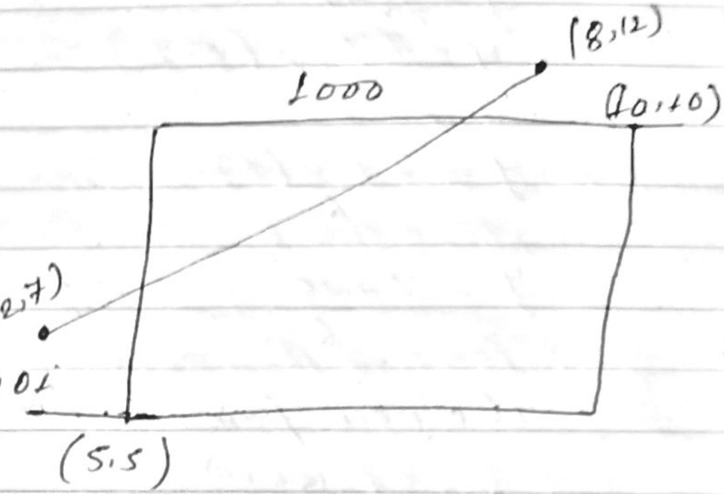
2018 spring
4(b)

Using cohen sutherland line clipping algorithm
given line (2,7) to (8,12)
Window $X_{wmin} = Y_{wmin} = 5$
$X_{wmax} = Y_{wmax} = 10$



from figure,
Region code for two endpoint are p_1 (0001) and p_2 (1000)

Step 1: Calculating logical OR
$p_1 | p_2 = 0001 | 1000 = 1001$
$p_1 | p_2 != 0000$ therefore, calculate logical AND

Step 2 Calculate p_1 AND p_2
$p_1 \& p_2 = 0001 \& 1000 = 0000$ line is partially visible.

Step-3: given line is intersection both horizental and vertical boundry therefore,
1. at first intersection horizental
$X = x_2 + (y - y_2)/m$ —— (1)
Slope $(m) = \frac{y_2 - y_1}{x_2 - x_1} = \frac{12 - 7}{8 - 2} = \frac{5}{6}$

$X = 8 + (10 - 12) / \frac{5}{6}$

$X = 8 + (-2) \frac{6}{5}$

$X = 8 - \frac{12}{5} = \frac{28}{5}$

The new point is $(x, y) = (\frac{28}{5}, 10)$
(5.6, 10)

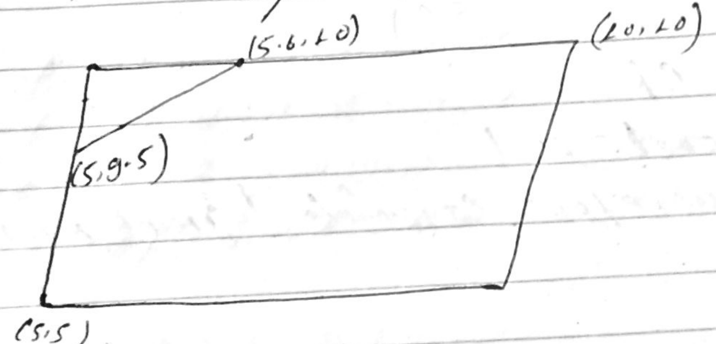
(ii) again line intersection vertical boundry

$y = y_1 + m(x - x_1)$
$y = 7 + 5/6 (5-2)$

$y = 7 + \frac{5}{6}(3)$

$y = 7 + \frac{15}{6} = 19/2 = 9.5$

The new point is $(x, y) = (5, 9.5)$



Bezier curve for matrix

$p(t) = P_0(1-t)^3 + P_1 3t(1-t)^2 + P_2 3t^2(1-t) + P_3 t^3$

$p(t) = (\cancel{2}1 - 3t + 3t^2 - t^3)P_0 + P_1(3t - 6t^2 + t^2) + P_2(3t^2 - 3t^3) + P_3 t^3$

