University of Asia Pacific

Department of CSE

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Year: 4th

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Course Code: CSE 425

Course Title: Computer Graphics

Date: 19.11.2021

University of Asia Pacific

Admit Card

Final-Term Examination of Spring, 2021

Financial Clearance	PAID

Registration No : 17201012

Student Name : Rashik Rahman

Program : Bachelor of Science in Computer Science and Engineering

SI.NO.	COURSE CODE	COURSE TITLE	CR.HR.	EXAM. SCHEDULE
1	CSE 425	Computer Graphics	3.00	
2	CSE 426	Computer Graphics Lab	1.50	
3	CSE 429	Compiler Design	3.00	
4	CSE 430	Compiler Design Lab	1.50	
5	BUS 401	Business and Entrepreneurship	3.00	
6	BUS 402	Business and Entrepreneurship Lab	0.75	
7	CSE 457	Design and Testing of VLSI	3.00	
8	CSE 458	Design and Testing of VLSI Lab	0.75	
9	CSE 400	Project / Thesis	3.00	

Total Credit: 19.50

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2. No examinees shall be allowed to submit their answer scripts before 50% of the allocated time of examination has elapsed.

3. No examinees would be allowed to go to washroom within the first 60 minutes of final examinations.

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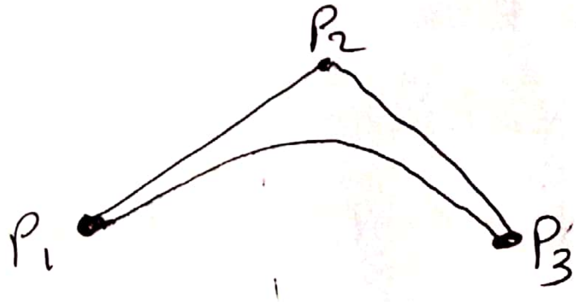
Answer to the Q. No. 1(a)

~~Affine co~~

If one can combine two or more points with particular fraction with a condition ~~of~~ that those fraction or parameters are sum up to 1, in that case combining two or more points one can get a new point. By using Bernstein polynomials we can draw a parabola as these polynomials adds upto 1 considering $0 \leq t \leq 1$.

$\therefore (1-t)^2 + 2t(1-t) + t^2 = 1$, It's an affine combination. Using this we can draw paraboly for that we use,

$$P = (1-t)^2 P_1 + 2t(1-t) P_2 + t^2 P_3 \quad \text{--- (i)}$$



For t value ranging from 0 to 1 we get points on curve which is always a parabola.

Here,

$a = 12 \% 5 + 2 = 4$

$b = 4 + 2 = 6$

For, $t = 4$:

