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S5 - CSB

109

①

① Given endpoints as A(30,50) to B(40,85)

$\Delta x = 10$; $\Delta y = 35$

$P = 2\Delta y - \Delta x = 60$

$P = \cancel{60}\ P + 2\Delta y - 2\Delta x = 110$

$P = P + 2\Delta y - 2\Delta x = 160$

P_k	x	y
	30	50
60	31	51
110	32	52
160	33	53

The first 3 points in this line are

(31, 51), (32,52), (33, 53)

② The endpoints of the given line is (20,30) and (40,55)

The steps for reflection about this line are

(i) Translate the line to origin

(ii) Rotate the line to coincide with the x-axis

(iii) Reflection about a axis

(iv) Rerotate

(v) Retranslate

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 20 \\ 0 & 1 & 30 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -20 \\ 0 & 1 & -30 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

(7)

(i) Place the triangle in one quadrant

(ii) Rotate and coincide with x-axis

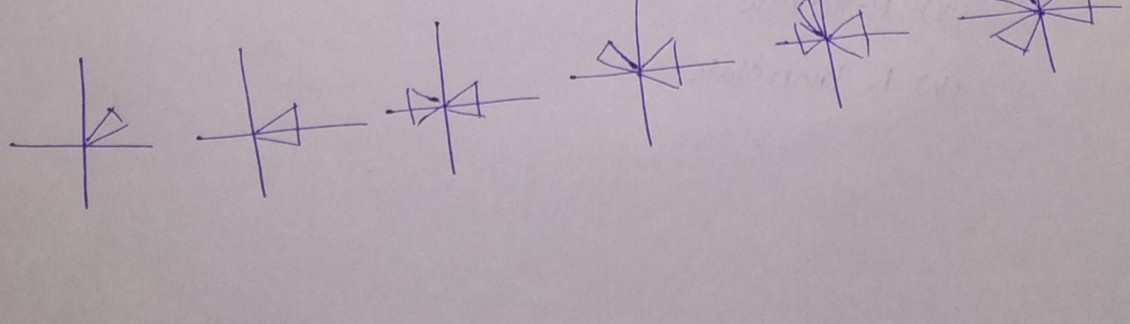
(iii) Reflect about y-axis

(iv) Rotate 2nd triangle 60° ~~ccw~~ about its apex clockwise

(v) Reflect triangle 1 about y-axis

(vi) Rotate triangle 3 about its apex 60°, counter clockwise

(~~##~~)



(3) no. of Control Points = 4

degree Parameter = 3

The entire set of subinterval end Points is called a knot Vector

Here the no: of entries in the knot vector is ~~3~~+3+1 = ~~8~~ 7

$B_{k,d}(u) = B_{k+1,d}(u+\Delta u) = B_{k+2d}(u+\Delta u \cdot 2)$

$B_{0,3}(u) = \frac{1}{2}u^2, \quad 0<=u<=1$

$= \frac{1}{2}u(2-u) + \frac{1}{2}(u-1)(3-u), \quad 1<=u<=2$

$= \frac{1}{2}(3-u)^2, \quad 2<=u<=3$

$B_{1,3}(u) = \frac{1}{2}(u-1)^2, \quad 1<=u<=2$

$= \frac{1}{2}(u-1)(3-u) + \frac{1}{2}(u-2)(4-u), \quad 2<=u<=3$

$= \frac{1}{2}(4-u)^2, \quad 3<=u<=4$

$B_{2,3} = \frac{1}{2}(u-2)^2, \quad 2<=u<=3$

$= \frac{1}{2}(u-2)(4-u) + \frac{1}{2}(u-3)(5-u), \quad 3<=u<=4$

$= \frac{1}{2}(5-u)^2, \quad 4<=u<=5$

$B_{3,3}(u) = \frac{1}{2}(u-3)^2 , \quad 3 <= u <= 4$

$= \frac{1}{2}(u-3)(5-u) + \frac{1}{2}(u-4)(6-u), \quad 4 <= u <= 5$

$= \frac{1}{2}(6-u)^2 , \quad 5 <= u <= 6$

no: of knot vectors $= n + d + 1$

$= \cancel{3} + 3 + 1$

$= 7$ //

(0001 222)

