CRT Monitor (cathod ray tube) :—

The CRT is a vaccume tube that contain 1 or more electron guns. In these CRT there is a phosphorescent screen. And it's use to display images it modulats, accelerates and deflects electron beam on to the screen to create the image, the image may be represent electrical wave form, pictures, radar tugates or other phonomena.

In television sets and computer monitors the entire front are is scanned multiple times, and symmetrically in a fixed pattern called a rester. And image is produce by controlling the intensity of each of the 3-electron beams, 1 for each aditive primary colour red, green and blue and with a vedio signal. In all moridan CRT monitors and computes; And beams are bent by magnetic deflection. In a variant megnetic field generated by coils.

• CRT Resolution : —— Dot pitch defines the maximum resolution of the display assuming delta gun CRTs.

1) What is Graphics?

→ Computer graphics is a branch of computer science that deal with images, figures, drawing and their analysis; Computer graphics mean drawing picture artificially by setting the pixels with different colour. For doing these, we need a lot of mathematical things.

2) How computer graphics is different from image processing?

→ It differs from image processing in the sense, image processing starts after the image is in the image space whereas. Computer graphis starts with the drawing of the object. Image processing generally means the pixel based operation on an already existing image and generate a new image.

3) How Computer graphics is differ from animation?

→ It differ from animation because animation starts with the motion of an image. The animation is very closely related with Computer graphs. There are still few differentces. Computer animation means generating graphical object in such a way that there is a motion in the picture sequence of picture generated by Computer

graphics can generate a motion.

4) Discuss about different graphics hardware?

→ Softcopy display :—

• CRT (cathod ray tube) :— It display high quality images. It uses cathod ray to form generating picture monitors.

• HD TV :— High defination television uses very high technology and supports 60 Hz interlaced and non-interlaced high resolution display.

• plazma display :— It uses plazma gas discharge technique for display. In high voltage it dissociates gas on plazma is then ready used for display.

• LCD :— Liquid cristal display used liquid cristals for it's display. The polarising characteristics of certain organic compound are to modify the characteristics of incedent light in these way it displays a very high resolution picture.

Hardcopy output devices :—

- Electronic plotters :— polter is use to print the output on a large page on sheet. It is specially used in engeneering design.

- printers :— It is the most popular hardcopy devices it's of two type one impact printer another is non impact printer.

Input devices :—

- Mouse :— It is specially use in ~~in~~ windows environment it's also use to drowing

- Joystick :— It is mainly use in game playing.

- lightpen :— It is use for graphics design.

■ Graphics Software :— Graphics uses two types of software.

One is general purpose software written in high level programing language with graphics library function and example of graphics is open GL. These type of packages include basic function like straight line drawing, Curve drawing etc. Exp — JAVA / C / C++.

Other is special purpose graphics software. Here user can generate graphics output easily. Here several readymate option available. 'AutoCAD' is an example dedicated graphics software these use for engineering design.

b) Application of computer graphics ?

(i) Computer Arts :- It is widely prints arts and mondern commercial arts. Artists use several hardware and software packages to draw their picture then give the effects to their picture.

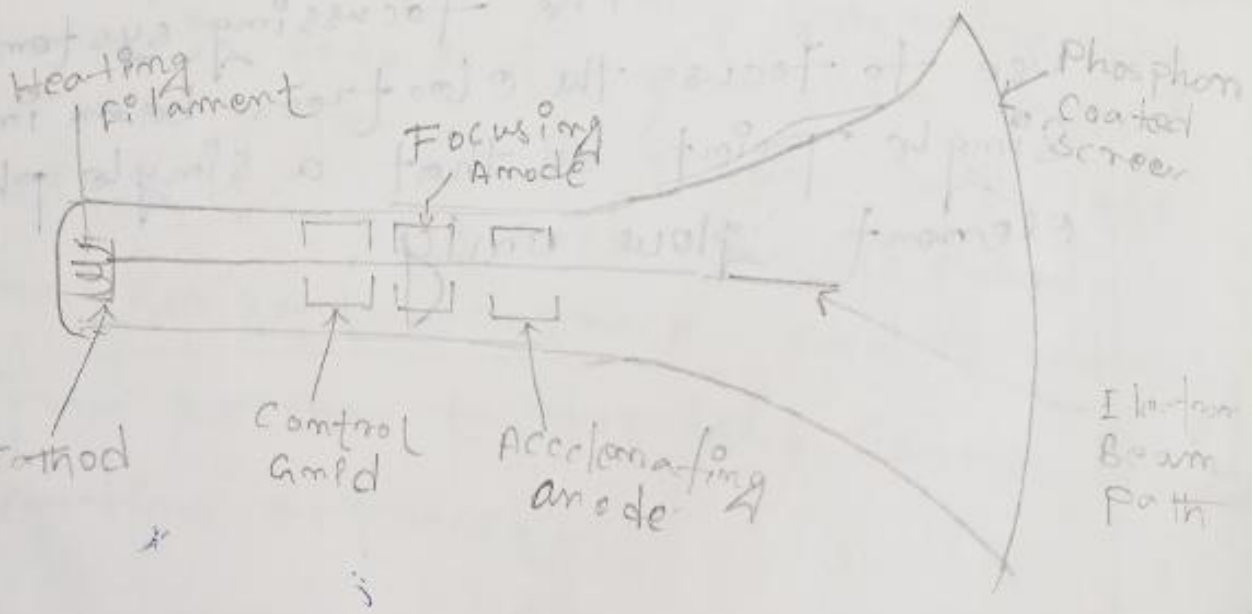
(ii) Entertainment :- Computers are use to generating movies, Cartoons etc, and now a days television shows, music vedios are also use in Computer graphics.

(iii) Computer aided education :- It generates models for different branches and train are use for education and trainning purpose.
Exp:- Biological structure, Plotting of graph etc.

(iv) GUI :- Computer graphics is use in computer for graphical user design. Multiple window buttons, Scroll bars, Combo box and tool bar are the example of Computer graphics.

Refreash cathod Ray Tubes:-

The first monitor was made of refreash Cathod ray tube in these type of terminal an eletron beam on cathod ray is focussed on phosphor coated screen. Phosphor glows and emits a small spot of light when a large number of phosphor glows with different colors we see a picture on the screen. The phosphor fate very quickly so one way to keep them glow for a long time is to redraw the picture repeatedly and very quickly by focussing the electron beam back over the same phosphor point. For these reason these type of CRT is called refreash CRT



when heat is generated by the filament the cathod emits free negatively charge electron towards the phosphor plate. The tube is vacuum so, electrons move freely the focussing anode focuses the electron beam and accelerating anode accelerate the electrol particle toward screen or phosphor plate by generating high positive voltages.

The intensity of the electron beam is controlled by the control grid which is a metal cylinder a negative voltage is applied to it's Control grid. The negative voltage of the control grid will drease the no. of electron on the electron beam.