→ This expression can be expressed in matrix form

$$p(t) = [F][B]$$

$$p[t] = [T][M][B]$$

Here the basis function matrix $[F]$ =

$[B_{0,3}(t)\ B_{1,3}(t)\ B_{2,3}(t)\ B_{3,3}(t)]$

The bezier geometry matrix

$$[B] = \begin{bmatrix} P_0 \\ P_1 \\ P_2 \\ P_3 \end{bmatrix} \qquad [T] = [t^3\ t^2\ t\ 1]$$

Bezier basis matrix $[M]$ = $\begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$

Such that $[F] = [T][M]$

Therefore a cubic Bezier curve controlled by the points P_0, P_1, P_2, P_3.

$$p(t) = [t^3\ t^2\ t\ 1] \begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_0 \\ P_1 \\ P_2 \\ P_3 \end{bmatrix}$$

019 full 3(a)

Digitize a circle $(x-2)^2+(y-3)^2=25$ using a midpoint circle drawing algorithm.

⇒ radius $r=5$ at center $(2,3)$

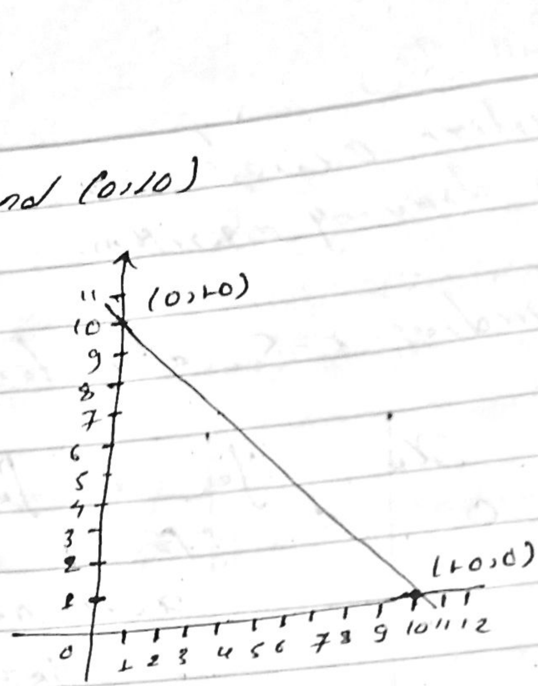
x_k	y_k	P_k	x_{k+1}, y_{k+1}	$(x_{k+1})+2$ $y_{k+1}+3$
0	5	$P_0=1-r=1-5=-4<0$ $x_{k+1}=0+1=1$ $y_{k+1}=y_k=5$	(1,5)	$2+1=3$ $3+5=8$
1	5	$P_{k+1}=P_k+2x_k+3$ $=-4+2*0+3$ $=-1<0$ $x_{k+1}=2$ $y_{k+1}=5$	(2,5)	$2+2=4$ $3+5=8$
2	5	$P_{k+1}=P_k+2x_k+3$ $=-1+2*1+3$ $=4>0$ $x_{k+1}=2+1=3$ $y_{k+1}=5-1=4$	(3,4)	$3+2=5$ $4+3=7$
3	4	$P_{k+1}=2x_k-2y_k+5$ $=2*2-2*5+5$ $=4-10+5$ $=-1<0$ $x_{k+1}=3+1=4$ $y_{k+1}=4$	(4,4)	$2+4=6$ $4+3=7$

Hence $x \geq y$ so, stop
$(x_{k+1})+2 \geq (y_{k+1})+3$.

<u>2017 Spring</u>

<u>4(a)</u>

given passes through points (10,0) and (0,10)



using two point formula

$$y - y_1 = m(x - x_1)$$
$$y - 0 = m(x - 10)$$
$$y = m(x - 10)$$

$$\text{Slope } (m) = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10 - 0}{10 - 0} = 1$$

$$y = (x - 10)$$
$$y = x - 10$$
$$y = 10 - x \quad \text{——— (1)}$$

Comparing with it $y = mx + b$

$m = -1$ and $b = 10$

Now, finding Transformation matrix

$$T = \begin{bmatrix} \frac{1-m^2}{1+m^2} & \frac{2m}{1+m^2} & -\frac{2bm}{1+m^2} \\ \frac{2m}{1+m^2} & \frac{m^2-1}{m^2+1} & \frac{2b}{1+m^2} \\ 0 & 0 & 1 \end{bmatrix}$$

$$T = \begin{bmatrix} \frac{1-1}{1+1} & \frac{2*-1}{1+1} & -\frac{2*10*-1}{1+1} \\ \frac{2*-1}{1+1} & \frac{1-1}{1+1} & \frac{2*10}{1+1} \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 10 \\ -1 & 0 & 10 \\ 0 & 0 & 1 \end{bmatrix}$$

