Experiment No. : 1

Date :

Page No. :

Experiment Name : Bresenham's Line Drawing

Write a program to generate a line using Bresenham's line drawing technique. Consider slopes greater than one and slopes less than one. User must able to draw as many lines and specify inputs through keyboard/mouse.

```
#include <iostream>
#include <GL/glut.h>
#include <time.h>
using namespace std;
int x1, x2, yc1, y2;
int flag=0;
void draw_pixel(int x, int y)
{
  glColor3f(1,0,0);
  glBegin(GL_POINTS);
  glVertex2i(x,y);
  glEnd();
  glFlush();
}
void draw_line()
{
  int dx,dy,i,e;
  int incx,inty,inc1,inc2;
  int x,y;
  dx= x2-x1;
  dy = y2-yc1;
  if(dx<0) dx=-dx;
```

```
if(dy<0) dy = -dy;
incx = 1;
if(x2 < x1) incx = -1;
incy = 1;
if(y2 < y1) incy = -1;
x = x1;
y = y1;
if (dx > dy)
{
  draw_pixel(x,y);
  e = 2*dy-dx;
  inc1 = = 2*(dy-dx);
  inc2 = 2*dy;
  for(i=0; i<dx; i++)
  { if(e>0)
    { y = y+incy;
      e = e+inc1;
    }
    else { e = e+inc2; }
    x = x+incx;
    draw_pixel(x,y);
  }
}
else {
    draw_pixel(x,y);
    e = 2*dx-dy;
    inc1 = 2*(dx-dy);
```

```
    inc2 = 2*dx;
    for(i=0;i<dy;i++)
    {
      if(e>0)
      {
        x+=incx;
        e+=inc1;
      }
      else
        e+=inc2;
      y+=incy;
      draw_pixel(x,y);
    }
  }
  gl_Flush();
}
void myinit()
{
  glClear(GL_COLOR_BUFFER_BIT);
  glClearColor(1,1,1,1);
  gluOrtho2D(-250,250,-250,250);
}
void MyMouse(int button,int state, int x,int y)
{
  switch(button)
  {
    case GLUT_LEFT_BUTTON:
      if(state==GLUT_DOWN) {
```

```
if(flag==0)
  { printf("Defining x1,y1");
    x1=x-250;
    yc1=250-y;
    flag++;
    cout<<x1<<" "<<yc1<<"\n";
  }
 else{
    printf("Defining x2,y2");
    x2=x-250;
    y2=250-y;
    flag=0;
    cout<<x2<<" "<<y2<<"\n";
    draw_line();
  }
 }
 break;
 }
}
void display()
{ }
int main(int argc, char* argv[])
{
  //FOR Keyboard
  cout<<"Enter x1\n";
  cin>>x1;
  cout<<"Enter y1\n";
```

```
cin>>y1;
cout<<"Enter x2\n";
cin>>x2;
cout<<"Enter y2\n";
cin>>y2;
//End keyboard
glutInit(&argc,argv);
glutInitDisplayMode(GLUT_SINGLE|GLUT_RGB);
glutInitWindowSize(500,500);
glutInitWindowPosition(100,200);
glutCreateWindow("Line");
myinit();
//glutMouseFunc(MyMouse); //Include To use Mouse, Remove while Using keyboard
draw_line(); //Include to use keyboard, Remove while using Mouse
glutDisplayFunc(display);
glutMainLoop();
return 0;
}
```

Program-1:

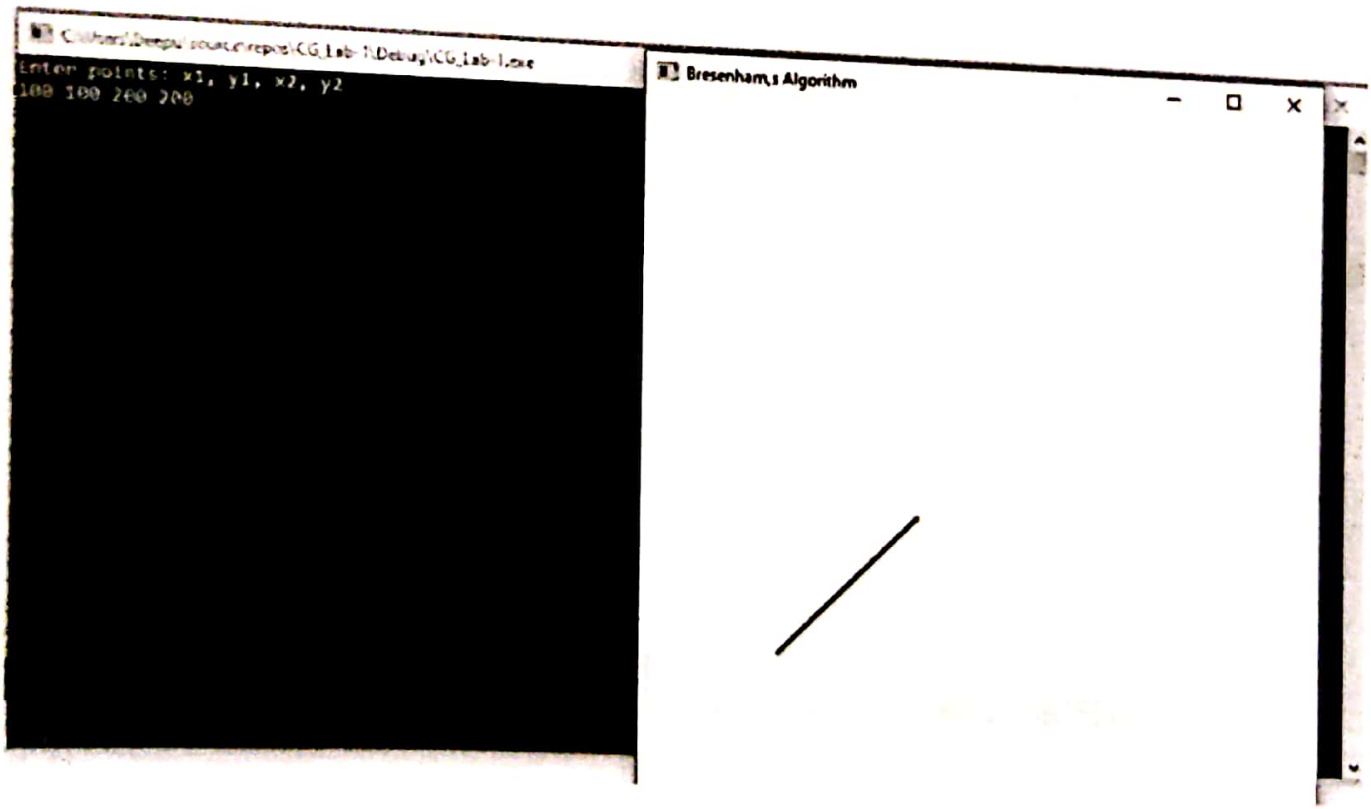
Write a program to generate a line using Bresenham's line drawing technique. Consider slopes greater than one and slopes less than one. User must able to draw as many lines and specify inputs through keyboard/mouse.

```
#include <iostream>
#include <GL/glut.h>
#include <time.h>
using namespace std;
int x1, x2, yc1, y2;
int flag = 0;
void draw_pixel(int x, int y)
{
	glColor3f(1, 0, 0);
	glBegin(GL_POINTS);
	glVertex2i(x, y);
	glEnd();
	glFlush();

}
void draw_line()
{
	int dx, dy, i, e;
	int incx, incy, inc1, inc2;
	int x, y;
	dx = x2 - x1;
	dy = y2 - yc1;
	if (dx < 0)dx = -dx;
	if (dy < 0)dy = -dy;
	incx = 1;
	if (x2 < x1)
		incx = -1;
	incy = 1;
	if (y2 < yc1)
		incy = -1;
	x = x1;
	y = yc1;
	if (dx > dy)
	{
		draw_pixel(x, y);
		e = 2 * dy - dx;
		inc1 = 2 * (dy - dx);
		inc2 = 2 * dy;
		for (i = 0; i < dx; i++)
		{
			if (e > 0)
			{
				y += incy;
				e += inc1;
			}
			else
				e += inc2;
			x += incx;
			draw_pixel(x, y);
		}
	}
	else
	{

		draw_pixel(x, y);
```

