<div align="center">**Computer Graphics**</div>

MODULE - I

Overview of Computer Graphics System: Video Display Devices – Raster Scan Systems – Random – ScanSystems - Graphics Monitors and Workstations – Input Devices – Hardcopy Devices – Graphics Software.

Overview of Computer Graphics System

Computer graphics is commonly seen as a computer science branch that deals with the computerized image fusion theory and technology. As simple as a triangle outline, a computer-generated image may represent a scene. The computer has become a powerful tool for producing images quickly and economically.

When a computer is used to create images, the same process is followed as creating images manually. The process's primary computational steps give a boost to several important computer graphics areas.

Also on computers, the term computer graphics covers almost everything. Here in the computer graphics program's classroom, we think of computer graphics as drawing images on machines, often known as **rendering**. The images can be photos, sketches, animations, or pictures of items imagined. Or they maybe pictures, we cannot see directly, like internal body parts.

We have put a great deal of our time to develop how computer images can replicate real-world scenes. We want objects on computers not only to look more real, but also their colors to be more realistic and how different materials appear. We can call it "real synthesis of the image."

The term computer graphics has been used to define "almost everything on the computer, including text orsound." Generally, the term computer graphics refer to the following things:

- Computer representation and manipulation of image data.
- Various technologies for creating and manipulating images.
- Computer graphics study is a sub-field of computer science that studies methods for digitallyincorporating and manipulating visual content.
- **Definition of Computer Graphics-**Computer graphics can be a series of images which is most often called a video or single image. Computer graphics is the technology that concerns with designs and pictureson computers. That's why, computer graphics are visual representations of data shown on a monitor made on a computer.
- "Computer graphics is the use of a computer to define, store, manipulate, interrogate, and represent the pictorial output." An image in computer graphics is made up of a number of pixels.
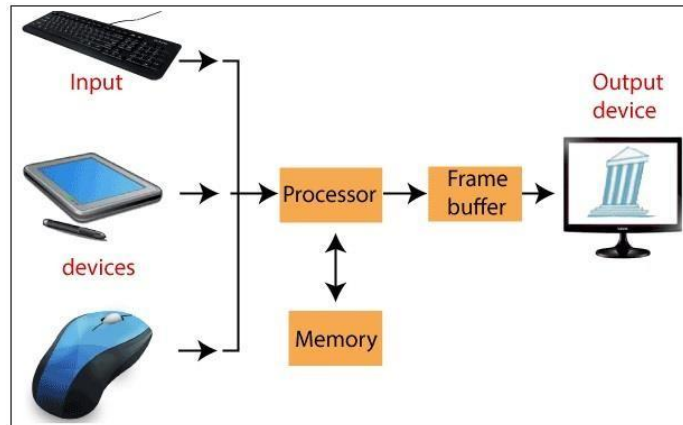
Types of Computer Graphics
- There are two kinds of computer graphics are–
- Interactive Computer Graphics
- Non-Interactive Computer Graphics

Interactive Computer Graphics

In interactive computer graphics, users have some controls over the image, i.e., the user can make any changes to the image produced.

Interactive Computer Graphics involves computer-user two-way communication.

For Example:

- Ping-pong game.
- Drawing on touch screens.
- Display weather forecast or other moving charts/graphs on the screen.
- Animating pictures or graphics in movies.
- Graphics animation in video games.

Working of Interactive Computer Graphics

The modern display of graphics is very simple to build. It is composed of three components:
- Display controller or video controller
- Digital memory or frame buffer
- Television monitor

1. Display controller or video controller- It's a Memory Buffer and TV Monitor interface. Its task is to pass Frame Buffer's contents to the monitor. The display controller reads each continuous byte of Memoryframe buffer data and converts 0's and 1's into appropriate video signals.

In today's term, the display controller is recognized as a display card, and one of our choices can be a VGA(Video Graphics Array) card with a resolution of 640×480. Display Controller is also capable of displaying the image in colors.

2. Digital memory or frame buffer-This is a place where images and pictures are stored as an array (matrix of 0 & 1, 0 represents darkness, and 1 represents image or picture). It is also called a frame buffer.

In today's term frame buffer is called V-RAM (video RAM), and it helps to store the image in bit form. It helps to increase the speed of graphics.

Representation of graphics

We can represent the graphics by following two ways:

1. Raster (Bitmap) Graphics
2. Vector Graphics

1. Raster Graphics: In raster graphics, the image is presented as a rectangular grid of colored squares.

Raster images are also called bitmap images. Bitmap images are stored as the collection of small individual dots called pixels.

Bitmap images require high resolution and anti-aliasing for a smooth appearance.

