrieve
- D) All of above

**186. Bit map terminal**

- A) support display containing multiple windows
- B) require considerable amount of video RAM
- C) requires tremendous amount of copying and hence low performance
- D) all of above

**187. First generation computers used \_\_\_\_\_ for memory**

- A) vacuum tubes
- B) silicon chips
- C) magnetic drum
- D) RAM

**188. Which of the following memories allows simultaneous read and write operations?**

- A) ROM
- B) RAM
- C) EPROM
- D) None of above

**189. EPROM can be used for**

- A) Erasing the contents of ROM
- B) Reconstructing the contents of ROM
- C) Erasing and reconstructing the contents of ROM
- D) Duplicating ROM

**190. ENIAC uses**

- A) Decimal Numbering System
- B) Octal Numbering System
- C) Binary Numbering System
- D) Hexadecimal Numbering System

**191. A term associated with the comparison of processing speeds of different computer system is:**

- A) EFTS
- B) MPG
- C) MIPS
- D) CPS

**192. which of the following is problem oriented language?**

- A) High level language
- B) Machine language
- C) Assembly language
- D) Low level language

**193. A 32 bit microprocessor has the word length equal to**

- A) 2 byte
- B) 32 byte
- C) 4 byte
- D) 8 byte

**194. The term GIGO is related to**

- A) Accuracy
- B) Reliability
- C) Versatility
- D) Automatic

**195. Web cam is an**

- A) input unit device
- B) output unit device
- C) processing device
- D) Input and Output device

**196. Bit stands for**

- A) Binary digits
- B) bit of system
- C) a part of byte

D) All of above

**197. Access time is**

A) seek time + latency time

B) seek time

C) seek time ? latency time

D) latency time

**198. Which device can understand difference between data & programs?**

A) Input device

B) Output device

C) Memory

D) Microprocessor

**199. Which of the following is a read only memory storage device?**

A) Floppy Disk

B) CD-ROM

C) Hard Disk

D) None of these

**200. Symbolic logic was discovered by**

A) George Boole

B) Herman Hollerith

C) Van Neumann

D) Basic Pascal

**201. Which of the following is not valid statement?**

A) Hard is referred to mean something temporary

B) Hard is used to mean something tangible

C) Soft is used to mean something permanent

D) Soft is used to mean something tangible

**202. Digital devices are**

A) Digital Clock

B) Automobile speed meter

C) Clock with a dial and two hands

D) All of them

**203. Primary memory stores**

A) Data alone

B) Programs alone

C) Results alone

D) All of these

**204. After copying the content how many times can you paste?**

A) 1

B) 16

C) 32

D) Many

**205. WAN stands for**

A) Wap Area Network

B) Wide Area Network

C) Wide Array Net

D) Wireless Area Network

**206. An error in computer data is called**

A) Chip

B) Bug

C) CPU

D) Storage device

**207. The instructions for starting the computer are house on**

A) Random access memory

B) CD-Rom

C) Read only memory chip

D) All of above

**208. 1 nibble equals to**

A) 1 bits

B) 2 bits

C) 4 bits

D) 8 bits

**209. Perforated paper used as input of output media is known as**

A) paper tapes

B) magnetic tape

C) punched papers tape

D) card punch

**210. The secondary storage devices can only store data but they cannot perform**

A) Arithmetic Operation

B) Logic operation

C) Fetch operations

D) Either of the above

**211. Which American computer**



*company is called Big Blue?*

- A) Microsoft
- B) Compaq Corp
- C) IBM
- D) Tandy Svenson

*212. It was in 2028 BS the \_\_\_\_\_ was brought in to calculate census data.*

- A) IBM 1400
- B) IBM 1401
- C) ICL 2950
- D) None of above

*213. Who is the inventor of ABC Computer?*

- A) John v. Atanasoff
- B) Clifford Berry
- C) Both of above
- D) None of above

*214. Which of the following is the largest unit?*

- A) data
- B) field
- C) record
- D) database file

*215. Find out who is not the inventor of transistors among following names*

- A) John Burdeen
- B) William Shockley
- C) Walter Brattain
- D) Lee de Forest

*216. Which of the following is not true for a magnetic disk?*

- A) It is expensive relative to magnetic tape
- B) It provides only sequential access to stored data
- C) Users can easily update records by writing over the old data
- D) All of above

*217. A disadvantage of the laser printer is*

- A) It is quieter than an impact printer
- B) It is very slow

- C) The output is of a lower quality
- D) None of the above

*218. The most commonly used standard data code to represent alphabetical, numerical and punctuation characters used in electronic data processing system is called*

- A) ASCII
- B) EBCDIC
- C) BCD
- D) All of above

*219. Which access method is used to access cassette tape?*

- A) Direct
- B) Sequential
- C) Both of the above
- D) None of the above

*220. A Compiler is \_\_\_\_*

- A) a combination of computer hardware
- B) a program which translates from one high-level language to another
- C) a program which translates from one high-level to a machine level language
- D) None of these

*221. Which unit holds data temporarily?*

- A) Input unit
- B) Secondary storage unit
- C) Output Unit
- D) Primary Memory Unit

*222. The computer size was very large in*

- A) First Generation
- B) Second Generation
- C) Third Generation
- D) Fourth Generation

*223. A name or number used to identify storage location devices?*

- A) A byte
- B) A record
- C) An address



D) All of above

**224. Which of the following is not computer language?**

- A) High level language
- B) Medium level language
- C) Low level language
- D) All of the above

**225. Reading data is performed in magnetic disk by**

- A) Read/write leads
- B) Sectors
- C) Track
- D) Lower surface

**226. IBM 7000 digital computer**

- A) Belongs to second generation
- B) Uses VLSI
- C) Employs semiconductor memory
- D) Has modular constructions

**227. Which of the following is not electro-mechanical computer?**

- A) Mark I
- B) ABC
- C) Zuse
- D) UNIVAC

**228. The term 'computer' is derived from**

- A) Greek language
- B) Sanskrit language
- C) Latin language
- D) German language

**229. Which statement is valid about magnetic tape?**

- A) It is a plastic ribbon
- B) It is coated on both sides with iron oxide
- C) It can be erased and reused
- D) All of above

**230. Which of the following is first generation computer?**

- A) EDSAC
- B) IBM 1401
- C) CDC 1604
- D) ICL 2950

**231. A hard copy would be prepared on a**

- A) Line printer
- B) Dot matrix Printer
- C) Typewriter terminal
- D) All of the above

**232. The term GIGO is relate to which characteristics of computers?**

- A) Speed
- B) Automatic
- C) Accuracy
- D) Reliability

**233. Which of the following programming language were used in first generation computers?**

- A) Machine language
- B) Assembly language
- C) Both of above
- D) None of above

**234. To locate a data item for storage is**

- A) Field
- B) Feed
- C) Database
- D) Fetch

**235. Who used punched cards practically for the first time in the history of computers?**

- A) Charles Babbage
- B) Dr. Herman Hollerith
- C) Howard Aikin
- D) Joseph Jacquard

**236. Hard disk is coated in both sides with**

- A) Magnetic metallic oxide
- B) Optical metallic oxide
- C) Carbon layer
- D) All of the above

**237. Which of the following term means to reckon?**

- A) putare
- B) com
- C) computa

D) computer

**238. An input/output device at which data enters or leaves a computer system is**

- A) Keyboard
- B) Terminal
- C) Printer
- D) Plotter

**239. Which of the following is first generation of computer**

- A) EDSAC
- B) IBM-1401
- C) CDC-1604
- D) ICL-2900

**240. A name or number used to identify a storage location is called**

- A) A byte
- B) A record
- C) An address
- D) All of above

**241. Computer professionals working in a computer centre are**

- A) Software
- B) Firmware
- C) Hardware
- D) Humanware

**242. The first general purpose electronic computer in the world was**

- A) UNIVAC
- B) EDVAC
- C) ENIAC
- D) All of above

**243. The contents of information are stored in**

- A) Memory data register
- B) Memory address register
- C) Memory arithmetic registers
- D) Memory access register

**244. Which of the following is correct full form of BCD?**

- A) Binary Coded Decimal
- B) Bit Coded Decimal

C) Binary Coded Digit

D) Bit Coded Digit

**245. Which was the world's first microcomputer that used Intel 80386 microprocessor chip?**

- A) IBM PS/2
- B) HP-9830
- C) DeskPro-386
- D) IBM-360

**246. The qualitative or quantitative attribute of a variable or set of variables is termed as**

- A) data
- B) information
- C) both of above
- D) none of above

**247. Main storage is also called**

- A) Accumulator
- B) Control Unit
- C) Register Unit
- D) Memory

**248. Which of the following are (is) considered to be video component?**

- A) Resolution
- B) Color depth
- C) Refresh rate
- D) All of the above

**249. For what Antikythera was used?**

- A) For counting
- B) For Calculating tax collection
- C) For calculating astronomical positions
- D) For calculating firing weapons

**250. Memory unit is one part of**

- A) Input device
- B) Control unit
- C) Output device
- D) Central Processing Unit

**251. Microprocessors can be used to make**

- A) Computer
- B) Digital systems
- C) Calculators

D) All of the above

**252. Which statement is valid about computer program?**

A) High level languages must be converted into machine language to execute

B) High level language programs are more efficient and faster to execute

C) It is more difficult to identify errors in high level language program than in low level programs

D) All of above

**253. By programmable machine we mean**

A) computers

B) modern television

C) washing machines

D) anything that can be set to perform different tasks with suitable programs

**254. Which of the following is a secondary memory device?**

A) Keyboard

B) Disk

C) ALU

D) All of the above

**255. The memory which is programmed at the time it is manufactured**

A) ROM

B) RAM

C) PROM

D) EPROM

**256. One of the popular mass storage device is CD ROM. What does CD ROM stand for?**

A) Compactable Read Only Memory

B) Compact Data Read Only Memory

C) Compactable Disk Read Only Memory

D) Compact Disk Read Only Memory

**257. Identify the true statement**

A) Computers are 100% accurate but it

can suffer from GIGO

B) Computers are reliable because they use electronic component

which have very low failure rate

C) Computer is never tired and does not suffer from boredom

D) All of above

**258. FORTRAN is**

A) File Translation

B) Format Translation

C) Formula Translation

D) Floppy Translation

**259. The programs which are as permanent as hardware and stored in ROM is known as**

A) Hardware

B) Software

C) Firmware

D) ROM ware

**260. Which of the following memories must be refreshed many times per second?**

A) Static RAM

B) Dynamic RAM

C) EPROM

D) ROM

**261. What do you call the translator which takes assembly language program as input & produce machine language code as output?**

A) Compiler

B) Interpreter

C) Debugger

D) Assembler

**262. Serial access memories are useful in applications where**

A) Data consists of numbers

B) Short access time is required

C) Each stored word is processed differently

D) Data naturally needs to flow in and out in serial form

**263. In \_\_\_\_\_ mode, the communication channel is used in both directions at the same time?**

- A) Full-duplex
- B) Simplex
- C) Half-duplex
- D) None of the above

**264. Who invented Slide Rules?**

- A) John Napier
- B) William Oughtred
- C) Gottfried Leibnitz
- D) Blaise Pascal

**265. The proper definition of a modern digital computer is**

- A) An electronic automated machine that can solve problems involving words and numbers
- B) A more sophistic and modified electronic pocket calculator
- C) Any machine that can perform mathematical operations
- D) A machine that works on binary code

**266. Memory is made up of**

- A) Set of wires
- B) Set of circuits
- C) Large number of cells
- D) All of these

**267. Which of the following is the most powerful computers?**

- A) Mainframe Computer
- B) Mini Computers
- C) Micro Computers
- D) Super Computers

**268. Which of the printers used in conjunction with computers uses dry ink powder?**

- A) Daisy wheel printer
- B) Line printer
- C) Laser printer
- D) Thermal printer

**269. What is the path from which data flow in a computer system is known as**

- A) Car
- B) Bus
- C) Truck
- D) Road

**270. Which term is used to describe RAM?**

- A) Dynamic RAM (DRAM)
- B) Static RAM (SRAM)
- C) Video RAM (VRAM)
- D) All of the above

**271. In which year was chip used inside the computer for the first time?**

- A) 1964
- B) 1975
- C) 1999
- D) 1944

**272. Assembly language started to be used from**

- A) first generation computers
- B) second generation computers
- C) third generation computers
- D) fourth generation computers

**273. Which technology is more reliable?**

- A) Mechanical
- B) Electro-Mechanical
- C) Electronic
- D) For reliability it does not matter. So all of above are reliable

**274. Which of the following is not an XT microprocessor?**

- A) 8006
- B) 8086
- C) 8088
- D) None of above

**275. Hard disk is coated in both side with**

- A) Magnetic metallic oxide
- B) Optical metallic oxide
- C) Carbon layer
- D) All of the above

**276. ASCII stands for**

- A) American Stable Code for International Interchange
- B) American Standard Case for Institutional Interchange
- C) American Standard Code for Information Interchange
- D) American Standard Code for Interchange Information

**277. Raw facts and figures about any particular topic are**

- A) Information
- B) facts
- C) data
- D) none of above

**278. A computer can solve more than one kind of problem. This is related to which of the following characteristics?**

- A) Accuracy
- B) Reliability
- C) Versatility
- D) Automatic

**279. From which generation computers the printers were used?**

- A) first
- B) second
- C) third
- D) fourth

**280. How many symbols exist in Baudot code?**

- A) 32
- B) 116
- C) 58
- D) 76

**281. Following IC chip integrates 100 thousands electronic components per chip**

- A) SSI
- B) MSI
- C) LSI
- D) VLSI

**282. An application program that helps the user to change any number and immediately see the**

**result of that change is**

- A) Desktop publishing program
- B) Database
- C) Spreadsheet
- D) All of above

**283. In 1830, Charles Babbage designed a machine called the Analytical Engine which he showed at the Paris Exhibition. In which year was it exhibition?**

- A) 1820
- B) 1860
- C) 1855
- D) 1870

**284. What is the name of the new color laptop computer which is powered by a 386 processor at 33 MHz and is built by Epson?**

- A) AX3/33
- B) NEC-20
- C) Magnum 2000
- D) HCL-3000

**285. In analog computer**

- A) Input is first converted to digital form
- B) Input is never converted to digital form
- C) Output is displayed in digital form
- D) All of the above

**286. Which of the following computer is not invented by J.P. Eckert and John Mauchly?**

- A) ENIAC
- B) EDVAC
- C) UNIVAC
- D) EDSAC

**287. When was the company named IBM?**

- A) 1914
- B) 1924
- C) 1975
- D) None of above

**288. Which of the following storage device can store the largest amount of data?**

- A) Hard Disks
- B) Flash Disks
- C) Blu-Ray Disks
- D) DVDs

**289. Who invented Mark I?**

- A) Howard Aikin
- B) J. P. Eckert
- C) John Mauchley
- D) John v. Atanasoff

**290. ALU is**

- A) Arithmetic Logic Unit
- B) Array Logic Unit
- C) Application Logic Unit
- D) None of above

**291. A computer program that converts an entire program into machine language at one time is called a/an**

- A) Interpreter
- B) CPU
- C) Compiler
- D) Simulator

**292. When did arch rivals IBM and Apple Computers Inc. decide to join hands?**

- A) 1978
- B) 1984
- C) 1990
- D) 1991

**293. The purpose of vacuum tube was to NOT act like**

- A) an amplifier
- B) a switch
- C) a router
- D) None of above

**294. As compared to diskettes, the hard disks are**

- A) More expensive
- B) More portable
- C) Less rigid
- D) Slowly accessed

**295. Which of the following is the most quickly accessible storage?**

- A) RAM

- B) Registers
- C) Disks
- D) Pen Drive

**296. The octal equivalence of 111010 is**

- A) 81
- B) 72
- C) 71
- D) None of above

**297. Excessive parallel processing is related to**

- A) First generation
- B) Fourth generation
- C) Fifth Generation
- D) Third generation

**298. Second generation computers were developed during**

- A) 1949 to 1955
- B) 1956 to 1965
- C) 1965 to 1970
- D) 1970 to 1990

**299. What do you call a single point on a computer screen?**

- A) Cell
- B) Element
- C) Pixel
- D) Bit

**300. Mostly which of the following device is used to carry user files?**

- A) Floppy Disk
- B) Hard Disk
- C) RAM
- D) CDROM

**301. Which of the following computer implemented binary numbers, perform calculations using electronics and implemented separate computation and memory for the first time?**

- A) Mark I
- B) ABC
- C) Z3

D) None of above

**302. FORTRAN is a programming language. What does FORTRAN stand for?**

- A) File Translation
- B) Format Translation
- C) Formula Translation
- D) Floppy Translation

**303. Which of the following memories needs refreshing?**

- A) SRAM
- B) DRAM
- C) ROM
- D) All of above

**304. Can you tell what passes into and out from the computer via its ports?**

- A) Data
- B) Bytes
- C) Graphics
- D) Pictures

**305. An output device that uses words**

**or messages recorded on a magnetic medium to produce audio response is**

- A) Magnetic tape
- B) Voice response unit
- C) Voice recognition unit
- D) Voice band

**306. Which of the items below are considered removable storage media?**

- A) Removable hard disk cartridges
- B) (Magneto-optical) disk
- C) Flexible disks cartridges
- D) All of the above

**307. Which of the following is not purely output device?**

- A) Screen
- B) Printer
- C) Speaker
- D) Plotter

## ANSWERS

1-A	19-C	37-A	55-C	73-C	91-D	109-C	127-B
2-D	20-D	38-C	56-C	74-D	92-C	110-C	128-C
3-D	21-B	39-B	57-C	75-B	93-C	111-C	129-B
4-D	22-D	40-B	58-C	76-A	94-A	112-D	130-B
5-C	23-C	41-C	59-B	77-D	95-D	113-A	131-C
6-A	24-B	42-B	60-B	78-C	96-B	114-C	132-A
7-C	25-A	43-C	61-C	79-A	97-D	115-B	133-A
8-D	26-B	44-D	62-B	80-A	98-C	116-B	134-B
9-C	27-B	45-C	63-D	81-C	99-C	117-C	135-B
10-B	28-A	46-A	64-A	82-D	100-B	118-C	136-A
11-C	29-B	47-B	65-D	83-C	101-B	119-A	137-B
12-C	30-D	48-D	66-D	84-B	102-C	120-D	138-A
13-D	31-B	49-A	67-C	85-D	103-B	121-A	139-B
14-C	32-D	50-B	68-A	86-D	104-B	122-A	140-D
15-C	33-A	51-D	69-B	87-A	105-B	123-A	141-C
16-B	34-A	52-B	70-C	88-C	106-C	124-B	142-C
17-B	35-A	53-B	71-C	89-D	107-B	125-A	143-D
18-B	36-D	54-D	72-B	90-D	108-C	126-D	144-B

145-C	159-B	173-A	187-C	201-B	215-D	229-D	243-A
146-C	160-B	174-A	188-B	202-A	216-B	230-A	244-A
147-C	161-B	175-C	189-C	203-D	217-D	231-D	245-C
148-C	162-A	176-A	190-A	204-D	218-A	232-C	246-A
149-C	163-B	177-C	191-C	205-B	219-B	233-A	247-D
150-A	164-A	178-A	192-A	206-B	220-C	234-D	248-D
151-C	165-B	179-C	193-C	207-C	221-D	235-B	249-C
152-D	166-A	180-A	194-A	208-C	222-A	236-A	250-D
153-B	167-B	181-A	195-A	209-A	223-C	237-A	251-D
154-D	168-B	182-A	196-A	210-D	224-B	238-B	252-A
155-C	169-C	183-C	197-A	211-C	225-A	239-A	253-A
156-D	170-D	184-A	198-D	212-B	226-D	240-C	254-B
157-A	171-C	185-D	199-B	213-C	227-D	241-D	255-C
158-B	172-A	186-D	200-A	214-D	228-C	242-C	256-D
257-D			276-C			295-B	
258-C			277-C			296-B	
259-C			278-C				
260-B			279-B				
261-D			280-A				
262-D							
263-A							
264-B							
							297-C
							298-B
				281-C			299-C
				282-C			300-A
				283-C			301-B
	265-A			284-A			302-C
	266-C			285-B			303-B
	267-D			286-D			304-A
	268-C			287-B			
	269-B			288-A			
	270-D						
	271-B						
	272-B						
					289-A		
					290-A		
					291-C		
					292-D		
		273-C			293-C		
		274-D			294-A		
		275-A					



305-B  
306-D  
307-A

# FUNDAMENTALS OF DBMS:

## OVERVIEW OF DATABASE

---

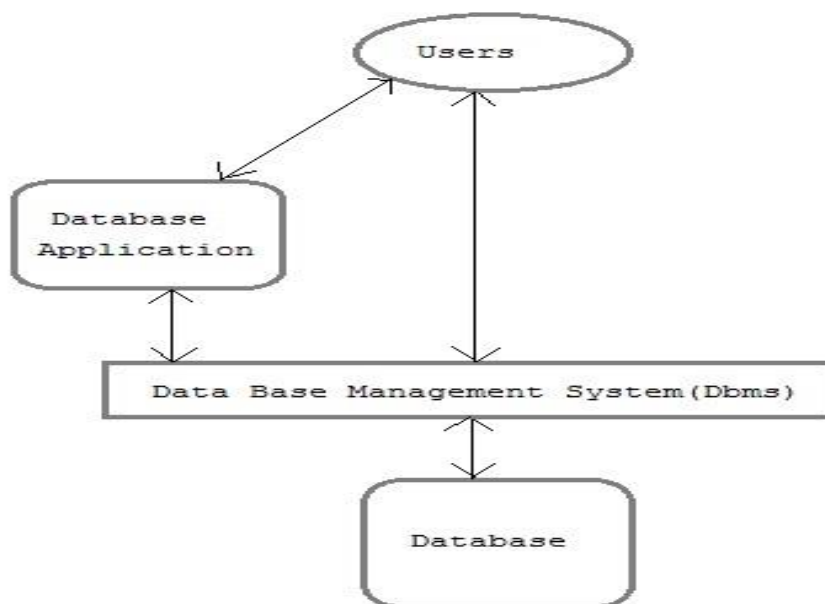
A **Database** is a collection of related data organized in a way that data can be easily accessed, managed and updated. Any piece of information can be a data, for example name of your school. Database is actually a place where related piece of information is stored and various operations can be performed on it.

## DBMS

A **DBMS** is a software that allows creation, definition and manipulation of database. Dbms is actually a tool used to perform any kind of operation on data in database. Dbms also provides protection and security to database. It maintains data consistency in case of multiple users. Here are some examples of popular dbms, MySQL, Oracle, Sybase, Microsoft Access and IBM DB2 etc.

