3/3/20

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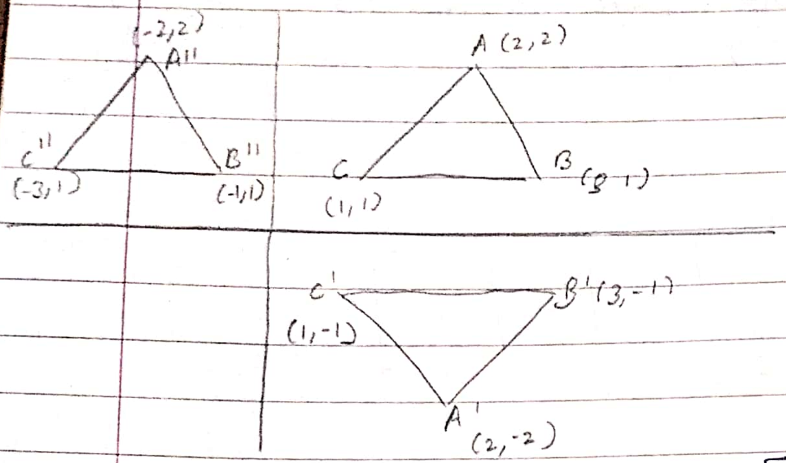
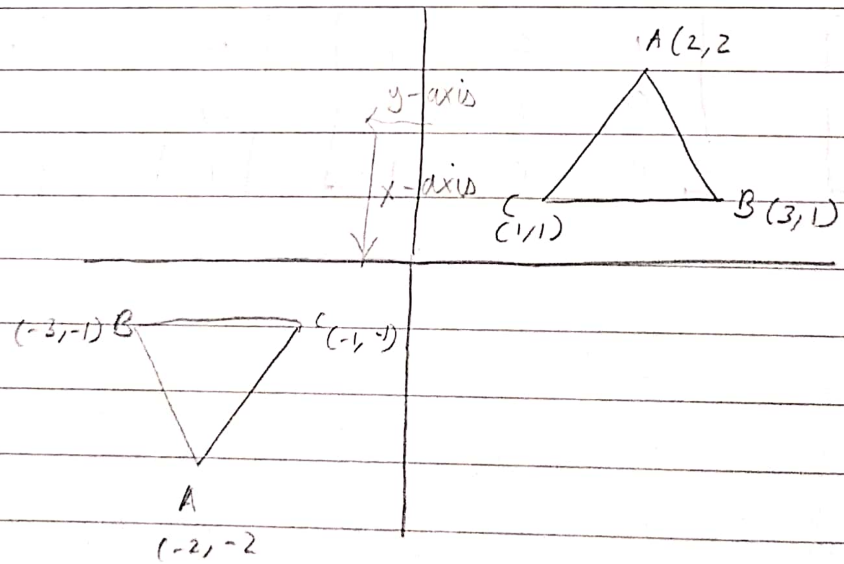
Reflection



Reflection about x-axis $= \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}_{3\times 3}$ IV quadrant $-y$

Reflection about y-axis $= \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ II quadrant $-x$



Reflection about the origin $= \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}_{3\times 3}$ III quadrant $-x, -y$

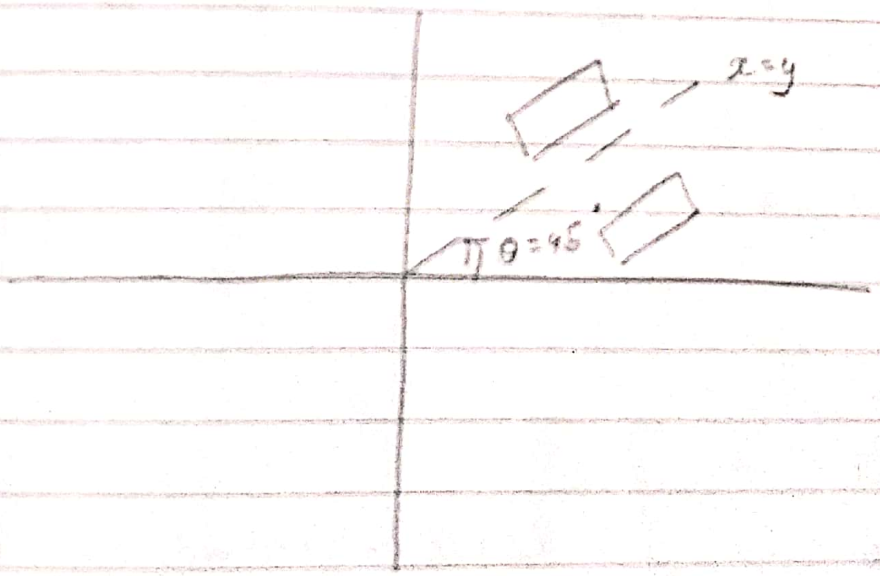
Ex A(1, 1) B (2, 3) C (4, 2)

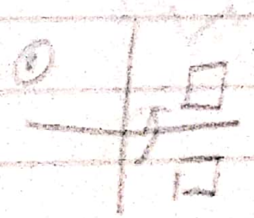
- Reflection about origin [P]

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

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} -2 \\ -3 \\ 1 \end{bmatrix} = (-2, -3)$$

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} -4 \\ -2 \\ 1 \end{bmatrix} = (-4, -2)$$





① $R(-\theta)$ $\theta = 45°$
② Reflection about x axis
③ $R(\theta)$

$[R\theta]$ [Reflection x-axis] $[R(-45°)]$ = [ ]

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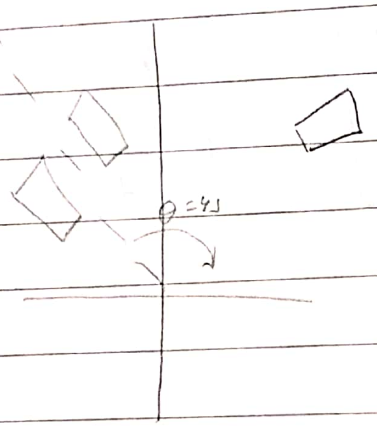
$$\begin{bmatrix} \cos 45^\circ & -\sin 45^\circ & 0 \\ \sin 45^\circ & \cos 45^\circ & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-45)^\circ & -\sin(-45) \\ \sin 45 & \cos 45 \\ 0 & 0 & 1 \end{bmatrix}$$

