1 SEAT No. A13A047.

NAME: YASH SARANG.

ROLL No. 47.

SEMESTER: III.

SUBJECT: CG

Page no. 1/21

Saraugyash

Q1.

1) Option D: Aliasing.

2) Option D: Integer Arithmetic only

3) Option D: Homogenous Co-ordinate system.

4) Option B: Rotation.

5) Option A: $(-x, -y)$.

6) Option B: 0000.

7) Option C: $(-5, 5.5)$.

8) Option B: $0 <= u <= 1$.

9) Option D: Area subdivision method.

10) Option B: Motion Capture.

Q2. A.
ii)

→ $A \equiv (4,5)$; $B \equiv (7,5)$; $C \equiv (6,7)$.

Reflection w.r.t x axis.

$\therefore x_{new} = x_{old}$
$y_{new} = -y_{old}$.

for $A(4,5)$
$x_{new} = x_{old} = 4$
$y_{new} = -y_{old} = -5$

for $B(7,5)$
$x_{new} = x_{old} = 7$
$y_{new} = -y_{old} = -5$

for $C(6,7)$
$x_{new} = x_{old} = 6$.
$y_{new} = -y_{old} = -7$.

$\therefore$ The co-ordinates after reflection w.r.t x axis are $(4,-5)$, $(7,-5)$ and $(6,-7)$, respectively.

Salangyash

Q2. A.
ii)

→ Rasterization:
It is the process by which most modern displays turn electric data or signal into projected image such as video or still graphics.
This typically is a process of identifying the needs of a specific media configuration, then allocating resources so the images are efficiently & optimally projected on the display device.

Examples: Colors, shading, textures, etc.

Scan conversion:
It is a process of representing a graphic object as a collection of pixels. The objects are continuos and the pixels used are discrete. Each pixel has an on & off state.

Example: Sector, Line, Arc, Point, etc.

Rendering:
It is the process of generating photorealistic form 2D

Sarangyasha

Q2.A iii)

or 3D models using a computer program.

The scene is stored using specific data types in the scene ~~file~~ file. The rendering program retrieves the information like vertex position, viewpoint, color, texture, lighting, etc. and render the scene on the main screen.

Thus, the term rendering is analogues to the 'artist's rendering' of the scene.

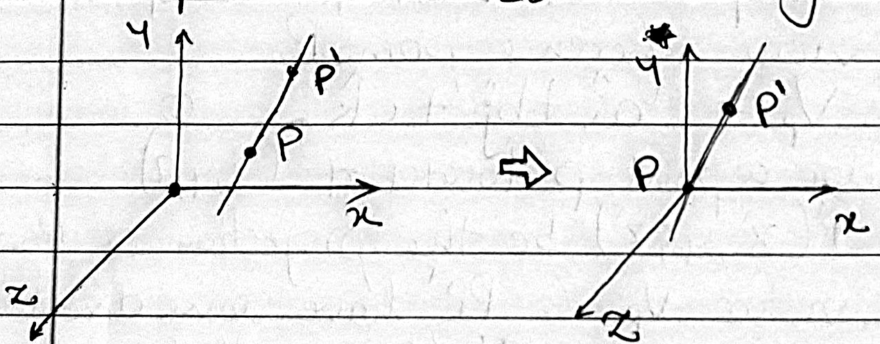
Rendering is mostly used in video games, simulators, special effects, VFx, etc.

Sabangpash

Q2 B.
i)
→ When an object is rotated about an axis that is not parallel to any one of co-ordinate axes i.e. x, y or z. Then, additional transformations are required.
First of all, proper alignment is performed and then the object is brought back to its original position.

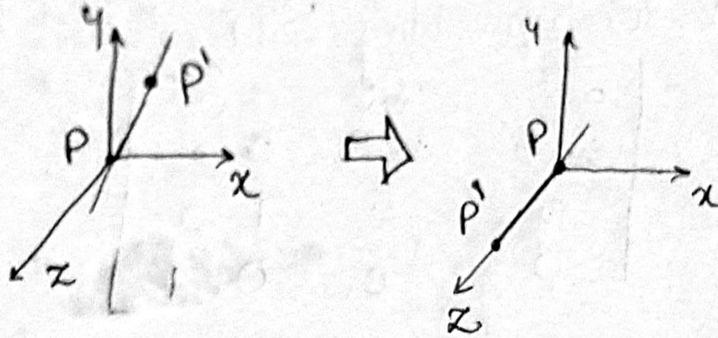
The following steps are required:

Step 1: Translate the object to origin.

