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4) Compare RGB and HSV color Model. [6m]

→

RGB	HSV
① RGB represent colors by combining varying intensities of red, green and blue light. Each color channel has values ranging From 0 to 255.	① HSV represent Colours by three component - Hue (0-360°), Saturation (0-100%), and Value (0 to 100%)
② Changing colour or make colour adjustment is complex, as modifying one channel may affect other.	② Easier to adjust specific aspect of colour without affecting its hue.
③ Represent colors in cube in 3d space, with each axis corresponding to one of color channel	③ Represent colour in cylindrical shape, where the height correspond to brightness (value) and angle around central axis represent hue.
④ RGB colour model is commonly used in digital display, computer graphics and lighting system	④ HSV color model is used in graphic design and image editing.

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② Explain and compare point source and diffuse illumination.

→

* point source :-
- point source illumination refers to light originating from single concentrated point in space.
- This light source emit rays that spread out in all direction.

* characteristics :-
- create distinct and sharp shadow
- Intensity decreases with distance from source.
- common example include a spotlight or a bare light bulb.

* Application :-
- used for accent lighting or to emphasizing specific object or areas.
- Photographic lighting.

* Diffuse illumination :-
- Diffuse illumination involves light that is scatterred or spread evenly in various direction.
- There is no specific point of origin and light appear to come from multiple direction.

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* Characteristics :
- Produce soft, subtle shadow with less constrast.
- Example include overcast daylight or light from a lampshade.

* Application :-
- used in architectural lighting to provide general ambient illumination.

Point Source	Diffuse
① create well defined sharp shadow.	① Produce softer, less distinct shadow.
② Intensity decrease with distance.	② offer more even intensity across surface
③ Suitable for focus lighting or emphasizing specific object or areas.	③ commonly used for general lighting purpose.
④ It can create dynamic / dromatic effect and highlight	④ It offer a softer and more subtle aesthetic, reducing harsh constrasts.

4) Explain z-buffer hidden surface algorithm.

→

*z buffer hidden surface:

- When viewing a picture containing non transparent object and surface it is not possible to see those object from view which are behind from object closer to eye.
- To get realistic screen image removal of this hidden surface is must. The identification and removal of these surface is called hidden surface promblem.
- z buffer commonly known as frame buffer is used for hidden surface detection.
- It is image space method which is based on pixel to be drawn on 2D.
- For these method, the running time complexity is no of pixel times number of object. And space complexity is two times no of pixel because two array of pixel are required one for frame buffer and other for depth buffer.
- The z buffer method compares surface depth at each pixel position on projection plane.

* Algorithm:

① Initialize the depth of each pixel.
i.e d(i,j) = infinite (max length)

② Initialize the colour value of each pixel
c(i,j) = background color

For each polygon do following steps
{
Find depth i.e z of polygon
at (x,y) corresponding to pixel
(i,j)

if (z < d(i,j))
{
d(i,j) = z;
c(i,j) = color;
}
}

5] Explain backface detection and removal. [6m]

→ - Object surface that are oriented away from viewer are called back faces.
- The back face of cube are completely blocked by cube itself and hidden from view.
- So the method which is used

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to identify and remove back face is back face detection and removal.
- This method will remove 50% of polygon from screen if parallel projection is used.
- If perspective projection is used more than 50% of invisible area will be removed.

* Algorithm For Back Face Removed Algorithm :-

① Do numbering of all polygon in clockwise direction i.e

$V_1, V_2, V_3 \ldots V_z$

② calculate normal vector i.e N_1

$N_1 = (V_2 - V_1) * (V_3 - V_2)$

③ consider projecter P, it is projection from any vertex

calculate dot product

$Dot = N \cdot P$

④ Test and Plot Whether Surface is visible or not

IF $Dot \geq 0$ then

Surface is visible

else

Not visible.

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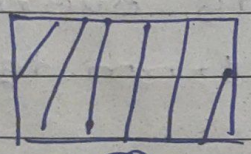
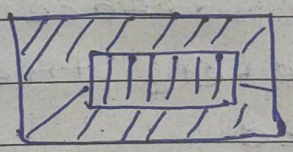
6] Write short on painters Algorithm.

→

- The object surface that are away from viewers are called back faces.
- For this there are many algorithm painter algorithm is one of them.
- The painter algorithm is also called depth sorting algorithm or priority algorithm.
- The painters algorithm processes the polygon as if they are painted onto viewplane in order of their distance from viewer.
- The polygon which are at more distance from viewer painted first then the nearer polygon will be painted.

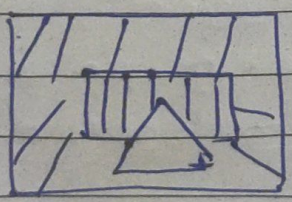


(a)



(b)

(c)



(c)

- The main factor over here is to decide the priority of polygon to determine which polygon to painted first.
- So this algorithm is also known as priority or depth priority algorithm.

