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Name: Shreejan Pandit

Level: Bachelor

Program: BESE

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Q1a

Ans CG 'Computer Graphics' is a field related to the generation of graphics using computers. It includes the creation, storage and manipulation of images of objects. These objects come from diverse field such as physical, mathematical engineering, architectural abstract structures and natural phenomenon. Computer graphic today is largely interactive; that is largely interactive; i.e the user controls the contents structure and apperance of image of the object by using input devices such as keyboard, mouse or touch sensitive panel on the screen.

The fields of Computer graphics use in many different areas of science, engineering, industry business, education, entertainment, medicine art and training. All of these mentioned field includes in the following category:

1> User interface
2> Plotting
3> Office automation & electronic publishing
5> Simulation
6> Art and commerce.

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Q 1 b

Ans GSK stands for Graphical Kernal System. It is software which used for two-dimensional graphics. It was adopted as first graphics software standard by international Standard organization. It has features for drawing in 2d vector graphics which is suitable for charting and similar purpose. The 2 dimensional CG which is closely related to six output functions of Graphical Kernal System. These are as follows:

a) Poly line b) Polymarker c) Text
d) Fill-area e) cell-array f) Generalized Drawing primitives

The main uses of GKS standard are:

- To give for probability of application graphics programs.
- To assist in the learning of graphics system by application programmers.
- To offer strategy for manufactures in relating ~~parti~~ practical graphics capabilites.

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Q1C

Ans Suther land Hodgeman Polygon Clipping is performed by processing the boundary of polygon against each window corner or edge. First of all entire polygon is clipped against one edge, the resulting polygon is considered, then the polygon is considered against the 2nd edge, so on for all four edges.

Four possible situation while processing:

1) If the 1st vertex is an outside the window, the 2nd vertex is inside the window. Then 2nd vertex is added to the output list. The point of intersection of window boundary and polygon side is also added to output line.
2) If both vertexes are inside window boundary. Then only 2nd vertex is added to the output list.
3) If the 1st vertex is inside the window and 2nd is outside window. The edge which intersects with window is ~~aded~~ added to output list.
4) If both vertices are the outside window then nothing is added to output list.

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Q2a

Raster Graphics	Vector Graphics
1) They are composed of pixels.	1) They are composed of paths.
2) In Raster Graphics, refresh process is independent of the complexity of the image.	2) Vector display flicker when the number of primitives in the image becom too large.
3) Graphic primitives are specified in terms of end points and must be scan converted into corresponding pixels	3) Vector graphics draw continuous and smooth lines.
4) Raster graphics can draw mathematical curves, polygons and boundaries of curved primitives only by pixel approximation.	4) Vector graphics cost more as compared to raster graphics.
5) Raster graphics cost less	5) They occupy less space.
6) They occupy more space which depends on image quality.	6) Scan conversion is not required.
7) It is also known as bit maps.	7) It is path made
8) File extensions: .BMP, .TIF, .GIF, .JPG	8) File Extension: .SVG, .EPS, .PDF, .AI, .DXF

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Q 3a

Ans Algorithm for calculating points of an circle:

- Step 1: Start
- Step 2: First, we allot the center coordinates (P_0, q_0) as follows

$P_0 = 0$

$q_0 = r$

- Step 3: Now we calculate the initial decision parameter d_0:

$d_0 = 1 - r$

- Step 4: Assume, the starting coordinates $= (P_k, q_k)$

The next coordinates will be (P_{k+1}, q_{k+1})

Now we find the 1st octant according to the value of decision parameter (d_k).

- Step 5: Now we follow two cases:
- Case 1: If

$d_k < 0$

then

$P_{k+1} = P_k + 1$

$q_{k+1} = q_k$

$d_{k+1} = d_k + 2P_k + 1$

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Case 2: If
$d_k >= 0$
then
$P_{k+1} = P_k + 1$
$q_{k+1} = q_k - 1$
$d_{k+1} = d_k - 2(q_{k+1} + 2P_{k+1}) + 1$

- Step 6: If the center co-ordinate point (P_0, q_0) is not at the origin (0,0) then we will draw the points as follow:
  For 'x' co ordinate $= x_c + P_0$
  For 'y' co ordinate $= y_c + q_0$

- Step 7: We repeat step 5 & step 6 until we get $x \geq y$.
- Stop.

