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Q1. MCQ

1. option D: Aliasing.

2. option D: Integer Arithmetic only.

3. option D: Homogeneous co-ordinate System.

4. option B: Rotation.

5. option A: (-x, -y)

6. option B: 0000

7. option C: (-5, 5, 5)

8. option B: $0 <= u <= 1$

9. option A: Area Subdivision method

10. option B: Motion Capture

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Q2.
A iii) a) Rasterization and Rendering.
Rasterization
It is a process of converting vector graphics into raster graphics. More formally, it converts the shapes into a set of pixels and displays it on the monitor screen or printer.
Rendering
i) Rendering refers to the process of generating photorealistic image from 2D or 3D models using a computer program.
ii) The scene is stored using specific data types in scene file. Rendering program retrieves the information like vertex position, viewpoint, color, texture, lighting, shading etc & render the scene on the screen.
iii) Thus, the term rendering is analogous to the 'artists' rendering' of the scene.
b) Scan Conversion
It is a process of representing continuous graphics as a collection of discrete pixels. Each pixel on monitor screen is either turned on or off according to the picture definition stored in the frame buffer.

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Q2) A) ii)

Given A(4, 5), B(7, 5), C(6, 7).

object Matrix in homogenous form

$$O = \begin{bmatrix} 4 & 5 & 1 \\ 7 & 5 & 1 \\ 6 & 7 & 1 \end{bmatrix}$$

Matrix for reflection with respect to x-axis.

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

$\therefore O' = O \cdot R$

$$= \begin{bmatrix} 4 & 5 & 1 \\ 7 & 5 & 1 \\ 6 & 7 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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$$O' = \begin{bmatrix} 4 & -5 & 1 \\ 7 & -5 & 1 \\ 6 & -7 & 1 \end{bmatrix}$$

$\therefore$ New co-ordinates of the object.

$A' = (4, -5)$
$B' = (7, -5)$
$C' = (6, -7)$

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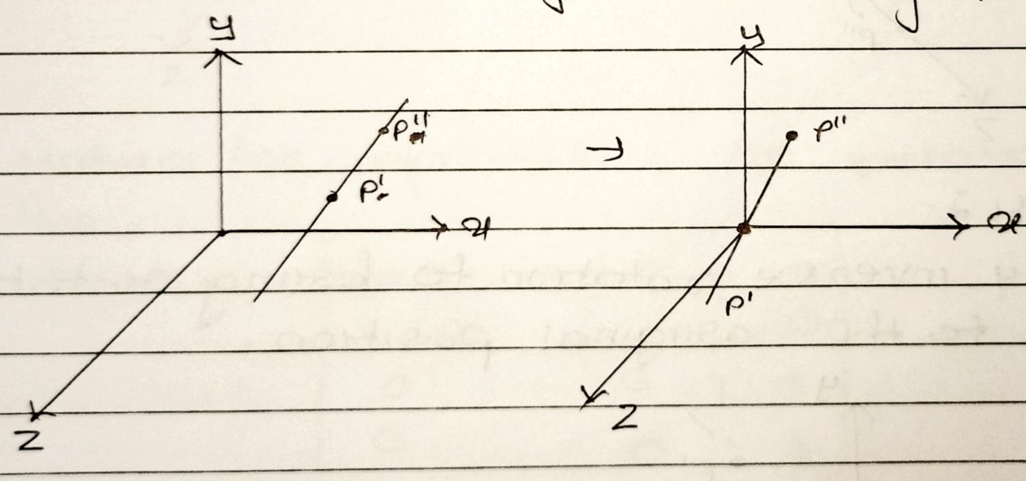
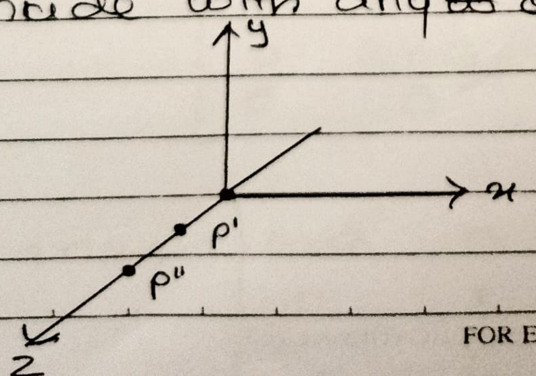
Q2 B

i. When the object is rotated about an axis that is not parallel to any one of co-ordinate axis i.e x, y, z. the additional transformations are required. First of all alignment is needed and then the object is being back to the original position.