*Algorithm:-

① Sorting surface based on given depth in increasing order
② Start painting from greatest depth
③ Compare the surface which surface the visible or not based on painting layer
④ This above process repeat until it complete all surface
⑤ If surface layer is overlapped completely then algorithm is stopped.

7] Write short note on Warnock's Algorithm.

→

*Warnock's Algorithm:-

- Warnock's Algorithm is called as area subdivision algorithm or area based algorithm.

- The painter algorithm deals with procedure but warnock's algorithm does not deal with procedure to remove hidden surface.

* Basically it is 2 step statergy :-

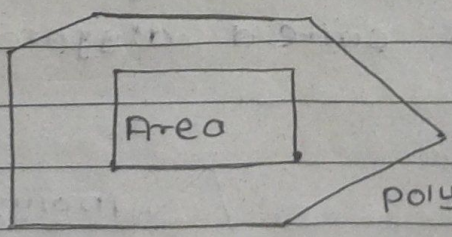
① Decide which polygon overlap the given area on screen
② Which polygon are visible in that area.

According to screen area, we are classifying polygon into 4 catogories

① Surrounding polygon
② Intersecting polygon
③ contained polygon
④ Disjoint polygon

① Surrounding polygon :-

- In this case polygon completely cover the given screen area.



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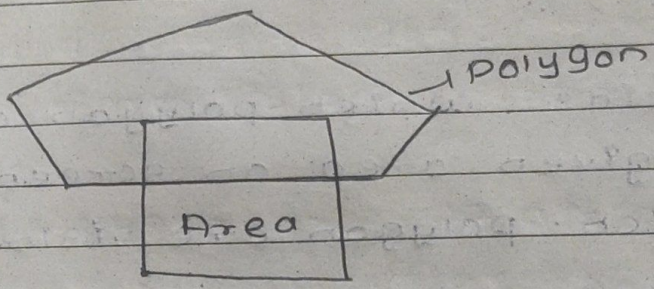
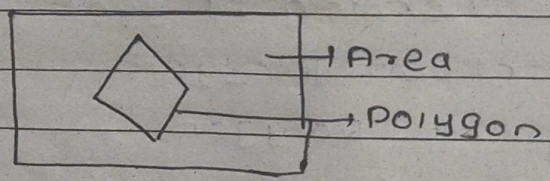
② Intersecting polygon:-
- In case a polygon is getting intersected with the screen area i.e polygon is partially inside screen area.

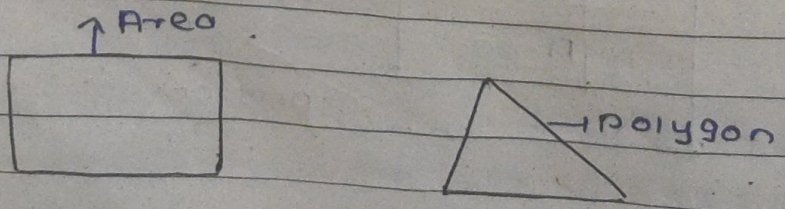


③ Contained polygon:-
- In this case a polygon is completely inside the screen area.

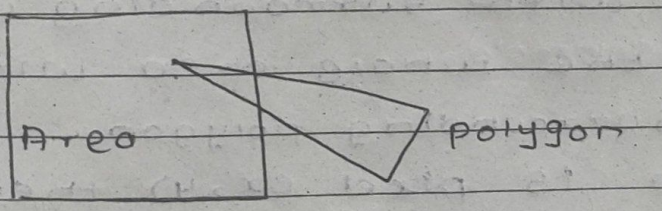


④ Disjoint polygon:-

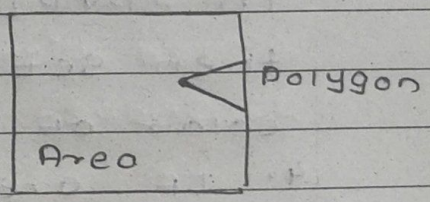
- Whenever the polygon lies completely outside the given screen area it is called disjoint polygon.



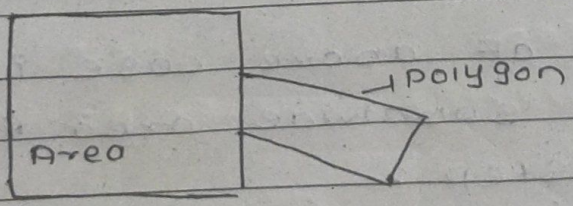
- Thus, polygon which are coming under catogory Four are total invisible so we are not considering them For visibility. We will keep this polygon in seprate list called as PVPL.
- If polygon is of catogory one i.e surrounding polygon, then whole area of screen will get colour of surrounding polygon.
- If polygon is of catogory two i.e intersecting polygon, we will apply clipping algorithm to convert catogory two into three and Four.



a) Intersecting polygon



b) contained polygon



c) Disjoint polygon

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* Algorithm:-

Step ① Initialize complete screen as area

Step ② Create PVPL with respect to area and sort zmin.