## Components of Database System

The database system can be divided into four components.



- **USERS:** Users may be of various type such as DB administrator, System developer and End users.
- **DATABASE APPLICATION :** Database application may be Personal, Departmental, Enterprise and Internal
- **DBMS:** Software that allow users to define, create and manages database access, Ex: MySQL, Oracle etc.
- **DATABASE:** Collection of logical data.

## Functions of DBMS

- Provides data Independence
- Concurrency Control
- Provides Recovery services
- Provides Utility services
- Provides a clear and logical view of the process that manipulates data.

### Advantages of DBMS

- Segregation of application program.
- Minimal data duplicity.
- Easy retrieval of data.
- Reduced development time and maintenance need.

### Disadvantages of DBMS

- Complexity
- Costly
- Large in size

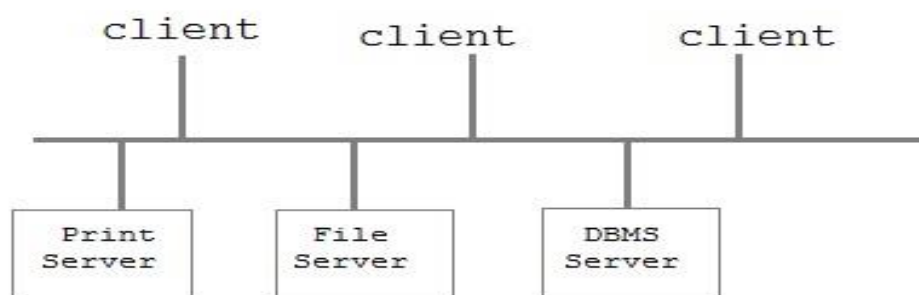
## DATABASE ARCHITECTURE

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Database architecture is logically divided into two types.

- Logical two-tier Client / Server architecture
- Logical three-tier Client / Server architecture

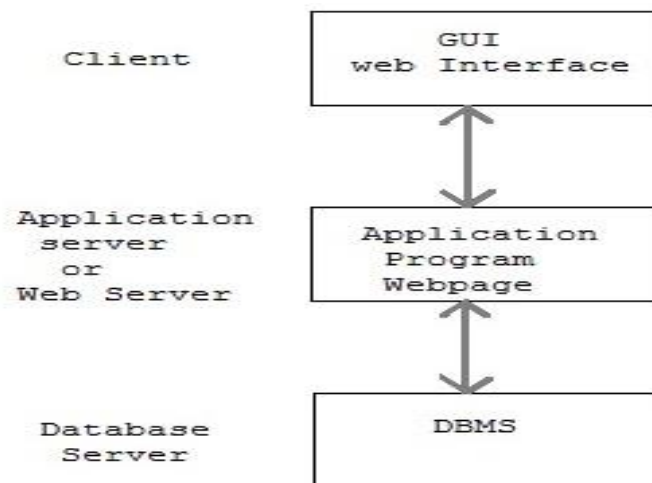
### TWO-TIER CLIENT / SERVER ARCHITECTURE



Two-tier Client / Server architecture is used for User Interface program and Application Programs that runs on client side. An interface called ODBC (Open Database Connectivity) provides an API that allow client side program to call the dbms. Most DBMS vendors provide ODBC drivers. A client program may connect to several DBMS's. In this architecture some variation of client is also possible for example in some DBMS's more functionality is transferred to the client including data dictionary, optimization etc. Such clients are called **Data server**.

### THREE-TIER CLIENT / SERVER ARCHITECTURE

Three-tier Client / Server database architecture is commonly used architecture for web applications. Intermediate layer called **Application server** or Web Server stores the web connectivity software and the business logic (constraints) part of application used to access the right amount of data from the database server. This layer acts like medium for sending partially processed data between the database server and the client.



## DATABASE MODEL

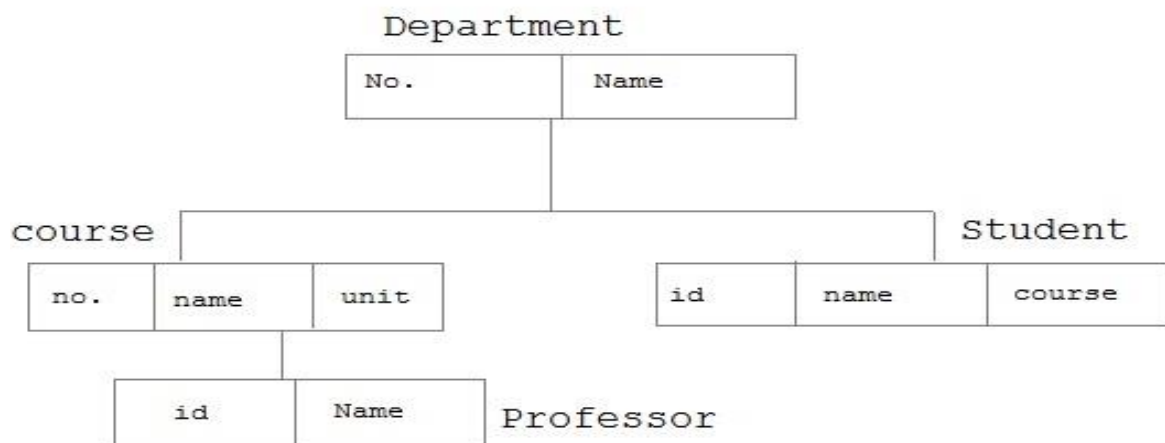
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A Database model defines the logical design of data. The model describes the relationships between different parts of the data. Historically, in database design, three models are commonly used. They are,

- Hierarchical Model
- Network Model
- Relational Model

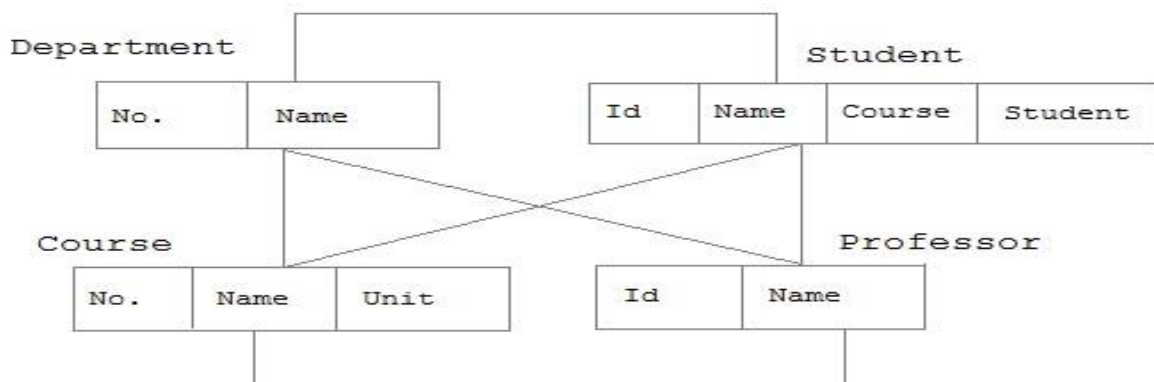
## HIERARCHICAL MODEL

In this model each entity has only one parent but can have several children . At the top of hierarchy there is only one entity which is called **Root**.



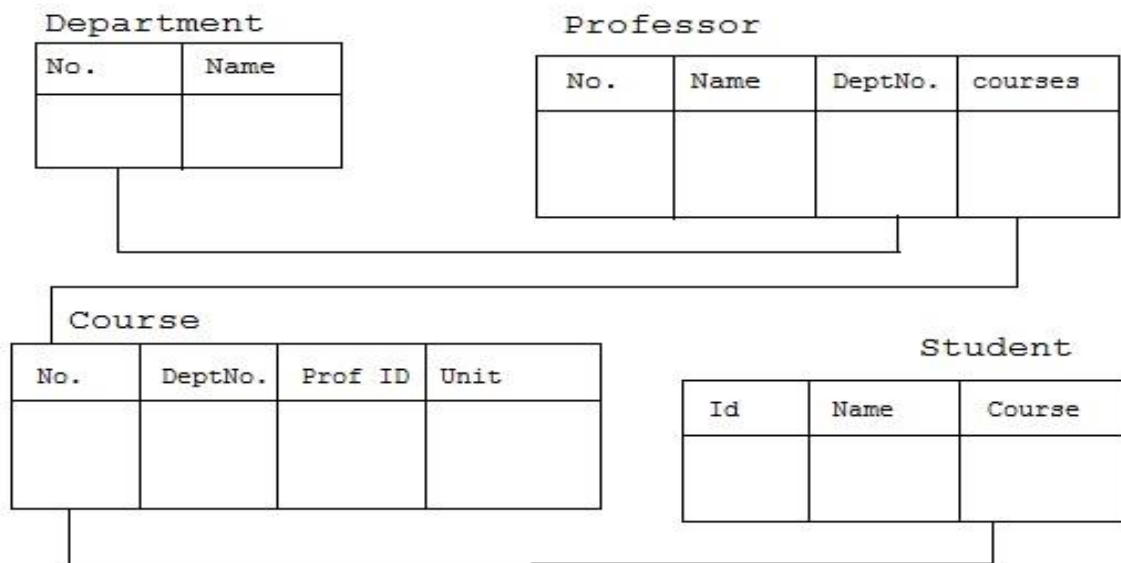
## NETWORK MODEL

In the network model, entities are organised in a graph, in which some entities can be accessed through several paths.



## RELATIONAL MODEL

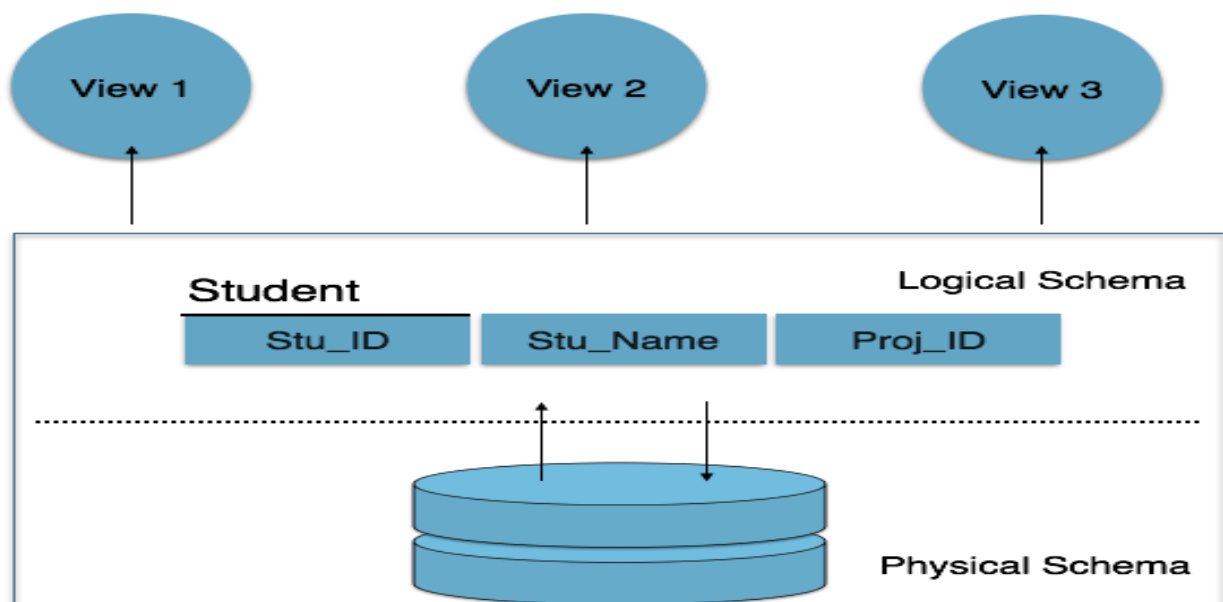
In this model, data is organized in two-dimensional tables called **relations**. The tables or relations are related to each other.



## DATABASE SCHEMA

A database schema is the skeleton structure that represents the logical view of the entire database. It defines how the data is organized and how the relations among them are associated. It formulates all the constraints that are to be applied on the data.

A database schema defines its entities and the relationship among them. It contains a descriptive detail of the database, which can be depicted by means of schema diagrams. It's the database designers who design the schema to help programmers understand the database and make it useful.



A database schema can be divided broadly into two categories –

- **Physical Database Schema** – this schema pertains to the actual storage of data and its form of storage like files, indices, etc. It defines how the data will be stored in a secondary storage.

- **Logical Database Schema** – this schema defines all the logical constraints that need to be applied on the data stored. It defines tables, views, and integrity constraints.

## DATABASE INSTANCE

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It is important that we distinguish these two terms individually. Database schema is the skeleton of database. It is designed when the database doesn't exist at all. Once the database is operational, it is very difficult to make any changes to it. A database schema does not contain any data or information.

A database instance is a state of operational database with data at any given time. It contains a snapshot of the database. Database instances tend to change with time. A DBMS ensures that its every instance (state) is in a valid state, by diligently following all the validations, constraints, and conditions that the database designers have imposed.

## CODD'S RULE

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E.F Codd was a Computer Scientist who invented **Relational model** for Database management. Based on relational model, **Relation database** was created. Codd proposed 13 rules popularly known as **Codd's 12 rules** to test DBMS's concept against his relational model. Codd's rule actually define what quality a DBMS requires in order to become a Relational Database Management System (RDBMS). Till now, there is hardly any commercial product that follows all the 13 Codd's rules. Even **Oracle** follows only eight and half out (8.5) of 13. The Codd's 12 rules are as follows.

### RULE 1: INFORMATION RULE

All information (including metadata) is to be represented as stored data in cells of tables. The rows and columns have to be strictly unordered.

### RULE 2: GUARANTEED ACCESS

Each unique piece of data (atomic value) should be accessible by : Table Name + primary key(Row) + Attribute(column).

NOTE: Ability to directly access via POINTER is a violation of this rule.

### RULE 3: SYSTEMETIC TREATMENT OF NULL

**Null** has several meanings, it can mean missing data, not applicable or no value. It should be handled consistently. Primary key must not be null. Expression on **NULL** must give null.

### RULE 4: ACTIVE ONLINE CATALOG

Database dictionary(catalog) must have description of **Database**. Catalog to be governed by same rule as rest of the database. The same query language to be used on catalog as on application database.

## RULE 5: POWERFUL LANGUAGE

One well defined language must be there to provide all manners of access to data. Example: **SQL**. If a file supporting table can be accessed by any manner except SQL interface, then its a violation to this rule.

## RULE 6: VIEW UPDATION RULE

All view that are theoretically updatable should be updatable by the system.

## RULE 7: RELATIONAL LEVEL OPERATION

There must be Insert, Delete, and Update operations at each level of relations. Set operation like Union, Intersection and minus should also be supported.

## RULE 8: PHYSICAL DATA INDEPENDENCE

The physical storage of data should not matter to the system. If say, some file supporting table were renamed or moved from one disk to another, it should not effect the application.

## RULE 9: LOGICAL DATA INDEPENDENCE

If there is change in the logical structure(table structures) of the database the user view of data should not change. Say, if a table is split into two tables, a new view should give result as the join of the two tables. This rule is most difficult to satisfy.

## RULE 10: INTEGRITY INDEPENDENCE

The database should be able to conforce its own integrity rather than using other programs. Key and Check constraints, trigger etc should be stored in Data Dictionary. This also make **RDBMS** independent of front-end.

## RULE 11: DISTRIBUTION INDEPENDENCE

A database should work properly regardless of its distribution across a network. This lays foundation of distributed database.

## RULE 12: NONSUBVERSION RULE

If low level access is allowed to a system it should not be able to subvert or bypass integrity rule to change data. This can be achieved by some sort of locking or encryption.

## DBMS - DATA INDEPENDENCE

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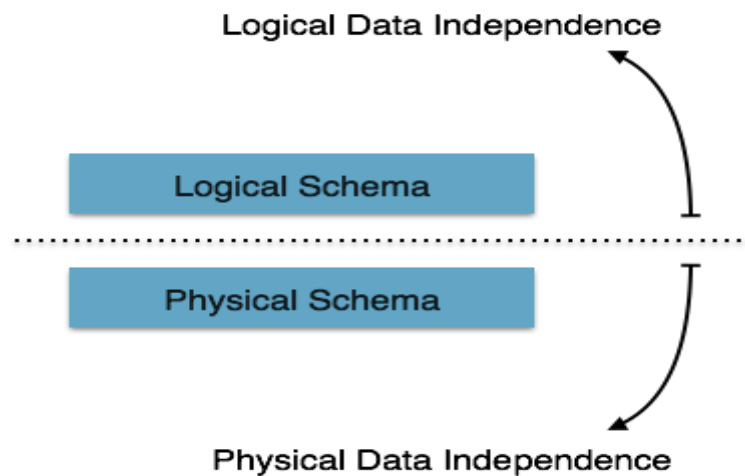
If a database system is not multi-layered, then it becomes difficult to make any changes in the database system. Database systems are designed in multi-layers as we learnt earlier.

## DATA INDEPENDENCE

A database system normally contains a lot of data in addition to users' data. For example, it stores data about data, known as metadata, to locate and retrieve data easily. It is rather difficult to modify or update a set of metadata once it is stored in the database. But as a



DBMS expands, it needs to change over time to satisfy the requirements of the users. If the entire data is dependent, it would become a tedious and highly complex job.



Metadata itself follows a layered architecture, so that when we change data at one layer, it does not affect the data at another level. This data is independent but mapped to each other.

### LOGICAL DATA INDEPENDENCE

Logical data is data about database, that is, it stores information about how data is managed inside. For example, a table (relation) stored in the database and all its constraints, applied on that relation.

Logical data independence is a kind of mechanism, which liberalizes itself from actual data stored on the disk. If we do some changes on table format, it should not change the data residing on the disk.

### PHYSICAL DATA INDEPENDENCE

All the schemas are logical, and the actual data is stored in bit format on the disk. Physical data independence is the power to change the physical data without impacting the schema or logical data.

For example, in case we want to change or upgrade the storage system itself – suppose we want to replace hard-disks with SSD – it should not have any impact on the logical data or schemas.

## ER MODEL - BASIC CONCEPTS

---

The ER model defines the conceptual view of a database. It works around real-world entities and the associations among them. At view level, the ER model is considered a good option for designing databases.

### ENTITY

An entity can be a real-world object, either animate or inanimate, that can be easily identifiable. For example, in a school database, students, teachers, classes, and courses offered can be considered as entities. All these entities have some attributes or properties that give them their identity.

An entity set is a collection of similar types of entities. An entity set may contain entities with attribute sharing similar values. For example, a Students set may contain all the students of a school; likewise a Teachers set may contain all the teachers of a school from all faculties. Entity sets need not be disjoint.

## ATTRIBUTES

Entities are represented by means of their properties, called **attributes**. All attributes have values. For example, a student entity may have name, class, and age as attributes.

There exists a domain or range of values that can be assigned to attributes. For example, a student's name cannot be a numeric value. It has to be alphabetic. A student's age cannot be negative, etc.

## TYPES OF ATTRIBUTES

- **Simple attribute** – Simple attributes are atomic values, which cannot be divided further. For example, a student's phone number is an atomic value of 10 digits.
- **Composite attribute** – Composite attributes are made of more than one simple attribute. For example, a student's complete name may have first\_name and last\_name.
- **Derived attribute** – Derived attributes are the attributes that do not exist in the physical database, but their values are derived from other attributes present in the database. For example, average\_salary in a department should not be saved directly in the database, instead it can be derived. For another example, age can be derived from data\_of\_birth.
- **Single-value attribute** – Single-value attributes contain single value. For example – Social\_Security\_Number.
- **Multi-value attribute** – Multi-value attributes may contain more than one values. For example, a person can have more than one phone number, email\_address, etc.

These attribute types can come together in a way like –

- simple single-valued attributes
- simple multi-valued attributes
- composite single-valued attributes
- composite multi-valued attributes

## ENTITY-SET

Key is an attribute or collection of attributes that uniquely identifies an entity among entity set.

For example, the roll\_number of a student makes him/her identifiable among students.

## RELATIONSHIP

The association among entities is called a relationship. For example, an employee **works\_at** a department, a student **enrolls** in a course. Here, Works\_at and Enrolls are called relationships.

## RELATIONSHIP SET

A set of relationships of similar type is called a relationship set. Like entities, a relationship too can have attributes. These attributes are called **descriptive attributes**.

## DEGREE OF RELATIONSHIP

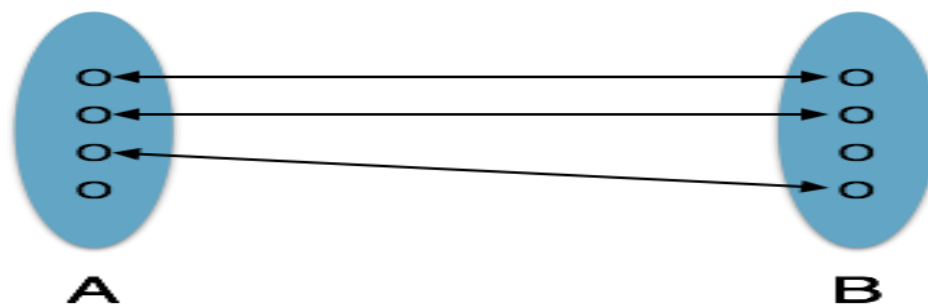
The number of participating entities in a relationship defines the degree of the relationship.

- Binary = degree 2
- Ternary = degree 3
- n-ary = degree

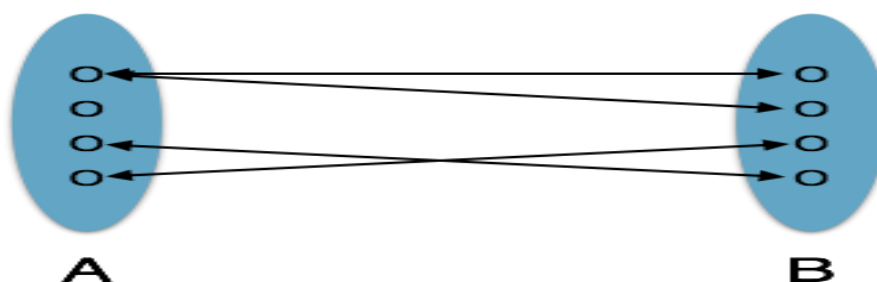
## MAPPING CARDINALITIES

**Cardinality** defines the number of entities in one entity set, which can be associated with the number of entities of other set via relationship set.