Now, we find triangle

$$\begin{bmatrix} A' \\ B' \\ C' \end{bmatrix} = \begin{bmatrix} 0 & -1 & 10 \\ -1 & 0 & 10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 & 20 & 10 \\ 50 & 40 & 70 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -50+10 & -40+10 & -70+10 \\ -5+10 & -20+10 & -10+10 \\ 1 & 1 & 1 \end{bmatrix}$$

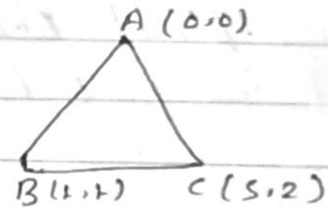
$$= \begin{bmatrix} -40 & -30 & -60 \\ 5 & -10 & 0 \\ 1 & 1 & 1 \end{bmatrix} \quad \underline{\text{Ans}}$$

2012 Spring

4(a).

Given vertices $A(0,0), B(1,1), C(5,2)$

Scaling factor $= S_x = S_y = 0.5$



fixed point is the center of triangle so,

$$x_f = \frac{x_1+x_2+x_3}{3} = \frac{0+1+5}{3} = 2$$

$$y_f = \frac{y_1+y_2+y_3}{3} = \frac{0+1+2}{3} = 1$$

$$\boxed{(x_f, y_f) = (2, 1)}$$

$$P' = S(x_f, y_f, S_x, S_y) \cdot P$$

$$P' = \begin{bmatrix} S_x & 0 & x_f(1-S_x) \\ 0 & S_y & y_f(1-S_y) \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 5 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$P' = \begin{bmatrix} 0.5 & 0 & 2(1-0.5) \\ 0 & 0.5 & 1(1-0.5) \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 5 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$P' = \begin{bmatrix} 0.5 & 0 & 1 \\ 0 & 0.5 & 0.5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 5 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$P' = \begin{bmatrix} 1 & 0.5+1 & 0.5\times5+1 \\ 0.5 & 0.5+0.5 & 0.5\times2+0.5 \\ 1 & 1 & 1 \end{bmatrix}$$

$$P' = \begin{bmatrix} 1 & 1.5 & 3.5 \\ 0.5 & 1 & 1.5 \\ 1 & 1 & 1 \end{bmatrix}$$

Hence, final coordinate after scaling are
$A'(1, 0.5)$ $B'(1.5, 1)$, $C'(3.5, 1.5)$.

2013 fall 3(b)

Given triangle $A(2,3)$, $B(5,3)$ and $C(3,1)$
angle 30°

average point of $x = \frac{2+5+3}{3} = \frac{10}{3}$

average point of $y = \frac{3+3+1}{3} = \frac{7}{3}$

point $(10/3, 7/3)$ at centered

Now, Composite matrix (CM) $= T \cdot R\theta \cdot T^{-1}$

$T(x_r, y_r) \cdot R\theta \cdot T(-x_r, -y_r)$

30° is clockwise

$$= \begin{bmatrix} 1 & 0 & 10/3 \\ 0 & 1 & 7/3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-30) & -\sin(-30) & 0 \\ \sin(30) & -\cos(-30) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -10/3 \\ 0 & 1 & -7/3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 10/3 \\ 0 & 1 & 7/3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sqrt{3}/2 & 1/2 & 0 \\ -1/\sqrt{2} & -\sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -10/3 \\ 0 & 1 & -7/3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 10/3 \\ 0 & 1 & 7/3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sqrt{3}/2 & 1/\sqrt{2} & \sqrt{3}/2 * -10/3 + 1/2 * -7/3 \\ -1/\sqrt{2} & -\frac{\sqrt{3}}{2} & 1/\sqrt{2} * 10/3 + \frac{\sqrt{3}}{2} * 7/3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 10/3 \\ 0 & 1 & 7/3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sqrt{3}/2 & 1/\sqrt{2} & -4.053 \\ -1/\sqrt{2} & -\sqrt{3}/2 & 3.687 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \sqrt{3}/2 & 1/\sqrt{2} & -4.050 + 10/3 \\ -1/\sqrt{2} & -\sqrt{3}/2 & 3.687 + 7/3 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \sqrt{3}/2 & 1/2 & -0.719 \\ -1/2 & -\sqrt{3}/2 & 6.0223 \\ 0 & 0 & 1 \end{bmatrix}$$