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

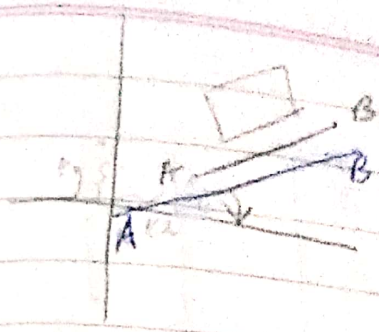


① $R(-\theta)$

② Reflection about y-axis

③ $R(\theta)$

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \text{Reflection about } x = -y$$



- Translation (t_x, t_y)
  Rotation (θ)
  Reflection about x axis
  $R(-\theta)$
  $T(-t_x, -t_y)$

Flip the quadrilateral about x-axis. given $(10,8)$ $(22,8)$ $(34,17)$, $(10,27)$

Reflection about x-axis, y-axis

- Reflection about x axis:

$(10,8)$ $$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 10 \\ 8 \\ 1 \end{bmatrix} = \begin{bmatrix} 10 \\ -8 \\ 1 \end{bmatrix} = (10,-8)$$

$(22,8)$ $$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 22 \\ 8 \\ 1 \end{bmatrix} = \begin{bmatrix} 22 \\ -8 \\ 1 \end{bmatrix} = (22,-8)$$

$(34,17)$ $$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 34 \\ 17 \\ 1 \end{bmatrix} = \begin{bmatrix} 34 \\ -17 \\ 1 \end{bmatrix} = (34,-17)$$

$(10,27)$ $$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 10 \\ 27 \\ 1 \end{bmatrix} = \begin{bmatrix} 10 \\ -27 \\ 1 \end{bmatrix} = (10,-27)$$

Reflection about y axis :

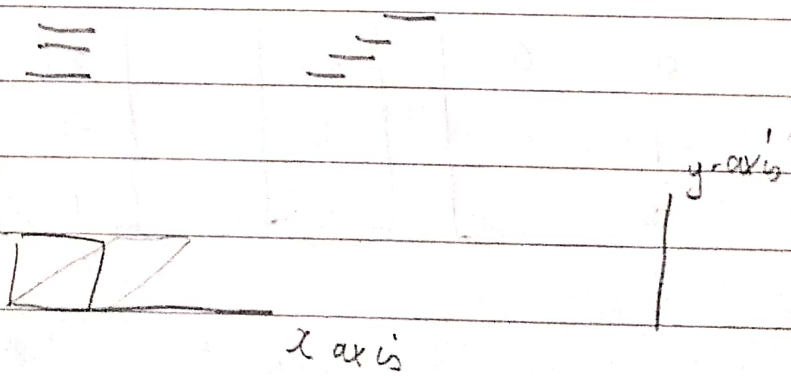
$(10, 8)$ $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -10 \\ 8 \\ 1 \end{bmatrix} = \begin{bmatrix} -10 \\ 8 \\ 1 \end{bmatrix} = (-10, 8)$

$(22, 8)$ $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -22 \\ 8 \\ 1 \end{bmatrix} = \begin{bmatrix} -22 \\ 8 \\ 1 \end{bmatrix} = (-22, 8)$

$(34, 17)$ $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -34 \\ 17 \\ 1 \end{bmatrix} = \begin{bmatrix} -34 \\ 17 \\ 1 \end{bmatrix} = (-34, 17)$

$(10, 27)$ $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -10 \\ 27 \\ 1 \end{bmatrix} = \begin{bmatrix} -10 \\ 27 \\ 1 \end{bmatrix} = (-10, 27)$

SHEAR



Date:

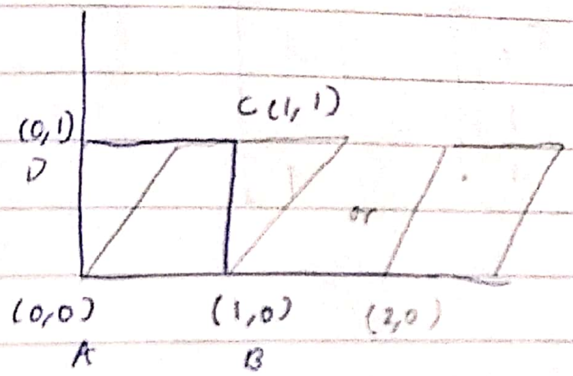
YOUVA

x - direction shear relative to x axis

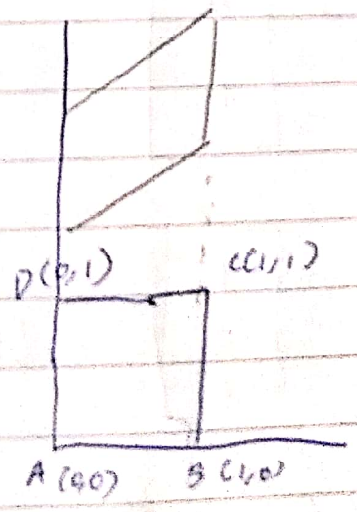
$$\begin{bmatrix} 1 & sh_x & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

y direction shear relative to y-axis

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & sh_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



y values remain same



ex ~~shy = 0.5~~ $sh_x = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $Sh_y = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

x - direction shear relative to x - axis

A
$$\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = (0,0)$$

B
$$\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = (1,0)$$

C
$$\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix} = (3,1)$$

D
$$\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} = (2,1)$$

y - direction shear relative to y axis

A
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = (0,0)$$

B
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = (1,0)$$

C
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0.5 \\ 1 \end{bmatrix} \quad (1,0.5)$$

D
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0.5 \\ 1 \end{bmatrix} \quad (0,0.5)$$

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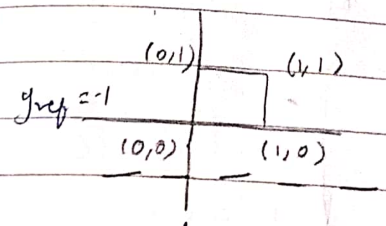
x- direction shear relative to other reference lines.
$\downarrow$
$y = y_{ref}$

$$= \begin{bmatrix} 1 & sh_x & -sh_x\, y_{ref} \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

y- direction shear relative to other reference line
$\downarrow$
$x = x_{ref}$

$$= \begin{bmatrix} 1 & 0 & 0 \\ sh_y & 1 & -sh_y\, x_{ref} \\ 0 & 0 & 1 \end{bmatrix}$$

1.