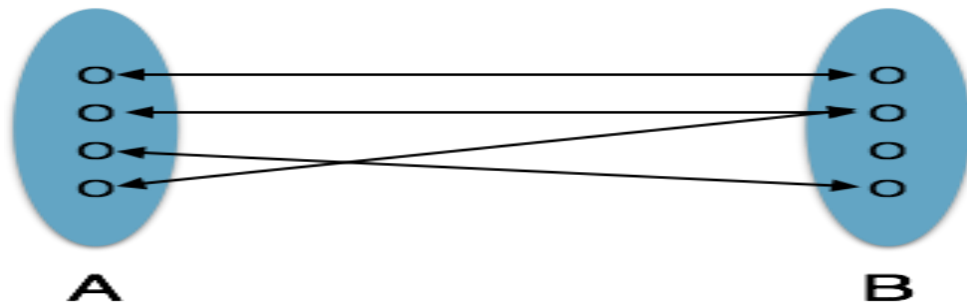
- **One-to-one** – One entity from entity set A can be associated with at most one entity of entity set B and vice versa.



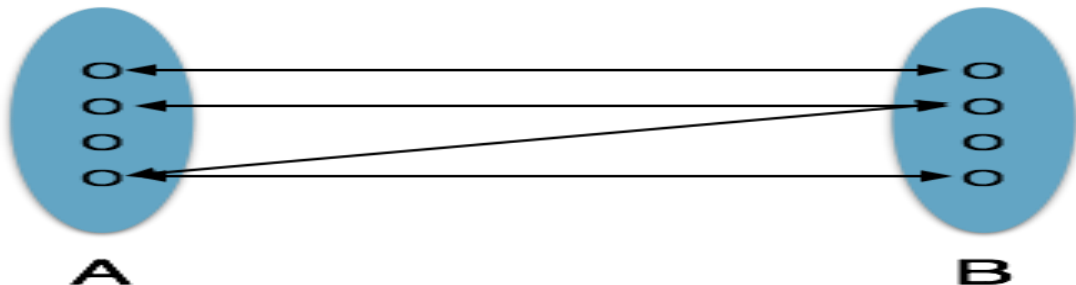
- **One-to-many** – One entity from entity set A can be associated with more than one entities of entity set B however an entity from entity set B, can be associated with at most one entity.



- **Many-to-one** – More than one entities from entity set A can be associated with at most one entity of entity set B, however an entity from entity set B can be associated with more than one entity from entity set A.



- **Many-to-many** – One entity from A can be associated with more than one entity from B and vice versa.



## ER DIAGRAM REPRESENTATION

Let us now learn how the ER Model is represented by means of an ER diagram. Any object, for example, entities, attributes of an entity, relationship sets, and attributes of relationship sets, can be represented with the help of an ER diagram.

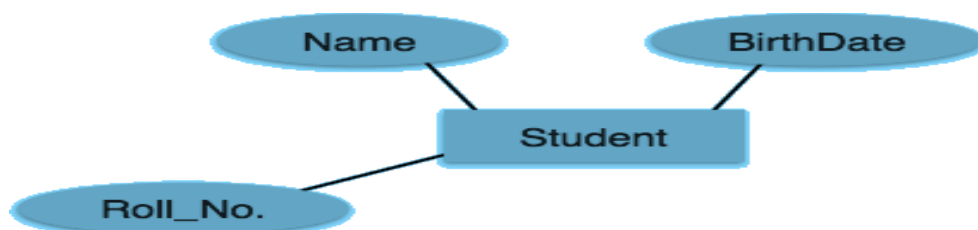
### ENTITY

Entities are represented by means of rectangles. Rectangles are named with the entity set they represent.

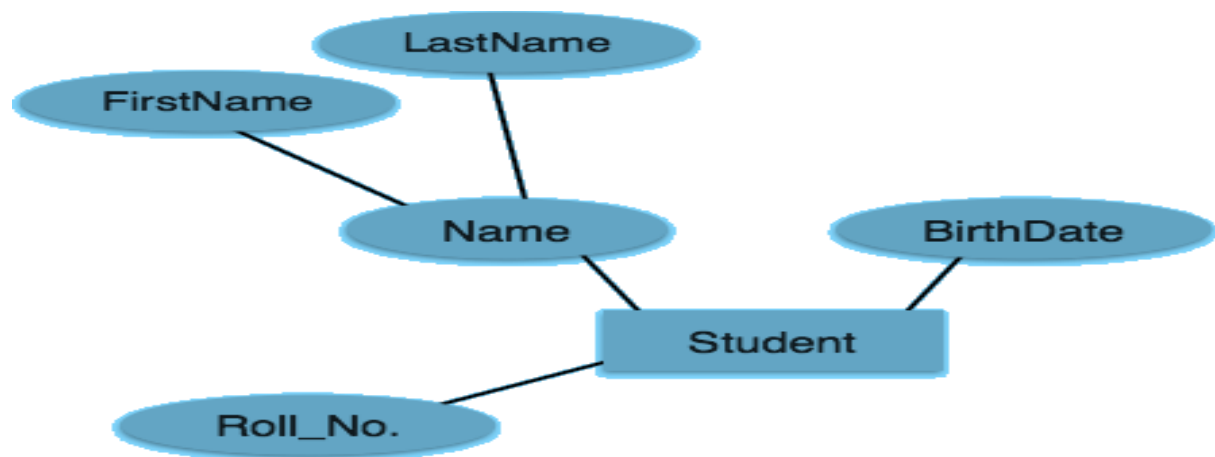


### ATTRIBUTES

Attributes are the properties of entities. Attributes are represented by means of ellipses. Every ellipse represents one attribute and is directly connected to its entity (rectangle).

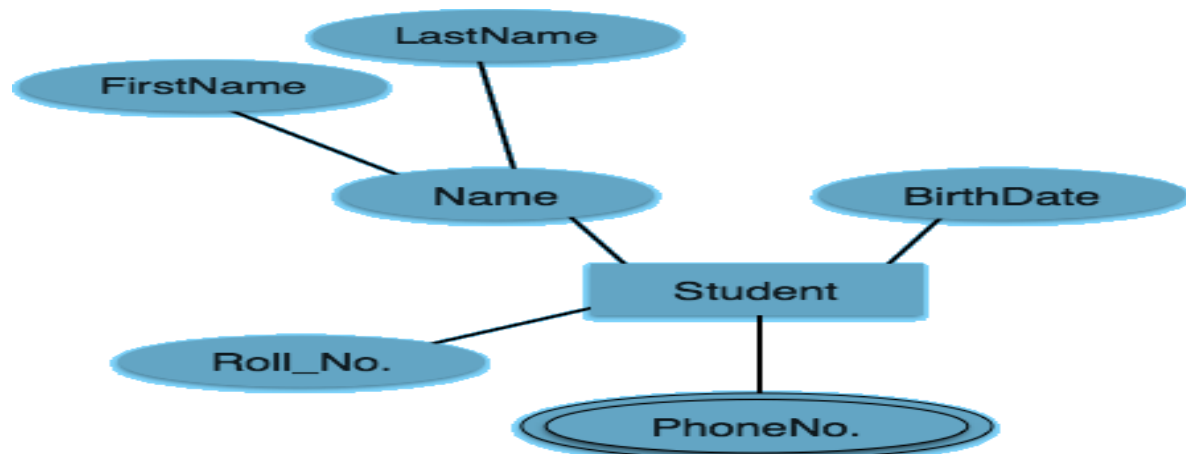


If the attributes are **composite**, they are further divided in a tree like structure. Every node is then connected to its attribute. That is, composite attributes are represented by ellipses that are connected with an ellipse.



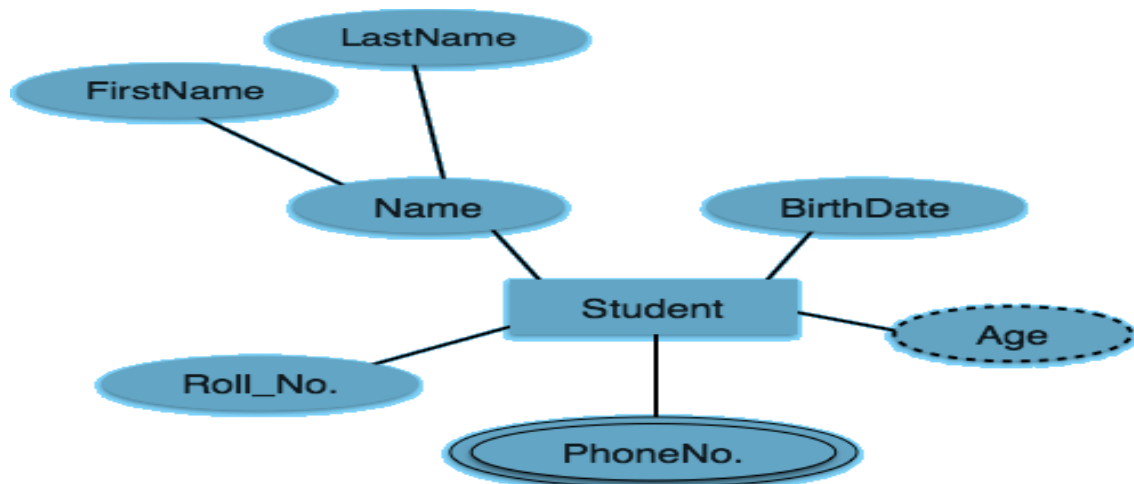
### MULTIVALUED

Attributes are depicted by double ellipse.



### DERIVED

Attributes are depicted by dashed ellipse.



## RELATIONSHIP

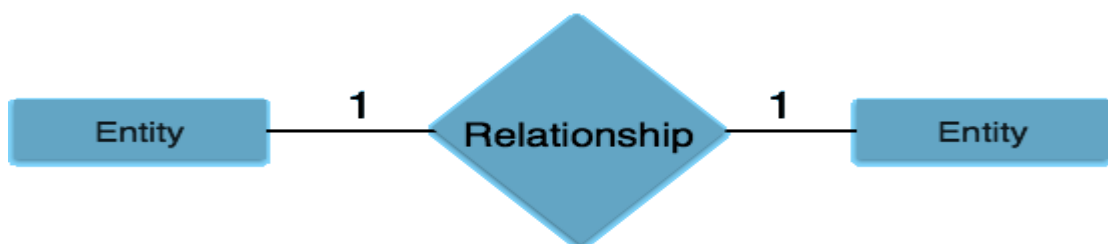
Relationships are represented by diamond-shaped box. Name of the relationship is written inside the diamond-box. All the entities (rectangles) participating in a relationship, are connected to it by a line.

### BINARY RELATIONSHIP AND CARDINALITY

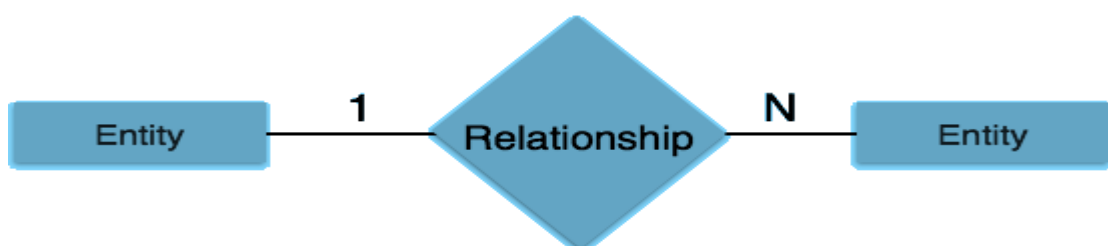
A relationship where two entities are participating is called a **binary relationship**.

Cardinality is the number of instance of an entity from a relation that can be associated with the relation.

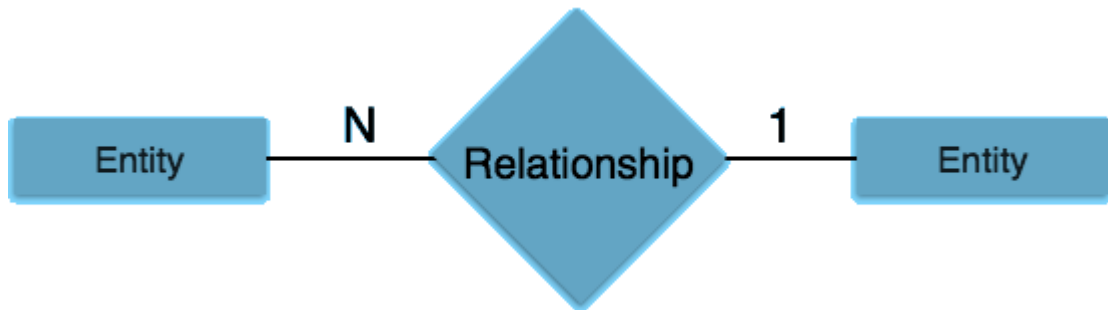
- **One-to-one** – when only one instance of an entity is associated with the relationship, it is marked as '1:1'. The following image reflects that only one instance of each entity should be associated with the relationship. It depicts one-to-one relationship.



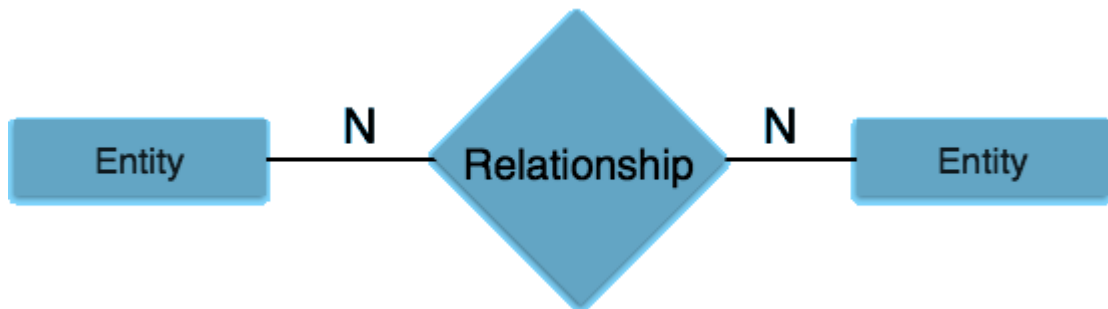
- **One-to-many** – When more than one instance of an entity is associated with a relationship, it is marked as '1:N'. The following image reflects that only one instance of entity on the left and more than one instance of an entity on the right can be associated with the relationship. It depicts one-to-many relationship.



- **Many-to-one** – When more than one instance of entity is associated with the relationship, it is marked as 'N:1'. The following image reflects that more than one instance of an entity on the left and only one instance of an entity on the right can be associated with the relationship. It depicts many-to-one relationship.

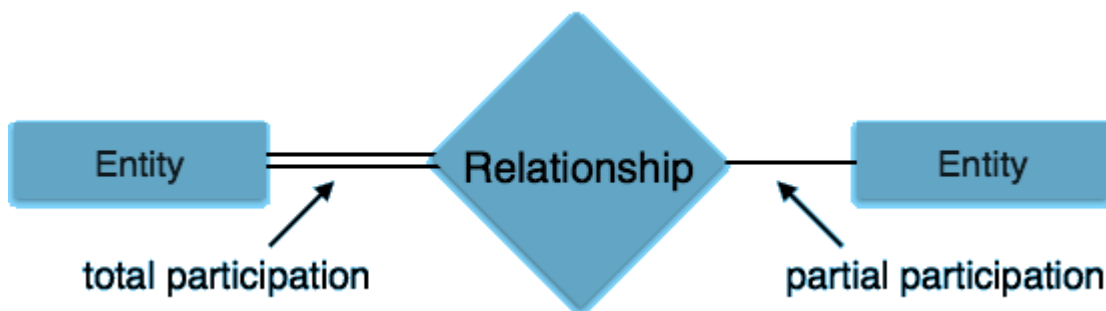


- **Many-to-many** – The following image reflects that more than one instance of an entity on the left and more than one instance of an entity on the right can be associated with the relationship. It depicts many-to-many relationship.



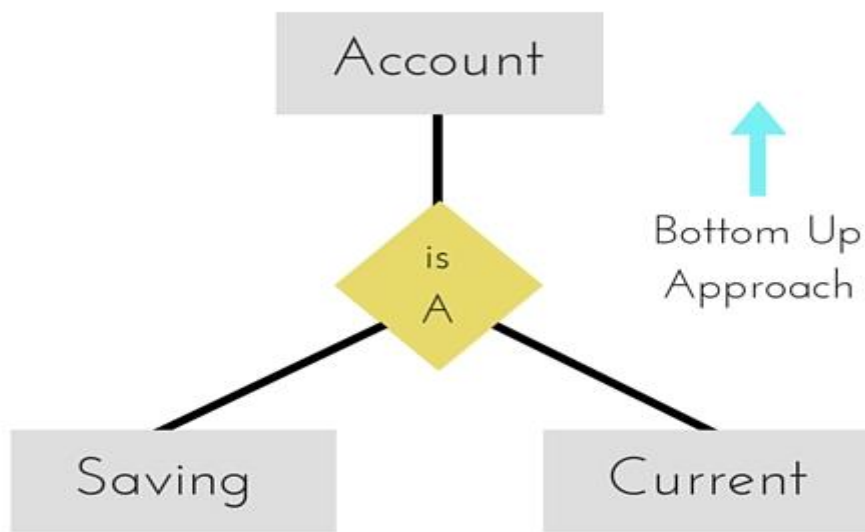
### PARTICIPATION CONSTRAINTS

- **Total Participation** – Each entity is involved in the relationship. Total participation is represented by double lines.
- **Partial participation** – Not all entities are involved in the relationship. Partial participation is represented by single lines.



### GENERALIZATION

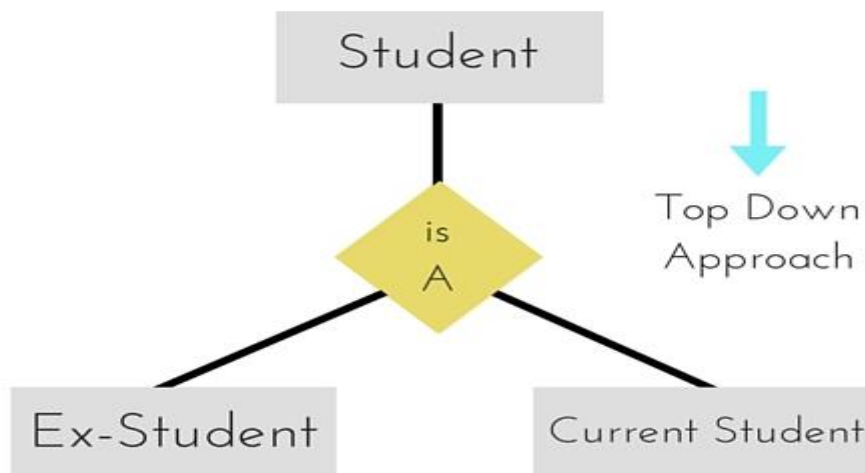
**Generalization** is a bottom-up approach in which two lower level entities combine to form a higher level entity. In generalization, the higher level entity can also combine with other lower level entity to make further higher level entity.



## SPECIALIZATION

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**Specialization** is opposite to Generalization. It is a top-down approach in which one higher level entity can be broken down into two lower level entity. In specialization, some higher level entities may not have lower-level entity sets at all.

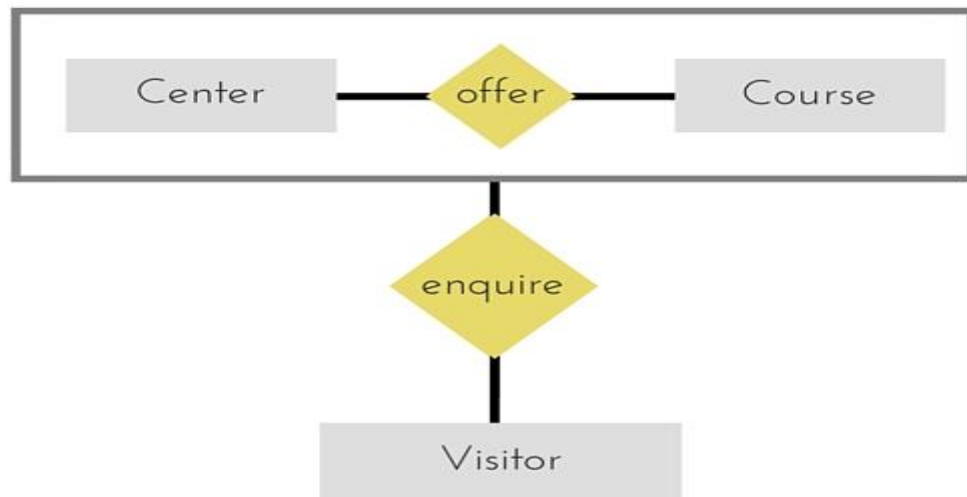


## AGGREGATION

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Aggregation is a process when relation between two entity is treated as a single entity. Here the relation between Center and Course, is acting as an Entity in relation with Visitor.





## RDBMS CONCEPTS

A **Relational Database management System**(RDBMS) is a database management system based on relational model introduced by E.F Codd. In relational model, data is represented in terms of tuples (rows).

**RDBMS** is used to manage Relational database. **Relational database** is a collection of organized set of tables from which data can be accessed easily. Relational Database is most commonly used database. It consists of number of tables and each table has its own primary key.

## WHAT IS TABLE?

In Relational database, a **table** is a collection of data elements organised in terms of rows and columns. A table is also considered as convenient representation of **relations**. But a table can have duplicate tuples while a true **relation** cannot have duplicate tuples. Table is the most simplest form of data storage. Below is an example of Employee table.

ID	Name	Age	Salary
1	Adam	34	13000
2	Alex	28	15000
3	Stuart	20	18000

4	Ross	42	19020
---	------	----	-------

### WHAT IS A RECORD?

A single entry in a table is called a **Record** or **Row**. A **Record** in a table represents set of related data. For example, the above **Employee** table has 4 records. Following is an example of single record.

1	Adam	34	13000
---	------	----	-------

### WHAT IS FIELD?

A table consists of several records (row), each record can be broken into several smaller entities known as **Fields**. The above **Employee** table consist of four fields, **ID**, **Name**, **Age** and **Salary**.

### WHAT IS A COLUMN?

In **Relational** table, a column is a set of value of a particular type. The term **Attribute** is also used to represent a column. For example, in Employee table, Name is a column that represent names of employee.

Name
Adam
Alex
Stuart
Ross

- **Relation instance** – A finite set of tuples in the relational database system represents relation instance. Relation instances do not have duplicate tuples.
- **Relation schema** – A relation schema describes the relation name (table name), attributes, and their names.