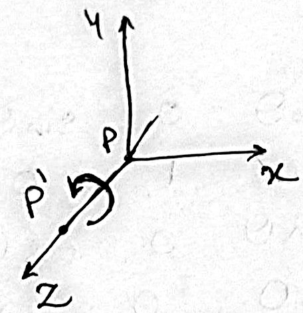


Step 2: Rotate the object so that the axis of object coincide with any of the co-ordinate axes.

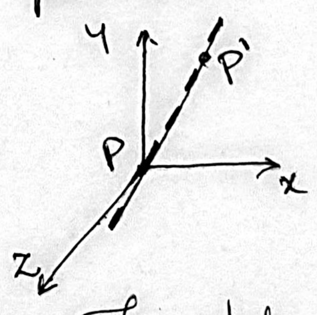
Q2.B i)



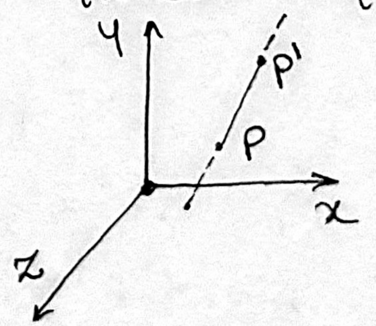
Step 3: Perform rotation about the co-ordinate axis with whom co-inciding is done.



Step 4: Apply inverse rotation to bring rotation back to the original position.



Step 5: Translate axis to the original position.



Q2. B. i)

Matrix for representing 3D rotations about

$$Z\text{-axis} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$X\text{-axis} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta & 0 \\ 0 & \sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$Y\text{-axis} = \begin{bmatrix} \cos\theta & 0 & \sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ \sin\theta & 0 & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Pg no. 9/21

Sahayagrah

Q.3 Q3.A. i)

3 →

Homogenous co-ordinates provide a mechanism for accomplishing rotations about points other than origin. This is accomplished using the following procedures:

1) Translating the point to origin.
2) Performing the required rotation.
3) Translating the result back to the original centre of rotation.

Thus, using concatenation rotation of a point whose position vector is $[x_0 \; y_0 \; 1]$, about an arbitrary point $(t_x \; t_y)$, through arbitrary angle in the accomplished as (b) reflection of an object through an ~~of~~ arbitrary line.

$$[x_0 \; y_0 \; 1] = [x_0 \; y_0 \; 1]\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -t_x & -t_y & 1 \end{bmatrix}\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 1 \end{bmatrix}$$

We noticed that the reflection of a point is done through lines that are passed through the origin. But reflection of an object through a line that does not pass

Satangyash

Q3.A i)

through the origin is also required in various cases. When reflection of a point or objects through an arbitrary line is required, the following procedure can be used:

1) Translate the line and the point or the object so that the line passes through the origin.

2) Rotate the line and the object about the origin until the line is coincident with one of the co-ordinate axes.

3) Reflect through the co-ordinate axes.

Jalangpah

Q3. A. iii)
→ Animation refers to the movement on the screen of the display device created by displaying a sequence of still images. The term computer animation generally refers to the time sequence of visual changes in a scene.

Principles of animation:

1) Squash & stretch: The flexibility of object to exaggerate or add ~~appeat~~ appeal to a movement.

2) Time and spacing: The number of frames between two poses and how those individuals are placed.

3) Anticipation: The setup for an action to happen.

4) Ease in and Ease out: The time for acceleration and deceleration of any movement

5) Follow through and overlapping action: The idea that seperates parts of the body will continue moving after a character or object comes to a

Pg no. 12/21

Q3.A iii)

full stop and idea that parts of the body move at different times.

6) Axes: The principle that smoothes animation and moves action in a realistic way.

7) Exaggeration: The pushing of movement further to add more appeal to an action.

8) Solid drawing: The accuracy of volume, weight, balance & anatomy.

9) Appeal: The relatability (or charisma) of a character.

10) Secondary action: The action that emphasizes or supports the main action of animation.

Satangpsh

Q3.B →
ii)

Filling is the process of "coloring in" a fixed area or region. Regions may be defined at pixel level or geometric level. When the regions are defined at pixel level, we are having different algorithms, like
1. Boundary fill & 2. Flood fill.

In case of geometric level, we have Scan line polygon fill algorithm.

The following steps depict how the algorithm works:

The scan line polygon fill algorithm works by intersecting scanline with polygon edges and fills the polygon between pairs of intersections.

Step 1: Find out Y_{min} and Y_{max} from the given polygon.