$sh_y = 1/2, \quad x_{ref} = -1$

$sh_x = 2$

-. x direction shear relative to other ref line

$$= \begin{bmatrix} 1 & 2 & -2 \times -1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 1 \end{bmatrix} = (2, 0)$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 4 \\ 1 \\ 1 \end{bmatrix} = (4, 1)$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 5 \\ 1 \\ 1 \end{bmatrix} = (5, 1)$$

Date:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 0 \\ 1 \end{bmatrix} = (3,0)$$

y - direction shear relative to other reference line $= \begin{bmatrix} 1 & 0 & 0 \\ 1/2 & 1 & -1/2 x_{ref} \\ 0 & 0 & 1 \end{bmatrix}$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 1/2 & 1 & 1/2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1/2 \\ 1 \end{bmatrix} = (0, 0.5)$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 1/2 & 1 & 1/2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1.5 \\ 1 \end{bmatrix} = (0, 1.5)$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0.5 & 1 & 0.5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = (1, 2)$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0.5 & 1 & 0.5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = (1, 1)$$

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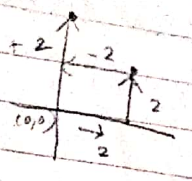
Composite Transformations

① Translation



$$\begin{bmatrix} 1 & 0 & tx_1 \\ 0 & 1 & ty_1 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & tx_2 \\ 0 & 1 & ty_2 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & tx_1+tx_2 \\ 0 & 1 & ty_1+ty_2 \\ 0 & 0 & 1 \end{bmatrix}$$

Given 2 successive translation vectors tx_1, ty_1 & tx_2, ty_2 that are applied to a coordinate position P, then

$$P' = \{T_{(tx_2, ty_2)} \; T_{(tx_1, ty_1)}\} \cdot P$$
$$= T_{(tx_2+tx_1,\ ty_2+ty_1)} \cdot P$$

② Rotation

$$\begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 \\ \sin\theta_2 & \cos\theta_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \cos(\theta_1+\theta_2) & -\sin(\theta_1+\theta_2) & 0 \\ \sin(\theta_1+\theta_2) & \cos(\theta_1+\theta_2) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$R' =$

The 2 successive rotations apply to a point P produced the transform positions

$$P' = \{R(\theta_2) \cdot (R\theta_1)\} \cdot P$$
$$= R(\theta_2+\theta_1) \cdot P$$

③ Scaling

$$\begin{bmatrix} Sx_2 & 0 & 0 \\ 0 & Sy_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} Sx_1 & 0 & 0 \\ 0 & Sy_1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Sx_2 \cdot Sx_1 & 0 & 0 \\ 0 & Sy_2 \cdot Sy_1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$P' = \{S_{(Sx_2, Sy_2)} \cdot S_{(Sx_1, Sy_1)}\} \cdot P$$
$$= S(Sx_2 \cdot Sx_1,\ Sy_2 \cdot Sy_1) \cdot P$$

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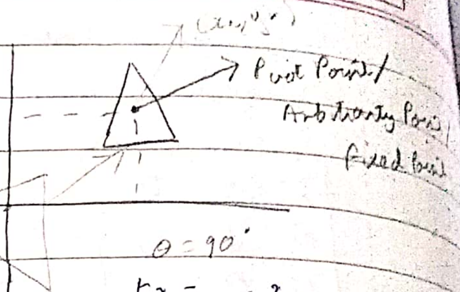
(4) General - Pivot Rotation

$$\begin{bmatrix} 1 & 0 & x_r \\ 0 & 1 & y_r \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -x_r \\ 0 & 1 & -y_r \\ 0 & 0 & 1 \end{bmatrix}$$



$t_x = -x_r$ $t_x = x_r$

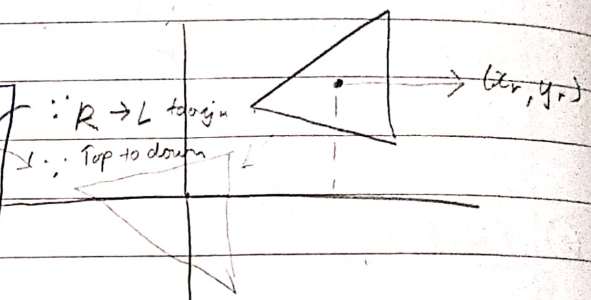
$t_y = -y_r$ $t_y = y_r$

(5) General Fixed Point Scaling

$$\begin{bmatrix} 1 & 0 & x_r \\ 0 & 1 & y_r \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} s_{x_1} & 0 & 0 \\ 0 & s_{y_1} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -x_r \\ 0 & 1 & -y_r \\ 0 & 0 & 1 \end{bmatrix}$$

$\because R \rightarrow L$ to origin

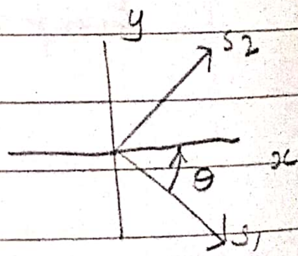
$\therefore$ Top to down



$$= \begin{bmatrix} s_{x_1} & 0 & x_r \\ 0 & s_{y_1} & y_r \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -x_r \\ 0 & 1 & -y_r \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} s_{x_1} & 0 & \cancel{s_{x_1}}\, x_r(1-s_x) \\ 0 & s_{y_1} & y_r(1-s_y) \\ 0 & 0 & 1 \end{bmatrix}$$