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Q5a

Ans- Perspective Projection transforms points along projects line that meet at Projection refrence point. Let the projection refrence point be at Z_{prp} along Z_v axis and view plane be at Z_{vp} the equations describing prespective coordinate points along prespective projection in parametric form is

$x' = x - x.u$, $y' = y - y.u$ and $z' = z - (z - Z_{prp}).u$

parameter 'u' takes values from 0 to 1 and coordinates (x', y', z') represents any point along projection line. When $u=0$ we are at position $p(x, y, z)$ and at the other end of the line $u=1$. On the view plane $z' = Z_{vp}$.

Solving the equation for parameter u at this position $u = (Z_{vp} - z) / (Z_{prp} - Z)$

Substituting value of u in eqn for x' and y'

The prespective transformation eqn are:

$X_p = X(Z_{prp} - Z_{vp}) / (Z_{prp} - Z) = X.(d_p / (Z_{prp} - Z))$

$Y_p = Y.(Z_{prp} - Z_{vp}) / (Z_{prp} - Z) = y.(d_p / (Z_{prp} - Z))$

where $d_p = Z_{prp} - Z_{vp}$ the distance of the view plane from projection refrence point

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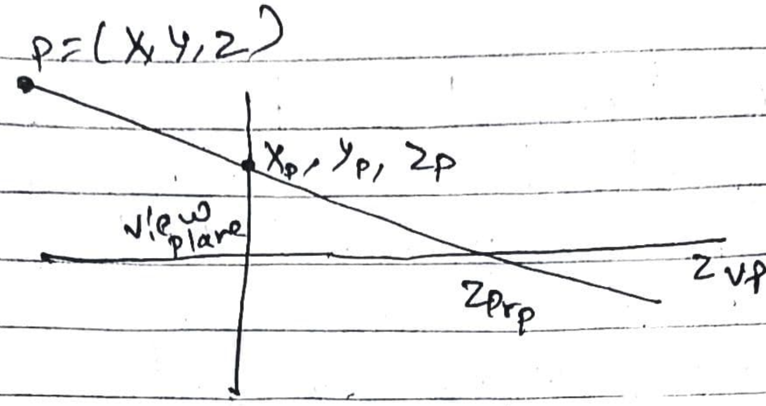

Using 3D homogenous co-ordinate representation the prespective transformation in matrix for is:

$$\begin{bmatrix} x_h \\ y_h \\ z_h \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & z_{rp}/d_p & z_{rp}(z_{pp}/d_p) \\ 0 & 0 & 1/d_p & z_{prp}/d_p \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

where the homogenous factor is $h = (z_{prp} - z)/d_p$ and projection co-ordinates on the view plane are $x_p = x_h/h$ & $y_p = y_h/h$

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Q5b

Ans The conceptual model of 3D viewing transformation:

For representing 3D - objects on 2D screen in a nice or recognizable way many techniques are combined. first the projection has to be defined which will be described in the next paragraph. After the projection has been set any of the following qualities can generated.

- Wire frame Representation
- Depth cueing
- Correct visibility
- Shading
- Illumination model
- Shadows
- Reflections. Transparency
- Textuers
- Surface Details
- Setreo Image

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Q6a

- Constant Shading model:
  A fast and simple method for rendering an object with polygon surface is constant intensity shading, also called flat shading. In this method a single intensity is calculated for each polygon. All points over the surface of the polygon are then displayed with the same intensity value. Constant shading can be useful for quickly displaying the general apperance of a curved surface.

- Gouraud Shading model:
  Also known as smooth shading is a per-vertex color computation. What this means is that the vertex shader must determine a color for each vertex and pass the color as an out variable to the fragment shader. Since this color is passed to the fragment shader as an in varying variable, it is interpolated across the fragments thus

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giving smooth shading.

- Phong shading model:
  It is a per fragment color computation. The vertex shader provides the normal and position data as out variables to the fragment shader. The fragment shader then interpolates these variables & computes the color. The color for the fragment is computed in fragment shader.