Step 1:-
Translate the object to origin:-



Step 2:-
Rotate object so that the axis of object coincide with any of co-ordinate axis



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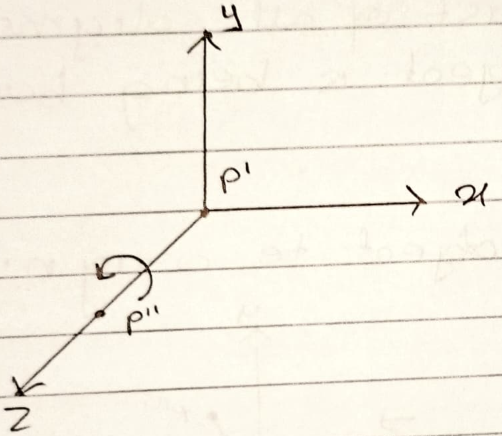
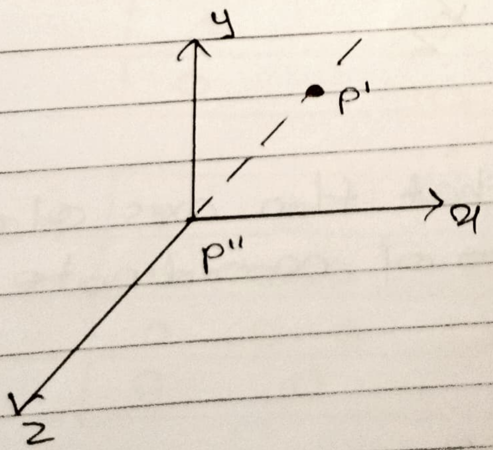
Step 3 :-
Perform rotation about the co-ordinate axis with whom coinciding is done.



Step 4 :-
Apply inverse rotation to bring rotation back to the original position.



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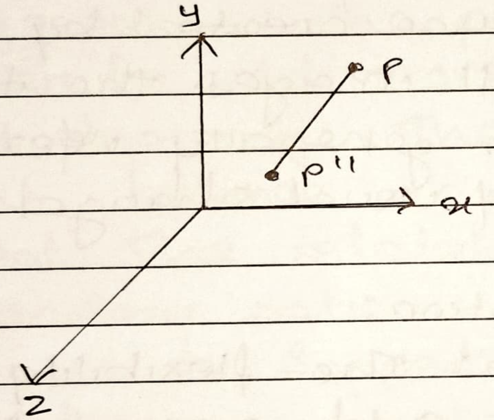
step 5 :-
Translate axis to the original position.



Matrix for representing 3D rotations about the-

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

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

Y axis →
$$\begin{bmatrix} \cos\theta & 0 & \sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ \sin\theta & 0 & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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Q3. A(iii).

Animation refers to the movement on screen of the display device created by displaying a sequence of still images. the term computer animation generally refers to any time sequence of visual changes in a scene

Principles of animation:

1. Squash and stretch: The flexibility of object to exxagerate or add appeal to to: movement.
2. Time and spacing: The no' of frames between two poses and how those individuals are placed.
3. Anticipation: The setup for an action to happen
4. ease in & ease out :- the time for acceleration and deacceleration of movement.
5. follow through and overlapping action: the idea that separate parts of the body will continue moving after a character or object comes to a full stop and idea that parts of the body move at different times.

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6. Axes :- The principle that smoothes animation and moves action in a realistic way.
7. Exaggeration : the pushing of movement further to add more appeal to an action.
8. Solid drawing : The accuracy of volume, weight, balance and anatomy.
9. Appeal : The relatability of a character.
10. Secondary action :- The action that emphasis or supports the main action of animation.

Q3. A ii) Back-Surface Detection.
When we project 3-D objects on 2-D screen we need to detect the faces that are hidden on 2D.
Back-Surface detection also known as Plane equation method, is an object space method in which objects and parts of objects are compared to find out the visible surfaces. Let us consider a triangular surface that whose visibility needs to decided. The idea is to check if the triangle will be facing away from the viewer or not. If it does so, discard it for the current frame and