Step ③ Categorize polygon

Step ④ Remove disjoint polygon

Step ⑤ Now Perform visibility test

1. If all polygon are of disjoint category set pixel color as background
2. If polygon is of contained polygon then color the polygon and remaining area as background
3. If we have single polygon in PVPL with surrounding category then set the whole area with color of surrounding polygon.
4. If area is pixel (x, y) then find z value of all polygon at pixel (x, y) then choose color of polygon with smallest z value and set pixel to this color.

Step ⑥ If none of above case is true then subdivide area further and goto step 2.

Step ⑦ If we reach to the stage where we can take decision based on visibility test then stop this process.

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8) Explain halftone shading [5m]

→

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9) Compare Gaurand shading and phoong shading?

→

Gaurand	phoong
① Gourond Shading was introduced by henri Gourond in 1970.	① Phoong Shading was introduced by Phoong Bui Tuong in 1973.
② Evaluate ~~Illumination~~ Interpola ~~tion~~ at border vertice s and interpolates	② Evaluate illumin ation at every point of polygon surface
③ Highlight on surface are sometimes dis played with anamolo us shape	③ It give more accurate result.
④ cheaper than Phoon g shading	④ more costly than Gourand shading
⑤ High cost	⑤ low cost
⑥ Lighting equation used at each vertex	⑥ lighting equation used at each pixel
⑦ Inter polates colors along edges and scan line	⑦ Interpolate nor mal instead of colors.

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10) What are types of projection and write in brief about each type of projection.

→

- Magenta subtracts the green component from incident light and yellow subtracts the blue component. Therefore cyan, magenta and yellow are said to be components of red, green, blue respectively.

(2) Properties of Light:

- Light is form of energy which helps in sense of vision.
- We are able to see object when light falls on object and some of light falls reflected back to our eyes.
- Color is one of important properties of light. Color of an object depend not only on object itself but also light source illuminating it.

- Rectilinear propogation of light :- It is a property of light due to which it travels in straight line

- Shadows : are formed because light rays travel in a straight line, and they cannot bend around the corners of objects. The shape of shadow is also the same as the shape of object because light travels in straight line path.

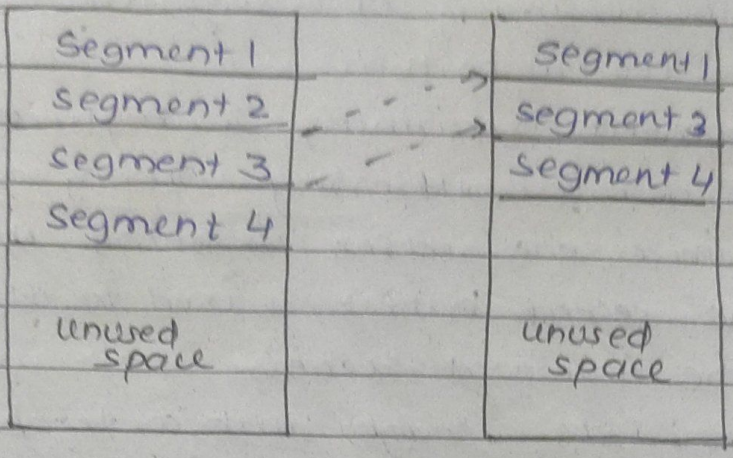
(iii) Animation languages:-

- Animation languages serve as a means to express motion specification in a structured manner.
- Common animation languages include:
  1) SMIL (Synchronized Multimidia Integration language): Uses XML to describe animations on web.
  2) MEL (Maya Embedded language): Scripting language for Autodesk Maya, widely used in entertainment industry.
  3) LUA: Lightweight scripting language used in game development for motion scripting.

2) Explain deletion of segment with suitable example and algorithm.

→ Deletion of segment:

- To delete a particular segment from display file, we must just delete that one segment without destroying or reforming the entire display and recover the space occupied by this segment.
- Use this space for some other segment
- The method to achieve this depends upon the data structure used to represent the display files.
- In the case of arrays, the gap left by deleted segment is filled by shifting up all segments following it.



Display file contents before and after deleting segment 2.

* Algorithm for Deleting a segment:

(i) Read the name of segment to be deleted.
(ii) If the segment name is not valid, give error message: "segment name is not a valid name" and go to step 8.
(iii) If segment is open, give error message: "Cant delete an open segment" and go to step 8.
(iv) If size of segment is less than 0, no processing is required and go to step 8.
(v) The segments which follow the deleted segment are shifted by its size.
(vi) Recover deleted space by resetting index of next free instruction.
(vii) The starting position of shifted segments is adjusted by subtracting the size of deleted segment from it.
(viii) Stop.

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3> Explain renaming of a segment with example and its algorithm.

→ - Segment renaming is required in case of double buffering. During the animation, while one buffer is being displayed, the second buffer is used to alter and fill the animated scene.