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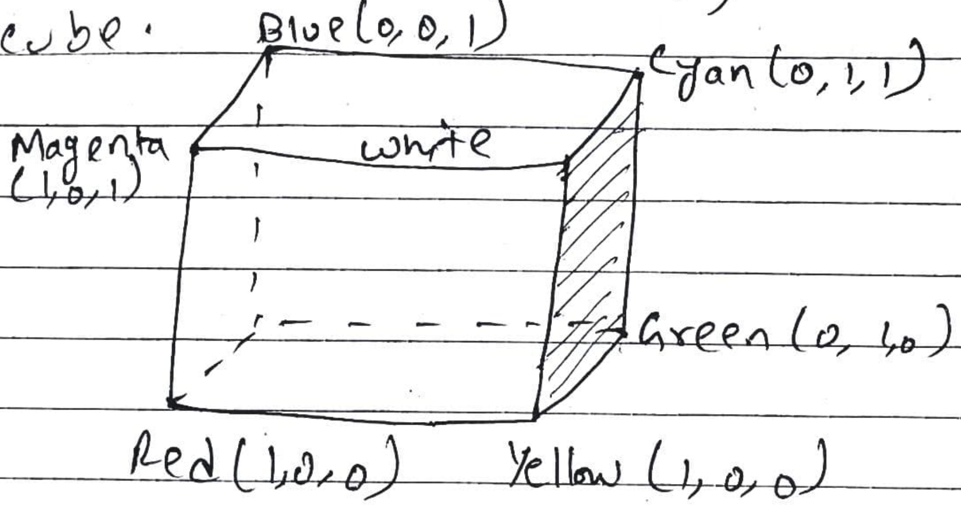
Q 6 b

Ans The RGB Model:

Represents color as a point in three dimensional space obtained from the three RGB component red, green & blue.
The color black is located at the origin (0,0,0) of the RGB model & white is at the point (1,1,1) all other colors are represented by points inside the cube.



• CMYK Model:

It uses the colors cyan, magenta and yellow which are the component of RGB color model. The white is located at the origin (0, 0, 0) ~~ab~~ and black (1, 1, 1) which is just the opposite of the RGB model.
This is a subtractive model and is popular in hard-copy devices which work with pigments eg press.

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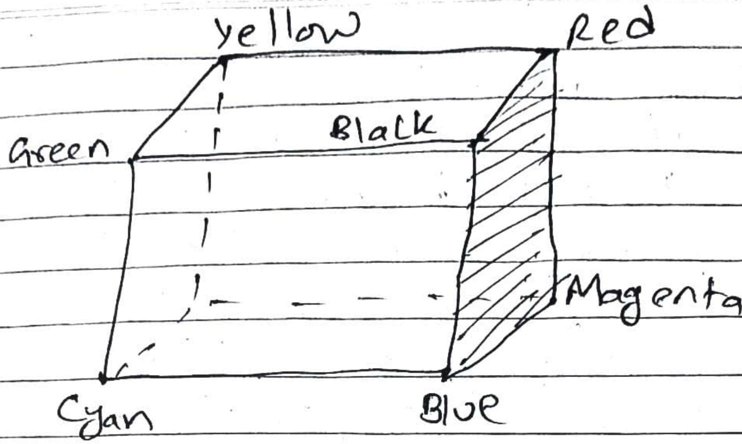

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Q7 ii)

Depth Buffer method:

It is also known as Z Buffer algorithm. Depth buffer algorithm is simplest image space algorithm. For each pixel on the display screen, we keep a record of the depth of an object within the pixel that ~~tins~~ lies closest to the observer. In addition to depth, we also record the intensity that should be displayed to show the the object. Depth buffer is an extension of the frame buffer. Depth buffer algorithm requires 2 arrays, intensity and depth each of which is indexed by pixel coordinates (x, y).

Limitations of Depth Buffer:

1) The depth buffer Algorithm is not always practical because of the enormous size of depth and intensity arrays.

2) Generating an image with a raster of 500 x 500 pixels requires 2,50,000 storage locations for each array.

3) Even though the frame buffer may provide memory for intensity array, the depth array remains large.

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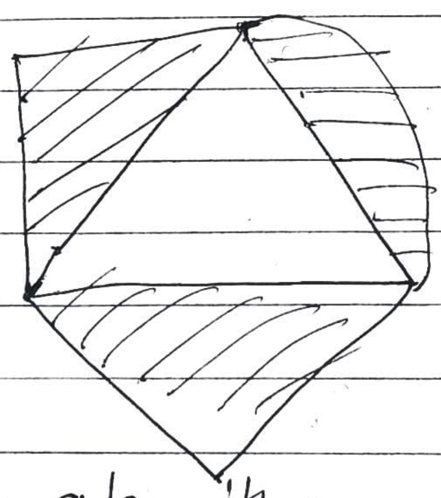
Q7 iii)

Flood Fill Algorithm:

In this method, a point or seed which is inside region is selected. This point is called a seed point. Then four connected approaches or eight connected approaches is used to fill with specified color.

The flood fill algorithm has many characters similar to boundry fill. But this method is more suitable for filling multiple colors boundary. When boundary is of many colors and interior is to be filled with one color we use this algorithm.