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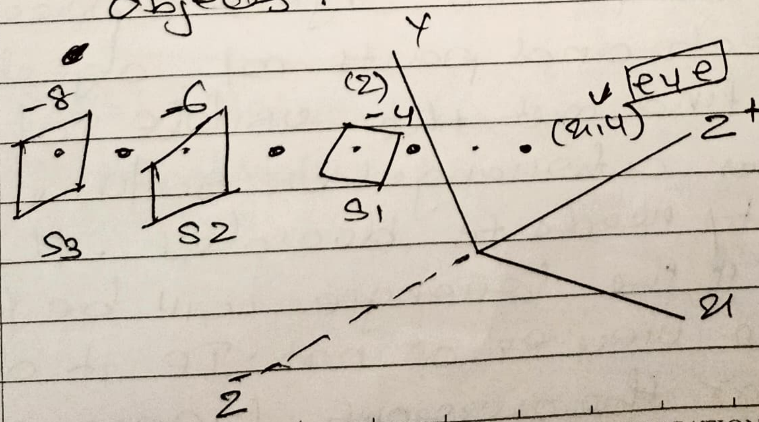
move onto the next one. Each surface has a normal vector. if this normal vector is pointing in direction of center of projection then it is a front face and can be seen by viewer. If this normal vector is pointing away from the center of projection, then it is a back face and can not be seen by the viewer.

Depth Buffer or Z Buffer Algorithm.

1. It is an image space method to eliminate hidden surface.
2. It compares surface depth at each pixel position.
3. Drawback of Back-face elimination
   - can't remove partially hidden surface
   - Do not work efficiently on overlapping objects.



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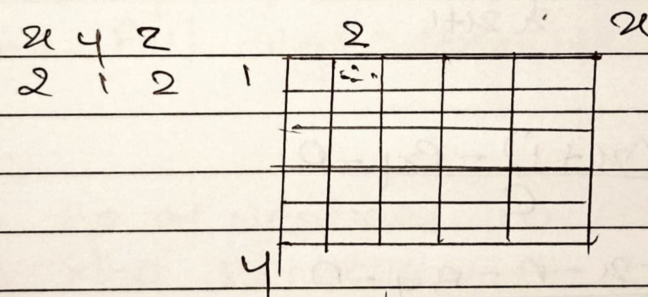
z value- How far is the surface from view plane

$\boxed{\text{Z Buffers.}}$

- Z-Buffer → z-value
- Refresh buffer → Intensity



Case 1
Sitting +z,
viewing origin
-z
larger z value-closer
Smaller z value = far

i) $D(x,y)=0$
$R(x,y)= I_{\text{background color}}$.

ii) $z_{new} > D(x,y)$
$D(x,y)=z_{new}$
$R(x,y)=I_{new}$ (surface)

case 2
Sitting in -z,
viewing origin z^{+}.

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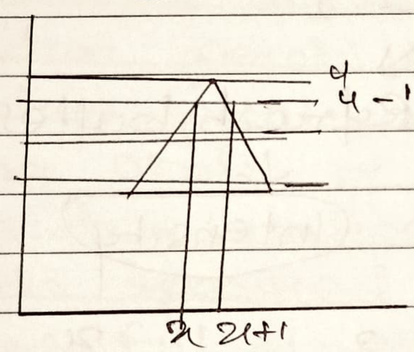
→ Surface Equation

$Ax + By + Cz + D = 0$

$$z = \frac{-Ax - By - D}{C}$$



for (x+1)

$$z' = \frac{-A(x+1) - By - D}{C}$$

$$= \frac{-Ax - A - By - D}{C}$$

$= z - \frac{A}{C} \rightarrow$ constant

Drawback-

Only used for opaque surface

It requires large memory time-consuming.

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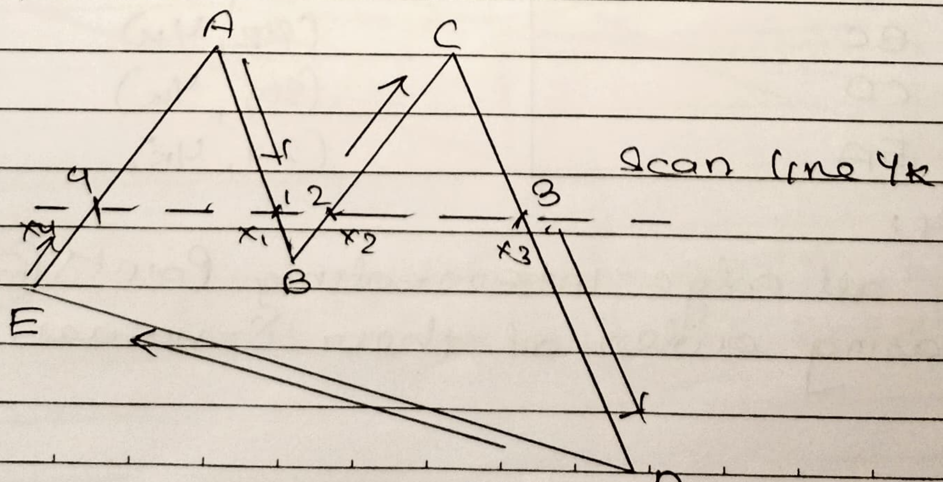
Q3. B ii). Scan-line Polygon Fill Algorithm:

Scan line polygon fill algorithm proceeds scan line by scan line. For scan line crossing a polygon the area fill algorithm locates the intersection points the polygon edges. These intersection points are the sorted on increasing order of their X-values. The corresponding locations in frame buffer are set to the specified fill colour.