- Invisible image with a temporary name is created. When the first image is deleted replace the temporary image with the original one.

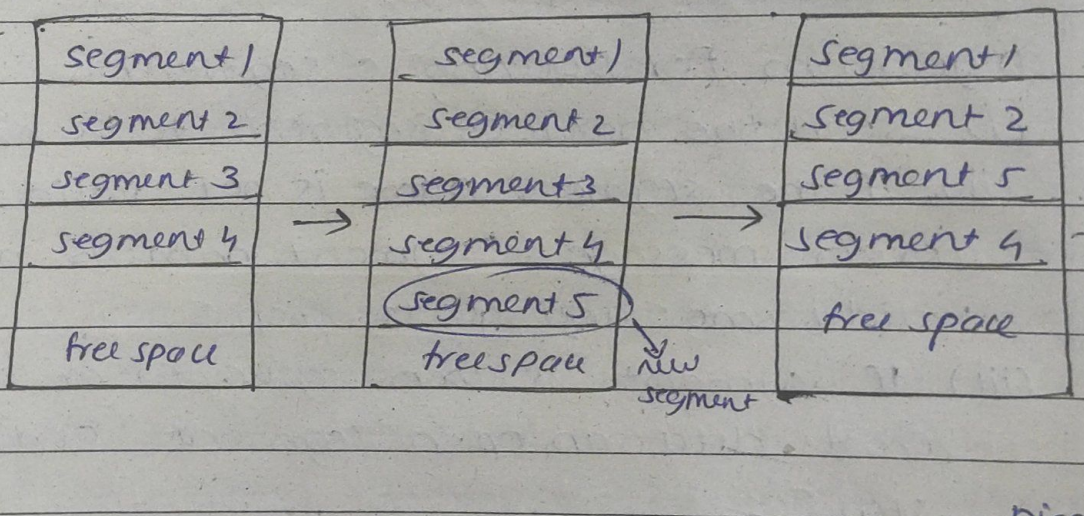

Fig. Renaming the segment

Display fill after renaming segment 3 by segment 5.

- This is done to achieve double buffering, ie the idea of storing two images, one to show and other to create alter and for animation.

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Algorithm:

(i) If both old and new segment names are not valid, give error message:
"Segment names are not valid names"
and go to step 6.

(ii) If any of two segment is open, give error message: "Segments are still open" and go to step 6

(iii) If new segment name given already exists in display list, give error msg:
"segment name already exists" and go to step 6.

(iv) The old segment table entry are copied into new position.

(v) Delete the old segment

(vi) Stop.

4] What is morphing and write applications of same.

→ Morphing :-

- Morphing is an animation function which is used to transform object shape from one form to another is called Morphing.
- It is one of the most complicated transformations. This function is commonly used in movies, cartoons, advertisement, and computer games.

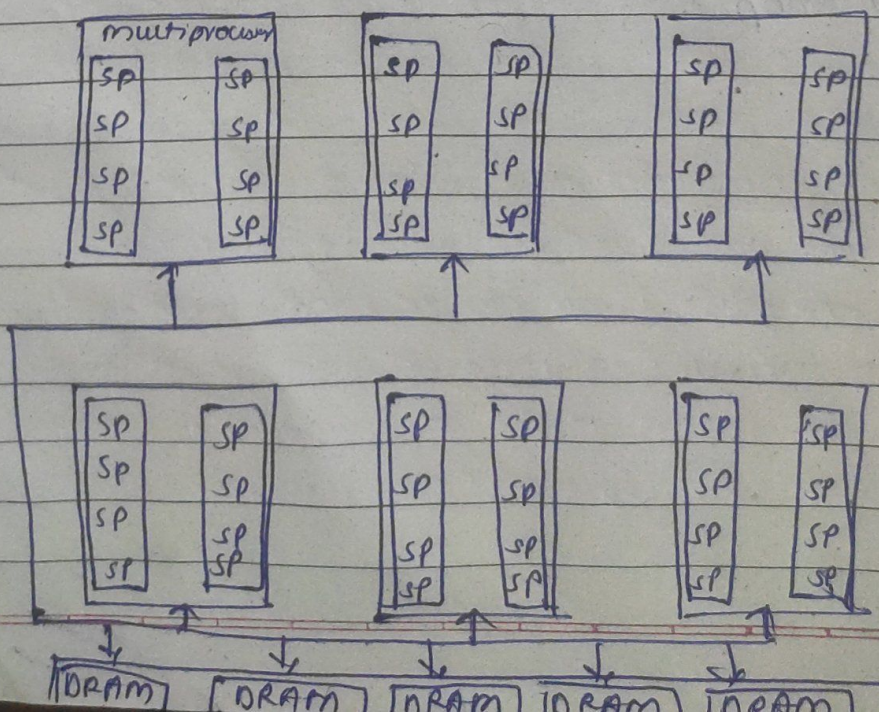
Application of Morphing :-

- It is used in motion picture and animation to create special effects.
- Used to create face and object morphing in advertisement and marketing
- used to know how particular organ will look like after surgery.

