Q 1) The Liang Barsky algorithm is a line clipping algorithm. This algorithm is more efficient than Cohen-Sutherland line clipping algorithm. This algorithm is considered to be faster.

The parametric eqn of a line can be given by:-

$x = x_1 + t(x_2 - x_1)$

$y = y_1 + t(y_2 - y_1)$.

Where t is between 0 & 1.

Then, writing the point-clipping algorithm conditions in the parametric form would be :-

$xw_{min} <= x_1 + t(x_2 - x_1) <= xw_{max}$

$yw_{min} <= y_1 + t(y_2 - y_1) <= yw_{max}$

The above 4 inequalities can be explained as,

$$tp_x \leq q_k \quad \text{where } k = 1, 2, 3, 4.$$

$P_1 = -(x_2 - x_1)$, $q_1 = x_1 - x_{w_{min}}$ (Left boundary)

$P_2 = (x_2 - x_1)$, $q_2 = x_{w_{max}} - x_1$ (Right boundary)

$P_3 = -(y_2 - y_1)$, $q_3 = y_1 - y_{w_{min}}$ (Bottom)

$P_4 = (y_2 - y_1)$, $q_4 = y_{w_{max}} - y_1$ (Top)

When the line is parallel to the view window boundary.

→ When $P_x < 0$ as t increases line goes from outsides to insides.

→ When $P_x > 0$ & $q_x < 0$ then line is trivially invisible because its outside view window.

→ When $P_x = 0$ & $q_k > 0$, then line is inside the corresponding window boundary.

Given $(x_{wmin}, y_{wmin}) = (10, 10)$

$(x_{wmax}, y_{wmax}) = (50, 50)$

.. $P_1 = (30, 60)$ & $P_2 = (60, 20)$

Solution:

Set $U_{min} = 0$ & $U_{max} = 1$

$U_{left} = q_1 / P_1$

$= x_1 - x_{min} / -\Delta x$

$= 20 / -30$

$= -0.67.$

$\boxed{\therefore U_{left} = -0.67}$

$U_{right} = q_2 / P_2$

$= x_{max} - x_1 / \Delta x$

$= 20/30$

$= 0.67$

$\boxed{U_{right} = 0.67}$

$$\upsilon_{bottom} = q_3 / p_3$$

$$= 0.29$$

$$\boxed{\therefore \upsilon_{bottom} = 0.29}$$

$$\upsilon_{TOP} = q_4 / p_4$$

$$= 0.29$$

$$\boxed{\upsilon_{TOP} = 0.29}$$

$\therefore Q - P = (\Delta x, \Delta y) = (30, -35)$

Since $U_{min} \geq U_{max}$, there is no line segment to draw.

Q2.

Sutherland - Hodgeman Polygon clipping is performed by processing the boundary of polygon against each window corner or edge. First of all, entire polygon is clipped against one edge, the resulting polygon is considered, then the polygon is considered against the second edge, so on for all 4 edges.

Shortcomings:-

This method requires a considerable amount of memory. The first of all polygons are stored in original form. Then clipping against left edge done and output is stored.

3) The Weiler- Algorithm is a program-clipping algorithm. It is used in are as like C.G & game development where clipping of polygons is needed It allows clipping of a subject or candidate polygon by an arbitrary shaped clipped polygon/area/ region.

It's generally applicaple in 2D. However it can be used in 3D through visible surface determination with improved efficiency ~~fre~~ through 2-ordering.

This polygon clipping algorithm does not work for itself- intersecting some polygons, although some methods have been proposed to be able to solve the ~~ist~~ issue & have successfully worked.