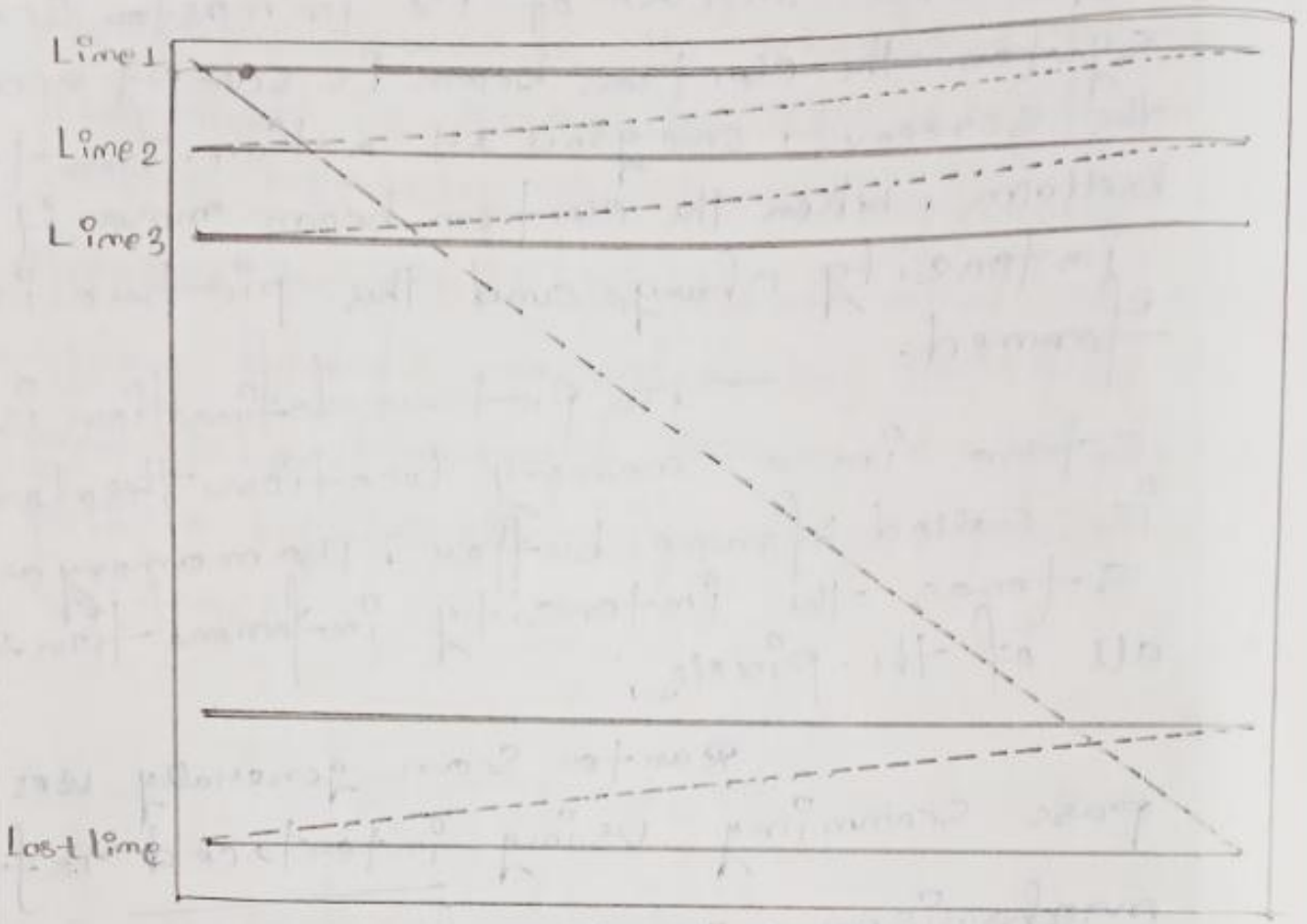
The focussing system is use to focuss the electron beam into a single point so that a single phosphor element glow only.

■ Raster Scan CRT:- These is the most common type CRT in case of TV in raster Scan system the electron beam is swept across the screen, one row at a time from top to buttom. when the electron beam move it's intensity change and this picture is formed.

The picture definition is store in a memory location. these location is called frame buffer. The memory area stores the intensity information for all of the pixels.

Raster Scan generally uses to pass scanning using interlaced refresh mechanism. In the first pass the beam sweeps every second line from the top to bottom to produce the half of the total Picture. Then it draws the next line in the second pass. These improves the image quality normally the refreshing rate is 60 to 80 frame/sec in a raster Scan system. The return to the left after Scanning each line is called horizontal retrace and returning from bottom to top left Connor is called vertical retrace.

~~what do you mean~~



Raster Scan CRT

■ Briefly discuss about colour CRT monitor ?