- **Relation key** – each row has one or more attributes, known as relation key, which can identify the row in the relation (table) uniquely.
- **Attribute domain** – every attribute has some pre-defined value scope, known as attribute domain.

## CONSTRAINTS

---

Every relation has some conditions that must hold for it to be a valid relation. These conditions are called **Relational Integrity Constraints**. There are three main integrity constraints –

- Key constraints
- Domain constraints
- Referential integrity constraints

### KEY CONSTRAINTS

There must be at least one minimal subset of attributes in the relation, which can identify a tuple uniquely. This minimal subset of attributes is called **key** for that relation. If there are more than one such minimal subsets, these are called ***candidate keys***.

Key constraints force that –

- In a relation with a key attribute, no two tuples can have identical values for key attributes.
- A key attribute cannot have NULL values.

Key constraints are also referred to as Entity Constraints.

### DOMAIN CONSTRAINTS

Attributes have specific values in real-world scenario. For example, age can only be a positive integer. The same constraints have been tried to employ on the attributes of a relation. Every attribute is bound to have a specific range of values. For example, age cannot be less than zero and telephone numbers cannot contain a digit outside 0-9.

### REFERENTIAL INTEGRITY CONSTRAINTS

Referential integrity constraints work on the concept of Foreign Keys. A foreign key is a key attribute of a relation that can be referred in other relation.

Referential integrity constraint states that if a relation refers to a key attribute of a different or same relation, then that key element must exist.

## RELATIONAL ALGEBRA

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Relational database systems are expected to be equipped with a query language that can assist its users to query the database instances. There are two kinds of query languages – relational algebra and relational calculus.

### RELATIONAL ALGEBRA

Relational algebra is a procedural query language, which takes instances of relations as input and yields instances of relations as output. It uses operators to perform queries. An operator can be either **unary** or **binary**. They accept relations as their input and yield relations as their output. Relational algebra is performed recursively on a relation and intermediate results are also considered relations.

The fundamental operations of relational algebra are as follows –

- Select
- Project
- Union
- Set different
- Cartesian product
- Rename

We will discuss all these operations in the following sections.

### SELECT OPERATION ( $\Sigma$ )

It selects tuples that satisfy the given predicate from a relation.

**Notation** –  $\sigma_p(r)$

Where  $\sigma$  stands for selection predicate and  $r$  stands for relation.  $p$  is propositional logic formula which may use connectors like **and**, **or**, and **not**. These terms may use relational operators like  $=, \neq, \geq, <, >, \leq$ .

**For example** –

$\sigma_{\text{subject} = \text{"database"}}(\text{Books})$

**Output** – Selects tuples from books where subject is 'database'.

$\sigma_{\text{subject} = \text{"database"} \text{ and } \text{price} = \text{"450"}}(\text{Books})$

**Output** – Selects tuples from books where subject is 'database' and 'price' is 450.

$\sigma_{\text{subject} = \text{"database"} \text{ and } \text{price} = \text{"450"} \text{ or } \text{year} > \text{"2010"}}(\text{Books})$

**Output** – Selects tuples from books where subject is 'database' and 'price' is 450 or those books published after 2010.

### PROJECT OPERATION ( $\Pi$ )

It projects column(s) that satisfy a given predicate.

**Notation** –  $\Pi_{A_1, A_2, A_n}(r)$

Where  $A_1, A_2, A_n$  are attribute names of relation  $r$ .

Duplicate rows are automatically eliminated, as relation is a set.

**For example –**

$\Pi_{\text{subject, author}} (\text{Books})$

Selects and projects columns named as subject and author from the relation Books.

### UNION OPERATION (U)

It performs binary union between two given relations and is defined as –

$$r \cup s = \{ t \mid t \in r \text{ or } t \in s \}$$

**Notion –**  $r \cup s$

Where  $r$  and  $s$  are either database relations or relation result set (temporary relation).

For a union operation to be valid, the following conditions must hold –

- $r$ , and  $s$  must have the same number of attributes.
- Attribute domains must be compatible.
- Duplicate tuples are automatically eliminated.

$\Pi_{\text{author}} (\text{Books}) \cup \Pi_{\text{author}} (\text{Articles})$

**Output –** Projects the names of the authors who have either written a book or an article or both.

### SET DIFFERENCE (–)

The result of set difference operation is tuples, which are present in one relation but are not in the second relation.

**Notation –**  $r - s$

Finds all the tuples that are present in  $r$  but not in  $s$ .

$\Pi_{\text{author}} (\text{Books}) - \Pi_{\text{author}} (\text{Articles})$

**Output –** Provides the name of authors who have written books but not articles.

### CARTESIAN PRODUCT (X)

Combines information of two different relations into one.

**Notation –**  $r \times s$

Where  $r$  and  $s$  are relations and their output will be defined as –

$$r \times s = \{ q \mid q \in r \text{ and } t \in s \}$$

$\sigma_{\text{author} = \text{'tutorialspoint'}}(\text{Books X Articles})$

**Output** – Yields a relation, which shows all the books and articles written by tutorialspoint.

### RENAME OPERATION (P)

The results of relational algebra are also relations but without any name. The rename operation allows us to rename the output relation. 'rename' operation is denoted with small Greek letter **rho**  $\rho$ .

**Notation** –  $\rho_x(E)$

Where the result of expression **E** is saved with name of **x**.

Additional operations are –

- Set intersection
- Assignment
- Natural join

### RELATIONAL CALCULUS

In contrast to Relational Algebra, Relational Calculus is a non-procedural query language, that is, it tells what to do but never explains how to do it.

Relational calculus exists in two forms –

### ER MODEL TO RELATIONAL MODEL

---

ER Model, when conceptualized into diagrams, gives a good overview of entity-relationship, which is easier to understand. ER diagrams can be mapped to relational schema, that is, it is possible to create relational schema using ER diagram. We cannot import all the ER constraints into relational model, but an approximate schema can be generated.

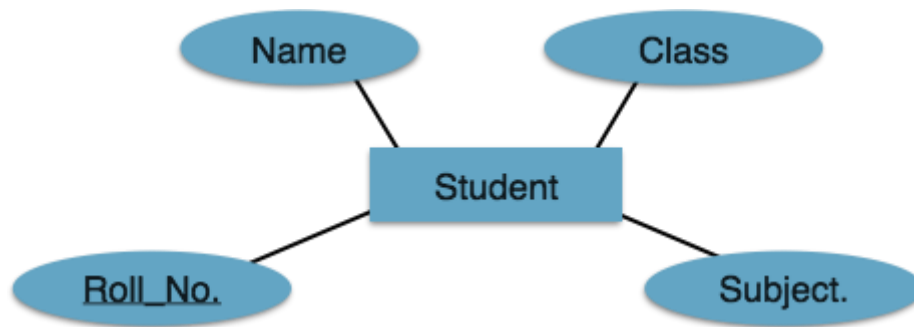
There are several processes and algorithms available to convert ER Diagrams into Relational Schema. Some of them are automated and some of them are manual. We may focus here on the mapping diagram contents to relational basics.

ER diagrams mainly comprise of –

- Entity and its attributes
- Relationship, which is association among entities.

### MAPPING ENTITY

An entity is a real-world object with some attributes.

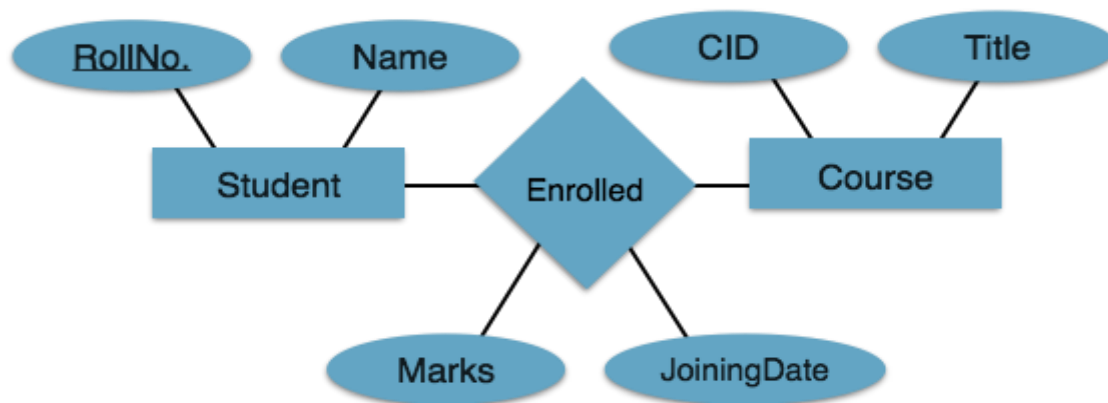


### MAPPING PROCESS (ALGORITHM)

- Create table for each entity.
- Entity's attributes should become fields of tables with their respective data types.
- Declare primary key.

### MAPPING RELATIONSHIP

A relationship is an association among entities.

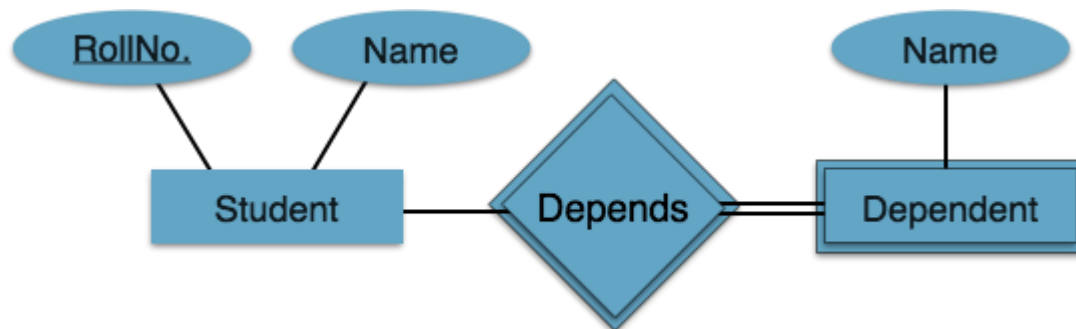


### MAPPING PROCESS

- Create table for a relationship.
- Add the primary keys of all participating Entities as fields of table with their respective data types.
- If relationship has any attribute, add each attribute as field of table.
- Declare a primary key composing all the primary keys of participating entities.
- Declare all foreign key constraints.

### MAPPING WEAK ENTITY SETS

A weak entity set is one which does not have any primary key associated with it.

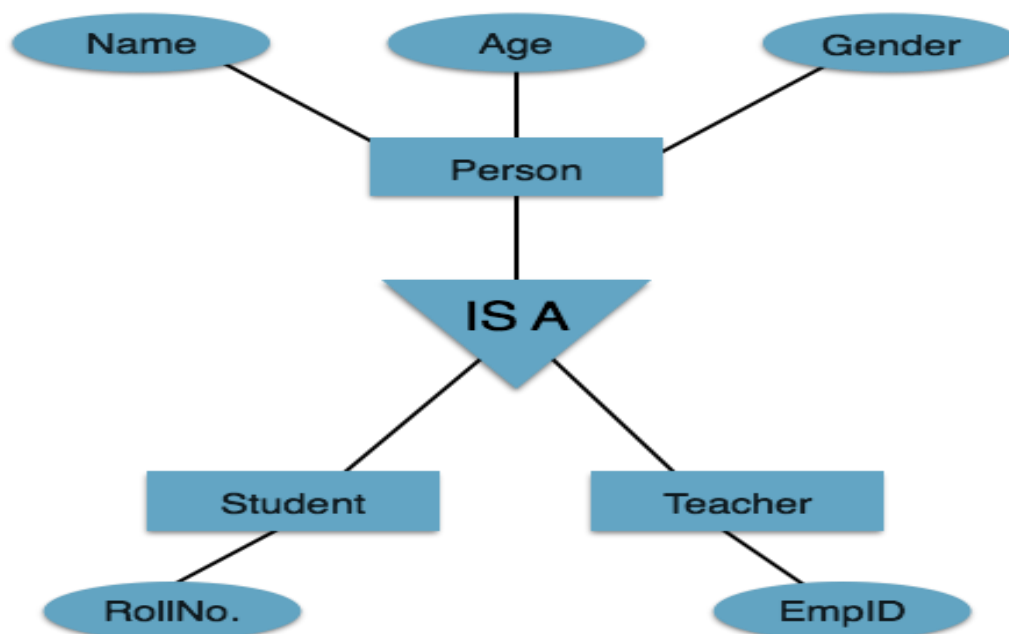


### MAPPING PROCESS

- Create table for weak entity set.
- Add all its attributes to table as field.
- Add the primary key of identifying entity set.
- Declare all foreign key constraints.

### MAPPING HIERARCHICAL ENTITIES

ER specialization or generalization comes in the form of hierarchical entity sets.



### MAPPING PROCESS

- Create tables for all higher-level entities.
- Create tables for lower-level entities.
- Add primary keys of higher-level entities in the table of lower-level entities.
- In lower-level tables, add all other attributes of lower-level entities.
- Declare primary key of higher-level table and the primary key for lower-level table.
- Declare foreign key constraints.



## DATABASE KEYS

---

Keys are very important part of Relational database. They are used to establish and identify relation between tables. They also ensure that each record within a table can be uniquely identified by combination of one or more fields within a table.

### SUPER KEY

**Super Key** is defined as a set of attributes within a table that uniquely identifies each record within a table. Super Key is a superset of Candidate key.


### CANDIDATE KEY

Candidate keys are defined as the set of fields from which primary key can be selected. It is an attribute or set of attribute that can act as a primary key for a table to uniquely identify each record in that table.

### PRIMARY KEY

Primary key is a candidate key that is most appropriate to become main key of the table. It is a key that uniquely identify each record in a table.

Primary Key



s_id	S_name	age	course	address

### COMPOSITE KEY

Key that consist of two or more attributes that uniquely identify an entity occurrence is called **Composite key**. But any attribute that makes up the **Composite key** is not a simple key in its own.

Composite Key



cust_id	order_id	sale_detail

## SECONDARY OR ALTERNATIVE KEY

The candidate key which are not selected for primary key are known as secondary keys or alternative keys

## NON-KEY ATTRIBUTE

**Non-key** attributes are attributes other than **candidate key** attributes in a table.

## NON-PRIME ATTRIBUTE

**Non-prime** Attributes are attributes other than **Primary attribute**.

## NORMALIZATION OF DATABASE

---

Database Normalization is a technique of organizing the data in the database. Normalization is a systematic approach of decomposing tables to eliminate data redundancy and undesirable characteristics like Insertion, Update and Deletion Anomalies. It is a multi-step process that puts data into tabular form by removing duplicated data from the relation tables.

Normalization is used for mainly two purpose,

- Eliminating redundant (useless) data.
- Ensuring data dependencies make sense i.e. data is logically stored.

## PROBLEM WITHOUT NORMALIZATION

Without Normalization, it becomes difficult to handle and update the database, without facing data loss. Insertion, Updation and Deletion Anomalies are very frequent if Database is not normalized. To understand these anomalies let us take an example of Student table.

S_id	S_Name	S_Address	Subject_opted
401	Adam	Noida	Bio
402	Alex	Panipat	Maths
403	Stuart	Jammu	Maths

404	Adam	Noida	Physics
-----	------	-------	---------

- **Updation Anamoly** : To update address of a student who occurs twice or more than twice in a table, we will have to update **S\_Address** column in all the rows, else data will become inconsistent.
- **Insertion Anamoly** : Suppose for a new admission, we have a Student id(S\_id), name and address of a student but if student has not opted for any subjects yet then we have to insert **NULL** there, leading to Insertion Anamoly.
- **Deletion Anamoly** : If (S\_id) 401 has only one subject and temporarily he drops it, when we delete that row, entire student record will be deleted along with it.

## NORMALIZATION RULE

Normalization rule are divided into following normal form.

- First Normal Form
- Second Normal Form
- Third Normal Form
- BCNF

## FIRST NORMAL FORM (1NF)

As per First Normal Form, no two Rows of data must contain repeating group of information i.e each set of column must have a unique value, such that multiple columns cannot be used to fetch the same row. Each table should be organized into rows, and each row should have a primary key that distinguishes it as unique.

The **Primary key** is usually a single column, but sometimes more than one column can be combined to create a single primary key. For example consider a table which is not in First normal form

**Student Table:**

Student	Age	Subject
Adam	15	Biology, Maths
Alex	14	Maths

Stuart	17	Maths
--------	----	-------

In First Normal Form, any row must not have a column in which more than one value is saved, like separated with commas. Rather than that, we must separate such data into multiple rows.

**Student Table following 1NF will be :**

Student	Age	Subject
Adam	15	Biology
Adam	15	Maths
Alex	14	Maths
Stuart	17	Maths

Using the First Normal Form, data redundancy increases, as there will be many columns with same data in multiple rows but each row as a whole will be unique.

## SECOND NORMAL FORM (2NF)

As per the Second Normal Form there must not be any partial dependency of any column on primary key. It means that for a table that has concatenated primary key, each column in the table that is not part of the primary key must depend upon the entire concatenated key for its existence. If any column depends only on one part of the concatenated key, then the table fails **Second normal form**.

In example of First Normal Form there are two rows for Adam, to include multiple subjects that he has opted for. While this is searchable, and follows First normal form, it is an inefficient use of space. Also in the above Table in First Normal Form, while the candidate key is {**Student, Subject**}, **Age** of Student only depends on Student column, which is incorrect as per Second Normal Form. To achieve second normal form, it would be helpful to split out the subjects into an independent table, and match them up using the student names as foreign keys.

**New Student Table following 2NF will be:**

Student	Age
Adam	15
Alex	14
Stuart	17

In Student Table the candidate key will be **Student** column, because all other column i.e **Age** is dependent on it.

**New Subject Table introduced for 2NF will be :**

Student	Subject
Adam	Biology
Adam	Maths
Alex	Maths
Stuart	Maths

In Subject Table the candidate key will be {**Student, Subject**} column. Now, both the above tables qualifies for Second Normal Form and will never suffer from Update Anomalies. Although there are a few complex cases in which table in Second Normal Form suffers Update Anomalies, and to handle those scenarios Third Normal Form is there.

### THIRD NORMAL FORM (3NF)

Third Normal form applies that every non-prime attribute of table must be dependent on primary key, or we can say that, there should not be the case that a non-prime attribute is determined by another non-prime attribute. So this transitive functional

dependency should be removed from the table and also the table must be in **Second Normal form**. For example, consider a table with following fields.

Student\_Detail Table :

Student_id	Student_name	DOB	Street	city	State	Zip
------------	--------------	-----	--------	------	-------	-----

In this table Student\_id is Primary key, but street, city and state depends upon Zip. The dependency between zip and other fields is called **transitive dependency**. Hence to apply **3NF**, we need to move the street, city and state to new table, with **Zip** as primary key.

**New Student\_Detail Table :**

Student_id	Student_name	DOB	Zip
------------	--------------	-----	-----

Address Table :

Zip	Street	city	state
-----	--------	------	-------

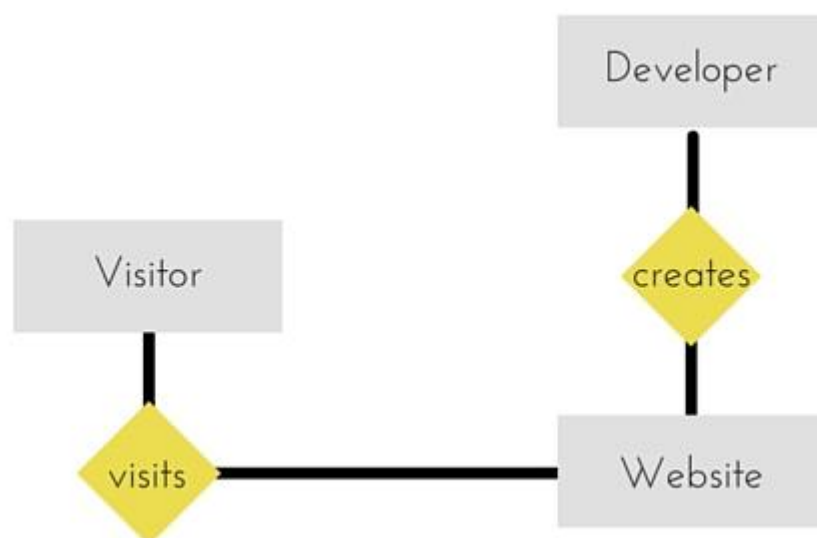
The advantage of removing transitive dependency is,

- Amount of data duplication is reduced.
- Data integrity achieved.

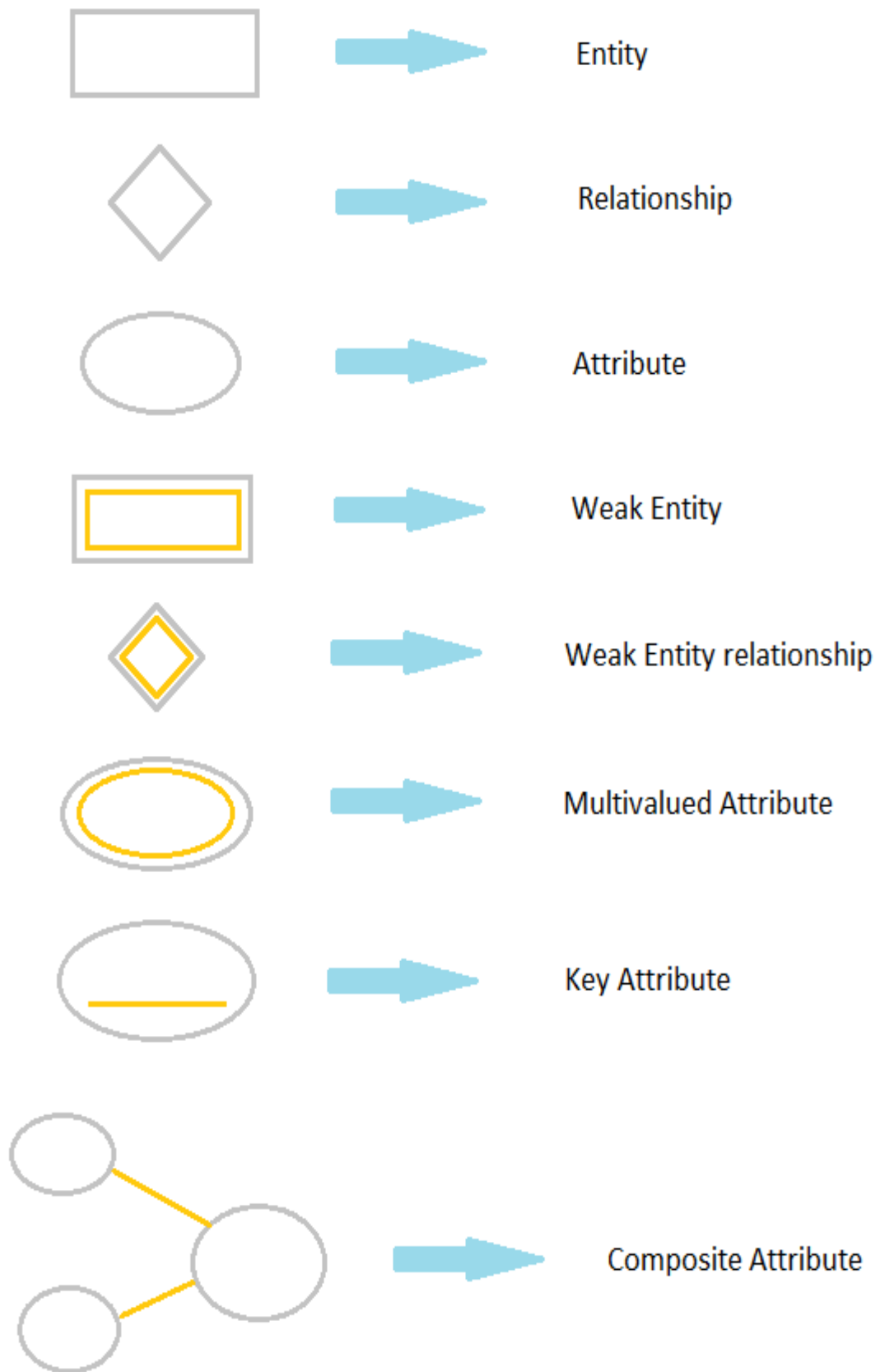
## E-R DIAGRAM

---

ER-Diagram is a visual representation of data that describes how data is related to each other.