Then $p' = CM \cdot P$

$$= \begin{bmatrix} \sqrt{3}/2 & 1/2 & -0.719 \\ -1/2 & -\sqrt{3}/2 & 6.022 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 5 & 3 \\ 3 & 3 & 1 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 2.51 & 5.11 & 2.37 \\ 2.423 & 0.92 & 3.65 \\ 1 & 1 & 1 \end{bmatrix}$$

Hence, the final coordinate after rotation are

A(2.51, 2.423), B(5.11, 0.92), C(2.37, 3.65).

• 2016 fall, 3(b)

Sol: given point (5,3) rotated at 45° clockwise

$$p' = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$= \begin{bmatrix} \cos(-45) & -\sin(-45) \\ \sin(-45) & \cos(-45) \end{bmatrix} \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$

$$= \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} \\ -1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$

$$= \begin{bmatrix} 5/\sqrt{2} + 3/\sqrt{2} \\ -5/\sqrt{2} + 3\sqrt{2} \end{bmatrix} = \begin{bmatrix} 4\sqrt{2} \\ -\sqrt{2} \end{bmatrix}$$

Now, again scaling factor is 3

$S_y = S_x = 3$

$$p' = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} 4\sqrt{2} \\ -\sqrt{2} \end{bmatrix}$$

$$p' = \begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix} \begin{bmatrix} 4\sqrt{2} \\ -\sqrt{2} \end{bmatrix}$$

$$p' = \begin{bmatrix} 12\sqrt{2} \\ -3\sqrt{2} \end{bmatrix}$$

Hence final point after Scaling are $(12\sqrt{2}, -3\sqrt{2})$.

2014 spring 4(a)

perform a 45° rotation of a line A(8,3) and B(14,10).

a. about origin

b. about a fixed point (4,2)

Sol^n if direction not given the assume 45° rotation ACW about origin.

i.e R(45) ACW [∴ ACW is +ve]

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

$$[A'B'] = \begin{bmatrix} \cos(45) & -\sin(45) & 0 \\ \sin(45) & \cos(45) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 8 & 14 \\ 3 & 10 \\ 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 8 & 14 \\ 3 & 10 \\ 1 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2}*8 + -1/\sqrt{2}*3 & 1/\sqrt{2}*14 - 1/\sqrt{2}*10 \\ 1/\sqrt{2}*8 + 1/\sqrt{2}*3 & 1/\sqrt{2}*14 + 1/\sqrt{2}*10 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 3.52 & 2.82 \\ 7.82 & 16.97 \\ 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & 3 \\ 8 & 17 \\ 1 & 1 \end{bmatrix} \text{ Ans}$$

Again, Rotate by 45° in ACW direction about a fixed point (4, 2).

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

$$= \begin{bmatrix} \cos 45 & -\sin 45 & 4(1-\cos 45) + 2\sin 45 \\ \sin 45 & \cos 45 & 2(1-\cos 45) + 4\sin 45 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$$= \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 4-\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2-3\sqrt{2} \\ 0 & 0 & 1 \end{bmatrix}$$

Now, $A'B' = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 4-\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2-3\sqrt{2} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 8 & 14 \\ 3 & 10 \\ 1 & 1 \end{bmatrix}$

$$= \begin{bmatrix} \frac{1}{\sqrt{2}}\times 8 + (-\frac{1}{\sqrt{2}})\times 3 + (4-\sqrt{2}) & \frac{1}{\sqrt{2}}\times 14 - \frac{1}{\sqrt{2}}\times 10 + (4-\sqrt{2}) \\ \frac{1}{\sqrt{2}}\times 8 + \frac{1}{\sqrt{2}}\times 3 + (2-3\sqrt{2}) & \frac{1}{\sqrt{2}}\times 14 + \frac{1}{\sqrt{2}}\times 10 + (2-3\sqrt{2}) \\ 1 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 6.12 & 5.41 \\ 55.19 & 190.72 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 6 & 5 \\ 55 & 190 \\ 1 & 1 \end{bmatrix} \underline{\text{Ans}}$$

