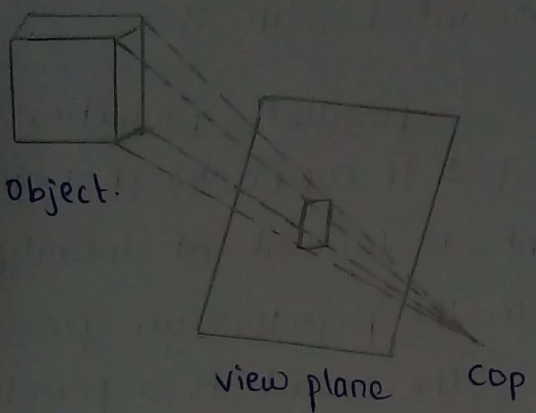
Assignment - 1

1Q. Differentiate between parallel projections, perspective projection and also write matrices associated with it.

Ans:-

Perspective Projection	Parallel projection.
1. If COP [centre of projection] is located at a finite point in 3 space, the result is a perspective projection.	1. If COP [centre of projection] is located at infinity, all the projectors are parallel and the result is a parallel Projection.
2. It is representing or drawing objects which resemble the real thing.	2. It is used in drawing objects when perspective projection cannot be used.
3. It will represent objects in 3-dimensional way.	3. It is much like seeing objects through a telescope, letting parallel light rays in to the eyes which produce visual representations without depth.
4. In this projection objects that are far away appear smaller and objects that are near appear bigger.	4. parallel projection does not create this effect.
5. It requires a distance b/w viewer and the target point	5. In parallel projection the centre of projection is at infinity, while in prospective projection, the centre of projection is at a point.
Types:-	Types:
1. one point perspective	1. orthographic
2. Two point perspective	2. oblique.
3. Three point perspective	

Perspective projection



6. Homogenous matrix form:

$$M = \begin{bmatrix} 1 & 0 & \frac{-x_c}{z_c} & 0 \\ 0 & 1 & \frac{-y_c}{z_c} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & \frac{1}{z_c} & 1 \end{bmatrix}$$

$x = x_c + (x_1 - x_c) \cdot t$

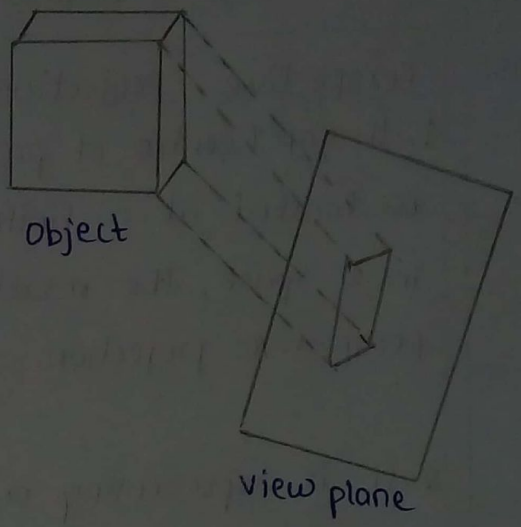
$y = y_c + (y_1 - y_c) \cdot t$

$z = z_c + (z_1 - z_c) \cdot t$

$z = 0 \Rightarrow t = z_c / (z_c - z_1)$

Here, $COP = [x_c \; y_c \; z_c]$

Parallel projection.



6. General parallel projection transformation:

$$\begin{bmatrix} x_s \\ y_s \\ z_s \\ w_s \end{bmatrix} = \begin{bmatrix} 1 & 0 & L_1 \cos\phi & 0 \\ 0 & 1 & L_1 \sin\phi & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix}$$

20, Explain different light sources and differentiate between Ambient light and transparent light.

Ans: Types of light sources:

- Directional light:
  - produced by a light source an infinite distance from the scene., All of the light rays emanating from the light strike the polygons in the scene from a single parallel direction and with equal intensity everywhere.
  - Sunlight is for all intents and purposes a directional light
  - characterized by color, intensity and direction.

- Point light:-

→A light that gives off equal amounts of light in all directions. polygons, and parts of polygons which are closer to the light appear brighter than those that are further away.

→The angle at which light from a point light source hits an object is a function of the positions of both the object and the light source.

→The intensity of the light source hitting the object is a function of the distance b/w them. Different graphic programs may (or may not) allow the programmer to adjust the falloff function in different ways.

o A bare bulb hanging from a chord is essentially a point light.

o charaterized by color, intensity, location, and falloff function.

- Spot light:-

→light that radiates light in a cone with more light in the center of the cone, gradually tapering off towards the sides of the cone. The simplest spotlight would just be a point light that is restricted to a certain angle around its primary axis of direction.

→ Think of something like a flashlight or a car headlight as opposed to a bare bulb hanging on a wire. More advanced spotlights have a falloff function making the light more intense at the center of the cone. and softer at the edges.

o charecterized as a point light, an axis of direction, a radius about that axis and possibly a radial falloff function.