## SYMBOLS AND NOTATIONS



## COMPONENTS OF E-R DIAGRAM

The E-R diagram has three main components.

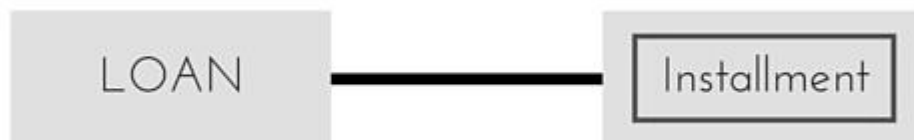
### 1) ENTITY

An **Entity** can be any object, place, person or class. In E-R Diagram, an **entity** is represented using rectangles. Consider an example of an Organisation. Employee, Manager, Department, Product and many more can be taken as entities from an Organisation.



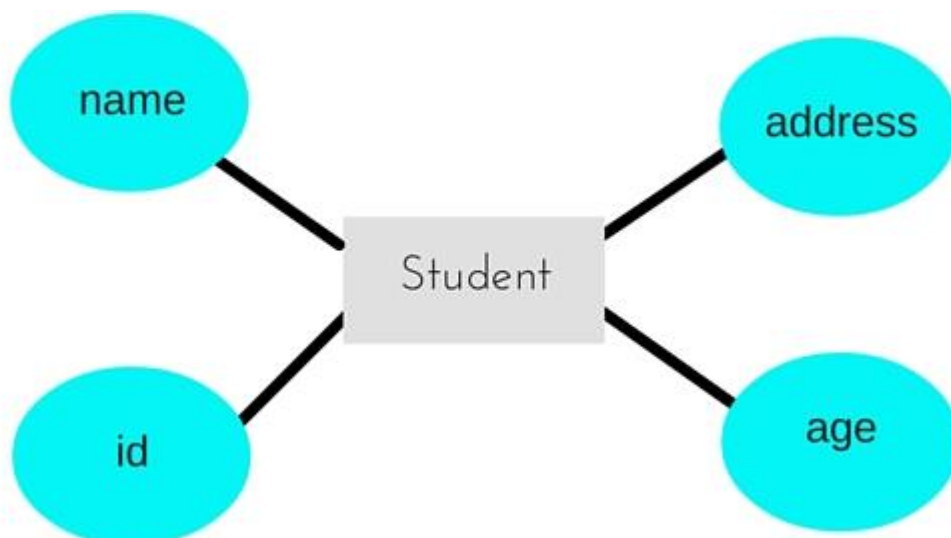
### WEAK ENTITY

Weak entity is an entity that depends on another entity. Weak entity doesn't have key attribute of their own. Double rectangle represents weak entity.



### 2) ATTRIBUTE

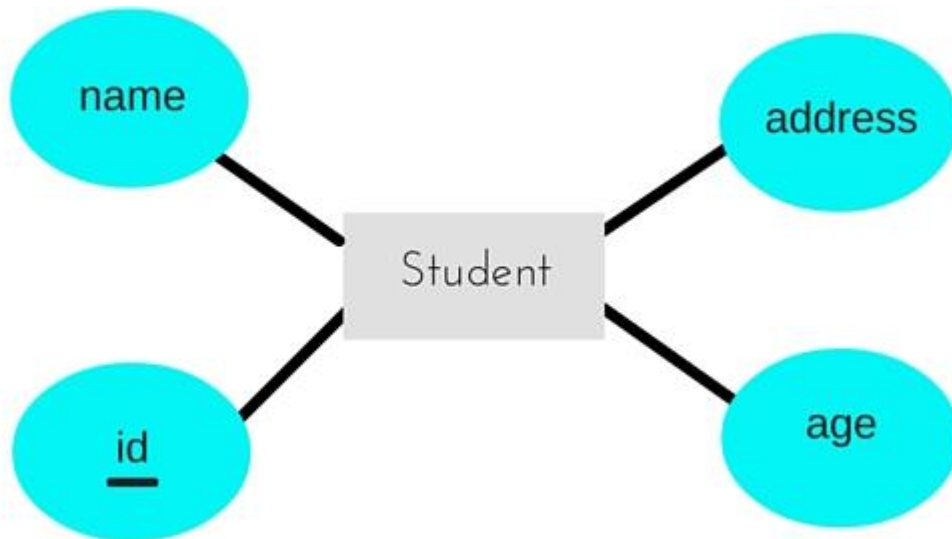
An **Attribute** describes a property or characteristic of an entity. For example, Name, Age, Address etc can be attributes of a Student. An attribute is represented using eclipse.





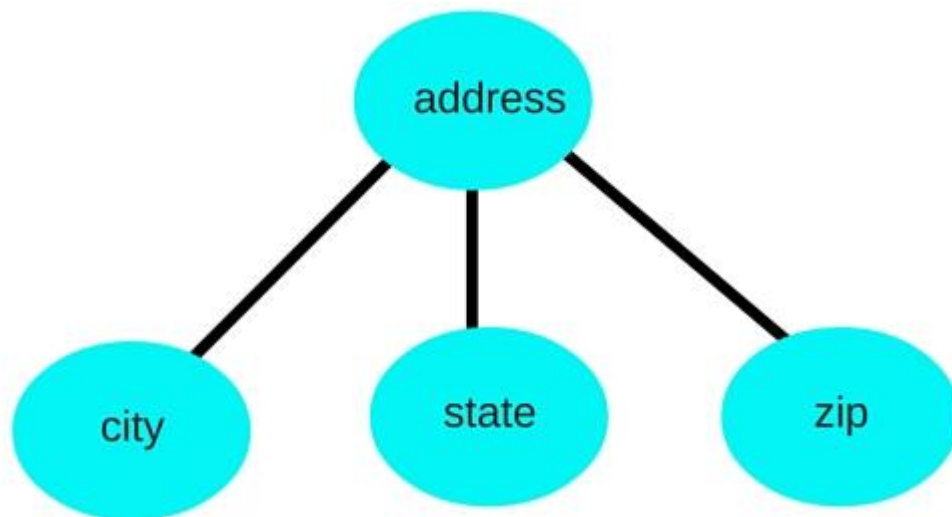
## KEY ATTRIBUTE

Key attribute represents the main characteristic of an Entity. It is used to represent Primary key. Ellipse with underlying lines represent Key Attribute.



## COMPOSITE ATTRIBUTE

An attribute can also have their own attributes. These attributes are known as **Composite** attribute.



## 3) RELATIONSHIP

A Relationship describes relations between **entities**. Relationship is represented using diamonds.



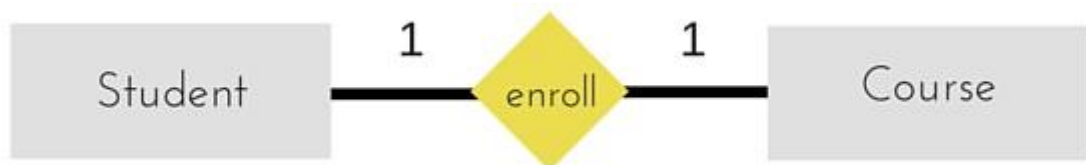
There are three types of relationship that exist between Entities.

- Binary Relationship
- Recursive Relationship
- Ternary Relationship

## BINARY RELATIONSHIP

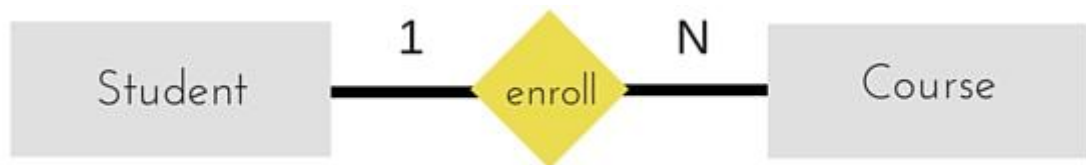
Binary Relationship means relation between two Entities. This is further divided into three types.

1. **One to One** : This type of relationship is rarely seen in real world.



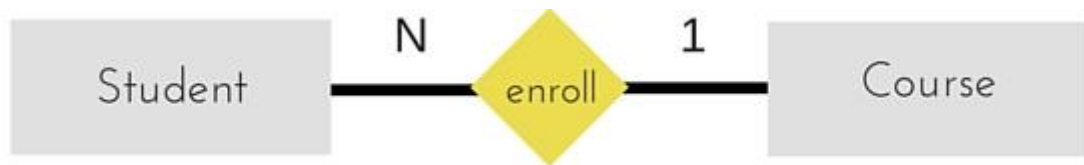
The above example describes that one student can enroll only for one course and a course will also have only one Student. This is not what you will usually see in relationship.

2. **One to Many** : It reflects business rule that one entity is associated with many number of same entity. The example for this relation might sound a little weird, but this means that one student can enroll to many courses, but one course will have one Student.

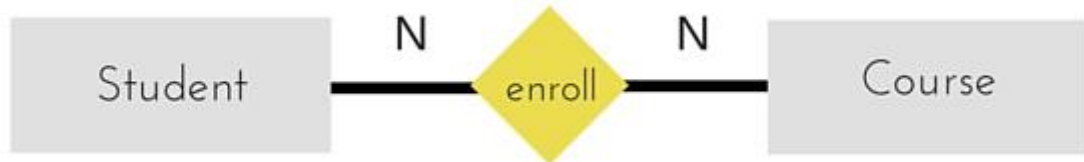


The arrows in the diagram describes that one student can enroll for only one course.

3. **Many to One** : It reflects business rule that many entities can be associated with just one entity. For example, Student enrolls for only one Course but a Course can have many Students.



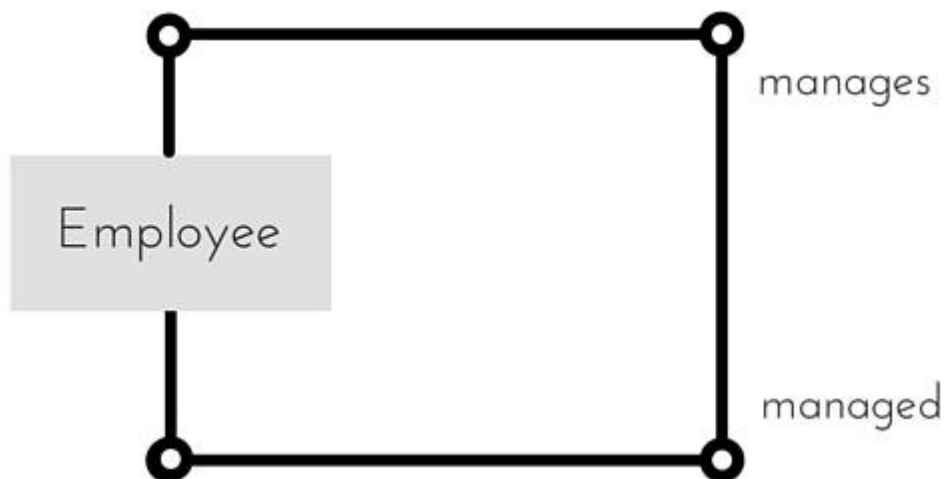
#### 4. Many to Many :



The above diagram represents that many students can enroll for more than one courses.

#### RECURSIVE RELATIONSHIP

When an Entity is related with itself it is known as **Recursive** Relationship.



#### TERNARY RELATIONSHIP

Relationship of degree three is called Ternary relationship.

## INTRODUCTION TO SQL

Structure Query Language(SQL) is a programming language used for storing and managing data in RDBMS. SQL was the first commercial language introduced for E.F Codd's **Relational** model. Today almost all RDBMS(MySql, Oracle, Infomix, Sybase, MS Access) uses **SQL** as the standard database language. SQL is used to perform all type of data operations in RDBMS.

### SQL COMMAND

---

SQL defines following data languages to manipulate data of RDBMS.

#### DDL : DATA DEFINITION LANGUAGE

All DDL commands are auto-committed. That means it saves all the changes permanently in the database.

Command	Description
create	to create new table or database
alter	for alteration
truncate	delete data from table
drop	to drop a table
rename	to rename a table

#### DML : DATA MANIPULATION LANGUAGE

DML commands are not auto-committed. It means changes are not permanent to database, they can be rolled back.

Command	Description
insert	to insert a new row

update	to update existing row
delete	to delete a row
merge	merging two rows or two tables

## TCL : TRANSACTION CONTROL LANGUAGE

These commands are to keep a check on other commands and their affect on the database. These commands can annul changes made by other commands by rolling back to original state. It can also make changes permanent.

Command	Description
commit	to permanently save
rollback	to undo change
savepoint	to save temporarily

## DCL : DATA CONTROL LANGUAGE

Data control language provides command to grant and take back authority.

Command	Description
grant	grant permission of right
revoke	take back permission.

## DQL : DATA QUERY LANGUAGE

Command	Description
select	retrieve records from one or more table

## CREATE COMMAND

---

**create** is a DDL command used to create a table or a database.

### CREATING A DATABASE

To create a database in RDBMS, *create* command is uses. Following is the Syntax,

```
create database database-name;
```

### EXAMPLE FOR CREATING DATABASE

```
create database Test;
```

The above command will create a database named **Test**.

### CREATING A TABLE

*create* command is also used to create a table. We can specify names and datatypes of various columns along.Following is the Syntax,

```
create table table-name
{
    column-name1 datatype1,
    column-name2 datatype2,
    column-name3 datatype3,
    column-name4 datatype4
};
```

create table command will tell the database system to create a new table with given table name and column information.

### EXAMPLE FOR CREATING TABLE

```
create table Student(id int, name varchar, age int);
```

The above command will create a new table **Student** in database system with 3 columns, namely id, name and age.

## ALTER COMMAND

---

*alter* command is used for alteration of table structures. There are various uses of *alter* command, such as,

- to add a column to existing table
- to rename any existing column
- to change datatype of any column or to modify its size.
- *alter* is also used to drop a column.

### TO ADD COLUMN TO EXISTING TABLE

Using alter command we can add a column to an existing table. Following is the Syntax,

```
alter table table-name add(column-name datatype);
```

Here is an Example for this,

```
alter table Student add(address char);
```

The above command will add a new column *address* to the **Student** table

### TO ADD MULTIPLE COLUMN TO EXISTING TABLE

Using alter command we can even add multiple columns to an existing table. Following is the Syntax,

```
alter table table-name add(column-name1 datatype1, column-name2 datatype2, column-name3 datatype3);
```

Here is an Example for this,

```
alter table Student add(father-name varchar(60), mother-name varchar(60), dob date);
```

The above command will add three new columns to the **Student** table

### TO ADD COLUMN WITH DEFAULT VALUE

alter command can add a new column to an existing table with default values. Following is the Syntax,

```
alter table table-name add(column-name1 datatype1 default data);
```

Here is an Example for this,

```
alter table Student add(dob date default '1-Jan-99');
```

The above command will add a new column with default value to the **Student** table

### TO MODIFY AN EXISTING COLUMN

alter command is used to modify data type of an existing column . Following is the Syntax,

```
alter table table-name modify(column-name datatype);
```

Here is an Example for this,

```
alter table Student modify(address varchar(30));
```

The above command will modify *address* column of the **Student** table

### TO RENAME A COLUMN

Using alter command you can rename an existing column. Following is the Syntax,

```
alter table table-name rename old-column-name to column-name;
```

Here is an Example for this,

```
alter table Student rename address to Location;
```

The above command will rename *address* column to *Location*.

## TO DROP A COLUMN

alter command is also used to drop columns also. Following is the Syntax,

```
alter table table-name drop(column-name);
```

Here is an Example for this,

```
alter table Student drop(address);
```

The above command will drop *address* column from the **Student table**

## SQL QUERIES TO TRUNCATE, DROP OR RENAME A TABLE

---

### TRUNCATE COMMAND

*truncate* command removes all records from a table. But this command will not destroy the table's structure. When we apply truncate command on a table its Primary key is initialized. Following is its Syntax,

```
truncate table table-name
```

Here is an Example explaining it.

```
truncate table Student;
```

The above query will delete all the records of **Student** table.

**truncate** command is different from **delete** command. delete command will delete all the rows from a table whereas truncate command re-initializes a table(like a newly created table).

**For eg.** If you have a table with 10 rows and an auto\_increment primary key, if you use *delete* command to delete all the rows, it will delete all the rows, but will not initialize the primary key, hence if you will insert any row after using delete command, the auto\_increment primary key will start from 11. But in case of *truncate* command, primary key is re-initialized.

### DROP COMMAND

*drop* query completely removes a table from database. This command will also destroy the table structure. Following is its Syntax,

```
drop table table-name
```

Here is an Example explaining it.

```
drop table Student;
```



The above query will delete the **Student** table completely. It can also be used on Databases. For Example, to drop a database,

```
drop database Test;
```

The above query will drop a database named **Test** from the system.

## RENAME QUERY

*rename* command is used to rename a table. Following is its Syntax,

```
rename table old-table-name to new-table-name
```

Here is an Example explaining it.

```
rename table Student to Student-record;
```

The above query will rename **Student** table to **Student-record**.

## DML COMMAND

Data Manipulation Language (DML) statements are used for managing data in database. DML commands are not auto-committed. It means changes made by DML command are not permanent to database, it can be rolled back.

### 1) INSERT COMMAND

Insert command is used to insert data into a table. Following is its general syntax,

```
INSERT into table-name values(data1,data2,..)
```

Lets see an example,

Consider a table **Student** with following fields.

S_id	S_Name	age
------	--------	-----

```
INSERT into Student values(101,'Adam',15);
```

The above command will insert a record into **Student** table.

S_id	S_Name	age
101	Adam	15

## EXAMPLE TO INSERT NULL VALUE TO A COLUMN

Both the statements below will insert NULL value into **age** column of the Student table.

```
INSERT into Student(id,name) values(102,'Alex');
```

Or,

```
INSERT into Student values(102,'Alex',null);
```

The above command will insert only two column value other column is set to null.

S_id	S_Name	age
101	Adam	15
102	Alex	

### EXAMPLE TO INSERT DEFAULT VALUE TO A COLUMN

```
INSERT into Student values(103,'Chris',default)
```

S_id	S_Name	age
101	Adam	15
102	Alex	
103	chris	14

Suppose the **age** column of student table has default value of 14.

Also, if you run the below query, it will insert default value into the age column, whatever the default value may be.

```
INSERT into Student values(103,'Chris')
```

### 2) UPDATE COMMAND

Update command is used to update a row of a table. Following is its general syntax,

```
UPDATE table-name set column-name = value where condition;
```

Lets see an example,

```
update Student set age=18 where s_id=102;
```

S_id	S_Name	age
101	Adam	15
102	Alex	18
103	chris	14

### EXAMPLE TO UPDATE MULTIPLE COLUMNS

```
UPDATE Student set s_name='Abhi',age=17 where s_id=103;
```

The above command will update two columns of a record.

S_id	S_Name	age
101	Adam	15
102	Alex	18
103	Abhi	17

### 3) DELETE COMMAND

Delete command is used to delete data from a table. Delete command can also be used with condition to delete a particular row. Following is its general syntax,

```
DELETE from table-name;
```

### EXAMPLE TO DELETE ALL RECORDS FROM A TABLE

```
DELETE from Student;
```

The above command will delete all the records from **Student** table.

### EXAMPLE TO DELETE A PARTICULAR RECORD FROM A TABLE

Consider the following **Student** table

S_id	S_Name	age
101	Adam	15
102	Alex	18
103	Abhi	17

```
DELETE from Student where s_id=103;
```

The above command will delete the record where s\_id is 103 from **Student** table.

S_id	S_Name	age
101	Adam	15
102	Alex	18

## TCL COMMAND

Transaction Control Language(TCL) commands are used to manage transactions in database. These are used to manage the changes made by DML statements. It also allows statements to be grouped together into logical transactions.

### COMMIT COMMAND

Commit command is used to permanently save any transaction into database.

Following is Commit command's syntax,

```
commit;
```

### ROLLBACK COMMAND

This command restores the database to last committed state. It is also used with savepoint command to jump to a savepoint in a transaction.

Following is Rollback command's syntax,

```
rollback to savepoint-name;
```

## SAVEPOINT COMMAND

**savepoint** command is used to temporarily save a transaction so that you can rollback to that point whenever necessary.

Following is savepoint command's syntax,

```
savepoint savepoint-name;
```

## EXAMPLE OF SAVEPOINT AND ROLLBACK

Following is the **class** table,

ID	NAME
1	abhi
2	adam
4	alex

Lets use some SQL queries on the above table and see the results.

```
INSERT into class values(5, 'Rahul');  
commit;  
UPDATE class set name='abhijit' where id='5';  
savepoint A;  
INSERT into class values(6, 'Chris');  
savepoint B;  
INSERT into class values(7, 'Bravo');  
savepoint C;  
SELECT * from class;
```

The resultant table will look like,

ID	NAME
1	abhi

2	adam
4	alex
5	abhijit
6	chris
7	bravo

Now **rollback** to **savepoint B**

```
rollback to B;
```

```
SELECT * from class;
```

The resultant table will look like

ID	NAME
1	abhi
2	adam
4	alex
5	abhijit
6	chris

Now **rollback** to **savepoint A**

```
rollback to A;
```

```
SELECT * from class;
```

The result table will look like

ID	NAME
1	abhi
2	adam
4	alex
5	abhijit

## DCL COMMAND

Data Control Language (DCL) is used to control privilege in Database. To perform any operation in the database, such as for creating tables, sequences or views we need privileges. Privileges are of two types,

- **System** : creating session, table etc are all types of system privilege.
- **Object** : any command or query to work on tables comes under object privilege.