5] Draw block diagram of NVIDIA workstation and explain it in brief.

→

Block diagram



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- At a high level, the GPU architecture consists of several streaming multiprocessors (SMs), which are connected to the GPU's DRAM (Dynamic random access memory)

- Each SM has a number of single instruction multiple data (SIMD) units also called stream processors (SPs) and supports a multithreading execution mechanism.

- GPU architecture employ two important execution paradigms:

(i) SIMD / SIMT :-
(single instruction, multiple data) is a parallel computing architecture that performs multiple operation on multiple data elements simultaneously In NVIDIA workstation architecture, SIMD is implemented through technologies like CUDA (Compute Unified Device architecture). CUDA allows developers to write parallel code that can be executed on NVIDIA GPU's taking advantage of their parallel processing capabilities.

(ii) Multithreading :- It envolves executing multiple threads concurrently, In NVIDIA workstation architecture, this typically refers to use multiple CPU threads or GPU threads to perform tasks concurrently. GPU are particularly well-suited for parallel processing, allowing multiple threads to execute simultaneously, improving overall performing.

6] Write algorithm for renaming of segment and draw state table.

→ refer question 3.

7] Write any 4 features of NVIDIA gaming platform.

→ (i) Share your favourite moments :-
NVIDIA allows to record and shares live streaming of game on various social media platforms like youtube, Facebook, etc. NVIDIA shadow play lets you broadcast with a bare minimum performance overhead.

(ii) Ready drivers: For major games, NVIDIA continuosly works on performance-boosting, bug fixing, etc. to improve the gaming experience. NVIDIA game works lets you optimize gameplay and bring you these improvements through game ready driver update. New drivers are automatically notified to user when they are available.

(iii) Capturing - in game photography :-
NVIDIA Ansel photo mode allows you to capture the professional looking high quality photographes of your games. It also allow you to directly share on various social media platforms.

(iv) Freestyle game filters:- NVIDIA freestyle game filter allow you to apply post processing filter on your game while you play. Change the look and mood of your game with tweaks to color or saturation, or apply dramatic post-process filters like HDR. Freestyle is integrated at driver level for seamless compatibility with supported games.

8] Define Keyframe and Animation.

→ Keyframe:

- A key frame in computer graphics is a specific frame in an animation sequence that defines the starting or ending points of smooth transitions.
- It contain essential information about position rotation, scale or other properties of an object at a particular moment.

Animation:-

- An Animation in CG refers to process of creating illusion of motion by displaying a series of images or frames in rapid sucession.
- These frames are often generated through the interpolation of keyframes, allowing for fluid and dynamic movement in digital environments.

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9] Write algorithm to create segment.

→ 1) check whether any segment is open. if so display error message: 'segment is still open' and go to step 9.

2) Read the name of new segment.

3) check whether the new segment name is valid; if not display error message: "Not a valid segment name" and go to step 9

4) check whether the new segment name is already existing in display list; if so display error message: "segment name already exists" and go to step 9.

5) Initialize the start of segment at the next free storage area in display file.

6) Initialize size of segment equal to zero

7) Initialize all attributes of line segment to their default values.

8) Indicate that new segment is now open.

9) stop.

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10] Explain architecture of 1860 processor

12] Write a short note on CMY model and properties of light.

→ **CMY model:**

- In this model cyan, magenta and yellow colors are used as primary colors. This model is used for describing color outputs to hard-copy devices.

- The subset of cartesian co-ordinate system for the CMY model is the same as that for RGB except that white instead of black is at origin.

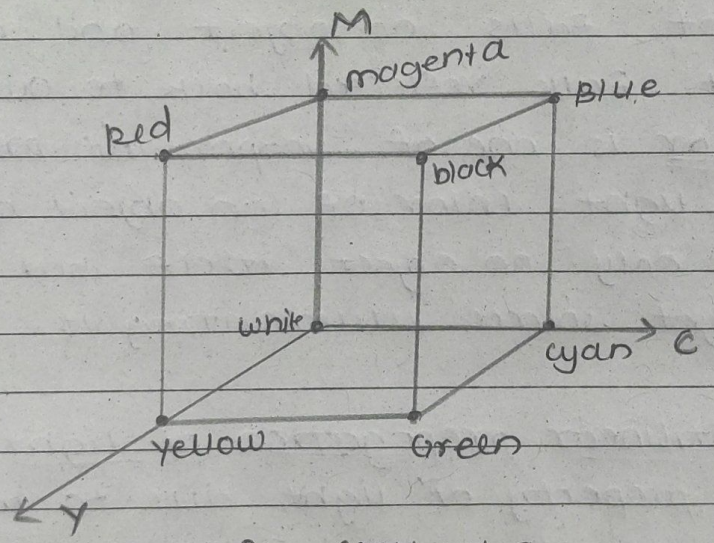

fig. CMY cube

- Colors are specified by what is ~~added~~ removed or subtracted from white light, rather than by what is added to blackness.