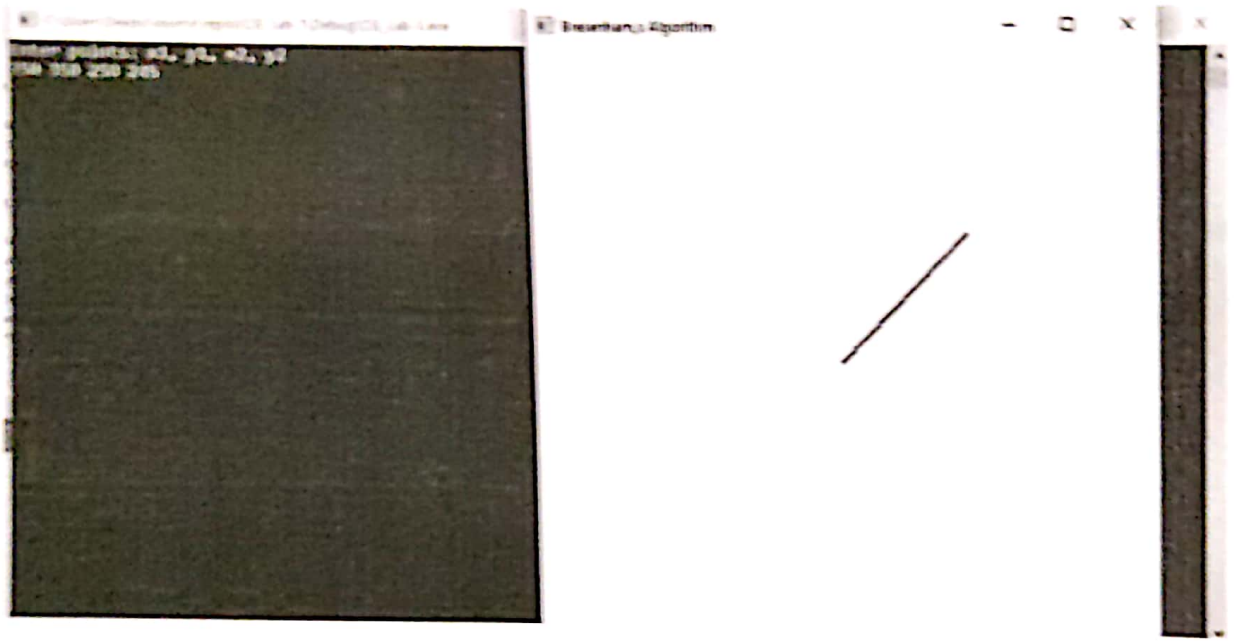
```
                e = 2 * dx - dy;
                inc1 = 2 * (dx - dy);
                inc2 = 2 * dx;
                for (i = 0; i < dy; i++)
                {
                        if (e > 0)
                        {
                                x += incx;
                                e += inc1;

                        }
                        else

                                e += inc2;
                        y += incy;

                        draw_pixel(x, y);
                }
        }
        glFlush();
}
void myinit()
{
        glClear(GL_COLOR_BUFFER_BIT);
        glClearColor(1, 1, 1, 1);
        gluOrtho2D(-250, 250, -250, 250);
}
void MyMouse(int button, int state, int x, int y)
{
        switch (button)
        {
        case GLUT_LEFT_BUTTON:
                if (state == GLUT_DOWN)
                {
                        if (flag == 0)
                        {
                                printf("Defining x1,y1");
                                x1 = x - 250;
                                yc1 = 250 - y;
                                flag++;
                                cout << x1 << " " << yc1 << " \n";
                        }
                        else
                        {
                                printf("Defining x2,y2");
                                x2 = x - 250;
                                y2 = 250 - y;
                                flag = 0;
                                cout << x2 << " " << y2 << " \n";
                                draw_line();

                        }

                }
                break;
        }
}
void display()
{}
int main(int ac, char* av[])
{
```

```
        //FOR KEYBOARD
        cout<<"X1\n";
        cin>>x1;
        cout<<"Y1\n";
        cin>>yc1;
        cout<<"X2\n";
        cin>>x2;
        cout<<"Y2\n";
        cin>>y2;
        //END KEYBOARD

        glutInit(&ac, av);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
        glutInitWindowSize(500, 500);
        glutInitWindowPosition(100, 200);
        glutCreateWindow("LINE");
        myinit();
        //glutMouseFunc(MyMouse); //INCLUDE TO USE MOUSE, REMOVE WHILE USING KEYBOARD
        draw_line(); //INCLUDE TO USE KEYBOARD, REMOVE WHILE USING MOUSE
        glutDisplayFunc(display);
        glutMainLoop();
        return 0;
}
```