In fill algorithm, we start from a specified interior point (x, y) and reassign all pixel values are currently set to a given interior color with the desired color.

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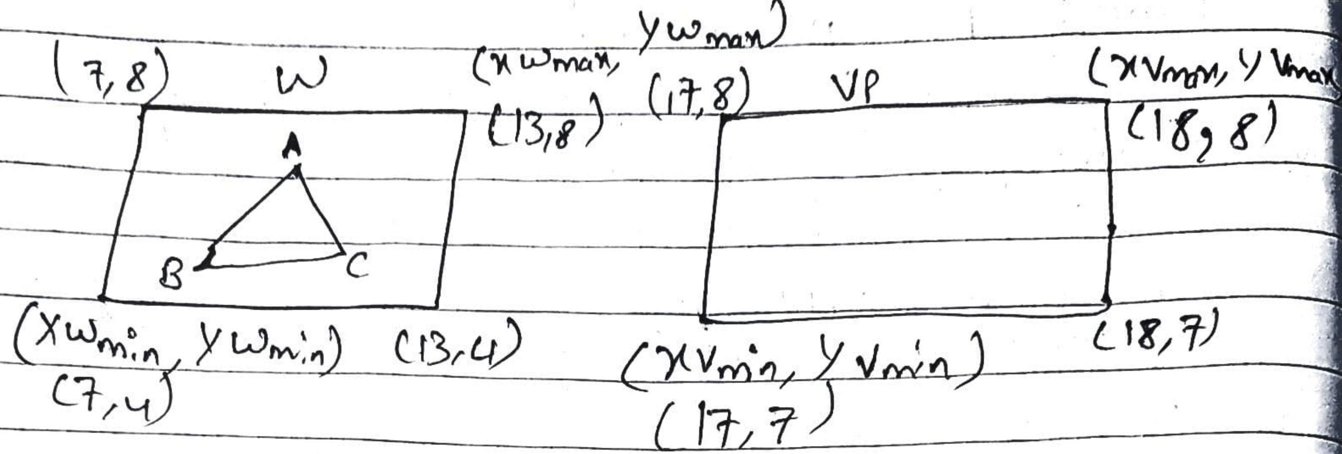
Q2b

Ans



$$S_x = \frac{18-17}{13-7} = \frac{1}{6}$$

$$S_y = \frac{8-7}{8-4} = 1/4$$

$T = T(xV_{min}, yV_{min})\, S(S_x, S_y)\, T(-xW_{min}, -yW_{min})$

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

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

$$= \begin{bmatrix} 1/6 & 0 & 17 \\ 0 & 1/9 & 7 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -7 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$$= \begin{bmatrix} 1/6 & 0 & 95/6 \\ 0 & 1/4 & 6 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/6 & 0 & \frac{1}{6}(-7)+7 \\ 0 & 1/4 & \frac{1}{4}(-4)+7 \\ 0 & 0 & 1 \end{bmatrix}$$

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

Now, $[A' \; B' \; C'] =$

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

$$= \begin{bmatrix} 106/6 & 15/6 + 95/6 & 10/6 + 95/6 \\ 5/4 + 6 & 5/4 + 6 & 10/4 + 6 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 106/6 & 110/6 & \frac{105}{6} \\ 29/4 & 29/4 & 34/4 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 53/3 & 55/3 & 35/2 \\ 29/4 & 29/4 & 17/2 \\ 1 & 1 & 1 \end{bmatrix}$$

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Q 4a

Ans soln

We rotate the line by rotating the endpoing of line.

- Rotating point A(5, 2)

Let the new coordinate of point A after rotation = (X_{new}, Y_{new})

$$X_{new} = 5 * \cos\theta - 2 * \sin\theta$$
$$= 5 * \cos 60 - 2 * \sin 60$$
$$= 2.5 - 1.37$$
$$= 0.768 \approx 1$$

$$Y_{new} = 5 \sin 60 + 2 \cos 60$$
$$= 4.33 + 1$$
$$= 5.33 \approx 5$$

$\therefore A_{new} = (1, 5)$

- Rotating point B(10, 10)