Step 2: Scanline intersects with each edge of the polygon from Y_{max} to Y_{min}. We name each intersection point of the polygon as $P_0, P_1, P_2, \ldots$

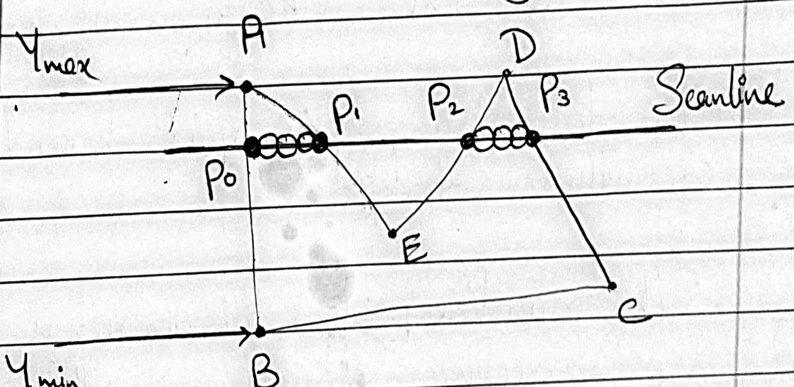
Satarupa ...

Q3.B. ii)

Step 3: Sort the intersection points in the increasing order of x-coordinate

Step 4: Find all the pair of co-ordinates that are inside polygons and ~~inside~~ ignore the alternate pairs.

For example, in the diagram below



In the polygon ABCDE, A and B points are Y_{max} & Y_{min} respectively

While using the scanline algorithm there will be an instance as represented in our diagram.

Here P_0P_1 and P_2P_3 are the pair of co-ordinates which are inside and the alternate pair P_1P_2 will be ignored.

 Sarangapah

4. A. ii)

→ The limitations of boundary fill algorithm, if the polygon is having boundaries with different colors then boundary fill algorithm fails.

This limitation of boundary fill algorithm is overcomed in flood fill algorithm. Which is also called as ~~set~~ seed fill algo.

The algorithm begins with seed point. Instead of checking boundary color, the algorithm checks whether the pixel is having the polygon's original color.

If the answer's yes, then fills with new color and use each of neighbouring pixel as a new seed in a recursive call.

If the answer is no. ie the colour is already changed then it returns to its caller

Recursive method for flood fill using 8-connected method.

```
f-fill (x,y, new color)
{
    Current = getpixel (x,y);
    If (Current != newcolor)
    {
        Putpixel (x, y, newcolor);
        f-fill (x-1 , y , newcolor);   f-fill (x-1 , y+1, newcolor);
        f-fill (x+1 , y , newcolor);   f-fill (x+1 , y-1, newcolor);
        f-fill (x , y , newcolor);     f-fill (x-1 , y-1, newcolor);
        f-fill (x , y-1, newcolor);    f-fill (x+1 , y+1, newcolor);
    }
}
```

Satangupoha

Q4. A. iii)

→ Parallel projection is the one where 'z' co-ordinate is discarded and parallel lines from each vertex of an object are extended until they intersect the view plane.

A parallel projection preserve the relative proportion of objects. Here, parallel project objects are transformed to the view plan (V_p) along the parallel lines.

Derivation of the homogenous transformation matrix.

The matrix is determined by prescribing the direction of projection vector V_p and the view plane. The viewplane is specified by its view reference point R_0

$\therefore V_p = a\hat{i} + b\hat{j} + c\hat{k}$ —— ①

Consider a point P located at (x,y,z)

Let $P'(x',y',z')$ be the projection of P onto xy pl

The vector V_p & PP' have same direction.

Then there is 'α' such that

$$PP' = \alpha V_p$$

$$\therefore x' - x = \alpha a \quad — ②$$

$$y' - y = \alpha b \quad — ③$$

$$z' - z = \alpha c \quad — ④$$

But $z' = 0$ (a point on xy plane)

$\therefore$ from ④ $\quad -z = \alpha c$

$$\boxed{\therefore \alpha = \frac{-z}{c}}$$

Q4.B i)
→ Midpoint ellipse algorithm plots points of an ellips on the first quadrant by dividing the quadrant into 2 regions.

Apply the midpoint ellipse ~~trans~~ algorithm only in the first quadrant.

The algorith is used to calculate all the perimeter points of an ellipse.

The working :
Let us consider the first elliptical curve

$$r_y^2 x^2 + r_x^2 y^2 - r_x^2 r_y^2 = 0 \quad (1)$$

where,
$r_x \Rightarrow$ Semi major axis, $r_y \Rightarrow$ Semi-minor axis.

we divide the region into 2 parts
R_1 & R_2 respectively.

$$m = dx/dy = -\left(2r_y^2 x / 2 r_x^2 y\right) = -1.$$

The region R_1 & $m < -1$
& region R_2 has $m > -1$.