Output-1:



Output-2:



Output-3:

Experiment No. : 2 Date : Page No. : 6

Experiment Name : Bresenham's Circle drawing & Ellipse Drawing

Write a program to generate a circle and ellipse using Bresenham's circle drawing and ellipse drawing techniques. Use two windows to draw circle in one window and ellipse in the other window. User can specify inputs through keyboard/mouse

```
#include<gl/glut.h>
#include<stdio.h>
#include<math.h>
int xc,yc,r;
int rx,ry,xce,yce;
void draw_circle(int xc,int yc,int x,int y)
{ glBegin(GL_POINTS);
  glVertex2i(xc+x,yc+y);
  glVertex2i(xc-x,yc+y);
  glVertex2i(xc+x,yc-y);
  glVertex2i(xc-x,yc-y);
  glVertex2i(xc+y,yc+x);
  glVertex2i(xc-y,yc+x);
  glVertex2i(xc+y,yc-x);
  glVertex2i(xc-y,yc-x);
  glEnd();
}
void circlebresc()
{ glClear(GL_COLOR_BUFFER_BIT);
  int x=0,y=r;
  int d=3-2*r;
  while(x<=y)
  { draw_circle(xc,yc,x,y);
```

```
        x++;
        if(d<0)
            d = d + 4*x + 6;
        else
        { y--;
            d = d + 4*(x-y) + 10;
        }
        draw_circle(xc, yc, x, y);
    }
    glFlush();
}
int p1_x, p2_x, p1_y, p2_y;
int point1_done = 0;
void myMouseFunccircle(int button, int state, int x, int y)
{ if(button == GLUT_LEFT_BUTTON && state == GLUT_DOWN && point1_done == 0)
    { p1_x = x - 250;
        p1_y = 250 - y;
        xc = p1_x;
        yc = p1_y;
        float exp = (p2_x - p1_x)*(p2_x - p1_x) + (p2_y - p1_y)*(p2_y - p1_y);
        r = (int)(sqrt(exp));
        circlebres();
        point1_done = 0;
    }
}
//ELLIPSE
Void draw_ellipse(int xce, int yce, int x, int y) {
```

```
        glBegin(GL_POINTS);
        glVertex2i(x+xce, y+yce);
        glVertex2i(-x+xce, y+yce);
        glVertex2i( x+xce, -y+yce);
        glVertex2i(-x+xce, -y+yce);
        glEnd();
    }

void midptellipse()
{ glClear(GL_COLOR_BUFFER_BIT);
    float dx,dy,d1,d2,x,y;
    x=0;
    y=ry;
    // Initial decision parameter of region 1
    d1=(ry*ry)-(rx*rx*ry)+(0.25*rx*rx);
    dx=2*ry*ry*x;
    dy=2*rx*rx*y;
    //for region 1
    while(dx<dy){
    // Print points based on 4-way Symmetry
    draw_ellipse(xce,yce,x,y);
    //Checking and updating value of decision parameter based on algorithm
    if(d1<0)
    { x++;
      dx=dx+(2*ry*ry);
      d1=d1+dx+(ry*ry);
    }
    else { x++;
```