(6) General Scaling Direction



$$\begin{bmatrix} \cos(-\theta) & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} s_1 & 0 & 0 \\ 0 & s_2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} s_1\cos^2\theta + s_2\sin^2\theta & (s_2 - s_1)\cos\theta\sin\theta & 0 \\ (s_2 - s_1)\cos\theta\cdot\sin\theta & s_2\cos^2\theta + s_1\sin^2\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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Given points $A = (0,0)$, $B(1,0)$, $C(1,1)$ $D(0,1)$
Scale the object S_1 by 1, S_2 by 2 where S_1 is at angle of 45° with respect to x-axis.

$$= \begin{bmatrix} S_1 \cos^2\theta + S_2 \sin^2\theta & (S_2 - S_1)\cos\theta \sin\theta & 0 \\ (S_2 - S_1)\cos\theta \sin\theta & S_2\cos^2\theta + S_1 \sin^2\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1.\frac{1}{2} + 2.\frac{1}{2} & (2-1)\frac{1}{2} & 0 \\ (2-1).\frac{1}{2} & 2.\frac{1}{2} + \frac{1}{2}.1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cancel{1.5}\ 3/2 = 1.5 & 0.5 & 0 \\ 0.5 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

A $\begin{bmatrix} 1.5 & 0.5 & 0 \\ 0.5 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = (0,0)$

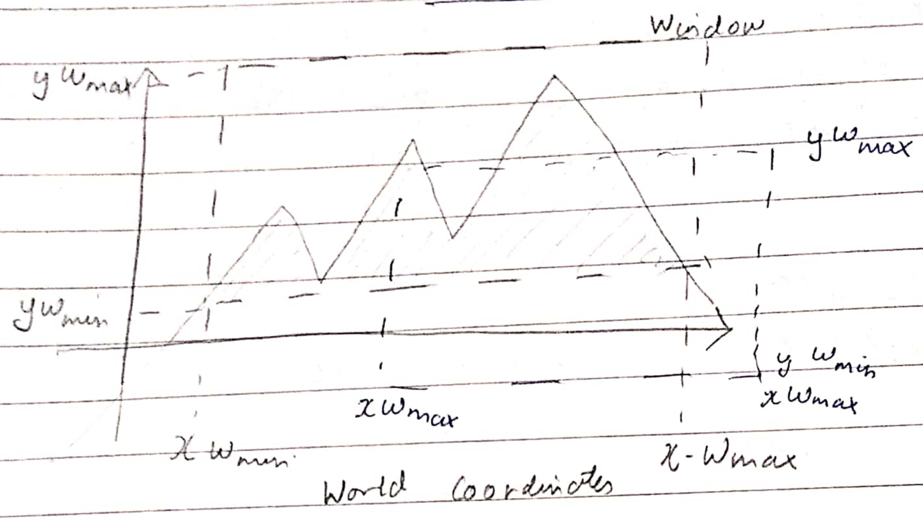
B $\begin{bmatrix} 1.5 & 0.5 & 0 \\ 0.5 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1.5 \\ 0.5 \\ 1 \end{bmatrix} = (1.5, 0.5)$

C $\begin{bmatrix} 1.5 & 0.5 & 0 \\ 0.5 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ \cancel{0}1 \\ 1 \end{bmatrix} = \begin{bmatrix} \cancel{1.5}\ 2 \\ \cancel{0.5}\ 2 \\ 1 \end{bmatrix} = (2,2)$

D $\begin{bmatrix} 1.5 & 0.5 & 0 \\ 0.5 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 1.5 \\ 1 \end{bmatrix} = (0.5, 1.5)$

6/3/20

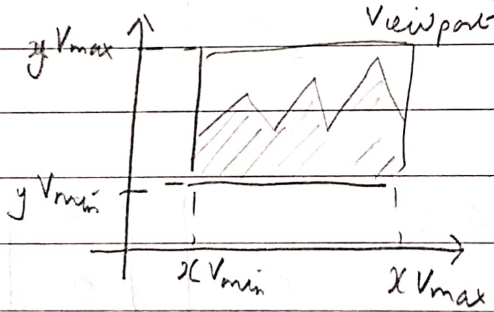
2-D VIEWING



(Transfering an image from world co-ordinate system to device co-ordinate system → 2-D Viewing Transformation.

Window - Tells the area to be captured

Viewport - tells Where it has to ~~de~~ be displayed on display device)



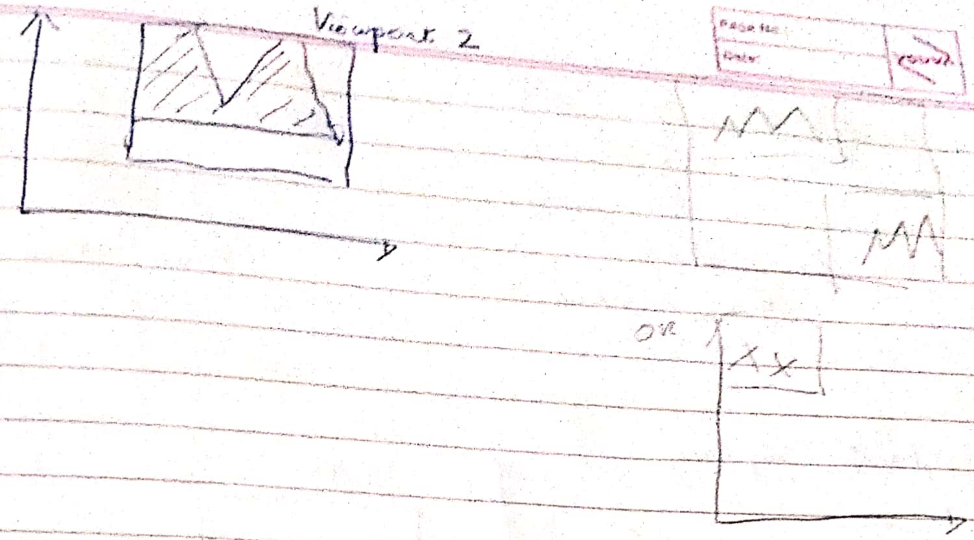
Window

A world coordinate area selected for display is called a window

Viewport

An area on a display device ~~a~~ to which a window is mapped

Mapping of point of world coordine scene to device coordinates is ~~refe~~ ref to as device transformation.