* Ambient light:-

1. Creates the effect of having light hit your object equally from all directions.
2. For a ambient color of a material to be visible, you must have atleast one light with a non-black Ambient color in the picture
3. To ensure that there are no dark sides to your objects, by setting the ambient value of one light in your scene to (0.1, 0.1, 0.1) and the ambient value of your object to their diffuse value.
4. Ambient light is a directionless light that exists in a environment but does not seem to come from a particular source in the environment. An approximation of light that has been reflected so many times that its original source can't be identified
5. Ambient light illuminates all objects in a scene equally.

* Light Transperency :-

→ Light transperency is the physical property of allowing light to pass through the material without being scattered.

30. Explain phong light mode? How it is different from mirag shading?

Ans:- 1. The phong reflection model (also called as phong illumination or phong lighting) is an empirical model of the local illumination of points on a surface. In 3D computer graphics it is sometimes referred to as "phong shading".

2. It describes the way a surface reflects light as a combination of the diffuse reflection of rough surfaces with the specular reflection of shiny surfaces.

3. It is based on phong's informal observation that shiny surfaces have small intense specular highlights, while dull surfaces have large highlights that fall off more gradually

4. The model also includes an ambient term to account for the small amount of light that is scattered about the entire scene.

Ambient + Diffuse + specular = phong reflection.

→ For each light source in the scene, components i_s and i_d are defined as the intensities of the specular and diffuse components of the light sources, respectively.

i_a controls the ambient lighting. It is sometimes computed as a sum of contributions from all light sources.

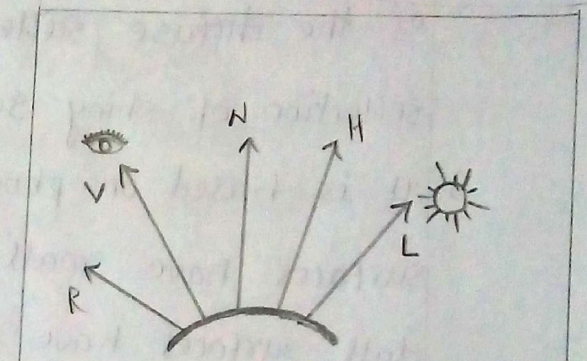
For each material in the siene following parameters are defined.

'k_s' is a specular reflection constant, The ratio of reflection of the specular term of incoming light

- 'k_d' is a diffuse reflection constant, The ratio of reflection of diffuse term of incoming light.
- 'k_a' is an ambient reflection constant, The ratio of reflection of ambient term present in all points in the scene.
- 'α' is shininess constant for this material which is larger for smoother surfaces and more mirror like. When this α is large specular highlight is small.

phong reflection model provides an equation for computing illumination of each surface point I_p:-

$$I_p = k_a i_a + \sum_{m \in \text{light}} [k_d (\hat{L}_m \cdot \hat{N}) i_{m,d} + k_s (\hat{R}_m \cdot \hat{V})^{\alpha} i_{m,s}).$$



Vector for calculating phong shading.

where,

$\hat{L}_m$ - direction vector from point on surface toward light source (m- specifies the light source).

$\hat{N}$ - is the normal at the point on surface.

$\hat{R}_m$ - is the direction that a perfectly reflected ray of light would take from the point on surface.

$\hat{V}$ - Direction pointing towards the user. (i.e, camera).

$\hat{R}_m$ is calculated as reflection of $\hat{L}_m$ on the surface characterized by normal $\hat{N}$. using

$$\hat{R}_m = 2(\hat{L}_m \cdot N)\hat{N} - \hat{L}_m$$

The hats indicate the vectors are normalised

→ The diffuse term is not effected by viewer direction ($\hat{V}$)

→ The specular term is only large when $\hat{V}$ is aligned with direction $\hat{R}_m$. Their alignment is measured by a power of the cosine of the angle blw them.

→ The cosine of the angle blw the normalized vectors $\hat{R}_m$ and $\hat{V}$ is equal to their dot product.

→ When color is represented as RGB values as often in computer graphics, this equation is typically modeled separately for R, G and B intensities. allowing different reflection constants k_a, k_d and k_s for different color channels.

Assignment - 2

(1) What is Rasterization? Antialiasing? oct-tree representation?

Ans:- **Rasterization**:- It is the process by which most modern display system turn electronic data or signals to projected images, such as video or still graphics

→ This is typically a process of identifying the needs of a specific media configuration, then allocating resources so that images are efficiently and optimally projected on the display device.

Antialiasing:- It is a technique used in computer graphics to remove the aliasing effect. The aliasing effect is the appearance of jagged edges or "jaggies" in a rasterized image (an image rendered using pixels).

→ The problem of jagged edges technically occurs due to distortion of the image when scan conversion is done with sampling at a low frequency, which is also known as undersampling.

→ aliasing occurs when real-world objects which comprise of smooth, continous curves are rasterized using pixels.