- Cyan can be formed by adding green and blue light. Therefore when white light is reflected from cyan colored ink, the reflected light does not have red component. That is red is subtracted or absorbed by ink

- Magenta subtracts the green component from incident light and yellow subtracts the blue component. Therefore cyan, magenta and yellow are said to be components of red, green, blue respectively.

(2) Properties of Light:

- Light is form of energy which helps in sense of vision.
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Q.1 What is fractal? Explain characteristics of Fractal. 6M

→

- The objects which are having smooth surfaces & regular shapes are generally described by using equations. But natural objects such as mountains, tree, ocean, waves & clouds have irregular shapes.

- It will be very difficult to draw there shapes by using normal equations. There are many methods of modeling these natural objects, but one of the most interesting from a mathematical perspective is that of fractals.

- So we can describe natural objects by using fractals, where procedures rather than equations are used to model the objects. Procedurally defined objects have characteristics quite different from objects described with equations.

Characteristics of fractals:

1) Self-similarity
2) Infinite Detail
3) Fractal Dimension
4) Natural occurrence.

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1) Self-similarity:

Fractals display self-similarity, meaning that parts of the object resemble the whole when viewed at different scales. This property repeats infinitely, creating intricate patterns within patterns.

2) Infinite Detail:

Fractals possess an infinite level of detail, no matter how much you zoom in. This characteristic arises from the recursive nature of the mathematical processes used to generate them.

3) Fractal Dimension:

Fractals can have a dimension that is not a whole number. For e.g., a straight line has a dimension of 1, a plane has a dimension of 2, but fractal can have dimension like 1.5, 2.7 etc.

4) Natural Occurrence:

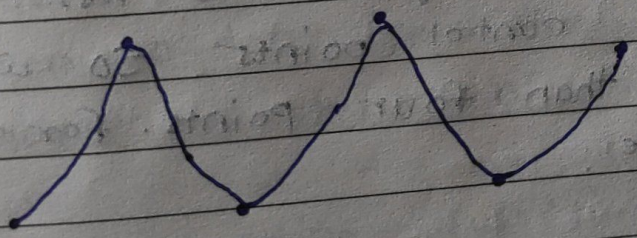
Fractal patterns can be found in various natural phenomena, such as coastlines, clouds, mountains, & biological structures.

Q.2) Write a short note on interpolation & approximation. 4m.

Interpolation:

- The curve is specified by a set of control points. Position of control points controls the shape of the curve. Fitting a single curve of the higher degree to all the control points is difficult. Normally, the big curve is approximated by joining piecewise polynomials of lower degree, which approximates few control points only.

- If the curve passes through the control points, it is called interpolation.
- Interpolation curves are used in animation & specifying camera motion. It is also used in digitizing the coordinates.



a) Interpolation

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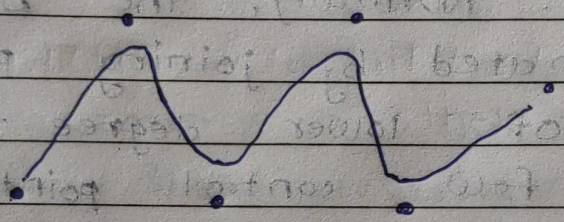
Approximation:

- If the curve does not pass through the control points & approximate the shape, it is called approximation.

Such curves are used to estimate the shape of object surface.



(b) Approximation

Q3. Explain Blending function for B-spline curve. 7m

→

- In the Bezier curve, the degree of the polynomial is always one less than the number of control points. So we cannot have more than four points for cubic Bezier curve.

- Furthermore, change in the single control points has a global effect on Bezier curve.

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- B-spline curves are the most widely used class of curves for approximating the shape due to its following properties.

- Degree of a polynomial is independent of a number of control points (which is not true in case of Bezier curve).
They have local control over the curve & surfaces.

- However, derivation & generation of B-spline are more complex than Bezier curve.

The B-spline curve with (n+1) control points is expressed in the formed of blending function as.

$$P(t) = \sum_{i=0}^{n} Px \cdot B_{i,d}(t), \quad t_{min} \le t \le t_{max}$$

& $2 \le d \le n+1$

For Bezier curve, the range of t was always between 0 & 1. In the B-spline curve, t depends on types of B-spline.

B-spline bending functions $B_{i,d}$ are polynomials with degree $d-1$. Degree d can take any integer value between 2 & number of control points.

We can achieve local control by defining the blending function on subinterval of the total range of parameter t.