(4) The given lines has endpoints at $P_1(30,50)$ and $P_2(240,285)$

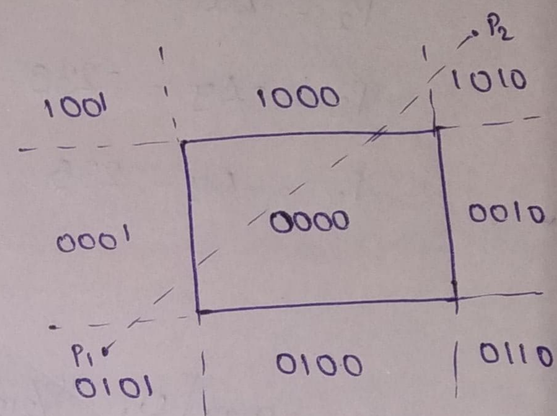
clipping window

$x_{wmin} = 100$ $\quad x_{winmax} = 200$

$y_{wmin} = 100$ $\quad y_{wmax} = 200$

(i) Cohen - Sutherland

$$P_1 \cdot P_2 = \begin{array}{r} 0101 \\ 1010 \\ \hline 0000 \end{array}$$



∵ the result of P_1 AND P_2 is 0000, a part of line is visible and hence, clipping is required

$$m = \frac{\Delta y}{\Delta x} = \frac{235}{210} = 1.119$$

while clipping in the left boundary,

$x = x_{wmin} = 100$

$y = (x_{wmin} - x_0)m + y_0$

$= (100-30) \times 1.119 + 50 = 128.33$

while clipping in the top boundary,

$y = y_{winmax} = 200$

$$x = \frac{(y_{wmax} - y_0)}{m} + x_0 = \frac{200 - \cancel{50}\, 285}{1.19} + \cancel{30}\, 240$$

$= \cancel{156.0504}\ 164.04$

The new endpoints are $(100, 128.33)$ and $(\cancel{156.05}\ 164.04, 200)$

(ii) Liang Barsky

$P_1 = -\Delta x = -210$ $\quad q_1 = x_0 - x_{wmin} = -70$

$P_2 = \Delta x = 210$ $\quad q_2 = x_{wmax} - x_0 = 170$

$P_3 = -\Delta y = -235$ $\quad q_3 = y_0 - y_{wmin} = -50$

$P_4 = \Delta y = 235$ $\quad q_4 = y_{wmax} - y_0 = 150$

$u_1 = \max\left[0, \ 70/210, \ 50/235\right] = 70/210$

$u_2 = \min\left[1, \ 170/210, \ 150/235\right] = 150/235$

$C_1(x) = x_0 + u_1 \Delta x = 30 + \frac{70}{210}[210] = 100$

$C_1(y) = y_0 + u_1 \Delta y = 50 + \frac{70}{210}[235] = 128.33$

$C_2(x) = x_0 + u_2 \Delta x = 30 + \frac{150}{235}[210] = 164.04$

$C_2(y) = y_0 + u_2 \Delta y = 50 + \frac{150}{235}[235] = 200$

The new endpoints are $(100, 128.33)$ and $(164.04, 200)$

1. The endpoint of given line are (30,50) and (40,85)

$\Delta x = 10 \Rightarrow \Delta y > \Delta x, \quad m > 1$

$\Delta y = 35$

~~$2\Delta x$~~ ∴ find

- $2\Delta x = 20$
- $2\Delta x - 2\Delta y = -50$
- $P_0 = 2\Delta x - \Delta y = -15$

∵ $\Delta x = +ve, \quad \Delta y = +ve$ and $m > 1$

the y coordinate will always increment whereas x is ~~ad~~ incremented when P_K is +ve and remains same when $P_K < 0$.