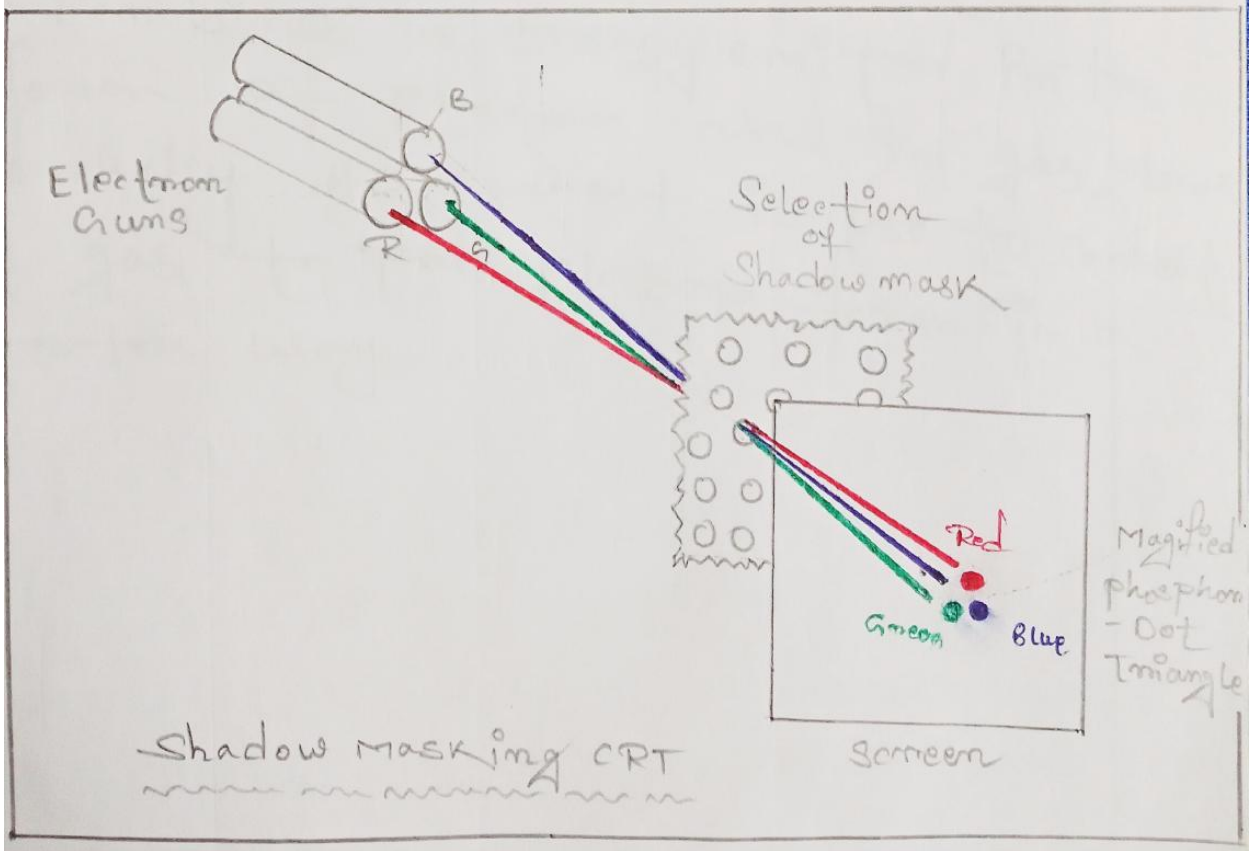
→ There are two method for colour CRT —

• Beam penitration method :— In these method, two layers of phosphors are coated inside the CRT screen. One layer is an red phosphor and other is for green phosphors. When the electron beam falls on the phosphor, the colour of the pixel depends on the penitration power of the electron beam. If the power of the electron beam is low then the beam can penitrate only the red layer and if the beam power is high the beam can reach to inner most green layer and excites the green phosphor. If the electron beam power is medium is shows the combination of red and green phosphor colour, generally orange and yellow. The electron beam power is control by controling the voltage of electricity.

• shadow mask method! — These method has 3 phosphor colour dots at each pixel position. The 3 phosphor emits 3 ~~diff~~ 3 different lights red, green and blue. This type of CRT has 3 electron guns one for red, one for green and one for blue dots. one grid with number of tine holds is placed just behind the phosphor coating. These grid plate is called shadow mask. when 3 electron guns emits electron beams the beam is pass through a hole of shadow mask grid. The phosphor dots are arranged in such a way that the corresponding beams activated it's own dots. The dots are placed in triangular shaped is called ~~delta~~ information.

Following is the list of complate 8 colours.

Red	Green	Blue	produced colour
off	off	off	Black
on	on	on	white
off	on	on	cyan
off on	off	on	Magenta
on	on	off	Yellow
on	off	off	Red
off	on	off	Green
off	off	on	blue



Shadow masking CRT

Total no. of colours that can be produce after combining 3 dot of different intensity is 256 for red dots x 256 for green dot x 256 for blue dot i.e.

$256 \times 256 \times 256 = 2^8 \times 2^8 \times 2^8 = 2^{24}$

So, approxmatly 17 milion colours can be produced.

■ Plazma monitor:- It also called plazma panel or gas discharge display. It is made of two glass plate to make a glass envalop. In these glass envalop there is matrix of cells each cell is filled with gas, the gas is generally inared gas. In general neon or neon argan mixture is placed, the gas is placed at low passer in the cell. when high voltage is applied to the gas the electrons are stripped from the atom. These form of gas is called plazma. when electron recombines the energy emited in the form of photon and the gas glows generally AC current is use to convert the gas to plazma form in a faster way.

LCD Monitor :— The LCD monitor are different from all the monitor types it does not emits light instead of passes the polarized light from the light stores through the LCD. This type of monitor uses a special type of liquied which molicules acts as cristals. It generally uses nematic liquid cristal compound. These liquid is placed between two glass plates. These glass plates have light polarizes at right angle to the other plate one glass plate is made of a series of horizontal transpharent conductors. The intersection of two conduction define a pixel position when power is applied the cristal are applied in such a way that light is not twisted, so it will reflected back to the viewers when no power is applied the cristals are aline in such a way that the light is reflected back to the viewer.

printing Devices:—

(Impact printer)

- Dot matrix printer :- It is one of the oldes hardcopy design. In these of printer one printing head runs back forth from left side to the paper to right side. And inked ribbon is placed between the paper and the writing head. The head is populated with a number pins normally the no. of pin is 64. They form an 8x8 square matrix when a character need to the printed say for example A, some pins come forward and forms the pattern A, the head then hammers on the ribbon and the impression of A is printed on the paper. The head then moves to the right side and prints the next character in the same machanism. As the pins strike the paper to print the impression, these printers are often called impact printer. The printing quality is very poor but it cheaper.

• Ink jet printer: (Non Impact printer)

It is used to print high quality graphics. Here head is made with several tiny nozzles, behind the nozzles, there are tiny chamber of ink. These elements of ink are connected with ink reservoir. When a character is to be printed say for example some nozzles are selected; these nozzles form a pattern of A. Behind the nozzles there is a ink chamber. Heat is applied using the power of electricity stream explosion and the ink comes rapidly through the nozzles and falls on the paper. The vaccume chamber is now filled up by another drop of ink coming from the reserver. These type of printer can produce finer and smoother details but it has dis advantages too. It's printing cost is very high and it is not an impact printer, it can not produce carbon copy output. Also very thin nozzles a prone to clogging with dry ink.

• ~~Laser~~ Laser printer :- (Non impact printer)

It has 7 step working principal.

• Raster image processing :- Each horizontal strip across the page is called raster line, it uses the page discription language to generate bit map of the page in the raster ~~memory~~ on memory.

• Charging :- A wire, named as Corona wire projects an electro-static charge on a revolving photo sensitive dram. These dram is capable of storing electro static charge on it's surface is called photo resector.

• Exposing :- A beam of laser is focus on the photo resector through the ~~photo~~ mirror on lenses. The stream of rasterized data stored in the memory, turns the laser on & off to form the image pattern.

• Developing :— The surface of dram with image defination with charge and nutral is then expose to tonner. Tonner is basically fine partical of dry plastic power mixed with the ~~to~~ blacks carbon, these tonner -ve ly charge & that it will not ~~charge~~ ~~the~~ touch the +ve partical of the dram.

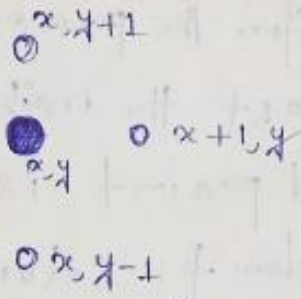
• Transfer :→ photo receptor is pressed on rolled over paper to transfer the image on the paper.

• Fusing :→ The paper then passes to roleers where heat and prassure bond the ~~bla~~ plastic powder to the paper parmanently.