2D Viewing transformation Pipeline

Construct world coordinate scene using Modeling coordinate transformation $\xrightarrow{WC}$ Convert World coordinate to Viewing Coordinate $\xrightarrow{VC}$ Map Viewing coordinates to Normalized Viewing coordinates using (0, 1). Window - Viewpoint Specifications $\xrightarrow{NVC}$ Map Normalized Viewport to Device Coordinates $\rightarrow$ DC

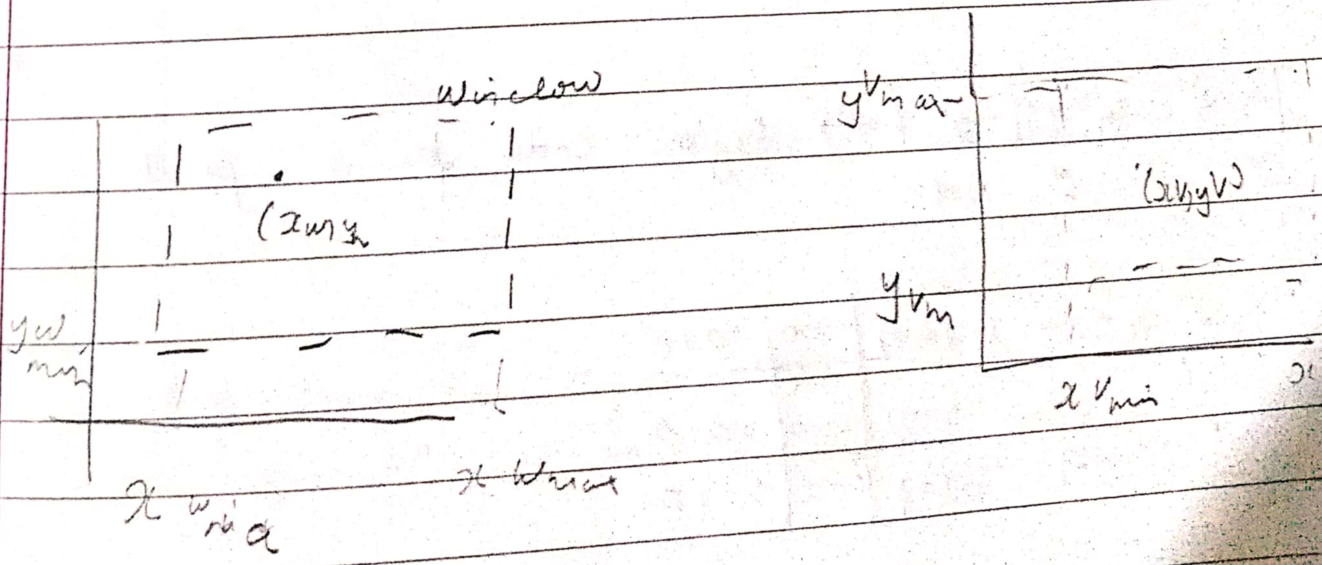
MC - Modelling coordinates

WC - World coordinates

VC - Viewing coordinates

NVC - Normalized Viewing Coordinates

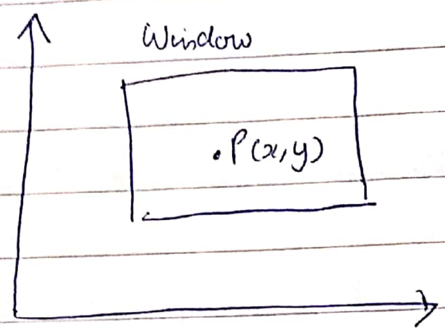
DC - Device coordinates.



$$\frac{xv - xv_{min}}{xv_{max} - xv_{min}} = \frac{xw - xw_{min}}{xw_{max} - xw_{min}}$$

$$\frac{yv - yv_{max}}{yv_{max} - yv_{min}} = \frac{yw - yw_{max}}{yw_{max} - yw_{min}}$$

Point Clipping



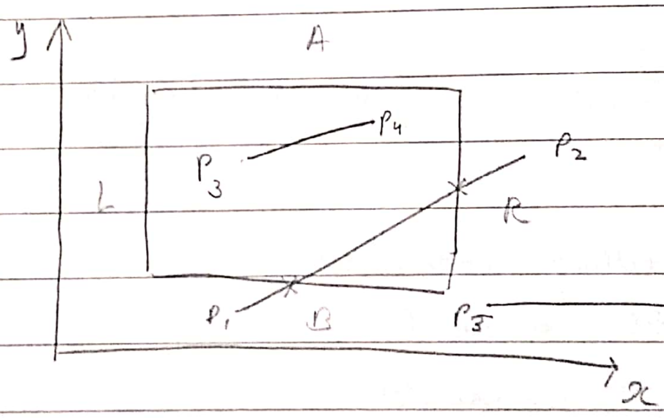
$x < xw_{max}$

$x > xw_{min}$

$y < yw_{max}$

$y > yw_{min}$

Line Clipping



Cohen - Sutherland Line Clipping

Above	Bottom	Right	Left
4	3	2	Bit 1

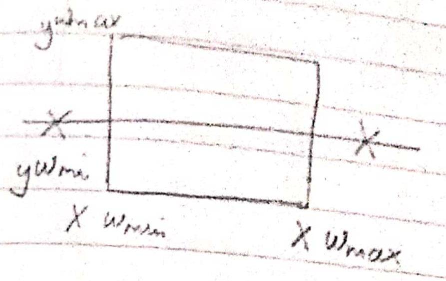
→ Region code for a point.