Experiment No. :

Experiment Name : Date : Page No. : 9

```
        y--;
        dx = dx + (2*ry*ry);
        dy = dy - (2*rx*rx);
        d1 = d1 + dx - dy + (ry*ry);
    }
}

//Decision parameter of region 2
d2 = ((ry*ry)*((x+0.5)*(x+0.5))) + ((rx*rx)*((y-1)*(y-1))) - (rx*rx*ry*ry);
//Plotting points of region 2
while(y>=0)
{ //Print points based on 4-way symmetry
    draw_ellipse(xce, yce, x, y);
    //Checking and updating parameter value based on algorithm
    if(d2>0)
    { y--;
      dy = dy - (2*rx*rx);
      d2 = d2 + (rx*rx) - dy;
    }
    else{ y--;
          x++;
          dx = dx + (2*ry*ry);
          dy = dy - (2*rx*rx);
          d2 = d2 + (dx - dy) + (rx*rx);
        }
}
glFlush();
}
```

```
int p1e_x, p2e_x, p1e_y, p2e_y, p3e_x, p3e_y;
int pointle_done=0;
void myMousefunc(int button, int state, int x, int y)
{ if(button==GL_LEFT_BUTTON && state==GLUT_DOWN && pointle_done==0)
  {
    p1e_x = x-250;   p1e_y = 250-y;
    xce = p1e_x;   yce = p1e_y;   pointle_done=1;
  }
  else if(button==GLUT_LEFT_BUTTON && state==GLUT_DOWN && pointle_done==1)
  { p2e_x = x-250;   p2e_y = 250-y;
    float exp = (p2e_x-p1e_x) * (p2e_x-p1e_x) + (p2e_y-p1e_y) * (p2e_y-p1e_y);
    rx = (int)(sqrt(exp));
    //midptellipse();
    pointle_done=2;
  }
  else if(button==GLUT_LEFT_BUTTON && state==GLUT_DOWN && pointle_done==2)
  { p3e_x = x-250;   p3e_y = 250-y;
    float exp = (p3e_x-p1e_x) * (p3e_x-p1e_x) + (p3e_y-p1e_y) * (p3e_y-p1e_y);
    ry = (int)(sqrt(exp));
    midptellipse();
    pointle_done=0;
  }
}
void minit()
{ glClearColor(1,1,1,1); glColor3f(1.0, 0.0, 0.0);
  glPointSize(3.0); gluOrtho2D(-250, 250, -250, 250);
}
int main(int argc, char* argv[]) {
```

```
glutInit(&argc, argv);
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(500,500);
glutInitWindowPosition(0,0);
//For Mouse
int id1 = glutCreateWindow("Circle");
glutSetWindow(id1);
glutMouseFunc(myMouseFunccircle);
glutDisplayFunc(myDrawing);
myinit();
glutInitWindowSize(500,500);
glutInitWindowPosition(600,100);
int id2 = glutCreateWindow("Ellipse");
glutSetWindow(id2);
glutMouseFunc(myMouseFunc);
glutDisplayFunc(myDrawing);
//End Mouse
/* //FOR KEYBOARD
printf("Enter 1 to draw circle, 2 to draw ellipse\n");
int ch;
scanf_s("%d",&ch);
switch(ch){
case 1: printf("Enter coordinates of center of circle and radius\n");
        scanf_s("%d%d%d",&xc,&yc,&r);
        glutCreateWindow("Circle");
        glutDisplayFunc(circlebres);
        break;
```

```
Case 2: printf("Enter coordinates of center of ellipse, major & minor axis");
        scanf_s("%d%d%d%d", &xce, &yce, &rx, &ry);
        glutCreateWindow("Ellipse");
        glutDisplayFunc(midptellipse);
        break;
    }
    // End Keyboard
    */
    minit();
    glutMainLoop();
    return 0;
}
```

Program 2:

Write a program to generate a circle and ellipse using Bresenham's circle drawing and ellipse drawing algorithms. Use two windows to draw circle in one window and ellipse in the other window. User can specify inputs through keyboard/mouse.

```
#include<glut.h>

#include<stdio.h>

#include<math.h>

int wx, wy;

int rx, ry, xce, yce;

void draw_circle(int xc, int yc, int x, int y)

{

        glBegin(GL_POINTS);

        glVertex2i(xc + x, yc + y);

        glVertex2i(xc - x, yc + y);

        glVertex2i(xc + x, yc - y);

        glVertex2i(xc - x, yc - y);

        glVertex2i(xc + y, yc + x);

        glVertex2i(xc - y, yc + x);

        glVertex2i(xc + y, yc - x);

        glVertex2i(xc - y, yc - x);

        glEnd();

}

void circle(void)

{

        glClear(GL_COLOR_BUFFER_BIT);

        int x = 0, y = r;

        int d = 3 - 2 * r;

        while (y >= x)

        {

                draw_circle(xc, yc, x, y);

                x++;

                if (d > 0)
```

```
                d = d + 4 * x + 6;
            else
            {
                y--;
                d = d + 4 * (x - y) + 10;
            }
            draw_circle(xc, yc, x, y);
        }
        glFlush();
}
int p1_x, p2_x, p1_y, p2_y;
int point1_done = 0;
void myMouseFunccircle(int button, int state, int x, int y)
{
        if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN && point1_done == 0)
        {
            p1_x = x - 250;
            p1_y = 250 - y;
            point1_done = 1;
        }
        else if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN)
        {
            p2_x = x - 250;
            p2_y = 250 - y;
            xc = p1_x;
            yc = p1_y;
            float exp = (p2_x - p1_x) * (p2_x - p1_x) + (p2_y - p1_y) * (p2_y - p1_y);
            r = (int)(sqrt(exp));
            circlebres();
            point1_done = 0;
        }
```

```
}
/////ELLIPSE//////////////
void draw_ellipse(int xce, int yce, int x, int y)
{
        glBegin(GL_POINTS);
        glVertex2i(x + xce, y + yce);
        glVertex2i(-x + xce, y + yce);
        glVertex2i(x + xce, -y + yce);
        glVertex2i(-x + xce, -y + yce);
        glEnd();
}
void midptellipse()
{
        glClear(GL_COLOR_BUFFER_BIT);
        float dx, dy, d1, d2, x, y;
        x = 0;
        y = ry;

        // Initial decision parameter of region 1
        d1 = (ry * ry) - (rx * rx * ry) +
                (0.25 * rx * rx);
        dx = 2 * ry * ry * x;
        dy = 2 * rx * rx * y;

        // For region 1
        while (dx < dy)
        {

                // Print points based on 4-way symmetry
                draw_ellipse(xce, yce, x, y);
                // Checking and updating value of
```

```
        // decision parameter based on algorithm
        if (d1 < 0)
        {
                x++;
                dx = dx + (2 * ry * ry);
                d1 = d1 + dx + (ry * ry);
        }
        else
        {
                x++;
                y--;
                dx = dx + (2 * ry * ry);
                dy = dy - (2 * rx * rx);
                d1 = d1 + dx - dy + (ry * ry);
        }
}
// Decision parameter of region 2
d2 = ((ry * ry) * ((x + 0.5) * (x + 0.5))) +
        ((rx * rx) * ((y - 1) * (y - 1))) -
        (rx * rx * ry * ry);
// Plotting points of region 2
while (y >= 0)
{
        // Print points based on 4-way symmetry
        draw_ellipse(xce, yce, x, y);
        // Checking and updating parameter
        // value based on algorithm
        if (d2 > 0)
        {
                y--;
                dy = dy - (2 * rx * rx);
```