k	P_K	x_{k+1}	y_{k+1}	P_{k+1}
0	-15	30	51	

If $P_K > 0$, then $P_{K+1} = P_K + 2\Delta x - 2\Delta y$

else, $P_{K+1} = P_K + 2\Delta x$

P_K	x	y	
	30	50	$P = 2\Delta x - \Delta y = -15$
-15	30	51	$P = P_K + 2\Delta x = -15+20 = 5$
5	31	52	$P = P_K + 2\Delta x - 2\Delta y = -45$
-45	31	53	

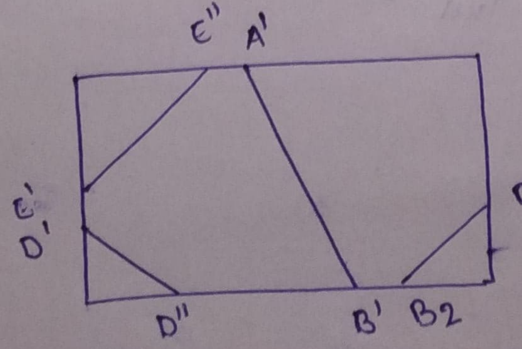
The first 3 Points are

(30,51), (31,52), (31,53)

⑥

	Left	Right	bottom	top
A	B	B'	B''	D''
B	C	C'D	—	D'
C	D	E'D'	D'', D'	E'
D	D'	E'	E'	E''
E	E', A	A	A	A'B₁
		B	B_2	B_2
			B_2B'	B''

clipped Polygon



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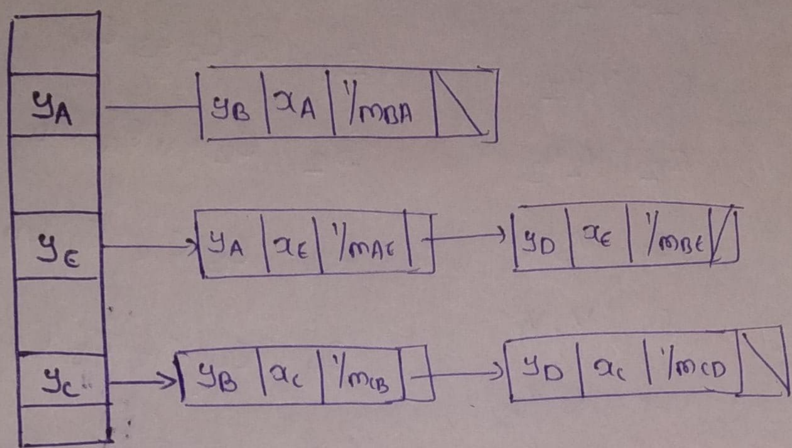
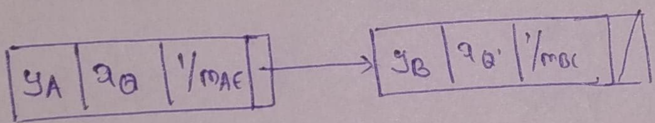