DCL defines two commands,

- **Grant** : Gives user access privileges to database.
- **Revoke** : Take back permissions from user.

## TO ALLOW A USER TO CREATE SESSION

```
grant create session to username;
```

## TO ALLOW A USER TO CREATE TABLE

```
grant create table to username;
```

## TO PROVIDE USER WITH SOME SPACE ON TABLESPACE TO STORE TABLE

```
alter user username quota unlimited on system;
```

## TO GRANT ALL PRIVILEGE TO A USER

```
grant sysdba to username
```

## TO GRANT PERMISSION TO CREATE ANY TABLE

```
grant create any table to username
```

## TO GRANT PERMISSION TO DROP ANY TABLE

```
grant drop any table to username
```

## TO TAKE BACK PERMISSIONS

```
revoke create table from username
```

## WHERE CLAUSE

Where clause is used to specify condition while retrieving data from table. *Where* clause is used mostly with *Select*, *Update* and *Delete* query. If condition specified by *where* clause is true then only the result from table is returned.

## SYNTAX FOR WHERE CLAUSE

```
SELECT column-name1,  
column-name2,  
column-name3,  
column-nameN  
from table-name WHERE [condition];
```

## EXAMPLE USING WHERE CLAUSE

Consider a **Student** table,

s_id	s_Name	age	address
101	Adam	15	Noida
102	Alex	18	Delhi
103	Abhi	17	Rohtak
104	Ankit	22	Panipat

Now we will use a **SELECT** statement to display data of the table, based on a condition, which we will add to the **SELECT** query using **WHERE** clause.

```
SELECT s_id,
```



```
s_name,  
age,  
address  
from Student WHERE s_id=101;
```

s_id	s_Name	age	address
101	Adam	15	Noida

## SELECT QUERY

Select query is used to retrieve data from a tables. It is the most used SQL query. We can retrieve complete tables, or partial by mentioning conditions using WHERE clause.

### SYNTAX OF SELECT QUERY

```
SELECT column-name1, column-name2, column-name3, column-nameN from table-name;
```

### EXAMPLE FOR SELECT QUERY

Consider the following **Student** table,

S_id	S_Name	age	address
101	Adam	15	Noida
102	Alex	18	Delhi
103	Abhi	17	Rohtak
104	Ankit	22	Panipat

```
SELECT s_id, s_name, age from Student.
```

The above query will fetch information of s\_id, s\_name and age column from Student table

S_id	S_Name	age
101	Adam	15
102	Alex	18
103	Abhi	17
104	Ankit	22

---

### EXAMPLE TO SELECT ALL RECORDS FROM TABLE

A special character **asterisk** `*` is used to address all the data(belonging to all columns) in a query. *SELECT* statement uses `*` character to retrieve all records from a table.

```
SELECT * from student;
```

The above query will show all the records of Student table, that means it will show complete Student table as result.

S_id	S_Name	age	address
101	Adam	15	Noida
102	Alex	18	Delhi
103	Abhi	17	Rohtak
104	Ankit	22	Panipat

### EXAMPLE TO SELECT PARTICULAR RECORD BASED ON CONDITION

```
SELECT * from Student WHERE s_name = 'Abhi';
```

103	Abhi	17	Rohtak
-----	------	----	--------

### EXAMPLE TO PERFORM SIMPLE CALCULATIONS USING SELECT QUERY

Consider the following **Employee** table.

eid	Name	age	salary
101	Adam	26	5000
102	Ricky	42	8000
103	Abhi	22	10000
104	Rohan	35	5000

```
SELECT eid, name, salary+3000 from Employee;
```

The above command will display a new column in the result, showing 3000 added into existing salaries of the employees.

eid	Name	salary+3000
101	Adam	8000
102	Ricky	11000
103	Abhi	13000

104	Rohan	8000
-----	-------	------

## LIKE CLAUSE

**Like** clause is used as condition in SQL query. **Like** clause compares data with an expression using wildcard operators. It is used to find similar data from the table.

## WILDCARD OPERATORS

There are two wildcard operators that are used in like clause.

- **Percent sign** `%` : represents zero, one or more than one character.
- **Underscore sign** `_` : represents only one character.

## EXAMPLE OF LIKE CLAUSE

Consider the following **Student** table.

s_id	s_Name	age
101	Adam	15
102	Alex	18
103	Abhi	17

```
SELECT * from Student where s_name like 'A%';
```

The above query will return all records where **s\_name** starts with character 'A'.

s_id	s_Name	age
101	Adam	15
102	Alex	18

103	Abhi	17
-----	------	----

### EXAMPLE

```
SELECT * from Student where s_name like '_d%';
```

The above query will return all records from **Student** table where **s\_name** contain 'd' as second character.

s_id	s_Name	age
101	Adam	15

### EXAMPLE

```
SELECT * from Student where s_name like '%x';
```

The above query will return all records from **Student** table where **s\_name** contain 'x' as last character.

s_id	s_Name	age
102	Alex	18

## ORDER BY CLAUSE

Order by clause is used with **Select** statement for arranging retrieved data in sorted order.

The **Order by** clause by default sort data in ascending order. To sort data in descending order **DESC** keyword is used with **Order by** clause.

### SYNTAX OF ORDER BY

```
SELECT column-list|* from table-name order by asc|desc;
```

### EXAMPLE USING ORDER BY

Consider the following **Emp** table,

eid	name	age	salary
-----	------	-----	--------

401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

```
SELECT * from Emp order by salary;
```

The above query will return result in ascending order of the **salary**.

eid	name	age	salary
403	Rohan	34	6000
402	Shane	29	8000
405	Tiger	35	8000
401	Anu	22	9000
404	Scott	44	10000

### EXAMPLE OF ORDER BY DESC

Consider the **Emp** table described above,

```
SELECT * from Emp order by salary DESC;
```

The above query will return result in descending order of the **salary**.

eid	name	age	salary
404	Scott	44	10000
401	Anu	22	9000
405	Tiger	35	8000
402	Shane	29	8000
403	Rohan	34	6000

## GROUP BY CLAUSE

Group by clause is used to group the results of a SELECT query based on one or more columns. It is also used with SQL functions to group the result from one or more tables.

Syntax for using Group by in a statement.

```
SELECT column_name, function(column_name)
FROM table_name
WHERE condition
GROUP BY column_name
```

## EXAMPLE OF GROUP BY IN A STATEMENT

Consider the following **Emp** table.

eid	name	age	salary
401	Anu	22	9000

402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	9000
405	Tiger	35	8000

Here we want to find name and age of employees grouped by their salaries

SQL query for the above requirement will be,

```
SELECT name, age
from Emp group by salary
```

Result will be,

name	age
Rohan	34
shane	29
anu	22

### EXAMPLE OF GROUP BY IN A STATEMENT WITH WHERE CLAUSE

Consider the following **Emp** table

eid	name	age	salary
401	Anu	22	9000



402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	9000
405	Tiger	35	8000

SQL query will be,

```
select name, salary
from Emp
where age > 25
group by salary
```

Result will be.

name	salary
Rohan	6000
Shane	8000
Scott	9000

You must remember that Group By clause will always come at the end, just like the Order by clause.

## HAVING CLAUSE

having clause is used with SQL Queries to give more precise condition for a statement. It is used to mention condition in Group based SQL functions, just like WHERE clause.

Syntax for having will be,

```
select column_name, function(column_name)
```

```
FROM table_name  
WHERE column_name condition  
GROUP BY column_name  
HAVING function(column_name) condition
```

### EXAMPLE OF HAVING STATEMENT

Consider the following **Sale** table.

oid	order_name	previous_balance	customer
11	ord1	2000	Alex
12	ord2	1000	Adam
13	ord3	2000	Abhi
14	ord4	1000	Adam
15	ord5	2000	Alex

Suppose we want to find the customer whose previous\_balance sum is more than 3000.

We will use the below SQL query,

```
SELECT *  
from sale group customer  
having sum(previous_balance) > 3000
```

Result will be,

oid	order_name	previous_balance	customer
11	ord1	2000	Alex

---

## DISTINCT KEYWORD

The **distinct** keyword is used with **Select** statement to retrieve unique values from the table. **Distinct** removes all the duplicate records while retrieving from database.

## SYNTAX FOR DISTINCT KEYWORD

```
SELECT distinct column-name from table-name;
```

## EXAMPLE

Consider the following **Emp** table.

eid	name	age	salary
401	Anu	22	5000
402	Shane	29	8000
403	Rohan	34	10000
404	Scott	44	10000
405	Tiger	35	8000

```
select distinct salary from Emp;
```

The above query will return only the unique salary from **Emp** table

salary
5000

8000
10000

## AND & OR OPERATOR

**AND** and **OR** operators are used with **Where** clause to make more precise conditions for fetching data from database by combining more than one condition together.

### AND OPERATOR

AND operator is used to set multiple conditions with *Where* clause.

### EXAMPLE OF AND

Consider the following **Emp** table

eid	name	age	salary
401	Anu	22	5000
402	Shane	29	8000
403	Rohan	34	12000
404	Scott	44	10000
405	Tiger	35	9000

```
SELECT * from Emp WHERE salary < 10000 AND age > 25
```

The above query will return records where salary is less than 10000 and age greater than 25.

eid	name	age	salary
-----	------	-----	--------

402	Shane	29	8000
405	Tiger	35	9000

## OR OPERATOR

OR operator is also used to combine multiple conditions with *Where* clause. The only difference between AND and OR is their behaviour. When we use AND to combine two or more than two conditions, records satisfying all the condition will be in the result. But in case of OR, atleast one condition from the conditions specified must be satisfied by any record to be in the result.

## EXAMPLE OF OR

Consider the following **Emp** table

eid	name	age	salary
401	Anu	22	5000
402	Shane	29	8000
403	Rohan	34	12000
404	Scott	44	10000
405	Tiger	35	9000

```
SELECT * from Emp WHERE salary > 10000 OR age > 25
```

The above query will return records where either salary is greater than 10000 or age greater than 25.

402	Shane	29	8000
-----	-------	----	------

403	Rohan	34	12000
404	Scott	44	10000
405	Tiger	35	9000

## SQL CONSTRAINTS

SQL Constraints are rules used to limit the type of data that can go into a table, to maintain the accuracy and integrity of the data inside table.

Constraints can be divided into following two types,

- **Column level constraints** : limits only column data
- **Table level constraints** : limits whole table data

Constraints are used to make sure that the integrity of data is maintained in the database. Following are the most used constraints that can be applied to a table.

- NOT NULL
- UNIQUE
- PRIMARY KEY
- FOREIGN KEY
- CHECK
- DEFAULT

### NOT NULL CONSTRAINT

NOT NULL constraint restricts a column from having a NULL value. Once **NOT NULL** constraint is applied to a column, you cannot pass a null value to that column. It enforces a column to contain a proper value. One important point to note about NOT NULL constraint is that it cannot be defined at table level.

### EXAMPLE USING NOT NULL CONSTRAINT

```
CREATE table Student(s_id int NOT NULL, Name varchar(60), Age int);
```

The above query will declare that the **s\_id** field of **Student** table will not take NULL value.

### UNIQUE CONSTRAINT

UNIQUE constraint ensures that a field or column will only have unique values. A UNIQUE constraint field will not have duplicate data. UNIQUE constraint can be applied at column level or table level.

## EXAMPLE USING UNIQUE CONSTRAINT WHEN CREATING A TABLE (TABLE LEVEL)

```
CREATE table Student(s_id int NOT NULL UNIQUE, Name varchar(60), Age int);
```

The above query will declare that the **s\_id** field of **Student** table will only have unique values and wont take NULL value.

## EXAMPLE USING UNIQUE CONSTRAINT AFTER TABLE IS CREATED (COLUMN LEVEL)

```
ALTER table Student add UNIQUE(s_id);
```

The above query specifies that **s\_id** field of **Student** table will only have unique value.

## PRIMARY KEY CONSTRAINT

Primary key constraint uniquely identifies each record in a database. A Primary Key must contain unique value and it must not contain null value. Usually Primary Key is used to index the data inside the table.

## EXAMPLE USING PRIMARY KEY CONSTRAINT AT TABLE LEVEL

```
CREATE table Student (s_id int PRIMARY KEY, Name varchar(60) NOT NULL, Age int );
```

The above command will creates a PRIMARY KEY on the **s\_id**.

## EXAMPLE USING PRIMARY KEY CONSTRAINT AT COLUMN LEVEL

```
ALTER table Student add PRIMARY KEY (s_id);
```

The above command will creates a PRIMARY KEY on the **s\_id**.

## FOREIGN KEY CONSTRAINT

FOREIGN KEY is used to relate two tables. FOREIGN KEY constraint is also used to restrict actions that would destroy links between tables. To understand FOREIGN KEY, let's see it using two table.

**Customer\_Detail Table :**

c_id	Customer_Name	address
101	Adam	Noida
102	Alex	Delhi

103	Stuart	Rohtak
-----	--------	--------

**Order\_Detail Table :**

Order_id	Order_Name	c_id
10	Order1	101
11	Order2	103
12	Order3	102

In **Customer\_Detail** table, c\_id is the primary key which is set as foreign key in **Order\_Detail** table. The value that is entered in c\_id which is set as foreign key in **Order\_Detail** table must be present in **Customer\_Detail** table where it is set as primary key. This prevents invalid data to be inserted into c\_id column of **Order\_Detail** table.

#### EXAMPLE USING FOREIGN KEY CONSTRAINT AT TABLE LEVEL

```
CREATE table Order_Detail(order_id int PRIMARY KEY,
order_name varchar(60) NOT NULL,
c_id int FOREIGN KEY REFERENCES Customer_Detail(c_id));
```

In this query, c\_id in table Order\_Detail is made as foreign key, which is a reference of c\_id column of Customer\_Detail.

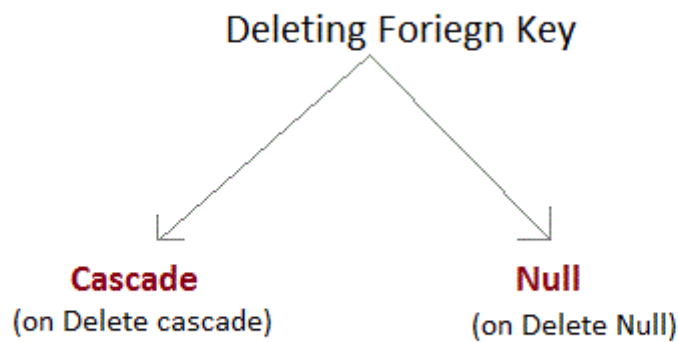
#### EXAMPLE USING FOREIGN KEY CONSTRAINT AT COLUMN LEVEL

```
ALTER table Order_Detail add FOREIGN KEY (c_id) REFERENCES Customer_Detail(c_id);
```

#### BEHAVIOUR OF FOREIGN KEY COLUMN ON DELETE

There are two ways to maintain the integrity of data in Child table, when a particular record is deleted in main table. When two tables are connected with Foreign key, and certain data in the main table is deleted, for which record exists in child table too, then we must have some mechanism to save the integrity of data in child table.





- **On Delete Cascade** : This will remove the record from child table, if that value of foreign key is deleted from the main table.
- **On Delete Null** : This will set all the values in that record of child table as NULL, for which the value of foreign key is deleted from the main table.
- If we don't use any of the above, then we cannot delete data from the main table for which data in child table exists. We will get an error if we try to do so.

ERROR : Record in child table exist

## CHECK CONSTRAINT

CHECK constraint is used to restrict the value of a column between a range. It performs check on the values, before storing them into the database. Its like condition checking before saving data into a column.

### EXAMPLE USING CHECK CONSTRAINT AT TABLE LEVEL

```
create table Student(s_id int NOT NULL CHECK(s_id > 0),  
Name varchar(60) NOT NULL,  
Age int);
```

The above query will restrict the s\_id value to be greater than zero.

### EXAMPLE USING CHECK CONSTRAINT AT COLUMN LEVEL

```
ALTER table Student add CHECK(s_id > 0);
```

## SQL FUNCTIONS

SQL provides many built-in functions to perform operations on data. These functions are useful while performing mathematical calculations, string concatenations, sub-strings etc. SQL functions are divided into two categories,

- Aggregate Functions
  - Scalar Functions
-

## AGGREGATE FUNCTIONS

These functions return a single value after calculating from a group of values. Following are some frequently used Aggregate functions.

### 1) AVG()

Average returns average value after calculating from values in a numeric column.

Its general Syntax is,

```
SELECT AVG(column_name) from table_name
```

#### Example using AVG()

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query to find average of salary will be,

```
SELECT avg(salary) from Emp;
```

Result of the above query will be,

avg(salary)
8200

## 2) COUNT()

Count returns the number of rows present in the table either based on some condition or without condition.

Its general Syntax is,

```
SELECT COUNT(column_name) from table-name
```

### EXAMPLE USING COUNT()

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query to count employees, satisfying specified condition is,

```
SELECT COUNT(name) from Emp where salary = 8000;
```

Result of the above query will be,

count(name)

2

---

## EXAMPLE OF COUNT(DISTINCT)

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query is,

```
SELECT COUNT(distinct salary) from emp;
```

Result of the above query will be,

count(distinct salary)
4

### 3) FIRST()

First function returns first value of a selected column

Syntax for FIRST function is,

```
SELECT FIRST(column_name) from table-name
```

### EXAMPLE OF FIRST()

Consider following **Emp** table

eid	name	age	salary
-----	------	-----	--------

401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query

```
SELECT FIRST(salary) from Emp;
```

Result will be,

<b>first(salary)</b>
9000

#### 4) LAST()

LAST return the return last value from selected column

Syntax of LAST function is,

```
SELECT LAST(column_name) from table-name
```

#### EXAMPLE OF LAST()

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000

402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query will be,

```
SELECT LAST(salary) from emp;
```

Result of the above query will be,

<b>last(salary)</b>
8000

## 5) MAX()

MAX function returns maximum value from selected column of the table.

Syntax of MAX function is,

```
SELECT MAX(column_name) from table-name
```

### EXAMPLE OF MAX()

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000

403	Rohan	34	6000
404	Scott	44	10000
405	Tiger	35	8000

SQL query to find Maximum salary is,

```
SELECT MAX(salary) from emp;
```

Result of the above query will be,

<b>MAX(salary)</b>
10000

## 6) MIN()

MIN function returns minimum value from a selected column of the table.

Syntax for MIN function is,

```
SELECT MIN(column_name) from table-name
```

## EXAMPLE OF MIN()

Consider following **Emp** table,

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000

404	Scott	44	10000
405	Tiger	35	8000

SQL query to find minimum salary is,

```
SELECT MIN(salary) from emp;
```

Result will be,

<b>MIN(salary)</b>
8000

## 7) SUM()

SUM function returns total sum of a selected columns numeric values.

Syntax for SUM is,

```
SELECT SUM(column_name) from table-name
```

### EXAMPLE OF SUM()

Consider following **Emp** table

eid	name	age	salary
401	Anu	22	9000
402	Shane	29	8000
403	Rohan	34	6000
404	Scott	44	10000



405	Tiger	35	8000
-----	-------	----	------

SQL query to find sum of salaries will be,

```
SELECT SUM(salary) from emp;
```

Result of above query is,

SUM(salary)
41000

## SCALAR FUNCTIONS

Scalar functions return a single value from an input value. Following are some frequently used Scalar Functions.

### 1) UCASE()

UCASE function is used to convert value of string column to Uppercase character.

Syntax of UCASE,

```
SELECT UCASE(column_name) from table-name
```

### EXAMPLE OF UCASE()

Consider following **Emp** table

eid	name	age	salary
401	anu	22	9000
402	shane	29	8000
403	rohan	34	6000
404	scott	44	10000

405	Tiger	35	8000
-----	-------	----	------

SQL query for using UCASE is,

```
SELECT UCASE(name) from emp;
```

Result is,

UCASE(name)
ANU
SHANE
ROHAN
SCOTT
TIGER

## 2) LCASE()

LCASE function is used to convert value of string column to Lowecase character.

Syntax for LCASE is,

```
SELECT LCASE(column_name) from table-name
```

## EXAMPLE OF LCASE()

Consider following **Emp** table

eid	name	age	salary
401	anu	22	9000

402	shane	29	8000
403	rohan	34	6000
404	scott	44	10000
405	Tiger	35	8000

SQL query for converting string value to Lower case is,

```
SELECT LCASE(name) from emp;
```

Result will be,

LCASE(name)
anu
shane
rohan
scott
tiger

### 3) MID()

MID function is used to extract substrings from column values of string type in a table.

Syntax for MID function is,

```
SELECT MID(column_name, start, length) from table-name
```

### EXAMPLE OF MID()

Consider following **Emp** table

eid	name	age	salary
401	anu	22	9000
402	shane	29	8000
403	rohan	34	6000
404	scott	44	10000
405	Tiger	35	8000

SQL query will be,

```
select MID(name,2,2) from emp;
```

Result will come out to be,

<b>MID(name,2,2)</b>
nu
ha
oh
co
ig

#### 4) ROUND()

ROUND function is used to round a numeric field to number of nearest integer. It is used on Decimal point values. Syntax of Round function is,

```
SELECT ROUND(column_name, decimals) from table-name
```

#### EXAMPLE OF ROUND()

Consider following **Emp** table

eid	name	age	salary
401	anu	22	9000.67
402	shane	29	8000.98
403	rohan	34	6000.45
404	scott	44	10000
405	Tiger	35	8000.01

SQL query is,

```
SELECT ROUND(salary) from emp;
```

Result will be,

ROUND(salary)
9001
8001
6000

10000
8000

## JOIN IN SQL

SQL Join is used to fetch data from two or more tables, which is joined to appear as single set of data. SQL Join is used for combining column from two or more tables by using values common to both tables. **Join** keyword is used in SQL queries for joining two or more tables. Minimum required condition for joining table, is **(n-1)** where **n**, is number of tables. A table can also join to itself known as, **Self Join**.

## TYPES OF JOIN

The following are the types of JOIN that we can use in SQL.