Sarangyash

The starting point of R_1 will be $(0, r_y)$ & for R_2 will be the endpoint of R_1, where the slopes become $= -1$.

Derivation for region 1:

Let us consider 2 points (pixels) which is outside (A) and other is inside (B).

for $A \equiv (x_k+1, y_k)$

$B \equiv (x_k+1, y_k-1)$

Value for thier midpoint will be

$$M_p \equiv \left(x_k+1, y_k - 1/2\right)$$

putting M_p in eqn ①, we get

$$P_k = r_y^2 (x_k+1)^2 + r_x^2 (y_k - 1/2)^2 - r_x^2 r_y^2 \quad \text{—②}$$

which is the decision parameter statement

The successive parameter can be defined as

$$P_{k+1} = r_y^2 (x_{k+1}+1)^2 + r_x^2 (y_{k+1} - 1/2)^2 - r_x^2 r_y^2 . \quad \text{—③}$$

Subtract ② from ③,

$$P_{k+1} - P_k = r_y^2 \left[(x_{k+1}+1)^2 - (x_k+1)^2\right] + r_x^2 \left[(y_{k+1} - 1/2)^2 - (y_k - 1/2)^2\right]$$

As the x-coordinate remains the same.

$$x_{k+1} = x_k + 1.$$

$$\therefore P_{k+1} - P_k = r_y^2 [2x_k + 3] + r_x^2 [(y_{k+1})^2 - y_{k+1} - (y_k)^2 + y_k]$$

$$P_{k+1} = P_k + r_y^2 [2x_k + 3] + r_x^2 [y_{k+1}^2 + y_k - y_{k+1} - y_k^2]$$

If $P_k < 0$ put $y_{k+1} = y_k$ [Choose point A]

$$\therefore P_{k+1} = P_k + r_y^2 [2x_k + 3]$$

If $P_k \geq 0$, put $y_{k+1} = y_k - 1$ [Choose point B]

$$P_{k+1} = P_k + r_y^2 [2x_k + 3] + 2[1 - y_k].$$

Initial decision parameter

Put initial point $(0, r_y)$ in eq^n (2).

$$P_0 = r_y^2 + r_x^2/4 - (r_y r_x)^2$$

Satangpah

Derivation for R_2 region:-

Let us consider P(outside) & Q(inside)

$P \equiv (x_k+1, y_k-1)$

$Q \equiv (x_k, y_k-1)$

$M_p = (x_k+1/2, y_k-1)$

Putting M_p in eq ①,

$P_{2k} = r_y^2 (x_k+1/2)^2 + r_x^2 (y_k-1)^2 - r_x^2 r_y^2$ — ⑤

is the decision parameter statement.

Successive parater will be

$P_{2k+1} = r_y^2 (x_{k+1} + 1/2)^2$
$- r_x^2 (y_{k+1} - 1)^2 - r_x^2 r_y^2$ — ⑥

Subtract ⑤ from ⑥.

$P_{2k+1} - P_{2k} = r_y^2 \left[(x_{k+1} + 1/2)^2 - (x_k + 1/2)^2 \right]$
$r_x^2 \left[(y_{k+1} - 1)^2 - (y_k - 1)^2 \right]$

As y coordinate is same, $\therefore y_{k+1} = y_k - 1$.

$P_{2k+1} - P_{2k} = r_y^2 \left[(x_{k+1})^2 + x_{k+1} - x_k^2 - x_k \right]$
$+ r_x^2 \left[3 - 2y_k \right]$

Sarangyali

Pg no. 21/21

If $P_{2k} > 0$ use $x_{k+1} = x_k$ [Choose point Q]

$$P_{2k+1} = P_{2k} - 2y_{k+1} r_x^2 + r_x^2$$

If $P_{2k} \leq 0$ use $x_{k+1} = x_k + 1$ [Choose point P]

$$P_{2k+1} = P_{2k} + 2r_y^2 [2x_{k+1} + 2y_{k+1} r_x^2 + r_x^2]$$

Putting endpoint of region R_1.

where $m > -1$ i.e (x, y) in eqn ⑤.

$$P_{20} = r_y^2 (x + 1/2)^2 + r_x^2 (y-1)^2 - r_x^2 r_y^2.$$

This is a incremental method for scan converting ~~&~~ an ellipse that is centred at the origin in ~~stat~~ standard position.
i.e major and minor axis parallel to the coordinate system axis.

It is very similar to the midpoint circle algorithm. Because of the fourway symmetry we have to consider the entire elliptical curve in the first quadrant.

* * * * *