For example– Paint, Photoshop, etc.

2. Vector Graphics: In vector graphics, the image is represented in the form of continuous geometric objects: line, curve, etc.

Vector images are not based on pixel pattern. They use mathematical formulas to draw line and curves. The lines and curves can be combined to create an image.

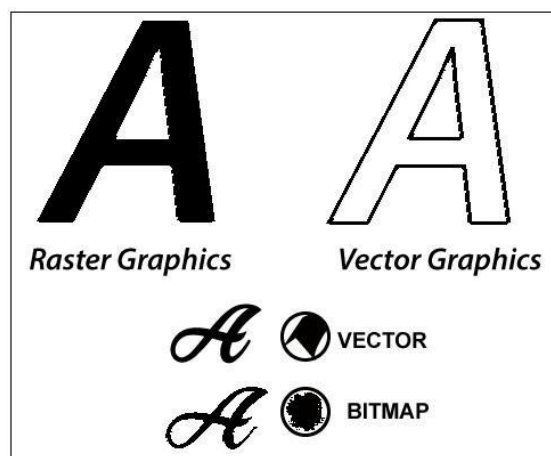**For Example**– PowerPoint, Corel Draw, etc.

Fig: Raster (Composition of Paths) Vector (Composition of Pixels)

Difference between Raster and Vector Graphics:

Raster Graphics	Vector Graphics
Raster images are the collection of the pixel.	The Vector images are composed ofpaths.
Scan conversion is required.	Scan Conversion is not required.
Raster Graphics are less costly.	Vector Graphics are more costly compared to raster graphics.
Raster image takes less space to store.	Vector image takes more space.
Raster graphics can draw mathematical curves, polygons, and boundaries.	Vector graphics can only drawcontinuous and smooth lines.
File Extension: .BMP, .TIF, .JPG etc.	**File Extension:** .SVG, .PDF, .AI etc.

Computer graphics is an art of drawing pictures on computer screens with the help of programming. It involves computations, creation, and manipulation of data. In other words, we can say that computer graphics is a rendering tool for the generation and manipulation of images.

Video Display

DevicesCathode

Ray Tube

CRT stands for Cathode ray tube. It is a technology which is used in traditional computer monitor andtelevision.

Cathode ray tube is a particular type of vacuum tube that displays images when an electron beam collideson the radiant surface.

The primary output device in a graphical system is the video monitor.

Component of CRT:

- **Electron Gun:** The electron gun is made up of several elements, mainly a heating filament (heater)and a cathode.

The electron gun is a source of electrons focused on a narrow beam facing the CRT.

- **Focusing & Accelerating Anodes:** These anodes are used to produce a narrow and sharply

focusedbeam of electrons.

- **Horizontal & Vertical Deflection Plates:** These plates are used to guide the path of the electron the beam. The plates produce an electromagnetic field that bends the electron beam through the areaas it travels.
- **Phosphorus-coated Screen:** The phosphorus coated screen is used to produce bright spots when thehigh-velocity electron beam hits it.

The operation of CRT is very simple −

- The electron gun emits a beam of electrons cathode rays.
- The electron beam passes through focusing and deflection systems that direct it towards specifiedpositions on the phosphor-coated screen.
- When the beam hits the screen, the phosphor emits a small spot of light at each position contactedby the electron beam.
- It redraws the picture by directing the electron beam back over the same screen points quickly.
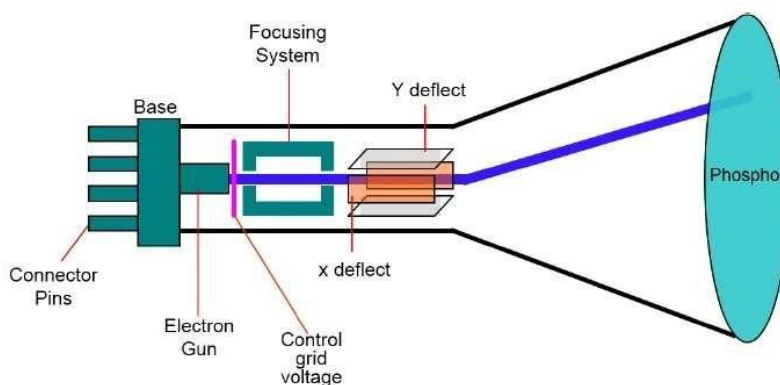
There are two ways Random scan and Raster scan by which we can display an object on the screen.

Raster Scan

In a raster scan system, the electron beam is swept across the screen, one row at a time from top to bottom. As the electron beam moves across each row, the beam intensity is turned on and off to create a pattern of illuminated spots.