• Cleaning :→ when the print is complete and electricaly nutral soft blade clears the access tonner from the photo receptor dram and the discharge lamp removes the remaining charge from the dram.

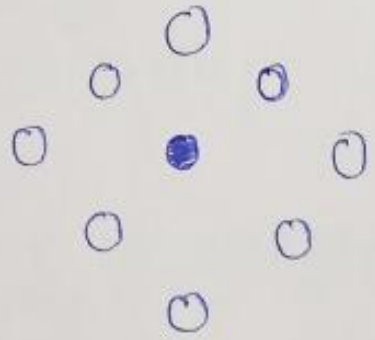
■ what do you mean by four connected and eight connected approach in filling algorithm

→ There are two ways in which pixels are conceder to be connected, to one another, four connected and eight connected. In four connected method pixel may have upto four neighbors



These are up, down, left, right ; if the current pixel is (x,y) the neighbors are (x, y+1), (x, y-1), (x-1, y), (x+1, y)

In eight connected approach the pixel may have up to eight neighbors.



These are up, down, left, right and forth Common points i.e. $(x, y-1)$, $(x, y+1)$, $(x+1, y)$, $(x-1, y)$, $(x-1, y-1)$, $(x-1, y+1)$, $(x+1, y+1)$, $(x+1, y-1)$.

Boundary fill algorithm :-

In case of boundary fill recursive algorithm takes an initial interior point (x, y), for the procedure to start. The procedure test the neibourhood point If neighbourhood point is a boundary pixel then we don't colour that pixel ② otherwise, the pixel are colour fill will fill colour and any of the neighbour pixel is then choosen to continue the same process again and again. The procedure stops when all pixel up to boundary are tested.

```
Boundaryfill(int x, int y, int fillcolour, int
                                    boundarycolour)
{
  int colour = getpixel(x,y)
  if(Currentcolour != boundarycolour &&
                    Currentcolour != fillcolour)
  then
    putpixel(x, y, fillcolour)
    Boundaryfill(x+1, y, fillcolour, Boundarycolour)
    Boundaryfill(x-1, y, fillcolour, boundarycolour)
    Boundaryfill(x, y+1, fillcolour, boundarycolour)
    Boundaryfill(x, y-1) fillcolour, boundarycolour)
  end if
}
```

Disadvantag of boundary fill algorithm:-

(1) These algorithm may not fill the region correctly, if some inimial pixels had already be painted in the fill colour. If any point is encounter with the fill colour that recursive bound stops there and a part of the region may not be filled. To avoid these, one may change the colour of any inimial point, if it is set to fill colour before appling these process.

(2) Another drawback of these algorithm it's extensive recursive function calls and therefore stacking of neighboging points.

Flood fill algorithm :-

when the boundary of a region is painted with several colour we can not apply boundary fill algorithm, In these we apply flood fill algorithm. Here we take ~~stati~~ starting interial point then we check whether it has the old interial colour or not; If the answer is yes then we replace the old colour as fill colour and ~~cos~~ consider all it's neighbour ~~hood~~ points ~~fom~~ the same procedure.

```
flood fill (int x, int y, int oldcolour, int
                                    fill colour)
    {
    if( getpixel(x,y) = oldcolour) then
      Putpixel (x, y, fillcolour)
    flood fill (x+1, y, oldcolour, fill colour)
    flood fill (x-1, y, oldcolour, fill colour)
    flood fill (x, y+1, oldcolour, fill colour)
    flood fill (x, y-1, oldcolour, fill colour)
    end if
    }
```

- Disadvantages :

(1) There is no stopping criteria for these algorithm for these reason Colour may get flooded out side boundary.

(2) Extensive recursive call.

■ what do you mean by aliasing effect ?

→ we know that the lines, Geometric shape, colour boundary are Continuous. where as a raster device is a discrete one, for these reason the picture is distorted These distortion is due to the under sampling there as various types of distortion these distortion are Connectively called aliasing.

- unequal brightness

- A slanted line appears to be less bright than a horizontal or vertical line.

There is because the slanted pixels are far apart that the horizontal and vertical pixel.

mapping of preodic figures :— In these case we may also have understanding.
In case of preodic information we need the sampling frequency at least twise the highest frequency of the object, these is called Nyquist frequency.

2D Transformation

The fundamental of all computer graphics is the manupulation of objects. These manupulation of several types, orientation, size, shape, main. These can be done by changing the co-ordinate description of the object. These alteration of the coordinate description is known as geomatric transformation.

- Translation:— A translation is moving the object along a straight line from one location to another without changing the shape or direction. The distance between the old position of the object and the new position of the object is called translation distance.

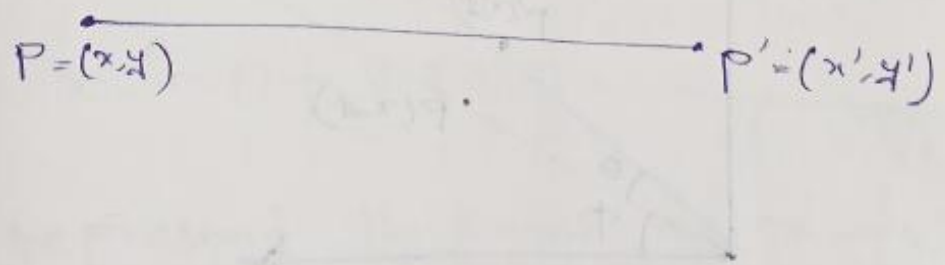
Let (x, y) is the original co-ordinate of a point the object; Let the transilation along the x axis is t_x and translation along y

axis is t_y. The new co-ordinate of that point (x', y') is —

$$x' = x + t_x \quad \text{——— (i)}$$

$$y' = y + t_y \quad \text{——— (ii)}$$

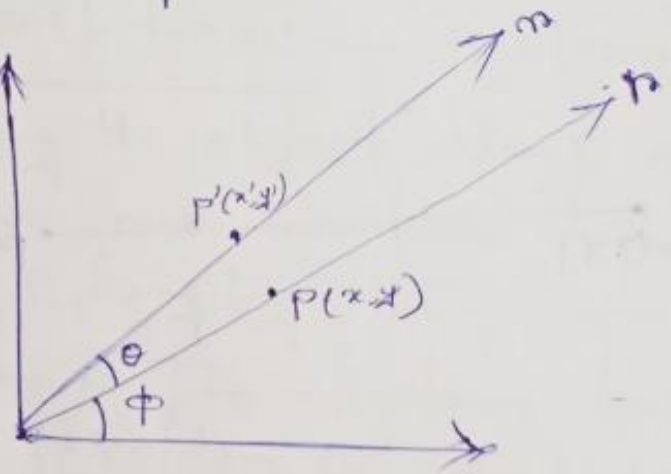
The translation distance pair (t_x, t_y) is called translation vector or shift vector and it's denoted by T_v so, $P' = T_v + P$ where $P' = (x', y')$, $P = (x, y)$



Rotation! —— Rotation means motation ~~among~~ along it's circular path without changing the shape of the circular path.