<u>2014 Spring 4(b)</u>

given rectangle A(2,2), B(5,2), C(2,4)

line $x = y$

$T = R(45)(cw) * R_{fx} \cdot R(5)\,cw$

$$= \begin{bmatrix} \cos 45° & -\sin 45° & 0 \\ \sin 45° & +\sin 45° & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & \sin 45 & 0 \\ -\sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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

Now, $[A'B'C'] = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 5 & 2 \\ 2 & 2 & 4 \\ 1 & 1 & 1 \end{bmatrix}$

$$= \begin{bmatrix} 2 & 2 & 4 \\ 2 & 5 & 2 \\ 1 & 1 & 1 \end{bmatrix} \underline{\text{Ans}}$$

2018 spring

5(b)

Sol^n Given that, the curve is defined by 4 control points so the given ~~f~~ curve is cubic Bezier curve.

The parametric equation for a cubic Bezier curve is

$$p(t) = p_0(1-t)^3 + p_1 3t(1-t)^2 + p_2 3t^2(1-t) + p_3 t^3$$

Substituting control points p_0, p_1, p_2 and p_3 we get.

$$p(t) = [0,0](1-t)^3 + [1,2]3t(1-t)^2 + [3,3]3t^2(1-t) + [4,0]t^3 \quad \text{--- (1)}$$

range $0 <= t <= 1$. lying point.

let 5 values of t are $0, 0.2, 0.5, 0.7, 1$.

for $t = 0$

Substituting $t=0$ in eq^n (1) we get

$$p(0) = [0,0](1-0)^3 + [1,2)3\cdot 0(1-0)^2 + [3,3]3\cdot 0^2(1-0) + [4,0]\cdot 0^3$$

$$\boxed{p(0] = [0,0]}$$

for $t = 0.2$ in eq^n (1) we get

$$p(0.2) = [0,0](1-0.2)^3 + [1,2]3\times 0.2(1-0.2)^2 + [3,3]3\times(0.2)^2(1-0.2) + [4,0](0.2)^3$$

$$p(0.2) = [0,0]0.512 + [1,2]0.384 + (3,3]0.096 + [4,0]0.008$$

$$p(0.2) = [0,0] + [0.384, 0.768] + [0.288, 0.288] + [0.032, 0]$$

$$\boxed{p(0.2] = [0.704, 1.056]}$$

for $t = 0.5$ in eqⁿ ① becomes

$$P(0.5) = [0,0](1-0.5)^3 + [1,2]\,3\times 0.5(1-0.5)^2 + [3,3]\,3\times(0.5)^2(1-0.5) + [4,0](0.5)^3$$

$$P(0.5) = [0,0] + [1,2]\,0.375 + [3,3]\,0.375 + [4,0]\,0.125$$

$$P(0.5) = [0,0] + [0.375, 0.75] + [1.125, 1.125] + [0.5, 0]$$

$$\boxed{P(0.5) = [2, 1.875]}$$

for $t = 0.7$ in eqⁿ ① becomes

$$P(0.7) = [0,0](1-0.7)^3 + [1,2]\,3\times 0.7(1-0.7)^2 + [3,3]\,3\times(0.7)^2(1-0.7) + [4,0](0.7)^3$$