$$X_{new} = 10 \cos 60 - 10 \sin 60$$
$$= -3.66$$
$$\approx -4$$

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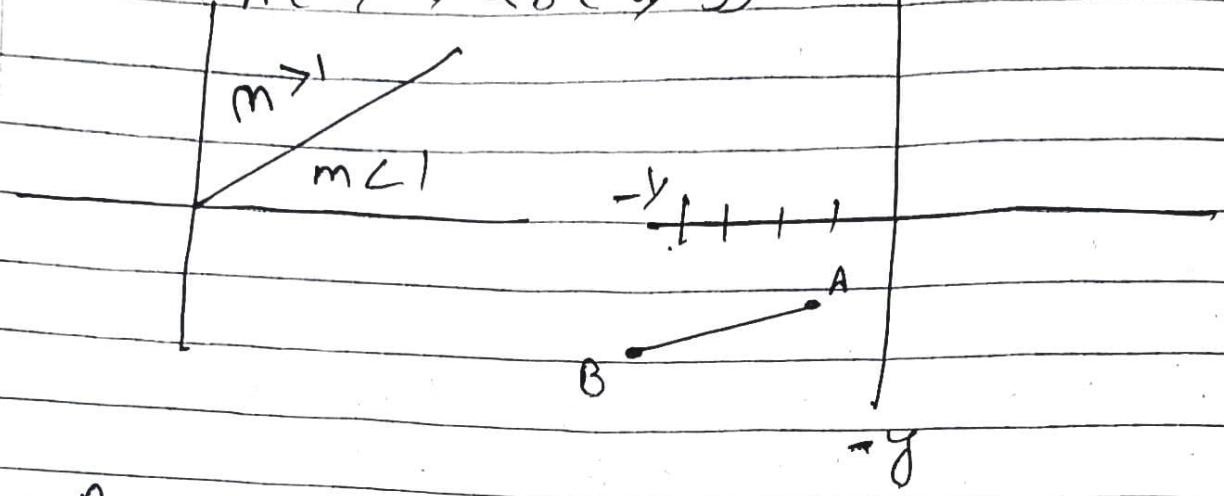
$$Y_{new} = 10 \sin 60 + 10 \cos 60$$
$$= 10 (1.360)$$
$$= 13.66$$
$$\simeq 14$$

$\therefore B_{new} = (-4, 14)$

$\therefore$ The line after rotating about origin is $A'(1, 5)$ & $B'(-4, 14)$

Q 3b

Ans Given: A (-2, -4) & B (-6, -9)



Soln

Translating ~~ling~~ line AB from 3rd quardent into 1st quardent we get,
A' (2, 4)   B' (6, 9)

Now using Bresenham's line drawing algorithm
we have, $(x_0, y_0) = (2, 4)$
$(x_1, y_1) = (6, 9)$

Now using Bresenham's line drawing Algorithm,
we have, $(x_0, y_0) = (2, 4)$
$(x_1, y_1) = (6, 9)$

$dx = x_1 - x_0 = 6 - 2 = 4$
$dx = y_1 - y_0 = 9 - 4 = 5$

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slope (m) $= \frac{dy}{dx} = 5/4 = 1.25$

we get $m = 1.25$

Since, $m > 1$
we know
d or dstart $= dy - 2dx$
$= 5 - 2(4) = 5 - 8 = -3$

Since, $d = -3$, $d < 0$

$x{+}{+} \Rightarrow 2+1 = 3$ $(3,5)$
$y{+}{+} \Rightarrow 4+1 = 5$

$d_{new} = d_{old} + 2(dy - dx)$
$= -3 + 2(5-4)$
$= -1$

Since $d < 0$,
$x{+}{+} \Rightarrow 3+1$ $(4,6)$
$y{+}{+} \Rightarrow 5+1$
$d_{new} = -1 + 2(5-4)$
$= -1+2$
$= 1$

Since $d > 0$
$y{+}{+} = 7$ $(4,7)$

$d_{new} = 1 - 2(4) \Rightarrow 1 - 8 \Rightarrow -7$

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Since, $d < 0$

$x{+}{+} = 5$ $(5, 8)$

$y{+}{+} = 8$

$d_{new} = d_{old} + 2(5-4)$

$= -7 + 2 = -5$

Since, $d < 0$

$x{+}{+} = 6$

$y{+}{+} = 9$

$d_{new} = d_{old} + 2(5-4)$

$= -5 + 2$

$= -3$

The coordinates are $(2, 4)$ $(3, 5)$, $(4, 6)$ $(4, 7)$ $(5, 8)$, $(6, 9)$

Again translating these coordinates into 3rd quadrant the ~~or~~ points are $(-2, -4)$, $(-3, -5)$, $(-4, -6)$, $(-4, -7)$ $(-5, -8)$ $(-6, -9)$