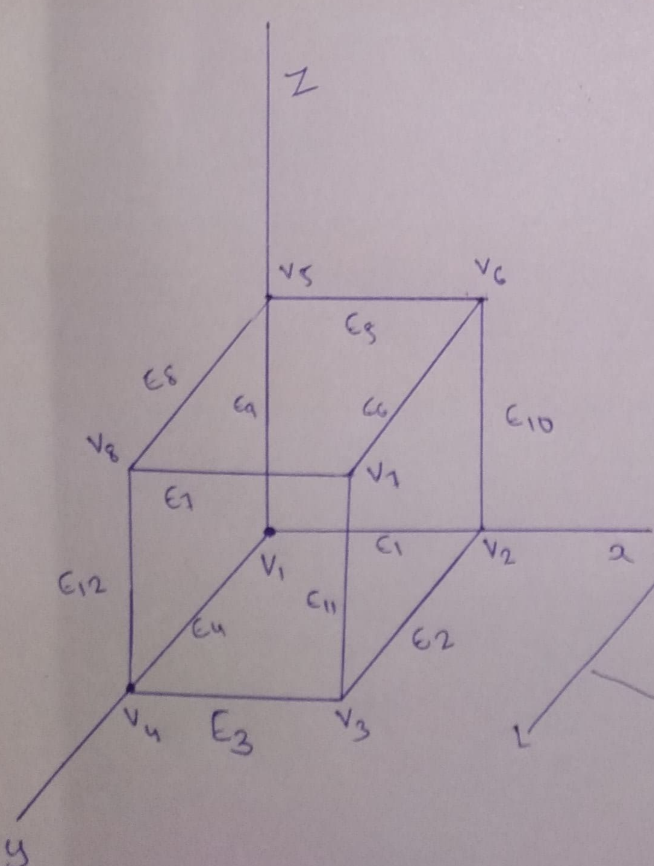
AET

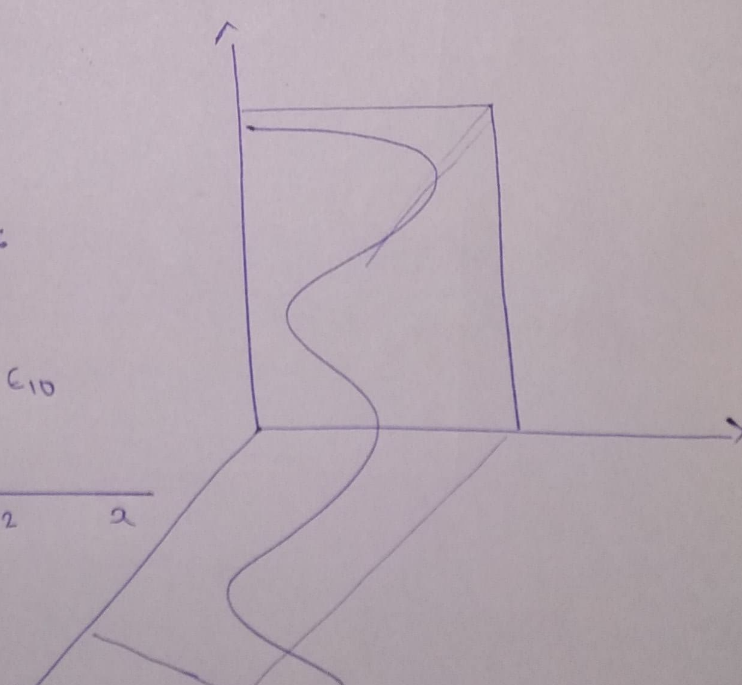
Scanline Q



(8)

Vertex table	Edge table	Surface table
$V_1 = 0,0,0$	E_1 V_1V_2	S_1 $E_1 E_2 E_3 E_4$
$V_2 = 3,0\,0$	E_2 V_2V_3	S_2 $E_2 E_{11} E_6 E_{10}$
V_3 - $3,3,0$	E_3 V_3V_4	S_3 $E_3 E_{12} E_7 E_{11}$
V_4 - $0,3,0$	E_4 V_4V_1	S_4 $E_4 E_{12} E_8 E_9$
V_5 - $0,0,3$	E_5 V_5V_6	S_5 $E_1 E_9 E_5 E_{10}$
V_6 - $3,0,3$	E_6 V_6V_7	S_6 $E_5 E_6 E_7 E_8$
V_7 - $3,3,3$	E_7 V_7V_8	
V_8 - $0,3,3$	E_8 V_8V_5	
	E_9 V_1V_5	
	E_{10} V_2V_6	
	E_{11} V_3V_4	
	E_{12} V_4V_8	





(9)