$$P(0.7) = [1,2]\,0.189 + [3,3]\,0.441 + [4,0]\,0.343$$

$$P(0.7) = (0.189, 0.378) + (1.323, 1.323] + [1.372, 0]$$

$$\boxed{P(0.7) = [2.884, 1.701]}$$

for $t = 1$ in eqⁿ ① becomes

$$P(1) = [1,2]\,3\times 1(1-1)^2 + [3,3]\,3\times(1)^2(1-1) + (4,0)(1)^3$$

$$\boxed{P(1) = [4,0]}$$

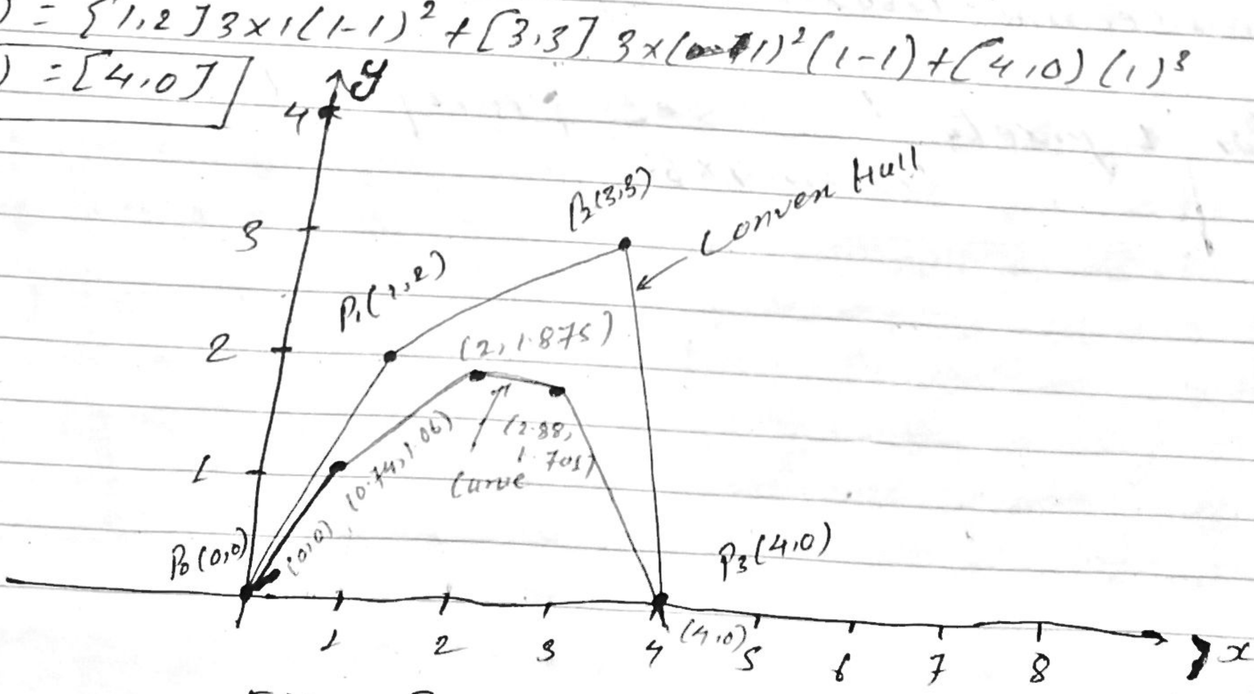


Fig Bezier curve and Convex Hull

2013 full

2 (a)

system 1:

Resolution = 640×480

frequency = 60 FPS

in 1 frame = $1/60$

$640 \times 480 = 1/60$

in 1 secod ; $640 \times 480 \times 60$ pixel/sec

$\boxed{\text{for 1 pixel} = \frac{1}{640 \times 480 \times 60} \text{ secod}}$ is required.

Again,

system 2:

Resolution = 1280×1024

frequency = 60 FPS

in 1 frame = $1/60$

$1280 \times 1024 = 1/60$

in 1 second : $1280 \times 1024 \times 60$ pixel/sec

for $\boxed{1 \text{ pixel} = \frac{1}{1280 \times 1024 \times 60} \text{ sec}}$ is required.