Picture definition is stored in memory area called the **Refresh Buffer** or **Frame Buffer**. This memory area holds the set of intensity values for all the screen points. Stored intensity values are then retrieved from the refresh buffer and "painted" on the screen one row scan line at a time as shown in the following illustration.

Each screen point is referred to as a **pixel** picture element or **pel**. At the end of each scan line, the electron beam returns to the left side of the screen to begin displaying the next scan line.
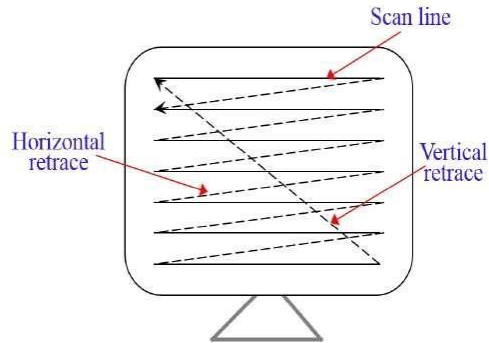
Random Scan /Vector Scan

In this technique, the electron beam is directed only to the part of the screen where the picture is to be drawnrather than scanning from left to right and top to bottom as in raster scan. It is also called **vector display, stroke-writing display,** or **calligraphic display**.

Picture definition is stored as a set of line-drawing commands in an area of memory referred to as the **refreshdisplay file**. To display a specified picture, the system cycles through the set of commands in the display file, drawing each component line in turn. After all the line-drawing commands are processed, the system cycles back to the first line command in the list.

Random-scan displays are designed to draw all the component lines of a picture 30 to 60 times each second.
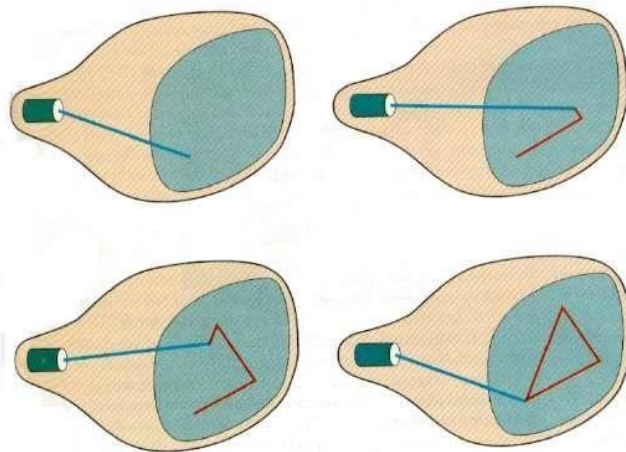
Application of Computer Graphics

Computer Graphics has numerous applications, some of which are listed below −

- **Computer graphics user interfaces** GUIs − A graphic, mouse-oriented paradigm which allows theuser to interact with a computer.
- **Business presentation graphics** − "A picture is worth a thousand words".

- **Cartography** − Drawing maps.
- **Weather Maps** − Real-time mapping, symbolic representations.
- **Satellite Imaging** − Geodesic images.
- **Photo Enhancement** − Sharpening blurred photos.
- **Medical imaging** − MRIs, CAT scans, etc. - Non-invasive internal examination.
- **Engineering drawings** − mechanical, electrical, civil, etc. - Replacing the blueprints of the past.
- **Typography** − The use of character images in publishing - replacing the hard type of the past.
- **Architecture** − Construction plans, exterior sketches - replacing the blueprints and hand drawingsof the past.
- **Art** − Computers provide a new medium for artists.
- **Training** − Flight simulators, computer aided instruction, etc.
- **Entertainment** − Movies and games.
- **Simulation and modeling** − Replacing physical modeling and enactments

2.Shadow–Mask Method: It is used with a **raster scan** monitor for displaying pictures. It has more rangeof color than the beam penetration method. It is used in television sets and monitors.

Structure:

1. It has three phosphorus color dots at each position of the pixel.

First Dot: **Red** color
Second Dot: **Green**
colorThird Dot:
Blue color

1. It has three different guns. Each for one color.
2. It has a metal screen or plate just before the phosphorus screen, named **"Shadow-Mask."**
3. It also has a shadow grid just behind the phosphorus coated screen with tiny holes in a triangularshape.

Working: A Shadow Mask is a metal plate with tiny holes present inside a color monitor.

A Shadow Mask directs the beam by consuming the electrons so that the beam hits only the desired point and displays a resulting picture.

It has three different guns. These guns direct their beams to shadow mask, which allows them to pass. It is a task of a shadow mask to direct the beam on its particular dot on the screen and produce a picture on the screen.