Scan_Line_fill_Algorithm (Vertexlist)
START:
{ Step 1:
Accept the no of vertices in polygon & co-ordinates of the vertices.
For example: Vertexlist: A, B, C, D, E, polygon = ABCDEA.



Edgelist

AB
BC
CD
DE
EA

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Step 2 :-
Active Edge list (AEL) is prepared for each scan-line intersecting the polygon that contains the list of edges intersecting the scan-line.
Active Edge list (AEL) for polygon ABCDEA

AB
BC
CD
EA

Step 3 :-
for each polygon edge in AEL, intersecting points are calculated.

Active edges.	Edge intersecting Point (EIP)
AB	(x_1, y_k)
BC	(x_2, y_k)
CD	(x_3, y_k)
EA	(x_4, y_k)

Step 4 :
Sort all edge intersecting Points (EIP) in increasing order of their X-values.

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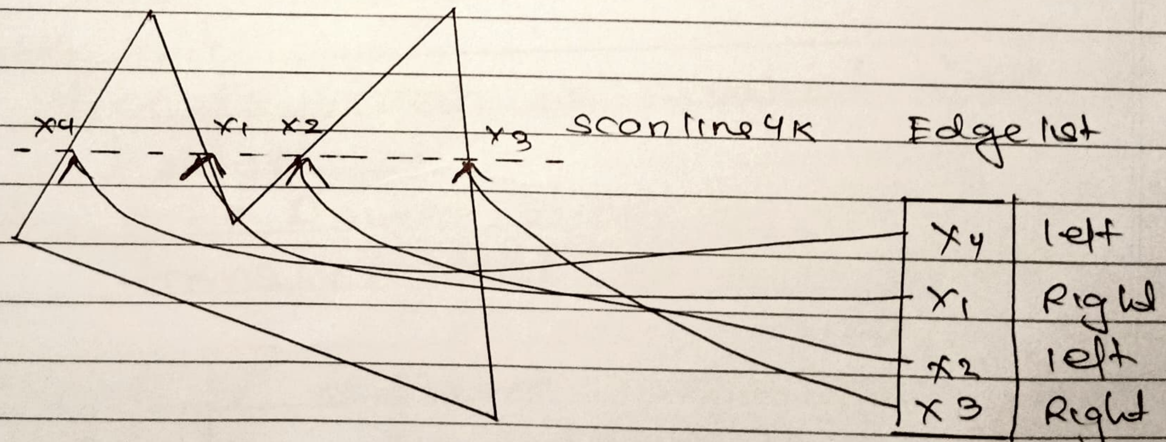
Sorted EIP

	EIP	Edge.
1	(x4, 4k)	EA
2	(x1, 4k)	AB
3	(x2, 4k)	BC
4	(x3, 4k)	CD

In Sorted EIP the first x values gives left intersection boundary & second x value gives right intersection boundary of Scanline with polygon.



step 5:
fill all pixel positions between left & right intersection boundary with the specified fill colour value.

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Step 6:

Repeat step 2 through 5 for all the scan lines.

} END.

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Q4 A.

Normalization transformation:-

(i) It is an active transformation. It is used to convert a sing ~~row~~ into multiple ~~rows~~ when Normalization transformation receives row that contains multiple occuring ~~receives row that contains multiple~~ data it returns a row for each instance of multiple occuring data.

(ii) In single row, there is repeating data it multiplies column then it can be split into multiple rows.

(iii) For eg: A relational source four feeds with flat sales data. We can configure a Normalizer transformation to generate a separate output row for each flat.

eg we create students mark record of diff classes.

Stud name	class7	class8	class9	class10
Joy	60	65	75	80
edward	65	70	80	90

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Step1:-
Create Source tab** stud-source & target table "stud-target" using script.

Step 2:
Create mapping having Source stud-Source and target table.

Step 3: From transformation menu create a new transformation.
Enter name norm-Stud.
And click on create

Step 4 :-
Transformation is created click done button.

Step 5 :- Double click on ~~norr~~ normalization transformation fill the details.

Step6 :- Then in Mapping fill required details. Save Mapping & execute Creating Workflow.