2016 Spring

1(b)

~~Size Of~~ Size of page = 9x11 inch

Resolution = 9x600x11x600x2 for two pages.

pixel depth = n bits

Size of frame buffer = (9x600x11x600x2)xn bits/sec

2017 2(a)

Spring

Size of Screen = 8"x10"

No. of required bits to display = 6 bits

resolution = 100 ppI

Now,

Size of frame buffer = $\frac{8 \times 6 \times 10 \times 6 \times 100}{8 \times 1024 \times 1024}$ MB

2018 fall 1(b)

case (I)

for 1 second

framebuffer = 640x480x12 bits

pixel depth = 12 bits/pixel

Now, for 10^5 bits to be transferred

$\boxed{\text{Time} = 1\text{ second} = \frac{640 \times 480 \times 12}{10^5} \text{ seconds.}}$

Case (ii)

for 1 second

framebuffer = 1280x1024x24 bits

pixel depth = 24 bits/pixel

Now, for 10^5 bits to be transferred

$\boxed{\text{Time} = \frac{1280 \times 1024 \times 24}{10^5} \text{ seconds.}}$ is required to load

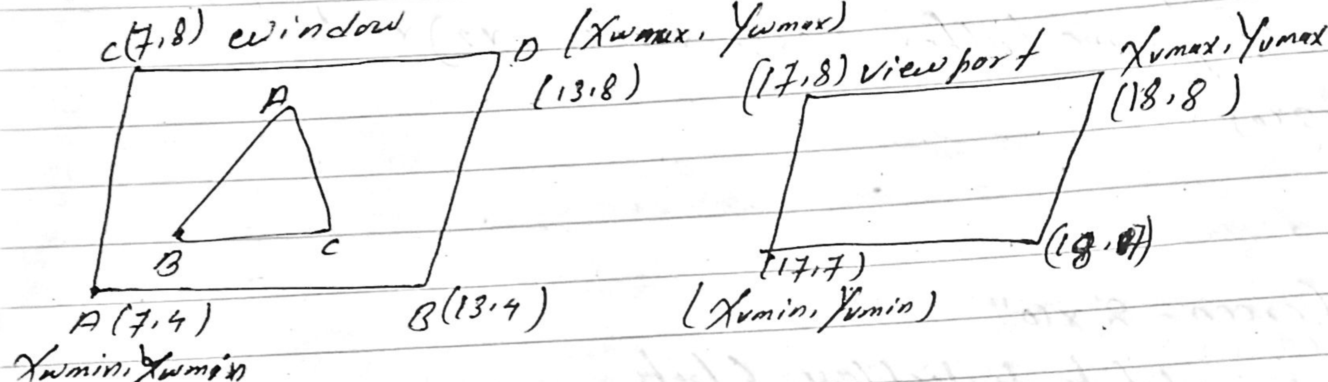
2014 fall

4(a)

Given triangle A(5,5), B(15,5) and C(10,10)

Window Coordinate = (7,4), (13,4), (7,8), (13,8)

Viewport location = (17,7), (18,7), (18,8), (17,8)



$$S_x = \frac{X_{vmax} - X_{vmin}}{X_{wmax} - X_{wmin}} = \frac{18-17}{13-7} = \frac{1}{6}$$

$$S_y = \frac{Y_{vmax} - Y_{vmin}}{Y_{wmax} - Y_{wmin}} = \frac{8-7}{8-4} = \frac{1}{4}$$

$$T = T(x_{vmin}, Y_{vmin})\, S(S_x, S_y)\, T(-x_{wmin}, -Y_{wmin})$$

$$= T(17,7)\, S(1/6, 1/4)\, T(-7,-4)$$

$$= \begin{bmatrix} 1 & 0 & 17 \\ 0 & 1 & 7 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/6 & 0 & 0 \\ 0 & 1/4 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -7 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/6 & 0 & 17 \\ 0 & 1/4 & 7 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -7 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/6 & 0 & 1/6 * (-7) + 17 \\ 0 & 1/4 & 1/4 * (-4) + 7 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/6 & 0 & \frac{95}{6} \\ 0 & 1/4 & 6 \\ 0 & 0 & 1 \end{bmatrix}$$

Now. [A', B', C']

$$\begin{bmatrix} 1/6 & 0 & 95/6 \\ 0 & 1/4 & 6 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 & 15 & 10 \\ 5 & 5 & 10 \\ 1 & 1 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 5/6 + 95/6 & 15/6 + 95/6 & 10/6 + 95/6 \\ 5/4 + 6 & 5/4 + 6 & 10/4 + 6 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 50/3 & 55/3 & 35/2 \\ 29/4 & 29/4 & 17/2 \\ 1 & 1 & 1 \end{bmatrix}$$