Q4)

① Translation $P' = P + T$

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

② Scaling $P' = S.P.$

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

③ Scaling with respect to reference point.

$$P' = T^{-1} . S.T.P.$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 & (1-S_x)\,x_r \\ 0 & S_y & 0 & (1-S_y)\,y_r \\ 0 & 0 & S_z & (1-S_z)\,z_r \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

④ Rotation > ⓐ Rotation about X-axis.

$$P' = R_x(\theta).P$$

$$x' = x$$
$$y' = y\cos\theta - z\sin\theta$$
$$z' = y\sin\theta + z\cos\theta.$$

$$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta & 0 \\ 0 & \sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

ⓑ Rotation about Y-axis

$$P' = R_y(\theta).P$$

$$x' = z\sin\theta + x\cos\theta$$
$$y' = y$$
$$z' = z\cos\theta - \overset{x\sin\theta}{\cancel{x\sin\theta}}$$

$$R_y(\theta) = \begin{bmatrix} \cos\theta & 0 & \sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta & 0 & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

> (c) Rotation about Z-axis.

$$P' = R_z(\theta)\, P$$

$$x' = x\cos\theta - y\sin\theta$$

$$y' = \cancel{x} \; x\sin\theta + y\cos\theta$$

$$z' = z.$$

$$R_z(\theta) = \begin{bmatrix} \cos\theta & \sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(5) Reflection

> (a) Ref $(x=0)$

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

(b) Ref $(y=0)$ $= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

(E) Ref (z=0) $= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

5) B-spline curve are independent of the no. of control points & made up of joining the several segments smoothly, where each segment shape is decided by some specific points that come in that region of curve.

Properties:

Sum of any parameter value is 1

Every basic function has one max value, except for K-1

The exhibits the variation diminishing property. The curve generally follows the shape of defining polygon.

Q6) A Bezier curve is a parametric curve used in Graphics & related field. Other uses include the design of computer graphics & animation.

Bezier curve can be combined to form a bezier spline.

Properties:-

It is an approximation curve.

Used in CAD, type face etc.

Easy to implement.

Parametric curve.

Solution:- $Q(t) = T_{B} \cdot G_{B} \cdot M_{B}$

$$= \begin{bmatrix} t^3 & t^2 & t \end{bmatrix} \begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} t^3 & t^2 & t \end{bmatrix} \begin{bmatrix} -4 & 0 \\ 3 & -6 \\ 3 & 6 \\ 1 & 1 \end{bmatrix}$$

$\therefore$ Equation of Bezier curve would be

$$P(t) = \begin{bmatrix} -4t^3 + 3t^2 + 3t + 1 & -6t^2 + 6t + 1 \end{bmatrix}$$

Let us find few points on curve for the given parametric values.

$t(0) = [1, 1]$

$t(0.2) = [1.688, 1.96]$

$t(0.8) = [3.272, 1.96]$

Similarly $t = 1$, $P(1) = [3, 1]$

7) Fractals - They are very complex pictures generated by a computer from a single formula. They are created using iterations. That means 1 formula is repeatedly used with slightly different values over & over again, taking into account the result from previous iteration.

Koch Curve - The Koch snowflake (also known as Koch star), Koch curve is a mathematical curve and one of the earliest practical curves to have been constructible from elementary geometry.

A Koch curve is a fractal generated by a replacement rule. This rule is, at each step, to replace the middle 131/3 of each line segment with two sides of a right angle triangle having sides of length equal to the replaced segment.

This quantity increases without bound. Hence, the Koch curve has infinite length. However, the curve still bounds a finite area.

Q8.

→ Parallel projection:- (Axonometric projections) is a projection of an object in 3-dimensional space onto a fixed plane, known as the projection plane or image plane, where the rays known as lines of right or projection lines are parallel to each other.

Perspective projection:- A form of projection in which a 3-dimensional surface or object is represented as seen from a particular viewpoint, withe parallel lines in the object represented as converging in the image.

Q9.

→ Generally, Computer Animation is a visual digital display technology that processes the moving images on screen. In simple words, it can ~~by~~ be put or defined the art of giving life.

Animation is the technique of designing, drawing, making layouts & presentation of photograhic series which are integrated into the multimedia & gaming products.