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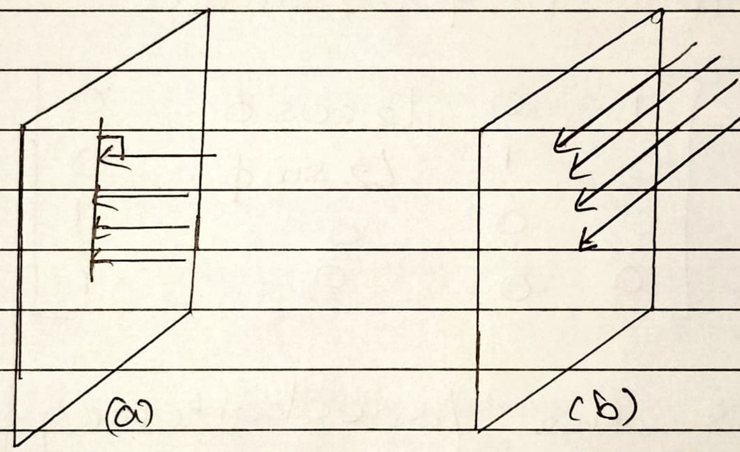
Q4. A iii)

1) Parallel projection is achieved by passing parallel rays from object vertices & projecting the object on view plane.
2) In parallel projection, all projection vectors are ~~pall~~ parallel to each other.



(a) (b)

1. Let $P(x, y, z)$ be point in space. Orthographic projection of point P on view plane XY is $P_{orth}(x, y, 0)$
2. oblique projection of P on the same plane is ~~here~~ say $P_{ob}(x_p, y_p, 0)$.
3. values of ~~object~~ oblique projection point $P(x, y, z)$ on XY view plane

$$x_p = x + L\cos\phi$$
$$y_p = y + L\sin\phi$$

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$\tan\alpha = \frac{y}{L}$

$\therefore L = \frac{y}{\tan\alpha} = x L_2$

$x_p = x + x \cancel{L_2} \cos\phi$
$y_p = y + y x L_2 \sin\phi.$

$$M = \begin{bmatrix} 1 & 0 & L_2 \cos\phi & 0 \\ 0 & 1 & L_2 \sin\phi & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

L_2 is the foreshortening factor.

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Q4 B.

ii) $P(x_1, y_1) = (2, 5)$
$P(x_2, y_2) = (8, 11)$

$(x_{min}, y_{min}) = (4, 4)$
$(x_{max}, y_{max}) = (10, 9)$

$\Delta x = x_2 - x_1 = 8 - 2 = 6$
$\Delta y = y_2 - y_1 = 11 - 5 = 6$

values of P_k & Q_k where $K = 1, 2, 3, 4$.

$P_1 = -\Delta x = -6$; $Q_1 = x_1 - x_{min} = 2 - 4 = -2$
$P_2 = \Delta x = 6$; $Q_2 = x_{max} - x_1 = 10 - 2 = 8$
$P_3 = -\Delta y = -6$; $Q_3 = y_1 - y_{min} = 5 - 4 = 1$
$P_4 = \Delta y = 6$; $Q_4 = y_{max} - y_1 = 9 - 5 = 4$.

case 1 → if any $P_k = 0$, line is parallel to window, as $P_k \neq 0$, line is not parallel to window.

case 2 → $P_k < 0$
$P_1 = -6$, $Q_1 = -2$
$P_3 = -6$, $Q_3 = 1$.

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$t_1 = \max\left(0, \frac{Q_K}{P_K}\right)$.

$= \max\left(0, \frac{-2}{-6}, \frac{1}{-6}\right) = \frac{1}{3} = 0.33$.

$x = x_1 + t_1 \Delta x = 2 + 0.33 \times 6 = 2+2 = 4$.
$y = y_1 + t_1 \Delta y = 5 + 0.33 \times 6 = 5+2 = 7$.

case 3 → $P_K > 0$.
$P_2 = 6$, $Q_2 = 8$.
$P_4 = 6$, $Q_4 = 4$

$t_2 = \min\left(1, \frac{Q_K}{P_K}\right) = \min\left(1, \frac{8}{6}, \frac{4}{6}\right)$

$t_2 = \frac{4}{6} = \frac{2}{3} = 0.67$.

$x = x_1 + t_2 \Delta x = 2 + 0.67 \times 6 = 2+4 = 6$.
$y = y_1 + t_2 \Delta y = 5 + 0.67 \times 6 = 5+4 = 9$.

at t_1 ⇒ $(x, y) = (4, 7)$
t_2 ⇒ $(x, y) = (6, 9)$

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