$P_2 = 1010$

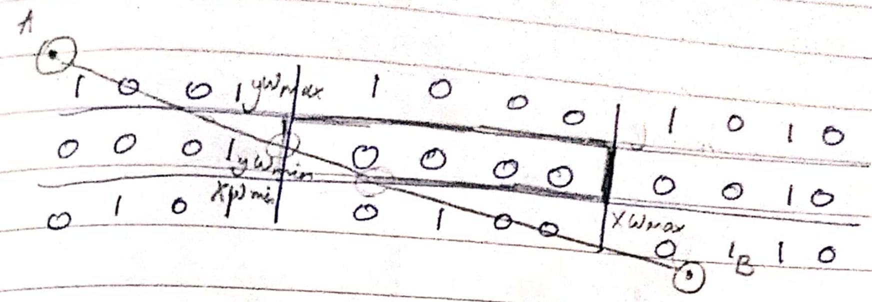
$P_1 = 0100$

1001	1000	1010
0001	0000	0010
0101	0100	0110

COHEN SUTHERLAND LINE CLIPPING



Clipping - discarding unwanted part (outside the window)



	1 0 0 1	→ Region Code for A
(AND)	0 1 1 0	→ Region Code for B
	0 0 0 0	

$x = xW_{min}$

$y = ?$

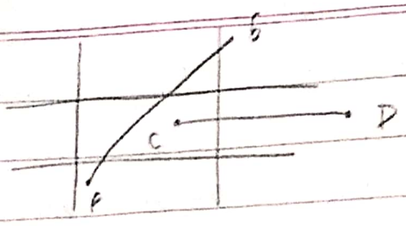
$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Replace $(x_2, y_2) \rightarrow (x, y)$

$$m = \frac{y - y_1}{x - x_1}$$

$$y - y_1 = m(x - x_1)$$

☆ (If any point has region code = 000, then no perform AND operatⁿ → directly clipping)



C = 0000

D = 0010

$x = xw_{max}$

$y = y_1 + m(x - x_1)$

E = 1010

F ⇒ 0100

0000 — ∴ 0000 ∴ it can be partially present or visible

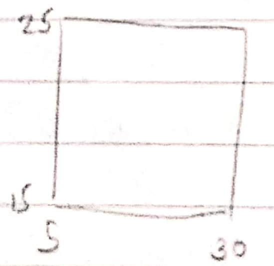
$m = \frac{y_2 - y_1}{x_2 - x_1}$

Replace (x_2, y_2)

(x, y)

$$\boxed{\begin{array}{l} y = \cancel{wy}\ \ yw_{max} / yw_{min} \\ x = x_1 + \frac{y - y_1}{m} \end{array}}$$

1. Clip the line with the coordinates $(x_1, y_1) = (2, 20)$ & $(x_2, y_2) = (10, 15)$ 2,2 $W_L = 5$ $W_R = 30$ $W_B = 15$ $W_T = 25$



Region Code for $(x_1, y_1) = (2, 20)$

Bit 1: $x - xw_{min} = x - W_L = 2 - 5 = -3 \Rightarrow -ve \Rightarrow 1$

Bit 2: $xw_{max} - x = W_R - x = 30 - 2 = 28 \Rightarrow +ve \Rightarrow 0$

Bit 3: $y - yw_{min} = y - W_B = 20 - 15 = 5 \Rightarrow +ve \Rightarrow 0$

Bit 4: $yw_{max} - y = W_T - y = 25 - 20 = 5 \Rightarrow +ve \Rightarrow 0$

Region code is $\boxed{0001}$

Region Code for $(x_2, y_2) = (10, 15)$

Bit 1 ; $x - xW_{min} = x - W_L$

Bit 2 : $xW_{max} - x = W_R - x = 10 - 5 = 5 \Rightarrow +ve \Rightarrow 0$

Bit 3 : $y - yW_{min} = y - W_B = 30 - 10 = 20 \Rightarrow +ve \Rightarrow 0$

Bit 4 : $yW_{max} - y = W_T - y = 15 - 15 = 0 \Rightarrow +ve \Rightarrow 0$

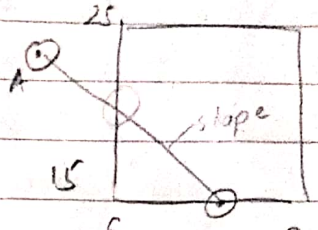
$25 - 15 = 15 \Rightarrow +ve \Rightarrow 0$

Region code is $\boxed{00001}$

∴ Since Region Code for 1st point is non-zero value (ie. 0001, ∴ Perform left clipping).

To find Intersection Point

$x = \cancel{xW_{max}}$ / for right / xW_{min} / for left $= 5$



$y = y_1 + m(x - x_1)$

$= 15 - \frac{5}{8}(5 - 10)$

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{15 - 20}{10 - 2} = -\frac{5}{8}$

$= 18.125$

$(5, 18.125)$

Region Code for $(x_1', y_1') = (5, 18.125)$

Bit 1 : $x - xW_{min} = x - W_L = 5 - 5 = 0 \Rightarrow +ve \Rightarrow 0$

Bit 2 , $xW_{max} - x = W_R - x = 0 - 5 = 25 \Rightarrow +ve \Rightarrow 0$

Bit 3 , $y - y_{min} = y - W_B = 18.125 - 15 = 3.125 \Rightarrow +ve \Rightarrow 0$

Bit 4 : $yW_{max}\ y = W_T - y = 25 - 18.125 = 7.875 \Rightarrow +ve \Rightarrow 0$

Region Code for point 1 is 0000 & Region Code for second pt 0000.
Hence we have clipped the line segment

Date:

2. $(x_1, y_1) = (2, 16)$ $(x_2, y_2) = (10, 15)$

Region code for $(x_1, y_1) = (2, 16)$

Bit 1 = $x - xw_{min}$ = $x - W_L$ = ~~10~~ 2 − 5 = −3 ⇒ −ve ⇒ 1

Bit 2 = $xw_{max} - x$ = $W_R - x$ = 30 − 2 = +28 ⇒ +ve ⇒ 0

Bit 3 = $y - yw_{min}$ = $y - W_B$ = 16 − 15 = ~~25~~ 1 ⇒ +ve ⇒ 0

Bit 4 = $yw_{max} - y$ = $W_T - y$ = 25 − 16 = 9 ⇒ +ve ⇒ 0

∴ Region code is 1010

Region code for $(x_2, y_2) = (10, 15)$

Bit 1 : $x - xw_{min}$ = $x - W_L$ = 10 − 5 = 5 1

Bit 2 : $xw_{max} - x$ = $W_R - x$ = 30 − 5 : 25 0

Bit 3 : $y - yw_{min}$ · $y - W_B$ = 15 − 15 = 0 1

Bit 4 = $yw_{max} - y$ = $W_T - y$ = 25 − 15 = 10 0

∴ Region code is 0101

~~1 0 0 0~~
~~0 1 0 1~~
~~0~~

0 0 0 1
0 1 0 1
0 0 0 1

∴ The result of the AND operation is a non-zero value, the line is completely outside the window region, Hence, the line is discarded.

3. (10, 12) , (34, 27)

0 1 0 0

Region code for $(x_1, y_1) = (10, 12)$

Bit 1 : $x - xw_{min}$ = $x - W_L$ = 10 − 5 = 5 ⇒ +ve ⇒ 0

Bit 2 : $xw_{max} - x$ = $W_R - x$ = 30 − 10 = 20 ⇒ +ve ⇒ 0

Bit 3 : $y - yw_{min}$ = $y - W_B$ = 12 − 15 = −3 ⇒ −ve ⇒ 1

Bit 4 : $yw_{max} - y$ = $W_T - y$ = 25 − 12 = 13 ⇒ +ve ⇒ 0

$\therefore$ The Region code is 0 1 0 0

Region code for $(x_2, y_2) = (34, 27)$

Bit 1 = $x - xw_{min} = x - w_L = 34 - 5 = 29 \Rightarrow +ve \Rightarrow 0$

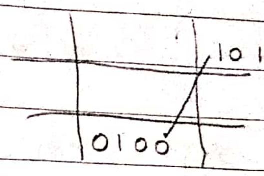
Bit 2 = $xw_{max} - x = w_R - x = 30 - 34 = -4 \Rightarrow -ve \Rightarrow 1$

Bit 3 = $y - yw_{min} = y - w_B = 27 - 15 = 12 \Rightarrow +ve \Rightarrow 0$

Bit 4 = $yw_{max} - y = w_T - y = 25 - 27 = -2 \Rightarrow -ve \Rightarrow 1$

$\therefore$ The Region code is 1010

$$\begin{array}{r} 0100 \\ 1010 \\ \hline 0000 \end{array}$$



$\therefore$ first point is non zero (i.e. 0100), perform bottom clipping.

To find intersection point

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{27 - 12}{34 - 10} = \frac{15}{24} = \frac{5}{8}$$

$$y = y_1 - \frac{5}{8}(x_2 - x_1)$$

To find intersection point

$$y = yw_{min} = 15$$

P_1.

$$\cancel{15 = 12 + \frac{5}{8}(x - 10)}$$

$$\cancel{15 = 12 + \frac{5}{8}x - \frac{50}{8}}$$

$$15 = 12 + \frac{5}{8}(x - 10)$$

$$x = \cancel{1.85}\ 8.875$$

$$x = 14.8$$

$$\therefore (x_1', y_1') = \cancel{(15, 14.8)}\ (14.8, 15)$$

Date:

P_2. $y =$ ~~$y = y_{Wmax} = 25$~~

~~$25 = 12 + \frac{5}{8}(x-10)$~~

~~$= 30.8$~~

$y = y_{max} = 25$

$25 = 12 + \frac{5}{8}(x - 10)$

$x = 30.8$

~~$(25, 30.8)$~~

$(30.8, 25)$

~~$x = x_{Wmax} = 30$~~

~~$y = \quad y = 27 + \frac{5}{8}(30 - 34)$~~

~~$= 24.5$~~

~~$\therefore (x_2', y_2') = (30, 24.5)$~~

Region code for $(x_1', y_1') = (14.8, 15)$

Bit 1	=	$x - x_{Wmin}$	=	$14.8 - 5$	=	9.8	⇒ +ve	⇒ 0
Bit 2	=	$x_{Wmin} - x$	=	$30 - 14.8$	=	15.2	⇒ +ve	⇒ 0
Bit 3	=	$y - y_{Wmin}$	=	$15 - 15$	=	0	⇒ +ve	⇒ 0
Bit 4	=	$y_{Wmin} - y$	=	$25 - 15$	=	10	⇒ +ve	⇒ 0

∴ The ~~regiod~~ region code is 0000

Region code for $(x_2', y_2') = (30, 24.5)$

Bit 1	=	$x - x_{Wmin}$	=	$30 - 5$	=	25	= +ve	⇒ 0
Bit 2	=	$x_{Wmin} - x$	=	$30 - 30$	=	0	= +ve	⇒ 0
Bit 3	=	$y - y_{Wmin}$	=	$24.5 - 15$	=	9.5	= +ve	⇒ 0
Bit 4	=	$y_{Wmin} - y$	=	$25 - 24.5$	=	0.5	= +ve	⇒ 0

∴ The region code is 0000

∴ The region code of both points is 0000

∴ we have clipped the line.