• Rotation about origin! ——

we shall first take the origin as the pivot point and perform the transformation; let the angle of rotation of a point is θ. And originally made an angle ϕ with the origin.



Let, the old original point is $P(x,y)$ and the change point is $P'(x',y')$. Also let the distance of the point from the origin (pivot point) is r.

$x' = r\cos(\theta+\phi)$ ——— (i)

$y' = r\sin(\theta+\phi)$ ——— (ii)

So, $x' = r\cos\theta\cos\phi - r\sin\theta\sin\phi$

$x' = x\cos\theta - y\sin\theta$ ——— (iii)

$y' = r\sin\theta\cos\phi + r\cos\theta\sin\phi$ ——— (iv)

It is clear from the above picture,

$x = r\cos\phi$ ——— (v)

$y = r\sin\phi$ ——— (vi)

Putting the value of (v) and (vi) in the eqn (iii) and (vi) we get,

$x' = x\cos\theta - y\sin\theta$ ——— (vii)

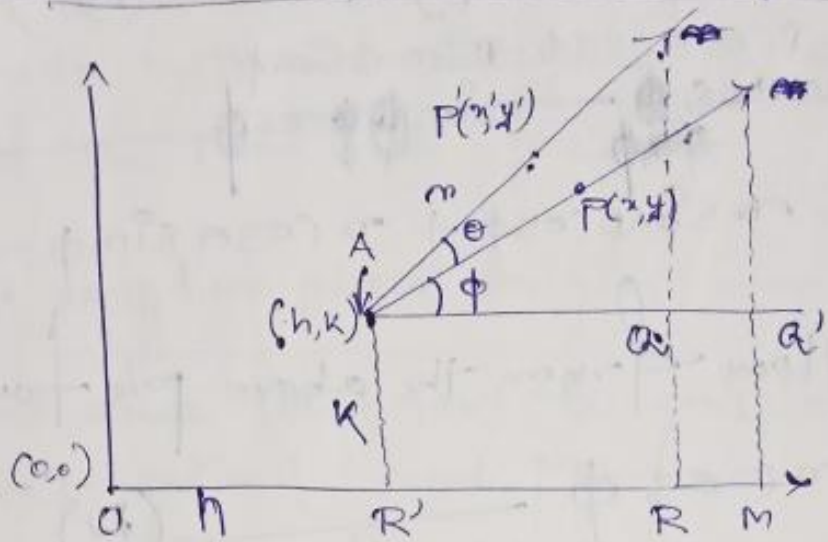
$y' = x\sin\theta + y\cos\theta$ ——— (viii)

∴ we represent the same as matrix form

$P' = R(\theta)\cdot P$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

• Rotation about an arbitary pivot point :-



we shall take an arbitary point (h,k) as the pivot point.

Clearly from the figure ~~AQ=AP'~~

~~cos(θ+φ)~~

$$AQ = AP' \cos(\theta+\phi) \quad \text{---------- (i)}$$

$$r\cos(\theta+\phi) \quad \text{---------- (ii)}$$

So, $$OR = h + r\cos(\theta+\phi) \quad \text{---------- (iii)}$$

$$x' = h + (r\cos\theta\cos\phi - r\sin\theta\sin\phi)$$

(iv)

Similarly, $$P'(Q) = r\sin(\theta+\phi)$$

$$RP' = K + r\sin(\theta+\phi)$$

$$y' = K + (r\sin\theta\cos\phi + r\cos\theta\sin\phi)$$

(v)

Now from APQ' triangle we get

$AQ' = r\cos\phi$

$\Rightarrow OM - OR' = r\cos\phi$

$\Rightarrow (x-h) = r\cos\phi$ ——— (vi)

Similarly, $PQ' = r\sin\phi$

$\Rightarrow PM - Q'M = r\sin\phi$

$\Rightarrow (y-k) = r\sin\phi$ ——— (vii)

Putting eqn. (6) and (7) in eqn (5)

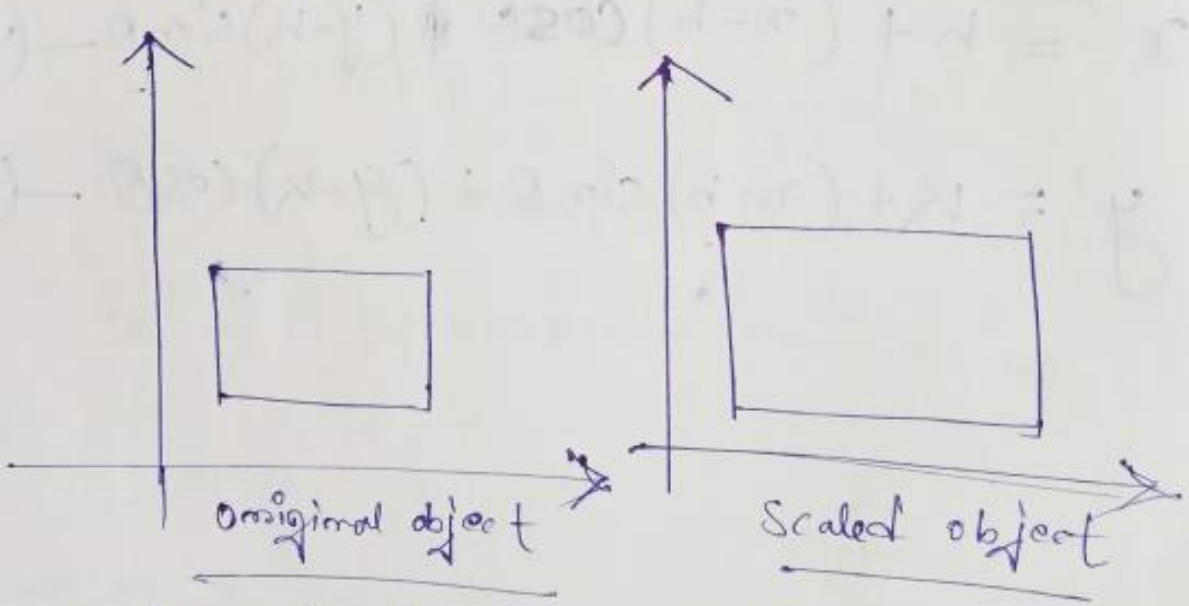
In eqn. (4) and (5) we get,

$x' = h + (x-h)\cos\theta + (y-k)\sin\theta$ ——— (viii)

$y' = k + (x-h)\sin\theta + (y-k)\cos\theta$ ——— (ix)

Scaling :⇒

Scaling means changing the size of the object i.e. scaling means expanding and compressing the dimension of an object. The constants that decide the changes in dimension are called scalling factors. The scaling factors in x and y direction are known as S_x and S_y respectively. If the scaling factor is < 1 then the object will be compressed otherwise if it is > 1 then the object will be expanded.