$P'_x = (1-t)^2 P_{1x} + 2t(1-t) P_{2x} + t^2 P_{3x}$

$P'_x = \alpha_1^2 P_{1x} + 2t\alpha_1 P_{2x} + \alpha_2^2 P_{3x}$

$\alpha_1 = 1-t$

$\alpha_2 = t$

$P'_y = (1-t)^2 P_{1y} + 2t(1-t) P_{2y} + t^2 P_{3y}$

$= \alpha_1^2 P_{1y} + \cancel{2t\alpha_1 P_{2y} + \alpha_2^2 P_{3y}}$

$P'_x = (1-t)^2 P_{1x} + 2t(1-t) P_{2x} + t^2 P_{3x}$

$= (1-4)^2 P_{1x} + 2 \times 4 (1-4) P_{2x} + (4)^2 P_{3x}$

$= 9 P_{1x} - 24 P_{2x} + 16 P_{3x}$

$P'_y = (1-t)^2 P_{1y} + 2t(1-t) P_{2y} + t^2 P_{3y}$

$= 9 P_{1y} - 24 P_{2y} + 16 P_{3y}$

$\therefore P(x, y) = (P'_x, P'_y)$

For $t=6$,

$$P'_x = (1-t)^2 P_{1x} + 2t(1-t)P_{2x} + t^2 P_{3x}$$

$$= (1-6)^2 P_{1x} + 2\times 6(1-6)P_{2x} + 6^2 P_{3x}$$

$$= 25P_{1x} - 60P_{2x} + 36P_{3x}$$

$$P'_y = (1-t)^2 P_{1y} + 2t(1-t)P_{2y} + t^2 P_{3y}$$

$$= 25P_{1y} - 60P_{2y} + 36P_{3y}$$

$$\therefore P'(x,y) = (P'_x, P'_y)$$

Ans.

Answer to the Q. No. 1(b)

Here,

$R = 12;\ \alpha = 0.1;\ \beta = 0.2$

$\therefore A = (2, 12+2) = (2, 14)$

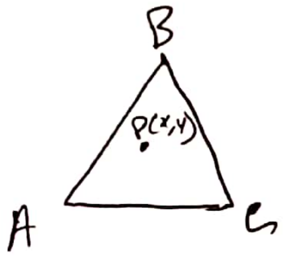
$B = (3, 12+4) = (3, 16)$

$C = (4, 12+5) = (4, 17)$

We know,

$\alpha + \beta + \gamma = 1$

$\therefore \gamma = 1 - \alpha - \beta = 1 - 0.1 - 0.2 = 0.7$



We can calculate $P(x,y)$ using Barycentric coordinates, which's equation is

$$P = \alpha P_1 + \beta P_2 + \gamma P_3 \quad \text{---} \quad (i)$$

Using (i);

$P_x = \alpha A_x + \beta B_x + \gamma C_x = 0.1 \times 2 + 0.2 \times 3 + 0.7 \times 4$

$= 0.2 + 0.6 + 2.8$

$= 3.6$

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and,

$$P_y = \alpha A_y + \beta B_y + \gamma C_y$$
$$= 0.1 \times 14 + 0.2 \times 16 + 0.7 \times 17$$
$$= 1.4 + 3.2 + 11.9 = 16.5$$

$$\therefore P(x, y) = (P_x, P_y) = (3.6, 16.5)$$

Ans.

Answer to the Q. No. 1(e)

(i)

Here,

$$w = 12 + 3 = 15$$

$\therefore$ In 4D space,

$$P_1 = (10, 10, 40, 15)$$
$$P_2 = (20, 50, 60, 15)$$
$$P_3 = (70, 70, 90, 15)$$
$$P_4 = (100, 110, 190, 15)$$
$$P_5 = (120, 60, 200, 15)$$

In 3D space;

$$P_1 = \left(\frac{10}{15}, \frac{10}{15}, \frac{\cancel{10}\ 40}{15}, \frac{15}{15}\right) = (0.667, 0.667, \cancel{0.233}\ 2.67, 1)$$

$$P_2 = \left(\frac{20}{15}, \frac{50}{15}, \frac{60}{15}, \frac{15}{15}\right) = (1.33, 3.33, 4, 1)$$

$$P_3 = \left(\frac{70}{15}, \frac{70}{15}, \frac{90}{15}, \frac{15}{15}\right) = (4.67, 4.67, 6, 1)$$

$$P_4 = \left(\frac{100}{15}, \frac{110}{15}, \frac{190}{15}, \frac{15}{15}\right) = (6.67, 7.33, 12.67, 1)$$

$$P_5 = \left(\frac{120}{15}, \frac{60}{15}, \frac{200}{15}, \frac{15}{15}\right) = (8, 4, 13.33, 1)$$

(ii)

Befor transformation;