- Inner
- Outer
- Left
- Right

## CROSS JOIN OR CARTESIAN PRODUCT

This type of JOIN returns the cartesian product of rows from the tables in Join. It will return a table which consists of records which combines each row from the first table with each row of the second table.

Cross JOIN Syntax is,

```
SELECT column-name-list
```

```
from table-name1
```

```
CROSS JOIN
```

```
table-name2;
```

## EXAMPLE OF CROSS JOIN

The **class** table,

ID	NAME
1	abhi

2	adam
4	alex

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI

**Cross JOIN** query will be,

```
SELECT *
  from class,
 cross JOIN class_info;
```

The result table will look like,

ID	NAME	ID	Address
1	abhi	1	DELHI
2	adam	1	DELHI
4	alex	1	DELHI

1	abhi	2	MUMBAI
2	adam	2	MUMBAI
4	alex	2	MUMBAI
1	abhi	3	CHENNAI
2	adam	3	CHENNAI
4	alex	3	CHENNAI

## INNER JOIN OR EQUI JOIN

This is a simple JOIN in which the result is based on matched data as per the equality condition specified in the query.

Inner Join Syntax is,

```
SELECT column-name-list
```

```
from table-name1
```

```
INNER JOIN
```

```
table-name2
```

```
WHERE table-name1.column-name = table-name2.column-name;
```

## EXAMPLE OF INNER JOIN

The **class** table,

ID	NAME
1	abhi



2	adam
3	alex
4	anu

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI

**Inner JOIN** query will be,

```
SELECT * from class, class_info where class.id = class_info.id;
```

The result table will look like,

ID	NAME	ID	Address
1	abhi	1	DELHI
2	adam	2	MUMBAI
3	alex	3	CHENNAI

**NATURAL JOIN**

Natural Join is a type of Inner join which is based on column having same name and same datatype present in both the tables to be joined.

Natural Join Syntax is,

```
SELECT *  
from table-name1  
NATURAL JOIN  
table-name2;
```

### EXAMPLE OF NATURAL JOIN

The **class** table,

ID	NAME
1	abhi
2	adam
3	alex
4	anu

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI

**Natural join query will be,**

```
SELECT * from class NATURAL JOIN class_info;
```

The result table will look like,

ID	NAME	Address
1	abhi	DELHI
2	adam	MUMBAI
3	alex	CHENNAI

In the above example, both the tables being joined have ID column(same name and same datatype), hence the records for which value of ID matches in both the tables will be the result of Natural Join of these two tables.

## OUTER JOIN

Outer Join is based on both matched and unmatched data. Outer Joins subdivide further into,

- Left Outer Join
- Right Outer Join
- Full Outer Join

## LEFT OUTER JOIN

The left outer join returns a result table with the **matched data** of two tables then remaining rows of the **left** table and null for the **right** table's column.

Left Outer Join syntax is,

```
SELECT column-name-list
from table-name1
LEFT OUTER JOIN
table-name2
on table-name1.column-name = table-name2.column-name;
```

Left outer Join Syntax for **Oracle** is,

```
select column-name-list
```

```
from table-name1,  
table-name2  
on table-name1.column-name = table-name2.column-name(+);
```

### EXAMPLE OF LEFT OUTER JOIN

The **class** table,

ID	NAME
1	abhi
2	adam
3	alex
4	anu
5	ashish

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI
7	NOIDA

8	PANIPAT
---	---------

**Left Outer Join** query will be,

```
SELECT * FROM class LEFT OUTER JOIN class_info ON (class.id=class_info.id);
```

The result table will look like,

ID	NAME	ID	Address
1	abhi	1	DELHI
2	adam	2	MUMBAI
3	alex	3	CHENNAI
4	anu	null	null
5	ashish	null	null

## RIGHT OUTER JOIN

The right outer join returns a result table with the **matched data** of two tables then remaining rows of the **right table** and null for the **left** table's columns.

Right Outer Join Syntax is,

```
select column-name-list
```

```
from table-name1
```

**RIGHT OUTER JOIN**

```
table-name2
```

```
on table-name1.column-name = table-name2.column-name;
```

Right outer Join Syntax for **Oracle** is,

```
select column-name-list
```

```
from table-name1,  
table-name2  
on table-name1.column-name(+) = table-name2.column-name;
```

### EXAMPLE OF RIGHT OUTER JOIN

The **class** table,

ID	NAME
1	abhi
2	adam
3	alex
4	anu
5	ashish

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI
7	NOIDA

8	PANIPAT
---	---------

**Right Outer Join** query will be,

```
SELECT * FROM class RIGHT OUTER JOIN class_info on (class.id=class_info.id);
```

The result table will look like,

ID	NAME	ID	Address
1	abhi	1	DELHI
2	adam	2	MUMBAI
3	alex	3	CHENNAI
null	null	7	NOIDA
null	null	8	PANIPAT

## FULL OUTER JOIN

The full outer join returns a result table with the **matched data** of two table then remaining rows of both **left** table and then the **right** table.

Full Outer Join Syntax is,

```
select column-name-list
```

```
from table-name1
```

**FULL OUTER JOIN**

```
table-name2
```

```
on table-name1.column-name = table-name2.column-name;
```

## EXAMPLE OF FULL OUTER JOIN IS,

The **class** table,

ID	NAME
1	abhi
2	adam
3	alex
4	anu
5	ashish

The **class\_info** table,

ID	Address
1	DELHI
2	MUMBAI
3	CHENNAI
7	NOIDA
8	PANIPAT

**Full Outer Join** query will be like,

```
SELECT * FROM class FULL OUTER JOIN class_info on (class.id=class_info.id);
```



The result table will look like,

ID	NAME	ID	Address
1	abhi	1	DELHI
2	adam	2	MUMBAI
3	alex	3	CHENNAI
4	anu	null	null
5	ashish	null	null
null	null	7	NOIDA
null	null	8	PANIPAT

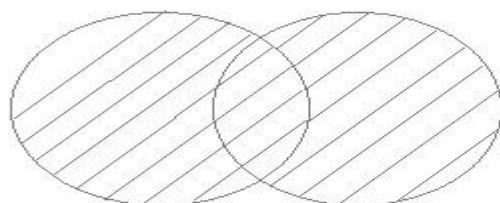
## SET OPERATION IN SQL

---

SQL supports few Set operations to be performed on table data. These are used to get meaningful results from data, under different special conditions.

### UNION

UNION is used to combine the results of two or more Select statements. However it will eliminate duplicate rows from its result set. In case of union, number of columns and datatype must be same in both the tables.



## EXAMPLE OF UNION

The **First** table,

ID	Name
1	abhi
2	adam

The **Second** table,

ID	Name
2	adam
3	Chester

Union SQL query will be,

```
select * from First
```

**UNION**

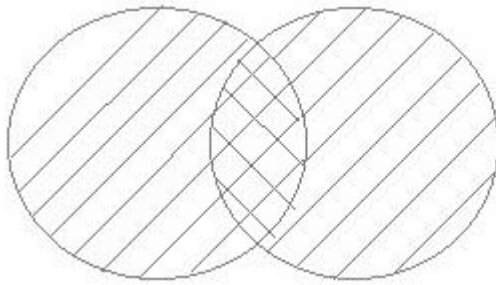
```
select * from second
```

The result table will look like,

ID	NAME
1	abhi
2	adam
3	Chester

## UNION ALL

This operation is similar to Union. But it also shows the duplicate rows.



## EXAMPLE OF UNION ALL

The **First** table,

ID	NAME
1	abhi
2	adam

The **Second** table,

ID	NAME
2	adam
3	Chester

Union All query will be like,

```
select * from First
```

## UNION ALL

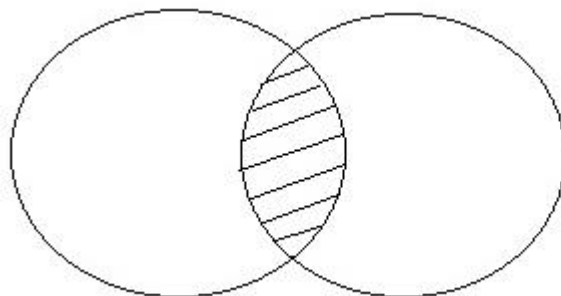
```
select * from second
```

The result table will look like,

ID	NAME
1	abhi
2	adam
2	adam
3	Chester

## INTERSECT

Intersect operation is used to combine two SELECT statements, but it only returns the records which are common from both SELECT statements. In case of **Intersect** the number of columns and datatype must be same. MySQL does not support INTERSECT operator.



## EXAMPLE OF INTERSECT

The **First** table,

ID	NAME
1	abhi
2	adam

The **Second** table,

ID	NAME
2	adam
3	Chester

Intersect query will be,

```
select * from First
```

**INTERSECT**

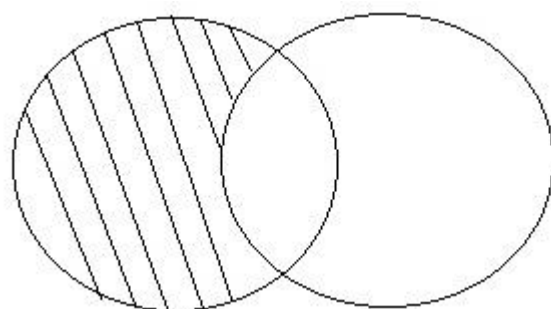
```
select * from second
```

The result table will look like

ID	NAME
2	adam

## MINUS

Minus operation combines result of two Select statements and return only those result which belongs to first set of result. MySQL does not support INTERSECT operator.



## EXAMPLE OF MINUS

The **First** table,

ID	NAME
----	------

1	abhi
2	adam

The **Second** table,

ID	NAME
2	adam
3	Chester

Minus query will be,

```
select * from First
```

**MINUS**

```
select * from second
```

The result table will look like,

ID	NAME
1	abhi

---

## DBMS - TRANSACTION

A transaction can be defined as a group of tasks. A single task is the minimum processing unit which cannot be divided further.

Let's take an example of a simple transaction. Suppose a bank employee transfers Rs 500 from A's account to B's account. This very simple and small transaction involves several low-level tasks.

## A's Account

```
Open_Account(A)
Old_Balance = A.balance
New_Balance = Old_Balance - 500
A.balance = New_Balance
Close_Account(A)
```

## B's Account

```
Open_Account(B)
Old_Balance = B.balance
New_Balance = Old_Balance + 500
B.balance = New_Balance
Close_Account(B)
```

## ACID PROPERTIES

A transaction is a very small unit of a program and it may contain several lowlevel tasks. A transaction in a database system must maintain **Atomicity, Consistency, Isolation,** and **Durability** – commonly known as ACID properties – in order to ensure accuracy, completeness, and data integrity.

- **Atomicity** – This property states that a transaction must be treated as an atomic unit, that is, either all of its operations are executed or none. There must be no state in a database where a transaction is left partially completed. States should be defined either before the execution of the transaction or after the execution/abortion/failure of the transaction.
- **Consistency** – The database must remain in a consistent state after any transaction. No transaction should have any adverse effect on the data residing in the database. If the database was in a consistent state before the execution of a transaction, it must remain consistent after the execution of the transaction as well.
- **Durability** – The database should be durable enough to hold all its latest updates even if the system fails or restarts. If a transaction updates a chunk of data in a database and commits, then the database will hold the modified data. If a transaction commits but the system fails before the data could be written on to the disk, then that data will be updated once the system springs back into action.
- **Isolation** – In a database system where more than one transaction are being executed simultaneously and in parallel, the property of isolation states that all the transactions will be carried out and executed as if it is the only transaction in the system. No transaction will affect the existence of any other transaction.

## SERIALIZABILITY

When multiple transactions are being executed by the operating system in a multiprogramming environment, there are possibilities that instructions of one transactions are interleaved with some other transaction.

- **Schedule** – A chronological execution sequence of a transaction is called a schedule. A schedule can have many transactions in it, each comprising of a number of instructions/tasks.
- **Serial Schedule** – It is a schedule in which transactions are aligned in such a way that one transaction is executed first. When the first transaction completes its cycle, then the next transaction is executed. Transactions are ordered one after the other. This type of schedule is called a serial schedule, as transactions are executed in a serial manner.

In a multi-transaction environment, serial schedules are considered as a benchmark. The execution sequence of an instruction in a transaction cannot be changed, but two transactions can have their instructions executed in a random fashion. This execution does no harm if two transactions are mutually independent and working on different segments of data; but in case these two transactions are working on the same data, then the results may vary. This ever-varying result may bring the database to an inconsistent state.

To resolve this problem, we allow parallel execution of a transaction schedule, if its transactions are either serializable or have some equivalence relation among them.

## EQUIVALENCE SCHEDULES

An equivalence schedule can be of the following types –

### RESULT EQUIVALENCE

If two schedules produce the same result after execution, they are said to be result equivalent. They may yield the same result for some value and different results for another set of values. That's why this equivalence is not generally considered significant.

### VIEW EQUIVALENCE

Two schedules would be view equivalence if the transactions in both the schedules perform similar actions in a similar manner.

For example –

- If T reads the initial data in S<sub>1</sub>, then it also reads the initial data in S<sub>2</sub>.
- If T reads the value written by J in S<sub>1</sub>, then it also reads the value written by J in S<sub>2</sub>.
- If T performs the final write on the data value in S<sub>1</sub>, then it also performs the final write on the data value in S<sub>2</sub>.

### CONFLICT EQUIVALENCE

Two schedules would be conflicting if they have the following properties –

- Both belong to separate transactions.
- Both accesses the same data item.
- At least one of them is "write" operation.



Two schedules having multiple transactions with conflicting operations are said to be conflict equivalent if and only if –

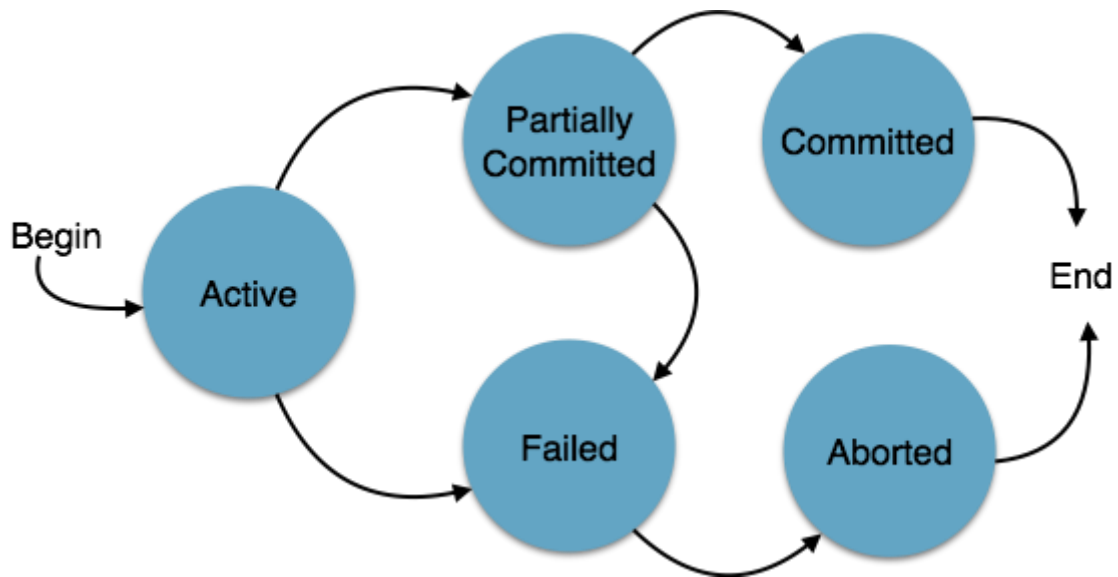
- Both the schedules contain the same set of Transactions.
- The order of conflicting pairs of operation is maintained in both the schedules.

**Note** – View equivalent schedules are view serializable and conflict equivalent schedules are conflict serializable. All conflict serializable schedules are view serializable too.

### STATES OF TRANSACTIONS

---

A transaction in a database can be in one of the following states –



- **Active** – In this state, the transaction is being executed. This is the initial state of every transaction.
- **Partially Committed** – When a transaction executes its final operation, it is said to be in a partially committed state.
- **Failed** – A transaction is said to be in a failed state if any of the checks made by the database recovery system fails. A failed transaction can no longer proceed further.
- **Aborted** – If any of the checks fails and the transaction has reached a failed state, then the recovery manager rolls back all its write operations on the database to bring the database back to its original state where it was prior to the execution of the transaction. Transactions in this state are called aborted. The database recovery module can select one of the two operations after a transaction aborts –
  - Re-start the transaction
  - Kill the transaction
- **Committed** – If a transaction executes all its operations successfully, it is said to be committed. All its effects are now permanently established on the database system.

## DBMS - DEADLOCK

---

In a multi-process system, deadlock is an unwanted situation that arises in a shared resource environment, where a process indefinitely waits for a resource that is held by another process.

For example, assume a set of transactions  $\{T_0, T_1, T_2, \dots, T_n\}$ .  $T_0$  needs a resource  $X$  to complete its task. Resource  $X$  is held by  $T_1$ , and  $T_1$  is waiting for a resource  $Y$ , which is held by  $T_2$ .  $T_2$  is waiting for resource  $Z$ , which is held by  $T_0$ . Thus, all the processes wait for each other to release resources. In this situation, none of the processes can finish their task. This situation is known as a deadlock.

Deadlocks are not healthy for a system. In case a system is stuck in a deadlock, the transactions involved in the deadlock are either rolled back or restarted.

## DEADLOCK PREVENTION

---

To prevent any deadlock situation in the system, the DBMS aggressively inspects all the operations, where transactions are about to execute. The DBMS inspects the operations and analyzes if they can create a deadlock situation. If it finds that a deadlock situation might occur, then that transaction is never allowed to be executed.

There are deadlock prevention schemes that use timestamp ordering mechanism of transactions in order to predetermine a deadlock situation.

### WAIT-DIE SCHEME

In this scheme, if a transaction requests to lock a resource (data item), which is already held with a conflicting lock by another transaction, then one of the two possibilities may occur –

- If  $TS(T_i) < TS(T_j)$  – that is  $T_i$ , which is requesting a conflicting lock, is older than  $T_j$  – then  $T_i$  is allowed to wait until the data-item is available.
- If  $TS(T_i) > TS(T_j)$  – that is  $T_i$  is younger than  $T_j$  – then  $T_i$  dies.  $T_i$  is restarted later with a random delay but with the same timestamp.

This scheme allows the older transaction to wait but kills the younger one.

### WOUND-WAIT SCHEME

In this scheme, if a transaction requests to lock a resource (data item), which is already held with conflicting lock by some another transaction, one of the two possibilities may occur –

- If  $TS(T_i) < TS(T_j)$ , then  $T_i$  forces  $T_j$  to be rolled back – that is  $T_i$  wounds  $T_j$ .  $T_j$  is restarted later with a random delay but with the same timestamp.
- If  $TS(T_i) > TS(T_j)$ , then  $T_i$  is forced to wait until the resource is available.

This scheme, allows the younger transaction to wait; but when an older transaction requests an item held by a younger one, the older transaction forces the younger one to abort and release the item.

In both the cases, the transaction that enters the system at a later stage is aborted.

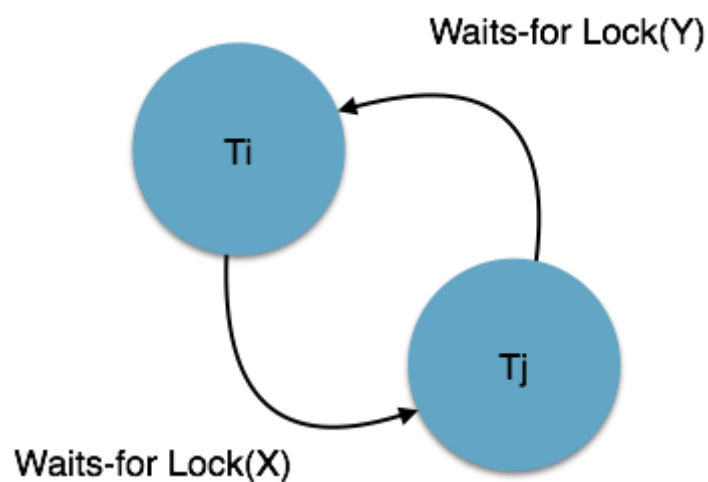
## DEADLOCK AVOIDANCE

Aborting a transaction is not always a practical approach. Instead, deadlock avoidance mechanisms can be used to detect any deadlock situation in advance. Methods like "wait-for graph" are available but they are suitable for only those systems where transactions are lightweight having fewer instances of resource. In a bulky system, deadlock prevention techniques may work well.

## WAIT-FOR GRAPH

This is a simple method available to track if any deadlock situation may arise. For each transaction entering into the system, a node is created. When a transaction  $T_i$  requests for a lock on an item, say  $X$ , which is held by some other transaction  $T_j$ , a directed edge is created from  $T_i$  to  $T_j$ . If  $T_j$  releases item  $X$ , the edge between them is dropped and  $T_i$  locks the data item.

The system maintains this wait-for graph for every transaction waiting for some data items held by others. The system keeps checking if there's any cycle in the graph.



Here, we can use any of the two following approaches –

- First, do not allow any request for an item, which is already locked by another transaction. This is not always feasible and may cause starvation, where a transaction indefinitely waits for a data item and can never acquire it.
- The second option is to roll back one of the transactions. It is not always feasible to roll back the younger transaction, as it may be important than the older one. With the help of some relative algorithm, a transaction is chosen, which is to be aborted. This transaction is known as the **victim** and the process is known as **victim selection**.