Scanned with CamScanner

$y = y_{max} = 25$
$25 = 12 + \frac{5}{8}(x - \ldots)$
$x = 30.8$
~~(25, 30.8)~~
(30.8, 25)

$y = W_T / W_B$
$x = W_L / W_R$

Region code for $(x_1, y_1) = (10, 12)$

Bit 1 $= x - xW_{max} = x - W_L = 10 - 5 \Rightarrow 5 \Rightarrow +ve \Rightarrow 0$

Bit 2 $= xW_{max} - x = W_R - x = 30 - 10 \Rightarrow 20 \Rightarrow +ve \Rightarrow 0$

Bit 3 $= y - yW_{min} = y - W_B = 12 - 15 \Rightarrow \cancel{15}\ -3 \Rightarrow +ve \Rightarrow 1$

Bit 4 $= yW_{max} - y = W_T - y = 25 - 12 \Rightarrow 13 \Rightarrow +ve \Rightarrow 0$

∴ Region code for (10, 12) is 0100

Region code for $(x_2, y_2) = (34, 27)$

Bit 1 $= x - xW_{min} = 34 - 5 = 29 \Rightarrow +ve \Rightarrow 0$

Bit 2 $= xW_{max} - x = 30 - 34 = -4 \Rightarrow -ve \Rightarrow 1$

Bit 3 $= y - yW_{min} = 27 - 15 = 12 \Rightarrow +ve \Rightarrow 0$

Bit 4 $= yW_{max} - y = 25 - 27 = -2 \Rightarrow -ve \Rightarrow 1$

∴ Region code for (34, 27) is 1010

Since bothe region codes are non-zero values, we perform, AND operation.

$P_1 \rightarrow 0100$

$P_2 \rightarrow 1010$

0000

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{27 - 12}{34 - 10} = \frac{15}{24} = \frac{5}{8}$

T B R L

Consider Point (10, 12) having region code 0100

We clip against bottom boundary

$$x = \frac{y - y_1}{m} + x_1 = 14.8$$

$$y = 15 = W_b$$

Hence, the new point is (14.8, 15)

Region Code for $(x_1', y_1') = (14.8, 15)$

Bit 1 $= x - xW_{min} = 14.8 - 5 = 9.8 \Rightarrow +ve \Rightarrow 0$

Bit 2 $= xW_{max} - x = 30 - 14.8 = 15.2 \Rightarrow +ve \Rightarrow 0$

Bit 3 $= y - yW_{min} = 15 - 15 = 0 \Rightarrow +ve \Rightarrow 0$

Bit 4 $= yW_{max} - y = 25 - 15 = 10 \Rightarrow +ve \Rightarrow 0$

∴ The region code for (34, 27) is 0000

T B R L
Consider Point (34, 21) having region code 1010
We clip against Top boundary

$x = \frac{y - y_1}{m} + x = 30.8$

$y = w_T = 25$

Hence, the new point obtained is (30.8, 25)

Region code for (x_2', y_2'): (30.8, 25)

Bit 1 0
Bit 2 1
Bit 3 0
Bit 4 0

∴ Region code for (30.8, 25) is 0010

We clip against Right Boundary.

$x = w_R = 30$

$y = y_1 + m(x - x_1) = 24.5$

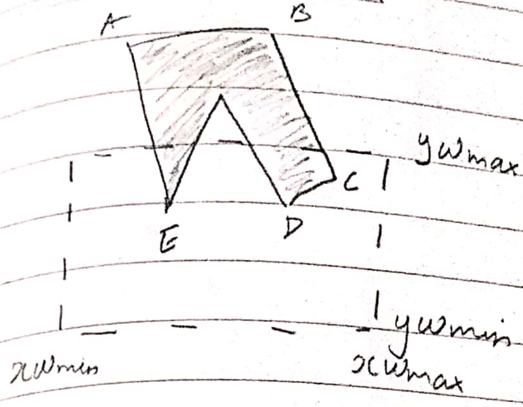
Region code for $(x_2', y_2') = (30, 24.5)$

Bit 1
Bit 2
Bit 3
Bit 4

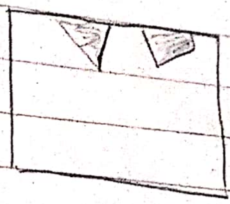
Region code for (30, 24.5) is 0000

Since region code for both the points is ~~000~~ 0000.
Hence, we have clipped the line
And the new ~~points of~~ line obtained is
~~(3~~ (14.8, 15) and (30, 24.5)

POLYGON CLIPPING

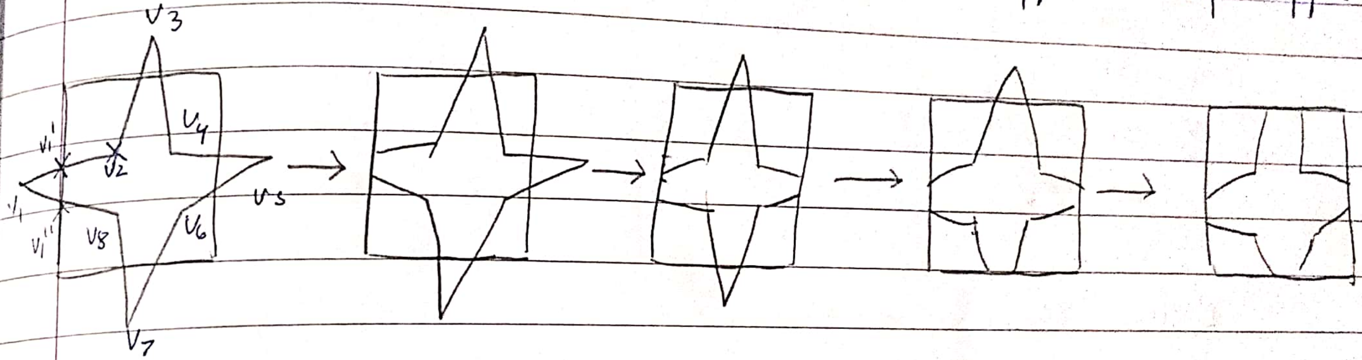


Clip:
L R B T



Sutherland Hodgeman Polygon Clipping

Left Clipper → Right Clipper → Bottom Clipper → Top Clipper.



Output Vertex List

for edge $V_1 V_2$, save $\{V_1', V_2\}$ (out → in)

$V_2 V_3$, Save $\{V_3\}$ (in → in)

$V_8 V_1$ save $\{V_1'', V_8\}$ (in → out)

Conditions :-

Start vertex → End vertex

1. out_1 → in_2 Save $\{out_1', in_2\}$
2. in_1 → in_2 save $\{in_2\}$
3. in → out save $\{\cancel{out', in}\}$ $\{in'\}$
4. out → out save $\{none\}$