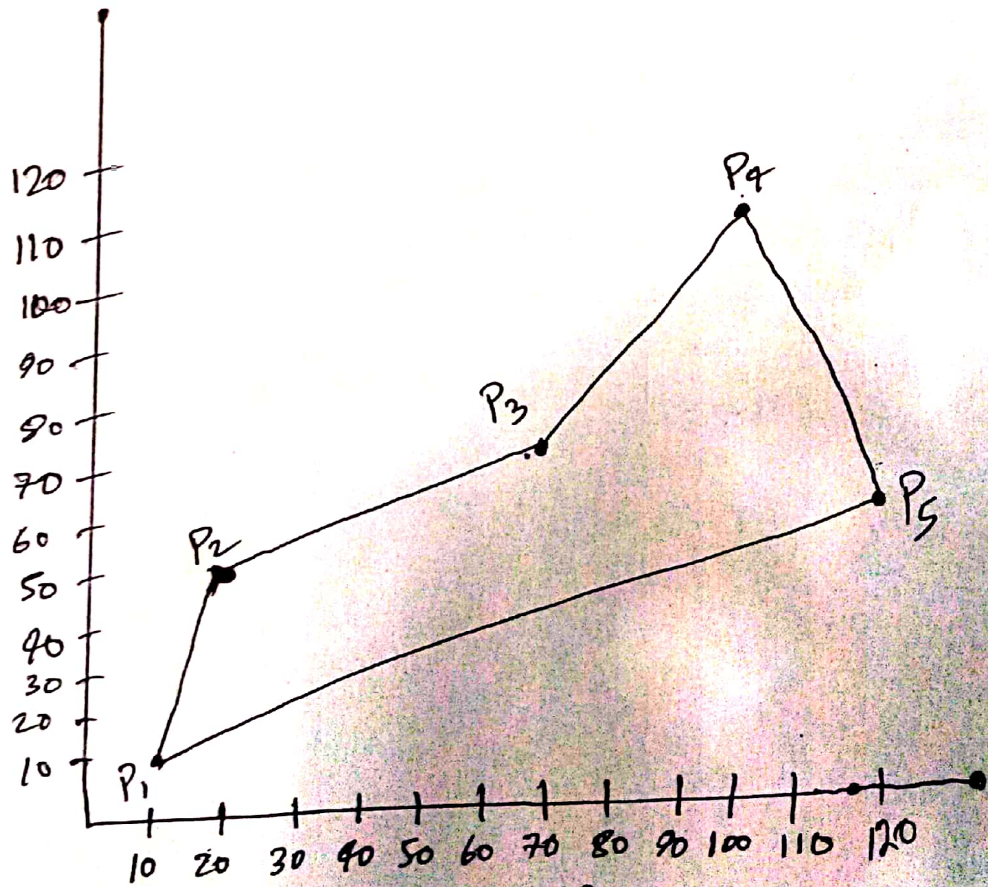

fig: Polygon in 4D space

After transformation:

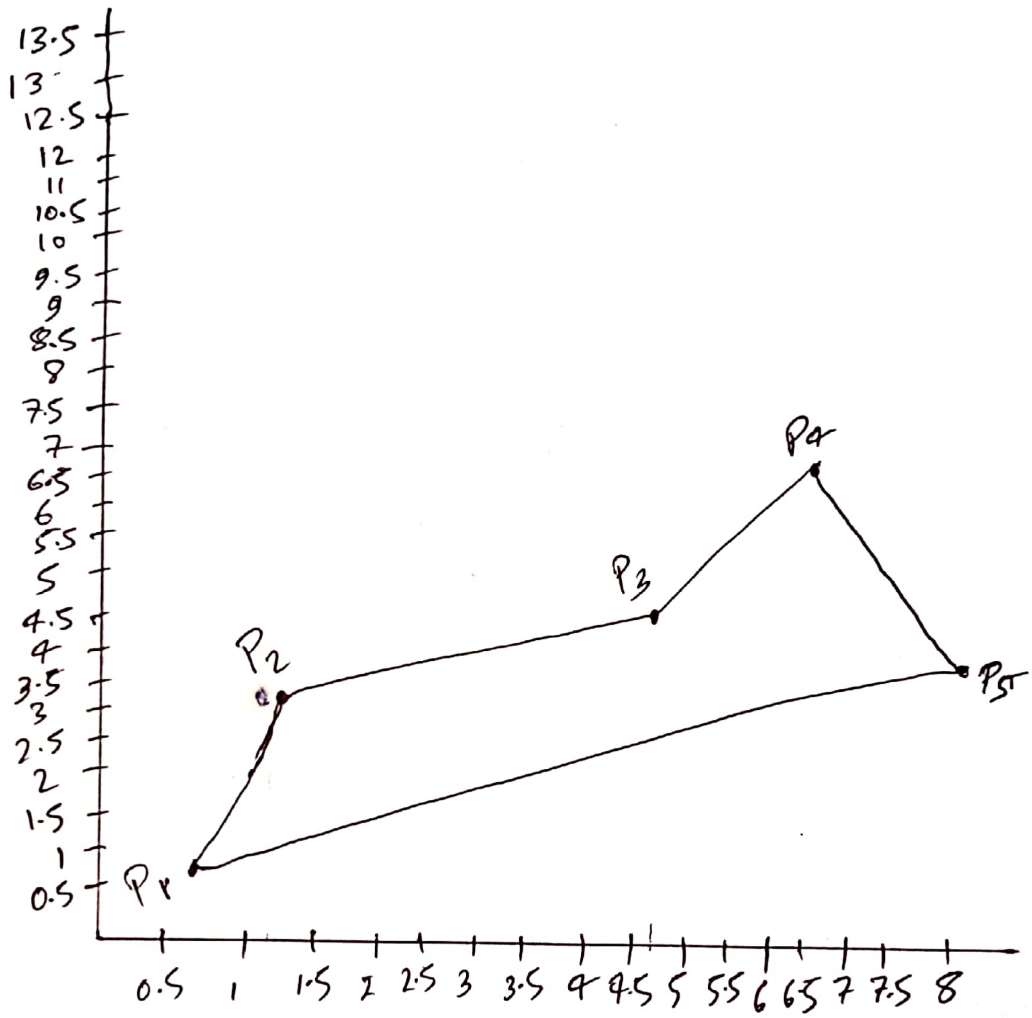

fig: Polygon in 3D space

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Answer to the Q.No. 4(a)

~~Fact~~

We know that, if the view port is on the +z ~~axis~~ axis looking at the origin, we only need to check the sign of the z component of the object's normal vector ~~Here~~ (n). Here conditions are the followings:

(i) If $n_z < 0$; it is back facing

(ii) if $n_z > 0$; it is front facing

(iii) if $n_z = 0$; the polygon is parallel to the view direction, so we don't see it.

$s_1 = (-4, 3, -3)$.

It satisfies condition (i) so it is back facing surface

$s_2 = (6, -3, -8)$

It also satisfies condition (i) thus back facing surface

$s_3 = (9, 2, -10)$

It satisfies (i) thus back facing surface

$s_4 = (-4, -11, 11)$

It satisfies condition (ii) thus it is front facing surface

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Answer to the Q.No.4(b)

Here,

$A = 12 \% 5 = 2$

$B = 12 \% 7 = 5$

$C = 12 \% 2 = 0$

$D = 12 \% 3 = 0$

$\therefore$ Initial z buffer =

$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$

Adding 1st ~~object~~ Object's pixel,

$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$
$-\infty$	$-\infty$	$-\infty$	$-\infty$

+

-2			
-2	-3		
-3	-4	-5	
-2	-5	0	0

=

-2	$-\infty$	$-\infty$	$-\infty$
-2	-3	$-\infty$	$-\infty$
-3	-4	-5	$-\infty$
-2	-5	0	0

Adding 2nd object pixel,

-2	$-\infty$	$-\infty$	$-\infty$
-2	-3	$-\infty$	$-\infty$
-3	-4	-5	$-\infty$
-2	-5	0	0

+

			-3
		-6	-2
	-5	-1	-3
-3	-4	-2	2

=

-2	$-\infty$	$-\infty$	-3
-2	-3	-6	-2
-3	-4	-1	-3
-2	-4	-2	2

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Adding 3rd object's pixel.