A Shadow Mask can display a wider range of pictures than beam penetration.

Shadow Mask CRT
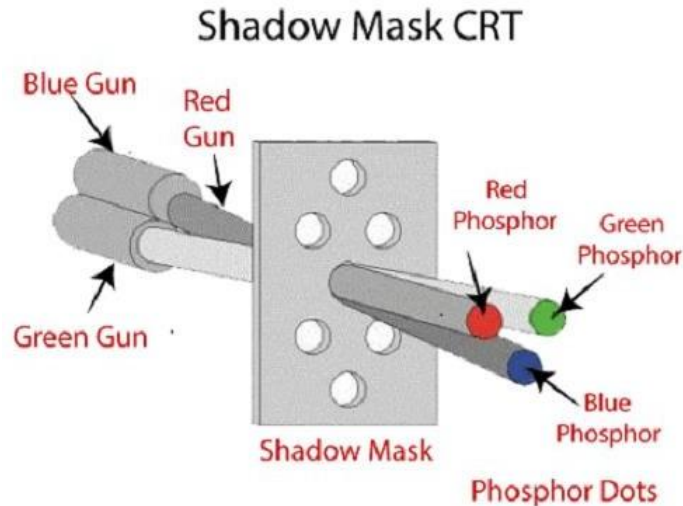
Advantages:

1. Display a wider range picture.
2. Display realistic images.
3. In-line arrangement of RGB color.

Liquid crystal display (LCD): The LCD depends upon the light modulating properties of liquid crystals. LCD is used in watches and portable computers. LCD requires an AC power supply instead of DC, so it is difficult to use it in circuits. It generally works on flat panel display technology. LCD consumes less power than LED. The LCD screen uses the liquid crystal to turn pixels on or off. Liquid Crystals are a mixture of solid and liquid. When the current flows inside it, its position changes into the desired color.

For Example: TFT(Thin Film Transistor)

Advantages:

1. Produce a bright image
2. Energy efficient
3. Completely flat screen

Disadvantages:

1. Fixed aspect ratio & Resolution
2. Lower Contrast
3. More Expensive

Light Emitting Diode (LED): LED is a device which emits when current passes through it. It is a semiconductor device. The size of the LED is small, so we can easily make any display unit by arranging a large number of LEDs. LED consumes more power compared to LCD. LED is used on TV, smartphones, motor vehicles, traffic light, etc. LEDs are powerful in structure, so they are

capable of withstanding mechanical pressure. LED also works at high temperatures.
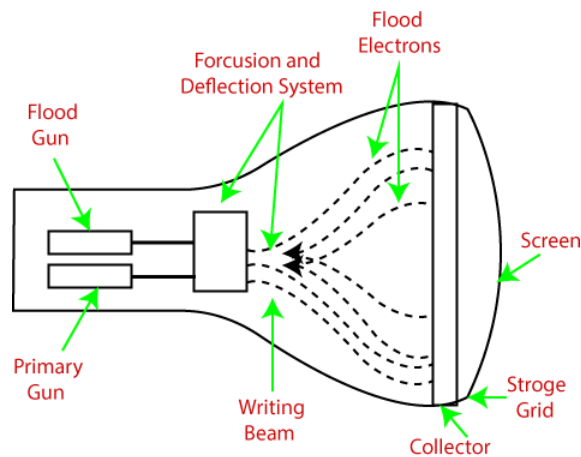
Advantages:

1. The Intensity of light can be controlled.
2. Low operational Voltage.
3. Capable of handling the high temperature.

Disadvantages:

More Power Consuming than LCD.

Direct View Storage Tube (DVST): It is used to store the picture information as a charge distributionbehind the phosphor-coated screen.There are two guns used in DVST:

1.Primary Gun: It is used to store the picture information.
2.Flood / Secondary Gun: It is used to display a picture on the screen.

Advantages:

1. Less Time Consuming
2. No Refreshing Required
3. High-Resolution
4. Less Cost

Disadvantages:

1. The specific part of the image cannot be erased.
2. They do not display color.

Plasma Display: It is a type of flat panel display which uses tiny plasma cells. It is also known as **the Gas-Discharge display**.

Input Devices

Following are some 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 to input data to the computer.

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

The keys on the keyboard are as follows −

Sl. No.	Keys & Description
1	**Typing Keys** These keys include the letter keys (A-Z) and digit keys (09) which generally give thesame layout as that of typewriters.

2	**Numeric Keypad** It is used to enter the 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 a 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 the 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 the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the 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 the keyboard.

Joystick

Joystick is also a pointing device, which is used to move the 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 the 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 similar to a pen. It is used to select a displayed menu item or draw pictureson 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 the pen button is pressed, its photocellsensing 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 isa ball which is half inserted and by moving fingers on the ball, the pointer can be moved.

Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes invarious shapes like a ball, a button, or a square.

Scanner

Scanner is an input device, which works more like a photocopy machine. It is used when some

informationis available on paper and it is to be transferred to the hard disk of the computer for further manipulation.

Scanner captures images from the source which are then converted into a digital form that can be stored onthe disk. 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 as it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for fine works of drawing and image manipulation applications.

Bar Code Readers

Bar Code Reader is a device used for reading bar coded data (data in the form of light and dark lines). Bar coded data is generally used in labelling goods, numbering the books, etc. It may be a handheld scanner ormay 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 that the bar code reader is connected to.

Graphics Workstations:

Generic term for a high-performance desktop computer that is used in the context of CAD drawings, 3D modelling or video editing. Usually includes one or more 64-bit processors, ultra-fast drives connected in RAID, one or more tabs graphs of high performance such as NVIDIA Quadro. Workstation, a high-performance computer system that is basically designed for a single user and has advanced graphics capabilities, large storage capacity, and a powerful central processing unit. A workstation is more capable than a personal computer (PC) but is less advanced than a server (which can manage a large network of peripheral PCs or workstations and handle immense data-processing and reporting tasks). The term workstation was also sometimes ascribed to dumb terminals (i.e., those without any processing capacity) that were connected to mainframe computers.

Their raw processing power allows high-end workstations to accommodate high-resolution or three-dimensional graphic interfaces, sophisticated multitask software, and advanced abilities to communicate with other computers. Workstations are used primarily to perform computationally intensive scientific and engineering tasks. They have also found favour in some complex financial and business applications. In addition, high-end workstations often serve a network of attached "client" PCs, which use resident tools and applications to access and manipulate data stored on the workstation.

GRAPHICS SOFTWARE:

Computer software applications that are used to display, create, and edit computer graphics. While many types of software will "support graphics", these programs are usually limited in what they can do with graphics; for example, word processors can be used to create simple line art or to display images alongside text, while some spreadsheet and database programs will allow data to be displayed in the form of graphs and charts but neither type of software will give you the ability to edit graphics in detail.

Graphics software, however, is capable of editing graphics in a multitude of ways and includes a number of types of software, including paint programs, illustration and design programs, photo/image editors, presentation graphics software, animation software, computer aided design software, and some desktop publishing software. Graphics software can edit bitmap and/or vector graphics, and can be used to design label templates. **Examples of graphics software include**

- Adobe Illustrator,
- Photoshop,
- In Design,
- CorelDraw,
- Inkscape,

- Microsoft Paint
- Paint.Net.

Hard Copy Devices / Printers:

A printer is a peripheral device which is used to represent the graphics or text on paper. The quality ismeasured by its resolution. The resolution of any printer is measured in dot per inch (dpi).

The printer usually works with the computer and connected via a cable. In present, many digital devicesupport printer features so that we can use Bluetooth, Wi-fi, and cloud technology to print.

Types of Printers

Some types of printers are:

- Impact Printers
- Non-impact Printers
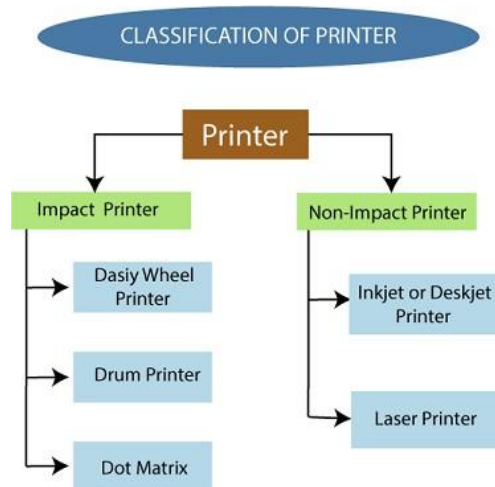
Impact Printers

In impact printers, there is a physical contact established between the print head, ribbon, ink-cartridge, andpaper. The printers hit print head on an ink-filled ribbon than the letter prints on the paper. Impact printers areworks like a typewriter. 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

Dot Matrix Printer

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

character which is whyit is called Dot Matrix Printer.

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

Disadvantages

- Slow Speed
- Poor Quality

Non-impact Printers

Non-impact printers print the characters without using the ribbon. These printers print a complete page at atime, thus 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
- Supports 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 charactersto be printed on a page.

Advantages

- Very high speed
- Very high quality output
- Good graphics quality
- Supports 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 charactersby 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 the cost per page is high
- Slow as compared to laser printer