Blending functions of Bezier curve are described by Bernstein polynomials, whereas blending functions for B-spline curve are defined using Cox-deBoor recursive formula as shown Below:

$$B_{i,1}(t) = \begin{cases} 1, & \text{if } t_i \le t < t_{i+1} \\ 0, & \text{otherwise} \end{cases}$$

$$B_{i,d}(t) = \frac{t - t_i}{t_{i+d-1} - t_i} B_{i,d-1}(t) + \frac{t_{i+d} - t}{t_{i+d} - t_{i+1}} B_{i+1,d-1}(t)$$

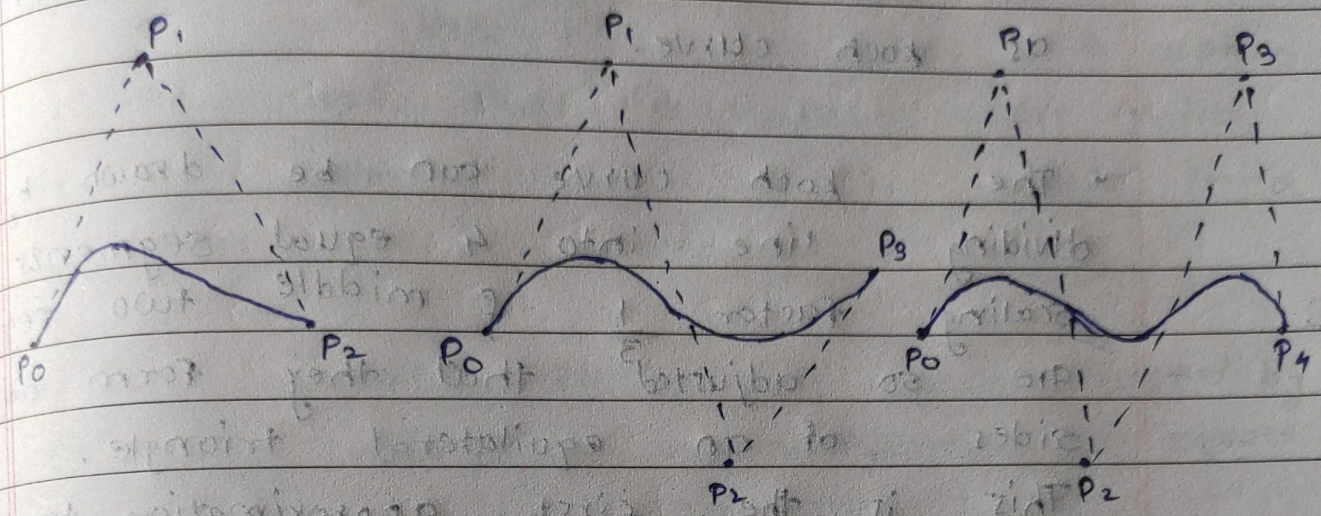
Q4.] Explain Bezier curve. Enlist its properties. 4m

→

Bezier Curve:

- Bezier curve is an another approach for the construction of the curve.
- A Bezier curve is determined by a defining polygon.
- Bezier curve have a number of properties that make them highly useful & convenient for curve & surface design.
- They are also easy to implement. Therefore, Bezier curves are widely available in various CAD systems & in general graphic packages.

- for e.g. three control points generate parbola, four points generate cubic curve & so on.



Properties of Bezier curve:

1) The basis functions are real.
2) Bezier curve always passes through the first & last control points.
3) The degree of the polynomial defining the curve segment is one less than the number of defining polygon point.
4) The curve generally follows the shape of defining polygon.
5) The curve lies entirely within the convex hull formed by four control points.

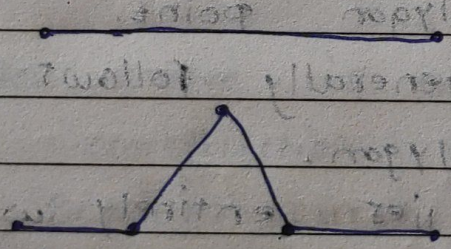
Q.5] Explain koch curve with example. 4m

→

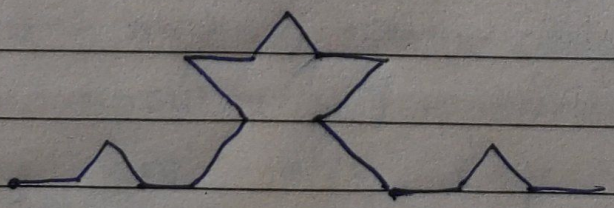
- The koch snow flake curve is also known as koch curve.

- The koch curve can be drawn by dividing line into 4 equal segments with scaling factor $\frac{1}{3}$ & middle two segments are so adjusted that they form adjacent sides of an equilateral triangle. This is the first approximation to the koch curve.

- To apply the second approximation to the koch curve we have to repeat the above process for each of the four segments. The resultant curve is shown in Figure.



First approximation of the koch curve.



The second approximation to koch curve.

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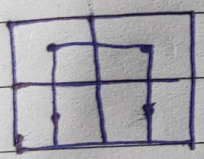
Explain Hilbert curve with example.