-2	-∞	-∞	-3
-2	-3	-6	-2
-3	-4	-1	-3
-2	-4	-2	2

+

-3	•4	-2	2
	-3	-4	-5
		-5	-6
			-7

=

-2	•4	-2	2
-2	-3	-4	-2
-3	-4	-1	-3
-2	-4	-2	2

Adding 4th object pixel,

-2	•4	-2	2
-2	-3	-4	-2
-3	-4	-1	-3
-2	-4	-2	2

+

-2	-5	0	0
-5	-1	-3	
-6	-1		
-7			

=

-2	•4	0	2
-2	-1	-3	-2
-3	-1	-1	-3
-2	-4	-2	2

∴ Output after applying Z algorithm is,

Ans =

-2	•4	0	2
-2	-1	-3	-2
-3	-1	-1	-3
-2	-4	-2	2

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Answer to the Q.No.4(c)

$a = 160 - 12 = 148°$

$b = 12/(12+5) = 12/17 = 0.706$

$c = 12/(12+10) = 0.545$

As $120 \le a < 240°$ thus it falls under GB section.

$\therefore H = a - 120° = 28°$

$R = c(1-b) = 0.545 \times (1 - 0.706)$
$= 0.1602$

$$G = c\left[1 + \frac{b\cos H}{\cos(60-H)}\right]$$

$$= 0.545\left(1 + \frac{0.706 \times 0.883}{0.848}\right)$$

$= 0.946$

$$B = 3 \times C - (R + G)$$

$$= 3 \times 0.545 - (0.1602 + 0.946)$$

$$= 1.635 - 1.1062$$

$$= 0.529$$

$$\therefore (R, G, B) = (0.1602, 0.946, 0.529)$$

Ans.

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Answer to the Q.No. 3

Here

$a = 12\%5 = 2$

$b = 12\%7 = 5$

$c = 12\%11 = 1$

$\therefore R_1 = (0, 2)$

$R_2 = (3, 5)$

$R_3 = (5, 1)$

(i)

For $R_1(0,2)$;

$sign(a) = \begin{cases} 1; \text{ if positive} \\ 0; \text{ otherwise} \end{cases}$

$Bit\ 1 = sign(y - y_{max})$

$= sign(2 - 7)$

$= 0$

$Bit\ 2 = sign(y_{min} - y)$

$= sign(-3 - 2)$

$= 0$

$Bit\ 3 = \cancel{(x - x_{max})}\ sign(x - x_{max})$

$= sign(0 - 11) = 0$

$Bit\ 4 = sign(x_{min} - x) = sign(-4 - 0) = 0$

$\therefore R_1$ region code $= 0000$

For $R_2(3,5)$;

$\text{Bit } 1 = \text{sign}(5-7) = 0$
$\text{Bit } 2 = \text{sign}(-3-5) = 0$
$\text{Bit } 3 = \text{sign}(3-11) = 0$
$\text{Bit } 4 = \text{sign}(-4-3) = 0$

$\therefore$ R_2 region code: 0000

For $R_3(5,1)$:

$\text{Bit } 1 = \text{sign}(1-7) = 0$
$\text{Bit } 2 = \text{sign}(-3-1) = 0$
$\text{Bit } 3 = \text{sign}(5-11) = 0$
$\text{Bit } 4 = \text{sign}(-4-5) = 0$

$\therefore$ R_3 region code: 0000 .

(ii) ~~We know~~,
classification coditions are:

(i) if (! (code(P_1) | code(P_2))
accept()

(ii) else if (code(P_1) & code(P_2))
reject

(iii) else
intersect_segment().