Let $P(x, y)$ is the original point and the scalling factors along x and y are S_x and S_y . The point will be transformed to $P' = (x', y')$

where, $x' = S_x X$ ——— (i)

$y' = S_y Y$ ——— (ii)

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Scalling matrix

What is reposition problem ?

→ Consider the case of a straight line Scalling with scalling factors $S_x = 1/2$, $S_y = 1/2$ where, the straight line is parallel to x axis. Let the co-ordinate of the end point P(2,2) and Q(2,4)

The transformed point for P i.e.

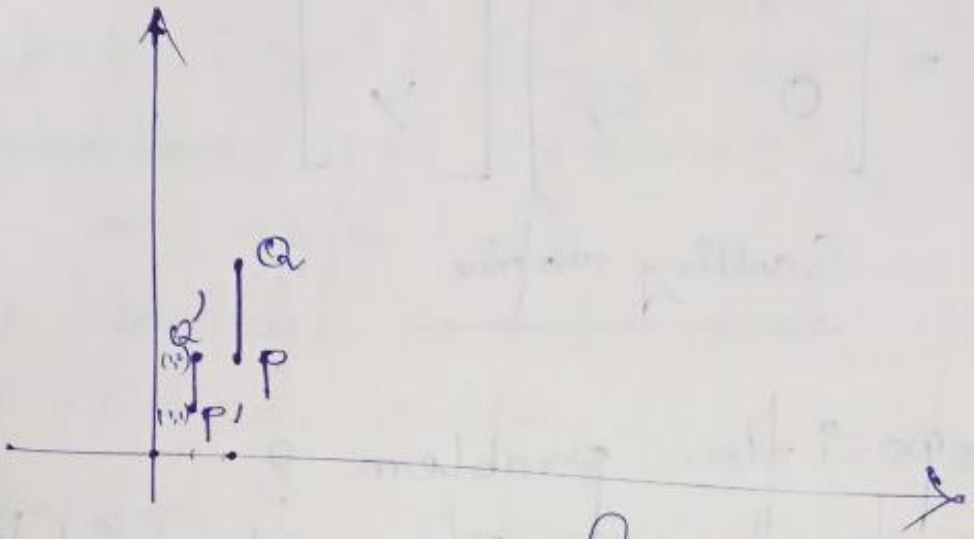
$$P' = \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1/2 & 0 \\ 0 & 1/2 \end{bmatrix} \begin{bmatrix} 2 \\ 2 \end{bmatrix}$$

$$= \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Similarly, for Q point the changed location is, $Q' = \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1/2 & 0 \\ 0 & 1/2 \end{bmatrix} \begin{bmatrix} 2 \\ 4 \end{bmatrix}$

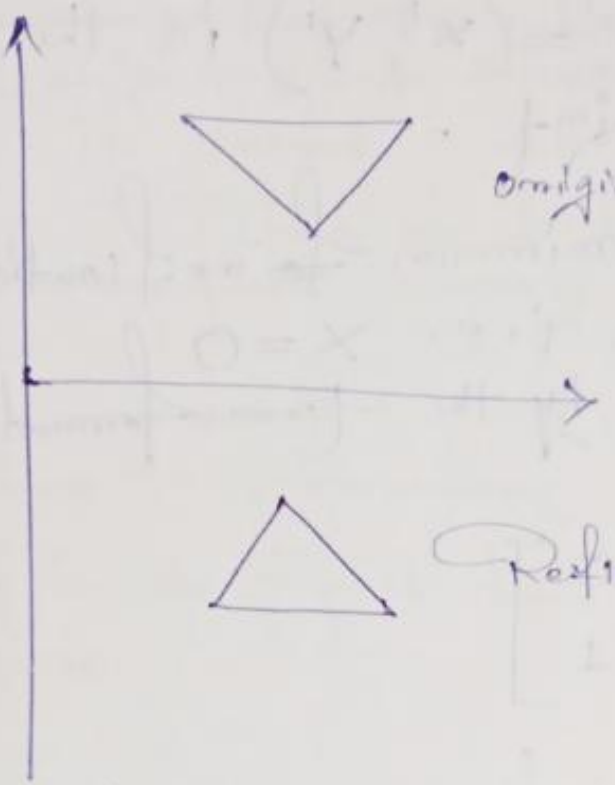
$$= \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

So the new line ends points are (1, 1), (1, 2)



From the above figure it is clear that the size of the straight line is reduce it is shifted towards the origin. These is called repositioning problem.

Mirror transformation:—



These transformation produces the mirror image of an object with respect to a given mirror axis. Reflection means rotating the object 180° with respect to the mirror axis.

Reflection about x axis i.e. $y = 0$ can be determined by transformation matrix

$$M = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$ So the

$$P = \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$

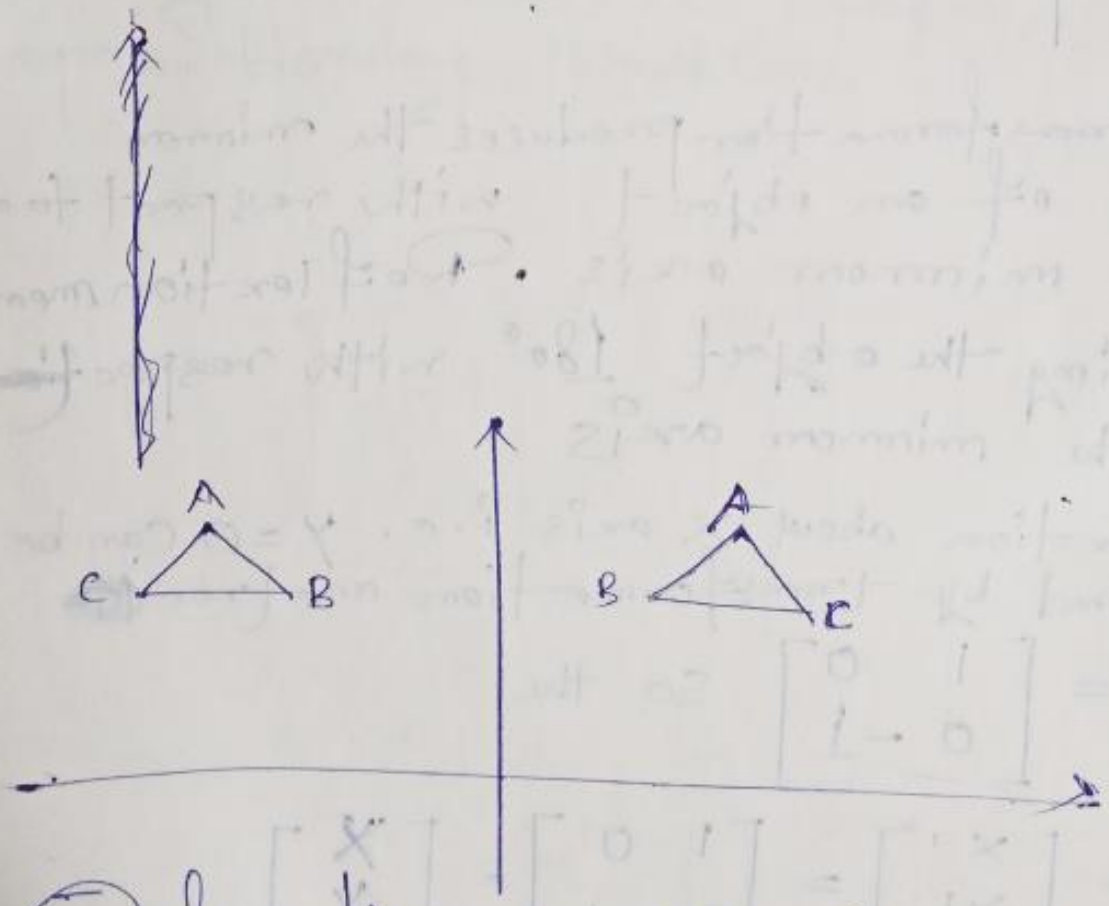
$$= \begin{bmatrix} x \\ -y \end{bmatrix}$$