## MCQS BASICS OF DBMS AND SQL

**1. DBMS is a collection of ..... that enables user to create and maintain a database.**

- A) Keys
- B) Translators
- C) Program
- D) Language Activity

**2. In a relational schema, each tuple is divided into fields called**

- A) Relations
- B) Domains
- C) Queries
- D) All of the above

**3. In an ER model, ..... is described in the database by storing its data.**

- A) Entity
- B) Attribute
- C) Relationship
- D) Notation

**4. DFD stands for**

- A) Data Flow Document
- B) Data File Diagram
- C) Data Flow Diagram
- D) None of the above

**5. A top-to-bottom relationship among the items in a database is established by a**

- A) Hierarchical schema
- B) Network schema
- C) Relational Schema
- D) All of the above

**6. .... table store information about database or about the system.**

- A) SQL
- B) Nested
- C) System
- D) None of these

**7. ....defines the structure of a relation which consists of a fixed set of attribute-domain pairs.**

- A) Instance
- B) Schema
- c) Program

D) Super Key

**8. .... clause is an additional filter that is applied to the result.**

- A) Select
- B) Group-by
- C) Having
- D) Order by

**9. A logical schema**

- A) is the entire database
- B) is a standard way of organizing information into accessible parts.
- C) Describes how data is actually stored on disk.
- D) All of the above

**10. .... is a full form of SQL.**

- A) Standard query language
- B) Sequential query language
- C) Structured query language
- D) Server side query language

**11) A relational database developer refers to a record as**

- A. a criteria
- B. a relation
- C. a tuple
- D. an attribute

**12) ..... keyword is used to find the number of values in a column.**

- A. TOTAL
- B. COUNT
- C. ADD
- D. SUM

**13) An advantage of the database management approach is**

- A. data is dependent on programs
- B. data redundancy increases
- C. data is integrated and can be accessed by multiple programs
- D. none of the above

**14) The collection of information stored in a database at a particular moment is called as .....**

- A. schema
- B. instance of the database

- C. data domain
- D. independence

**15) Data independence means**

- A. data is defined separately and not included in programs.
- B. programs are not dependent on the physical attributes of data
- C. programs are not dependent on the logical attributes of data
- D. both B and C

**16) A ..... is used to define overall design of the database**

- A. schema
- B. application program
- C. data definition language
- D. code

**17) Key to represent relationship between tables is called**

- A. primary key
- B. secondary key
- C. foreign key
- D. none of the above

**18) Grant and revoke are ..... statements.**

- A. DDL
- B. TCL
- C. DCL
- D. DML

**19) DBMS helps achieve**

- A. Data independence
- B. Centralized control of data
- C. Neither A nor B
- D. Both A and B

**20) ..... command can be used to modify a column in a table**

- A. alter
- B. update
- C. set
- D. create

**21. The candidate key is that you choose to identify each row uniquely is called .....**

- A) Alternate Key<sub>1</sub>

- B) Primary Key
- C) Foreign Key
- D) None of the above

**22. .... is used to determine whether of a table contains duplicate rows.**

- A) Unique predicate
- B) Like Predicate
- C) Null predicate
- D) In predicate

**23. To eliminate duplicate rows ..... is used**

- A) NODUPLICATE
- B) ELIMINATE
- C) DISTINCT
- D) None of these

**24. State true or false**

- i) A candidate key is a minimal super key.
- ii) A candidate key can also refer to as surrogate key.
- A) i-true, ii-false
- B) i-false, ii-true
- C) i-true, ii-true
- D) i-false, ii-false

**25. DCL stands for**

- A) Data Control Language
- B) Data Console Language
- C) Data Console Level
- D) Data Control Level

**26. .... is the process of organizing data into related tables.**

- A) Normalization
- B) Generalization
- C) Specialization
- D) None of the above

**27. A ..... Does not have a distinguishing attribute if its own and mostly are dependent entities, which are part of some another entity.**

- A) Weak entity
- B) Strong entity
- C) Non attributes entity
- D) Dependent entity

**28. .... is the complex search criteria in the where clause.**

- A) Sub string
- B) Drop Table
- C) Predict
- D) Predicate

**29. .... is preferred method for enforcing data integrity**

- A) Constraints
- B) Stored Procedure
- C) Triggers
- D) Cursors

**30. The number of tuples in a relation is called its ..... While the number of attributes in a relation is called it's**

- A) Degree, Cardinality
- B) Cardinality, Degree
- C) Rows, Columns
- D) Columns, Rows

**31) The language that requires a user to specify the data to be retrieved without specifying exactly how to get it is**

- A. Procedural DML
- B. Non-Procedural DML
- C. Procedural DDL
- D. Non-Procedural DDL

**32) Which two files are used during operation of the DBMS?**

- A. Query languages and utilities
- B. DML and query language
- C. Data dictionary and transaction log
- D. Data dictionary and query language

**33) The database schema is written in**

- A. HLL
- B. DML
- C. DDL
- D. DCL

**34) The way a particular application views the data from the database that the application uses is a**

- A. module
- B. relational model
- C. schema
- D. sub schema

**35) The relational model feature is that there**

- A. is no need for primary key data
- B. is much more data independence than some other database models
- C. are explicit relationships among records.
- D. are tables with many dimensions

**36) Which one of the following statements is false?**

- A. The data dictionary is normally maintained by the database administrator
- B. Data elements in the database can be modified by changing the data dictionary.
- C. The data dictionary contains the name and description of each data element.
- D. The data dictionary is a tool used exclusively by the database administrator.

**17) Which of the following are the properties of entities?**

- A. Groups
- B. Table
- C. Attributes
- D. Switchboards

**38) Which database level is closest to the users?**

- A. External
- B. Internal
- C. Physical
- D. Conceptual

**39) Which are the two ways in which entities can participate in a relationship?**

- A. Passive and active
- B. Total and partial
- C. Simple and Complex
- D. All of the above

**40)..... Data type can store unstructured data**

- A. RAW
- B. CHAR
- C. NUMERIC
- D. VARCHAR

**41. State true or false.**

- i) Select operator is not a unary operator.
- ii) Project operator chooses subset of attributes or columns of a relation.

- A) i-True, ii-False
- B) i-True, ii-True
- C) i-False, ii-True
- D) i-False, ii-False

**42. .... database is used as template for all databases created.**

- A) Master
- B) Model
- C) Tempdb
- D) None of the above

**43. One aspect that has to be dealt with by the integrity subsystem is to ensure that only valid values can be assigned to each data items. This is referred to as**

- A) Data Security
- B) Domain access
- C) Data Control
- D) Domain Integrity

**44. .... operator is basically a join followed by a project on the attributes of first relation.**

- A) Join
- B) Semi-Join
- C) Full Join
- D) Inner Join

**45. Which of the following is not a binary operator in relational algebra?**

- A) Join
- B) Semi-Join
- C) Assignment
- D) Project

**46. Centralizing the integrity checking directly under the DBMS ..... Duplication and ensures the consistency and validity of the database.**

- A) Increases

- B) Skips
- C) Does not reduce
- D) Reduces

**47. Which of the following is/are the DDL statements?**

- A) Create
- B) Drop
- C) Alter
- D) All of the above

**48. In snapshot, ..... clause tells oracle how long to wait between refreshes.**

- A) Complete
- B) Force
- C) Next
- D) Refresh

**49. .... defines rules regarding the values allowed in columns and is the standard mechanism for enforcing database integrity.**

- A) Column
- B) Constraint
- C) Index
- D) Trigger

**50. For like predicate which of the following is true.**

- i) % matches zero or more characters.
- ii) \_ matches exactly one character.
- A) i-only
- B) ii-only
- C) Both of them
- D) None of them

**51. The relational model is based on the concept that data is organized and stored in two-dimensional tables called**

- A) Fields
- B) Records
- C) Relations
- D) Keys

**52. .... contains information that defines valid values that are stored in a column or data type.**

- A) View
- B) Rule
- C) Index
- D) Default

**53. Which of the syntax is correct for insert statement?**

- i) insert into <table\_name> values <list of



values>

ii) insert into <table\_name> (column list) values  
<list of values>

- A) i-only
- B) ii-only
- C) Both of them
- D) None of them

**54. .... First proposed the process of normalization.**

- A) Edgar. W
- B) Edgar F. Codd
- C) Edward Stephen
- D) Edward Codd

**55. For using a specific database ..... command is used.**

- A) use database
- B) database name use
- C) Both A & B
- D) None of them

**56. Which of the following is not comparison operator?**

- A) <>
- B) <
- C) =<
- D) >=

**57. An outstanding functionality of SQL is its support for automatic ..... to the target data.**

- A) programming
- B) functioning
- C) navigation
- D) notification

**58. .... is a special type of integrity constraint that relates two relations & maintains consistency across the relations.**

- A) Entity Integrity Constraints
- B) Referential Integrity Constraints
- C) Domain Integrity Constraints
- D) Domain Constraints
- E) Key Constraints

**59. .... specifies a search condition for a group or an aggregate.**

- A) GROUP BY Clause
- B) HAVING Clause
- C) FROM Clause
- D) WHERE Clause

**60. Drop Table cannot be used to drop a table referenced by a .....**

**constraint.**

- A) Local Key
- B) Primary Key
- C) Composite Key
- D) Foreign Key

**61. .... joins are SQL server default**

- A) Outer
- B) Inner
- C) Equi
- D) None of the above

**62. The ..... is essentially used to search for patterns in target string.**

- A) Like Predicate
- B) Null Predicate
- C) In Predicate
- D) Out Predicate

**63. Which of the following is/are the Database server functions?**

- i) Data management      ii) Transaction management
- iii) Compile queries      iv) Query optimization

- A) i, ii, and iv only
- B) i, ii and iii only
- C) ii, iii and iv only
- D) All i, ii, iii, and iv

**64. To delete a database ..... command is used**

- A) delete database database\_name
- B) Delete database\_name
- C) drop database database\_name
- D) drop database\_name

**65. .... is a combination of two of more attributes used as a primary key**

- A) Composite Key
- B) Alternate Key
- C) Candidate Key
- D) Foreign Key

**66. Which of the following is not the function of client?**

- A) Compile queries
- B) Query optimization
- C) Receive queries

D) Result formatting and presentation

**67. .... is a special type of stored procedure that is automatically invoked whenever the data in the table is modified.**

- A) Procedure
- B) Trigger
- C) Curser
- D) None of the above

**68. .... requires that data should be made available to only authorized users.**

- A) Data integrity
- B) Privacy
- C) Security
- D) None of the above

**69. Some of the utilities of DBMS are .....**

- i) Loading      ii) Backup      iii) File organization      iv) Process Organization
- A) i, ii, and iv only
- B) i, ii and iii only
- C) ii, iii and iv only
- D) All i, ii, iii, and iv

**70. .... allows individual row operation to be performed on a given result set or on the generated by a selected by a selected statement.**

- A) Procedure
- B) Trigger
- C) Curser
- D) None of above

71. Processed data is called .....

- A) Raw data
- B) Information
- C) Useful data
- D) Source

72. .... is a utility to capture a continuous record of server activity and provide auditing capability.

- A) SQL server Profile
- B) SQL server service manager
- C) SQL server setup

D) SQL server wizard.

**73. Data items grouped together for storage purposes are called a**

- A) record
- B) title
- C) list
- D) string

**74. .... contains data assisting day to day activities of the organization.**

- A) Control database
- B) Operational database
- C) Strategic database
- D) Sequential database

**75. .... approach reduces time and effort required for design and lesser risk in database management.**

- A) Single global database
- B) Top-down approach
- C) Multiple database
- D) None of the above

**76. HSAM stands for .....**

- A) Hierarchic Sequential Access Method
- B) Hierarchic Standard Access Method
- C) Hierarchic Sequential and Method
- D) Hierarchic Standard and Method

**77. SQL server stores index information in the ..... system table**

- A) syst indexes
- B) system indexes
- C) sysind
- D) sys indexes

**78. The one guideline to be followed while designing the database is**

- A) A database design may be ambiguous.
- B) Unrelated data should be in the same table so that updating the data will be easy.
- C) It should avoid/reduce the redundancy.
- D) An entity should not have attributes.

**79. Which of the following is not a logical database structure?**

- A) Chain
- B) Network

- C) Tree
- D) Relational

**80. .... is a preferred method for enforcing data integrity**

- A) Constraints
- B) Stored procedure
- C) Triggers
- D) Cursors

**81. Reflexivity property says that  $X - Y$  is true if  $Y$  is .....**

- A) Subset of  $X$
- B) Null set of  $X$
- C) Super set of  $Y$
- D) Subset of  $Y$

**82. Anything that affects the database schema is a part of**

- A) DML
- B) DCL
- C) DDL
- D) All of the above

**83. An instance of a relation is a time varying set of .....**

- A) Tuples
- B) Rows
- C) Both of them
- D) None of them

**84. In the ..... mode any record in the file can be accessed at random**

- A) Sequential access
- B) Random access
- C) Standard access
- D) Source access

**85. Which can be used to delete all the rows if a table?**

- A) Delete \* from table\_name
- B) Delete from table\_name
- C) Delete table\_name
- D) all rows cannot be deleted at a time.

**86. Which if the following is not the type of data integrity.**

- A) Key integrity
- B) Domain integrity
- C) Entity integrity

- D) Referential integrity

**87. 4NF stands for ..**

- A) Fourth Normal File
- B) Fourth Normal Form
- C) Fourth Normal Fraction
- D) Fourth Negative File

**88. A ..... allows to make copies of the database periodically to help in the cases of crashes & disasters.**

- A) Recovery utility
- B) Backup Utility
- C) Monitoring utility
- D) Data loading utility

**89. .... Allows definitions and query language statements to be entered; query results are formatted and displayed.**

- A) Schema Processor
- B) Query Processor
- C) Terminal Interface
- D) None of the above

**90. The main task carried out in the ..... is to remove repeating attributes to separate tables.**

- A) First Normal Form
- B) Second Normal Form
- C) Third Normal Form
- D) Fourth Normal Form

**91) Which of the following is not a characteristic of a relational database model?**

- A. Table
- B. Tree like structure
- C. Complex logical relationship
- D. Records

**92) Field is otherwise called as ..... of the record**

- A. data item
- B. data type
- C. value
- D. variable

**93) A table can have only one**

- A. Secondary key
- B. Alternate key
- C. Unique key
- D. Primary key

**94) A field can be called as ..... in relation context.**

- A. random file
- B. direct file
- C. attribute
- D. tuple

**95) In the relational modes, cardinality is termed as**

- A. Number of tuples
- B. Number of attributes
- C. Number of tables
- D. Number of constraints

**96) The ..... is used for creating and destroying table, indexes and other forms of structures.**

- A. data manipulation language
- B. data control language
- C. transaction control language
- D. data definition language

**97) The view of total database content is**

- A. Conceptual view
- B. Internal view
- C. External view
- D. Physical view

**98) The ..... refers to the way data is organized in and accessible from DBMS.**

- A. database hierarchy
- B. data organization
- C. data sharing

- D. data model

**99) Architecture of the database can be viewed as**

- A. two levels
- B. four levels
- C. three levels
- D. one level

**100) ..... introduced the relational database rules.**

- A. Atul kahate
- B. James Gossling
- C. EF Codd
- D. Dennies Rithchie

**101) In a relational model, relations are termed as**

- A. Tuples
- B. Attributes
- C. Tables
- D. Rows

**102) When the values in one or more attributes being used as a foreign key must exist in another set of one or more attributes in another table, we have created a(n) .....**

- A. transitive dependency
- B. insertion anomaly
- C. referential integrity constraint
- D. normal form

**103) In the architecture of a database system external level is the**

- A. physical level
- B. logical level
- C. conceptual level
- D. view level

**104) A functional dependency is a relationship between or among .....**

- A. tables
- B. rows
- C. relations
- D. attributes

**105) Related fields in a database are grouped to form a**

- A. data file
- B. data record
- C. menu
- D. bank

**106) ..... is, a table have more than one set of attributes that could be chosen as the key**

- A. foreign key
- B. integrity key
- C. relationship
- D. candidate key

**107) The database environment has all of the following components except.**

- A. users
- B. separate files
- C. database
- D. database administrator

**108) The operation of eliminating columns in a table done by ..... operation.**

- A. Restrict
- B. Project
- C. Union
- D. Divide

**109) The way a particular application views the data from the database that the application uses is a**

- A. module
- B. relational model
- C. schema

- D. sub schema

**110) ..... is a condition specified on a database schema and restricts the data that can be stored in an instance of the database.**

- A. Key Constraint
- B. Check Constraint
- C. Foreign key constraint
- D. integrity constraint

## SQL MCQS

**111. DML is provided for**

- A) Description of logical structure of database
- B) Addition of new structure in the database system.
- C) Manipulation & processing of database
- D) Definition of physical structure of database system

**112. 'AS' clause is used in SQL for**

- A) Selection operation
- B) Rename Operation
- C) Join operation
- D) Projection Operation

**113. Count function in SQL returns the number of**

- A) values
- B) distinct values
- C) groups
- D) columns

**114. The statement in SQL which allows to change the definition of a table is**

- A) Alter
- B) Update
- C) Create
- D) Select

**115. Which of the following is correct.**

- A) A SQL query automatically eliminates duplicates
- B) SQL permits attribute names to be repeated in the same relation
- C) A SQL query will not work if there are no indexes on the relations
- D) None of the above

**116. Which of the following operation is used if we are interested in only certain columns of a table?**

- A) PROJECTION
- B) SELECTION
- C) UNION
- D) JOIN

**117. Which of the following is a legal expression in SQL?**

- A) SELECT NULL FROM EMPLOYEE;
- B) SELECT NAME FROM EMPLOYEE;
- C) SELECT NAME FROM EMPLOYEE WHERE SALARY=NULL;
- D) None of the above

**118. Which of the following is a valid SQL type?**

- A) CHARACTER
- B) NUMERIC
- C) FLOAT
- D) All of the above

**119. Which command is used to select distinct subject (SUB) from the table (BOOK)?**

- A) SELECT ALL FROM BOOK
- B) SELECT DISTINCT SUB FROM BOOK
- C) SELECT SUB FROM BOOK
- D) All of the above

**120. In SQL, which of the following is not a data definition language commands?**

- A) RENAME
- B) REVOKE
- C) GRANT
- D) UPDATE

**121. Which of the following query is correct for using comparison operators in SQL?**

- A) SELECT sname, coursename FROM studentinfo WHERE age>50 and <80;
- B) SELECT sname, coursename FROM studentinfo WHERE age>50 and age <80;
- C) SELECT sname, coursename FROM studentinfo WHERE age>50 and WHERE age<80;
- D) None of the above

**122. How to select all data from studentinfo table starting the name from letter 'r'?**

- A) SELECT \* FROM studentinfo WHERE sname LIKE 'r%';

B) SELECT \* FROM studentinfo WHERE sname LIKE '%r%';

C) SELECT \* FROM studentinfo WHERE sname LIKE '%r';

D) SELECT \* FROM studentinfo WHERE sname LIKE '\_r%';

**123. Which of the following SQL query is correct for selecting the name of staffs from 'tblstaff' table where salary is 15,000 or 25,000?**

- A) SELECT sname from tblstaff WHERE salary IN (15000, 25000);
- B) SELECT sname from tblstaff WHERE salary BETWEEN 15000 AND 25000;
- C) Both A and B
- D) None of the above

**124. The SELECT statement, that retrieves all the columns from empinfo table name starting with d to p is .....**

- A) SELECT ALL FROM empinfo WHERE ename like '[d-p]%';
- B) SELECT \* FROM empinfo WHERE ename is '[d-p]%';
- C) SELECT \* FROM empinfo WHERE ename like '[p-d]%';
- D) SELECT \* FROM empinfo WHERE ename like '[d-p]%';

**125. Select a query that retrieves all of the unique countries from the student table?**

- A) SELECT DISTINCT coursename FROM studentinfo;
- B) SELECT UNIQUE coursename FROM studentinfo;
- C) SELECT DISTINCT coursename FROM TABLE studentinfo;
- D) SELECT INDIVIDUAL coursename FROM studentinfo;

**126. Which query is used for sorting data that retrieves the all the fields from empinfo table and listed them in the ascending order?**

- A) SELECT \* FROM empinfo ORDER BY age;
- B) SELECT \* FROM empinfo ORDER age;
- C) SELECT \* FROM empinfo ORDER BY COLUMN age;
- D) SELECT \* FROM empinfo SORT BY age;

**127. Select the right statement to insert values to the stdinfo table.**

- A) INSERT VALUES ("15", "Hari Thapa", 45, 5000) INTO stdinfo;
- B) INSERT VALUES INTO stdinfo ("15", "Hari Thapa", 45, 5000);
- C) INSERT stdinfo VALUES ("15", "Hari Thapa", 45, 5000);
- D) INSERT INTO stdinfo VALUES ("15", "Hari Thapa", 45, 5000);

**128. How to Delete records from studentinfo table with name of student 'Hari Prasad'?**

- A) DELETE FROM TABLE studentinfo WHERE sname='Hari Prasad';
- B) DELETE FROM studentinfo WHERE sname='Hari Prasad';
- C) DELETE FROM studentinfo WHERE COLUMN sname='Hari Prasad';
- D) DELETE FROM studentinfo WHERE sname LIKE 'Hari Prasad';

**129. Constraint checking can be disabled in existing ..... and ..... constraints so that any data you modify or add to the table is not checked against the constraint.**

- A) CHECK, FOREIGN KEY
- B) DELETE, FOREIGN KEY
- C) CHECK, PRIMARY KEY
- D) PRIMARY KEY, FOREIGN KEY

**130. .... joins two or more tables based on a specified column value not equaling a specified column value in another table.**

- A) OUTER JOIN
- B) NATURAL JOIN
- C) NON-EQUIJOIN
- D) EQUIJOIN

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- |       |       |        |
|-------|-------|--------|
| 1. C  | 44. B | 87. B  |
| 2. B  | 45. D | 88. B  |
| 3. A  | 46. D | 89. C  |
| 4. C  | 47. D | 90. D  |
| 5. A  | 48. D | 91. B  |
| 6. C  | 49. B | 92. A  |
| 7. B  | 50. C | 93. D  |
| 8. C  | 51. C | 94. C  |
| 9. B  | 52. C | 95. A  |
| 10. C | 53. C | 96. D  |
| 11. C | 54. B | 97. A  |
| 12. B | 55. A | 98. D  |
| 13. C | 56. C | 99. C  |
| 14. B | 57. C | 100. C |
| 15. D | 58. B | 101. C |
| 16. A | 59. B | 102. C |
| 17. C | 60. D | 103. D |
| 18. C | 61. B | 104. D |
| 19. D | 62. A | 105. B |
| 20. A | 63. A | 106. D |
| 21. B | 64. C | 107. A |
| 22. A | 65. A | 108. B |
| 23. C | 66. B | 109. D |
| 24. C | 67. B | 110. B |
| 25. A | 68. C | 111. C |
| 26. A | 69. B | 112. B |
| 27. A | 70. C | 113. A |
| 28. D | 71. B | 114. A |
| 29. A | 72. B | 115. D |
| 30. B | 73. A | 116. A |
| 31. B | 74. B | 117. B |
| 32. C | 75. C | 118. D |
| 33. C | 76. A | 119. B |
| 34. D | 77. D | 120. D |
| 35. B | 78. C | 121.   |
| 36. B | 79. A |        |
| 37. C | 80. A |        |
| 38. A | 81. A |        |
| 39. B | 82. C |        |
| 40. A | 83. C |        |
| 41. C | 84. B |        |
| 42. B | 85. A |        |
| 43. D | 86. A |        |