Hilbert Curve:

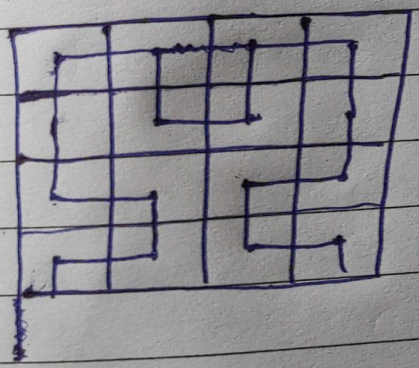
The hilbert curve is a space-filling curve that traverses every point in a square grid, visiting points in a sequential & continuous manner.

- The hilbert's curve can be constructed by following sucessive approximation. The square is divided into four quadrants.

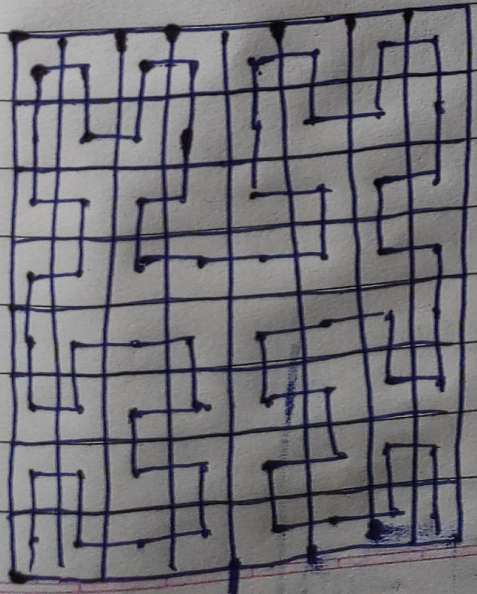
① 

1st approximation

- We can draw 1st approximation to the hibert's curve by connecting centre points of each quadrant.

② 

- The second approximation to the Hilbert's curve can be drawn by further sub-dividing each of the quadrants & connecting their centres before moving to next major quadrant.

③ 

- The 3rd approximation subdivides the quadrant again. We can draw 3rd approximation to Hilbert's curve by connecting the centres of finest level of quadrants before stepping to the next level of quadrant.

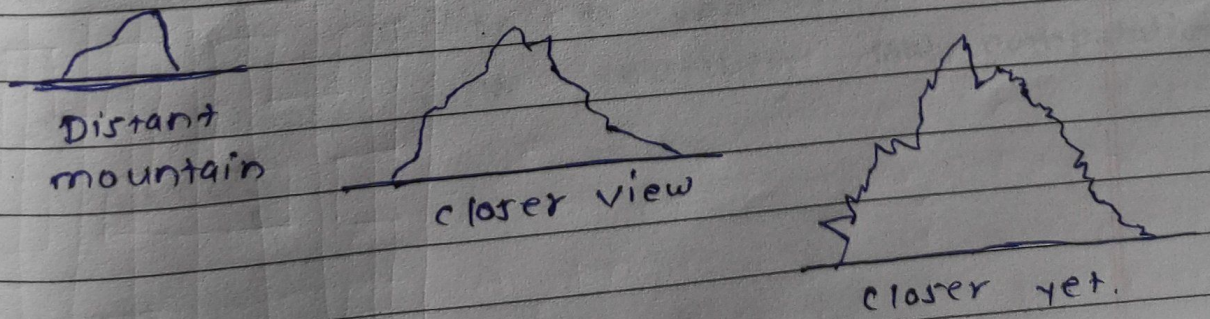
Q7. With suitable example, Write short note on fractal lines.

→ Fractals are infinitely complex patterns that are self-similar across different scales. Natural objects are often fractals, for example tree, mountain, clouds, hurricanes etc.

Fractal objects possess the following 2 properties.
- Infinite detail at every point.
- self-similarity between object parts.

- Natural objects have infinite details, however, we should design a process which produces finite detail because on the computer we cannot display infinite detail.

- After certain level of zoom in, Euclidean shapes lead to smooth drawing. While in the fractal object, if we keep zoom in, we continue to see the same detail as it appears in the original object.



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Q8] ~~Write~~ Derive blending function of beizier curve. How blending function is calculated for cubic polynomial curve.

It →

- We have already seen interpolation technique to generate a smooth curve, it must pass through all sample points.

I

Q.9] Write short note on B-spline curve with suitable example.

- B-spline (Basis spline) curves are widely used in computer graphics to represent smooth & flexible curves. The term "B-Spline curves are defined by a set of control points & a set of basis functions.

- These basis functions, often represented as B-spline basis functions, determine the shape of the curve. The degree of the B-spline curves defines the number of control points influencing a specific portion of the curve, providing control over its smoothness & flexibility.

- One of the key advantages of B-spline curves find applications in areas such as 3D modeling, animation, & is their local control property. Modifying a control point only affects a limited portion of the curve, making them particularly useful for interactive design & editing. B-spline curves are also known for their ability to approximate a wide range of shapes with relatively low computational complexity.