therefore $x' = x$ and $y' = -y$

here. $P = (x, y)$ is the original point and $P' = (x', y')$ is the reflected point.

Similarly mirror reflection about y axis i.e. $x = 0$ can be given by the transformation matrix.

$$M = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

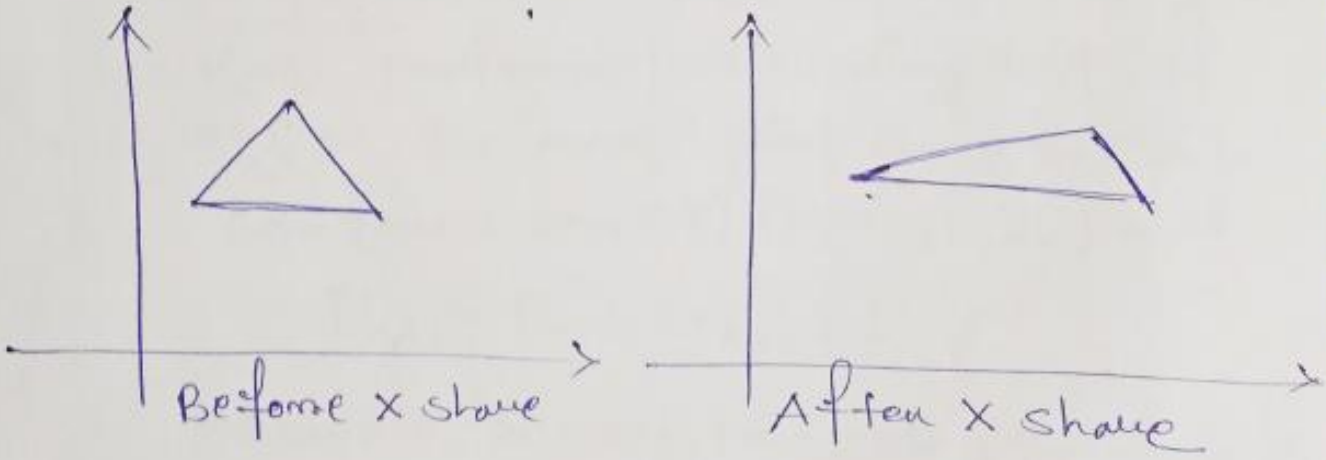


Reflection about y axis

Shear transformation :—

A transformation that distorts the shape of the object and makes the object slant is called a shear transformation. There are 2 types of shear transformation namely x shear and y shear.

X shear transformation :— x shear means slanting in the right hand and left hand sit side.



$$Sh_x = \begin{bmatrix} 1 & SF_x \\ 0 & 1 \end{bmatrix}$$

where SF_x is the x shearing factors.

So, P(xy) will be changed to P'(x'y')

where $x' = x + SF_x \cdot y$

$y' = y$

Similarly, Y shear with respect to y axis can be given by the matrix ~~Shy~~ =

$$Shy = \begin{bmatrix} 1 & 0 \\ SF_y & 1 \end{bmatrix}$$

Homogenious quadinates :→

we shall represent the cartesian coordinate p (x, y) by homogenious quadinate X_h, Y_h, h

where x equal to $\frac{X_h}{h}$

and y " " $\frac{Y_h}{h}$

we shall choose any non 0. h. Let a, h = 1

The homogenious quadinate representation for translation is as follows.

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The homogenious quadinate representation for ~~translation~~ rotation as follo

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The homogenious quadinate representation for scalling as follows—

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Composite transformation :—

- **Multiple translation :—**

Let there be two translation with translation vector t_{x1}, t_{x2} and t_{y1}, t_{y2},

$$P' = T(t_{x_2}, t_{y_2}) \left[T(t_{x_1}, t_{y_1}) \cdot P \right]$$

$$T(t_{x_2}, t_{y_2}) \cdot T(t_{x_1}, t_{y_1}) \cdot P$$

As matrix multiplication is associative.

$$P' = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_{x_2} \\ 0 & 1 & t_{y_2} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & t_{x_1} \\ 0 & 1 & t_{y_2} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & t_{x_1} + t_{x_2} \\ 0 & 1 & t_{y_1} + t_{y_2} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

So, $P' = T(t_{x_1} + t_{x_2}, t_{y_1} + t_{y_2}) \cdot P$

• Successive Rotation :—

$$P' = R(\theta_2)\left[R(\theta_1)\cdot P\right]$$

$$= R(\theta_2)\cdot R(\theta_1)\cdot P$$

$$P' = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 \\ \sin\theta_2 & \cos\theta_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos(\theta_1+\theta_2) & -\sin(\theta_1+\theta_2) & 0 \\ \sin(\theta_1+\theta_2) & \cos(\theta_1+\theta_2) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$\text{So, } P' = R(\theta_1+\theta_2)\cdot P$$