(i) If all Points of the Polygon is within the area bounds ie

for $P(x_i, y_i)$, $i = 0, 1 \ldots n$

if $\forall x, y \ldots$ $x_{left} < x < x_{right}$ and

$y_{bottom} < y_i < y_{top}$

(ii) If all the Points of the Polygon is outside the area bounds

for $P(x_i, y_i)$ .... $i = 0 \ldots n$

$\forall x, y$ $x_i < x_{left}$ or $x_i > x_{right}$

$y_i < y_{bottom}$ and $y_i > y_{top}$

(iii) if any Point of the Polygon is with the bounded area,

for $P(x_i, y_i)$ $i = 0 \ldots n$

$\forall$ $x_i y_i$ where $x_{left} < x_i < x_{right}$ and

$y_{bottom} < y_i < y_{top}$

(iv) If the bounde area is with the Polygon

for $E(x, y)$ $y = m_i x + c_i$ $i = 0 \ldots n$

whe E_i edge of Polygon

$\forall$ E_i $E_i(x_{left}, y_{bottom})$, $E_i(x_{left}, y_{top})$ $E_i(x_{right}, y_{bottom})$

$E_i(x_{right}, y_{top})$ are all of same sign

(11) we have Point $(30,40,10)$ $(50,100,50)$ and $(150,50,10)$

Let eq of Surface be $Ax+By+Cz=-1$

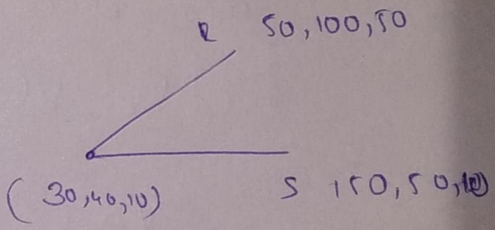
Then substitute and solving the eqn, we get

$A = 1/275$ $B = -12/275$ $C = 7/110$

$\cancel{\vec{QR} = 30\hat{i} +}$

$\vec{QR} = 20\hat{i} + 60\hat{j} + 40\hat{k}$ $\vec{QS} = 120\hat{i} + 10\hat{j} + 0\hat{k}$

$$\vec{QR} \times \vec{QS} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 20 & 60 & 40 \\ 120 & 10 & 0 \end{vmatrix}$$



$$= -4\hat{i} + 45\hat{j} - 70\hat{k}$$

$$= -2\hat{i} + 24\hat{j} - 35\hat{k} = n$$

$\vec{QP} = (x-30)\hat{i} + (y-40)\hat{j} + (z-10)\hat{k}$, v

$\therefore$ $n.v = -2(x-30) + 24(y-40) + (z-10)(-35) = 0$

eqn of normal $= -2x + 24y - 35z = 550$

eqn of Surface $= x/275 - y/275 - 7z/110 = -1$

(12) The surface eqn of the given surface

$$x/275 - y/275 + 7z/110 + 1 = 0$$

Consider the line joining (50, 50, 50) to (0,0,0)

Direction vector ⇒ (50, 50, 50)

eqn of the line $x/50 = y/50 = z/50$

$$x/50 + y/50 - 2z/50 = 0$$

$$x + y - 2z = 0 \Rightarrow \hat{i} + \hat{j} - 2\hat{k} \quad (1, 1, -2)$$

Viewing vector, $V = \hat{i} + \hat{j} - 2\hat{k}$

normal vector, $n = -2\hat{i} + 24\hat{j} - 35k$

$$V.n = -2 + 24 + 70 = 92 > 0$$

∴ the Polygon is back face

(14) Tests for identifying backface using Pantoi's algorithm

(i) The bounding rectangles in the xy direction for the two surfaces do not overlap. The overlap in x direction is checked first and then y direction. If there is no overlap in any of the direction, then order is correct

(ii) Surface S is completely behind the overlapping surface relative to the view position. This can be checked by substituting the vertices of S in S' and seeing that all the vertices are behind S'

(iii) The overlapping surface S' is completely in front of S relative to the viewing position

(iv) The boundary edge projections of the 2 surfaces onto view plane do not overlap

If all the test fails, then the surfaces S and S' are to be reordered.

The given figure is