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For line R_1R_2:

$$!(R_1 | R_2) = !(0000 | 0000) = 1111$$

As it return 1111 then (i) is ~~a~~ satisfied thus accepted. ~~R~~ Line R_1R_2 is inside the viewpoint.

For line R_2R_3:

$$!(R_2 | R_3) = !(0000 | 0000) = 1111$$

Thus line R_2R_3 inside viewpont.

For line R_3R_1:

$$!(R_3 | R_1) = !(0000 | 0000) = ~~1111~~\ 1111$$

Thus line R_3R_1 also inside viewpont.

(iii) As all the line satisfies classification condition no. (i) thus all the lines are ~~in~~ ~~acc~~ accepted and inside viewpont. All the lines can be drawn without ~~the~~ the need of clipping. Thus we can say ~~there~~ ~~exist~~ there are no intersection points.

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Answer to the Q.No.2(a)

Here,

$\theta = 12+35 = 47^\circ$

$A = (2,3)$

$B = (5,6)$

$C = (10,2)$

(i) Triangle = $\begin{bmatrix} 2 & 5 & 10 \\ 3 & 6 & 2 \\ 1 & 1 & 1 \end{bmatrix}$

Using world coordinate

$$R = \begin{bmatrix} \cos 47^\circ & -\sin 47^\circ & 0 \\ \sin 47^\circ & \cos 47^\circ & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0.682 & -0.731 & 0 \\ 0.731 & 0.682 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

(i) Rotation about the origin:

Triangle' = R. Triangle | (right to left)

$$= \begin{bmatrix} 0.682 & -0.731 & 0 \\ 0.731 & 0.682 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 5 & 10 \\ 3 & 6 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -0.829 & -0.976 & 5.358 \\ 3.508 & 7.747 & 8.674 \\ 1 & 1 & 1 \end{bmatrix}$$

ii

About point $P(-3,5)$

$$I_+ = \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix}$$

$$I_- = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix}$$

Using world coordinate.

Triangle$' = T_+ \cdot R \cdot I_- \cdot$ Triangle

$$= \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 0.682 & -0.731 & 0 \\ 0.731 & 0.682 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\times \begin{bmatrix} 2 & 5 & 10 \\ 3 & 6 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

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$$= \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 0.682 & -0.731 & 0 \\ 0.731 & 0.682 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 5 & 8 & 13 \\ -2 & 1 & -3 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 4.872 & 4.725 & 11.059 \\ 2.291 & 6.53 & 7.457 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1.872 & 1.725 & 8.059 \\ 7.291 & 11.53 & 12.457 \\ 1 & 1 & 1 \end{bmatrix}$$

∴ After rotation around a point new coordinates of triangle

$A = (1.872, 7.291)$

$B = (1.725, 11.53)$

$C = (8.059, 12.457)$

Ans.

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(20)

Answer to the Q.No. 2(b)

(i) A general 3D ~~mat~~ rotation matrix on y-axis looks like

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

The value of theta(θ) should be consistent in all places. Here the value of ~~the~~ $\theta = 60°$ in 3 places but the $-\sin\theta$ position ~~the~~ doesn't have $\theta = 60°$.

$\therefore$ -0.707 should have been -0.866.

This was wrong here.

(ii) The given matrix is a scaling matrix. The correct 2D ~~ma~~ translation matrix according to world coordinate will be:

$$\begin{bmatrix} 1 & 0 & T_x \\ 0 & 1 & T_y \\ 0 & 0 & 1 \end{bmatrix}$$

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iii) It will not produce connect result.
In a scaling matrix the factors are in different position, for e.g., if it's scalled by (x, y) the scaling matrix ~~would~~ ~~be~~ according to world coordinate should be,

$$\begin{bmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The connect version is,

$$\begin{bmatrix} 5 & 10 & 15 \\ 5 & 10 & 5 \\ 1 & 1 & 1 \end{bmatrix} * \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Ans.