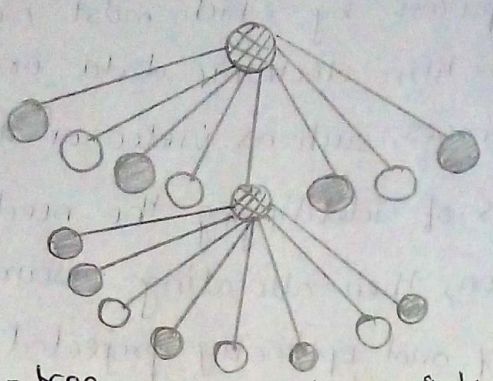
oct-tree Representation:- octtree is a tree data structure where each internal node has 8-children

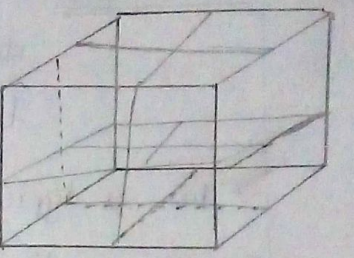
→ An octree is generally used to represent relation b/w objects in a 3D space. It is used in 3D graphics

→ oct trees are also used for nearest neighbour search which can be done easily in logarithmic time.

→ An oct tree save a large amount of space when storing points in a 3D space, especially if the space is sparsely populated.

If there are k points in a 3D cube of dimension N, then space used by the tree is $O(k \log_2 N)$



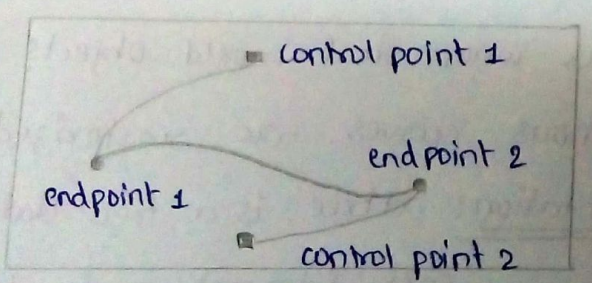


oct-tree represents points in a space.

20) Explain bezier curves? Differentiate blw splines and B-splines?

Ans:- Bezier curve:- A bizier curve is a mathematically defined curve used in two-dimesional graphic applications. The curve is defined by 4 points: the initial positions and the terminating position (which are called "anchors") and two seperate middle points (which are called "handles").

The shape of the bezier curve can be altered by moving the handles.

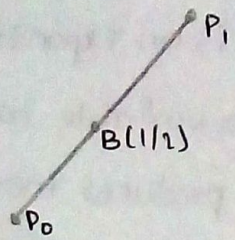


The curve can be represented mathematically as -

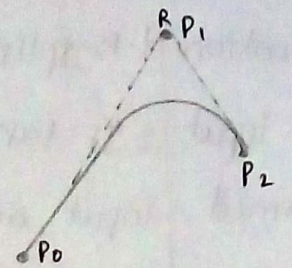
$$\sum_{k=0}^{n} P_i B_i^n(t)$$

where n is polynomial degree, i is the index, and t is the variable.

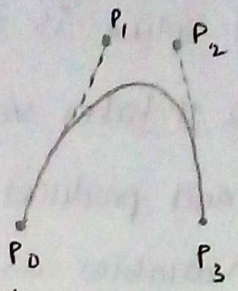
A cubic Bezier curve is determined by four control points.



Simple bezier curve



Quadratic bazier curve



cubic bazier curve.

* Properties of Bazier curves:-

1. They generally follow the shape of the control polygon, which consits of the segments joining the control points.
2. They always pass through the first and last control points.
3. They are contained in the convex hull of their defining control points.
4. The degree of the polynomial defining the curve segment is one less that the number of defining polygon point. Therefore for 4 control points, the degree of the polynomial is 3, i.e, cubic polynomial.
5. A Bezier curve generally follows the shape of the defining polygon.
6. Bezier curve exhibit global control. means moving a control point alters the shape of the whole curve.
7. A given Bazier curve can be divided at a point $t = t_0$ into two Bazier segments which join together at the point corresponding to the parameter value $t = t_0$.

SPLINE	B-SPLINE
1. Spline is a transformation	1. B-spline is an expansion
2. It takes variable as input and produces a transformed variables as output.	2. It takes a variable as input and produces more than one variable as output
3. Internally, with spline, a B-spline basis is used to find the transformation, which is a linear combination of the columns of the B-spline basis.	3. The output variables compose the B-spline basis that is used internally by spline.

30. Explain cubic bazier curves? with applications of splines, bazier curves?

Ans:- A cubic-bezier() function defines a cubic Bezier curve.

A cubic bezier curve is defined by four points P_0, P_1, P_2 and P_3 are the start and the end of the curve and, in CSS these points are fixed as the coordinates are ratios.

P_0 is (0,0) and represents the initial time and the initial state, P_3 is (1,1) represents the final time and final state.