• Successive Scaling :—

$$P' = S(S_{x_2}, S_{y_2})\left[S(S_{x_1}, S_{y_1})\cdot P\right]$$

$$= S(S_{x_2}, S_{y_2})\, S(S_{x_1}, S_{y_1})\cdot P$$

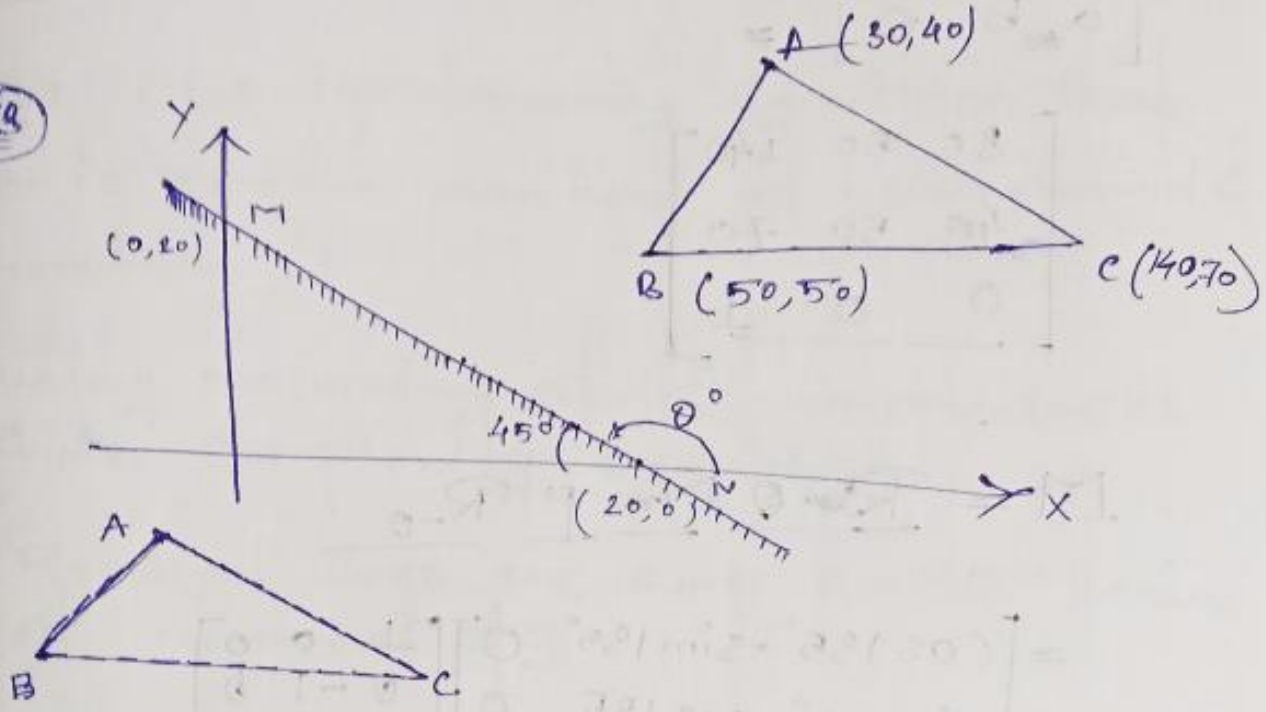
$$P' = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} S_{x_2} & 0 & 0 \\ 0 & S_{y_2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} S_{x_1} & 0 & 0 \\ 0 & S_{y_1} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} S_{x_1}\cdot S_{x_2} & 0 & 0 \\ 0 & S_{y_1}\cdot S_{y_2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

So, $P' = S(S_{x_1}, S_{x_2}, S_{y_1}, S_{y_2}) \cdot P$

(41, 42, 43) → same / different digits

(iii)



$\theta = 180 - 45$

$\theta = 135°$

The mirror has x intersect (20, 0) and y intersect (0, 20).

We know that $m = \tan\theta$

$= \frac{Y_2 - Y_1}{X_2 - X_1}$

$= \frac{20 - 0}{0 - 20}$

$= -1$

So, $\tan\theta = -1 = \tan 135°$

So, $\theta = 135°$

∴ Now, the triangle is given by the matrix

$$[a\ b\ c] =$$

$$= \begin{bmatrix} 30 & 50 & 140 \\ 40 & 50 & 70 \\ 0 & 0 & 1 \end{bmatrix}.$$

$$M = R_{\theta} \; M_x \; P \; R_{-\theta}$$

$$= \begin{bmatrix} \cos 135^\circ & -\sin 135^\circ & 0 \\ \sin 135^\circ & \cos 135 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 30 & 50 & 140 \\ 40 & 50 & 70 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 30 & 40 & 0 \\ 50 & 50 & 0 \\ 140 & 70 & 1 \end{bmatrix} \begin{bmatrix} \cos 135^\circ & \sin 135^\circ & 0 \\ -\sin 135^\circ & \cos 135^\circ & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

Q.6 Same

In DDA line drawing algorithm there is extra overhead of using round of function.

- using rounding of fn. increases the time complexity algorithm.
- Resulted lines are not smooth because of round of fn.
- The points generated by the algorithm is not accurate.

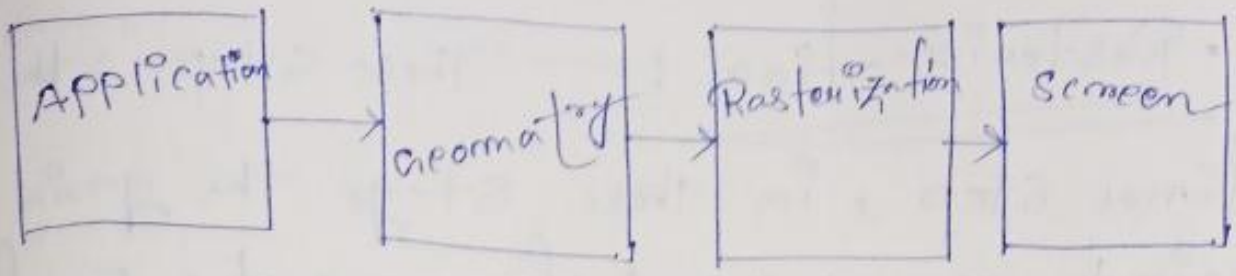
Advantage of DDA algo.

- It is a simple algorithm.
- It's easy to implement.
- It avoid using multiplication operation which is costly in term of time Complexity.

36/ In computer graphics, a computer graphics pipeline, rendering pipeline or, simply graphics pipeline is a conceptual model that describes what steps a graphics system needs to perform to convert a 3D scene to a 2D seen screen. once a 3D model has been created, for instance in video game or any other 3rd computer animation the graphics pipeline is the process of turning that 3D model into what the computer displays. The model of graphics pipeline is usually used in real time rendering.

A graphics pipeline can be devided into 3 main parts —

- Application
- Geometry
- Rasterization.



- Application :— The application state is executed by the software of the main processor (CPU). In the application step changes are made to the scen as required. Example of the task that are done in the application steps are collition detection, animation, morphing etc.

- Geometry :— The geometry step which is responsible majority of the operation with polygon of their vertices. (The world co-ordinate system)

• Rasterization :— These step is the final step, in these stage the grid point are called fragment. Each fragment correspond to one pixel in the frame buffer these can be coloured. The colour of a fragment depends on the illumination, texture and other material properties.

(29) Interlacing is where the horizontal lines of a vedio display are updated on odd and even lines alternatively.

+ Raster Scan CRT