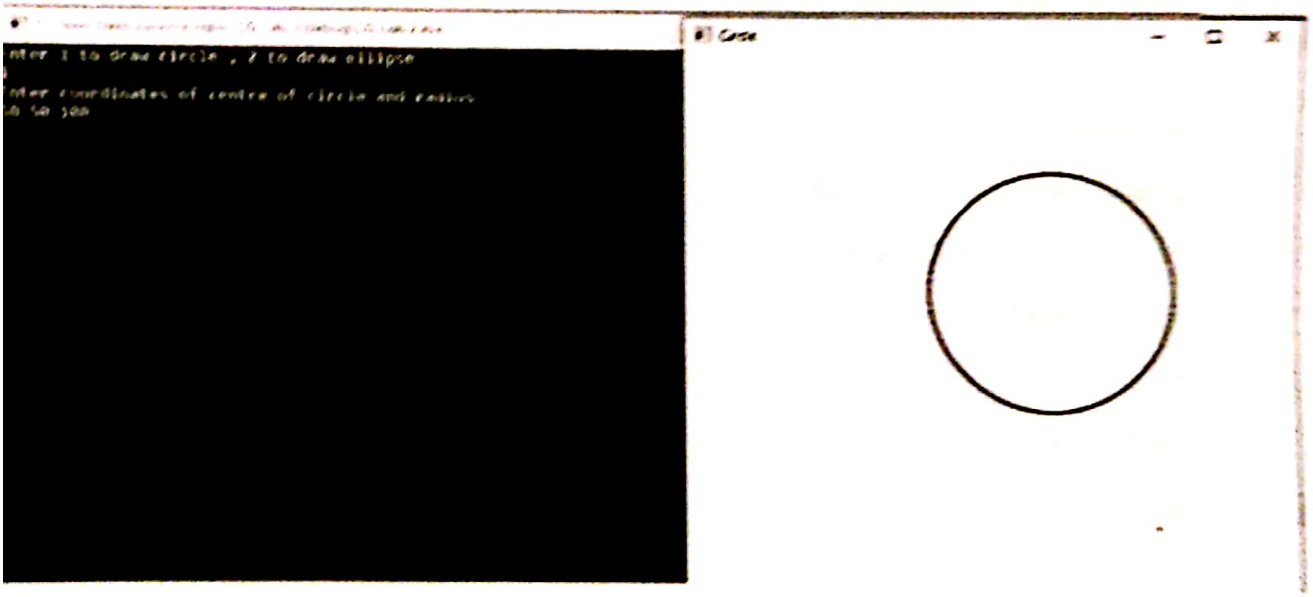
```
                d2 = d2 + (rx * rx) - dy;
            }
            else
            {
                y--;
                x++;
                dx = dx + (2 * ry * ry);
                dy = dy - (2 * rx * rx);
                d2 = d2 + dx - dy + (rx * rx);
            }
        }
        glFlush();
}
int p1e_x, p2e_x, p1e_y, p2e_y, p3e_x, p3e_y;
int point1e_done = 0;
void myMouseFunc(int button, int state, int x, int y)
{
        if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN && point1e_done == 0)
        {
            p1e_x = x - 250;
            p1e_y = 250 - y;
            xce = p1e_x;
            yce = p1e_y;
            point1e_done = 1;
        }
        else if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN && point1e_done == 1)
        {
            p2e_x = x - 250;
            p2e_y = 250 - y;
            float exp = (p2e_x - p1e_x) * (p2e_x - p1e_x) + (p2e_y - p1e_y) * (p2e_y - p1e_y);
            rx = (int)(sqrt(exp));
```

```
            //midptellipse();
            point1e_done = 2;
        }
        else if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN && point1e_done == 2)
        {
            p3e_x = x - 250;
            p3e_y = 250 - y;
            float exp = (p3e_x - p1e_x) * (p3e_x - p1e_x) + (p3e_y - p1e_y) * (p3e_y - p1e_y);
            ry = (int)(sqrt(exp));
            midptellipse();
            point1e_done = 0;
        }
}
void myDrawing()
{}
void myDrawingc()
{}

void minit()
{
        glClearColor(1, 1, 1, 1);
        glColor3f(1.0, 0.0, 0.0);
        glPointSize(3.0);
        gluOrtho2D(-250, 250, -250, 250);
}

int main(int argc, char* argv[])
{

        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
```

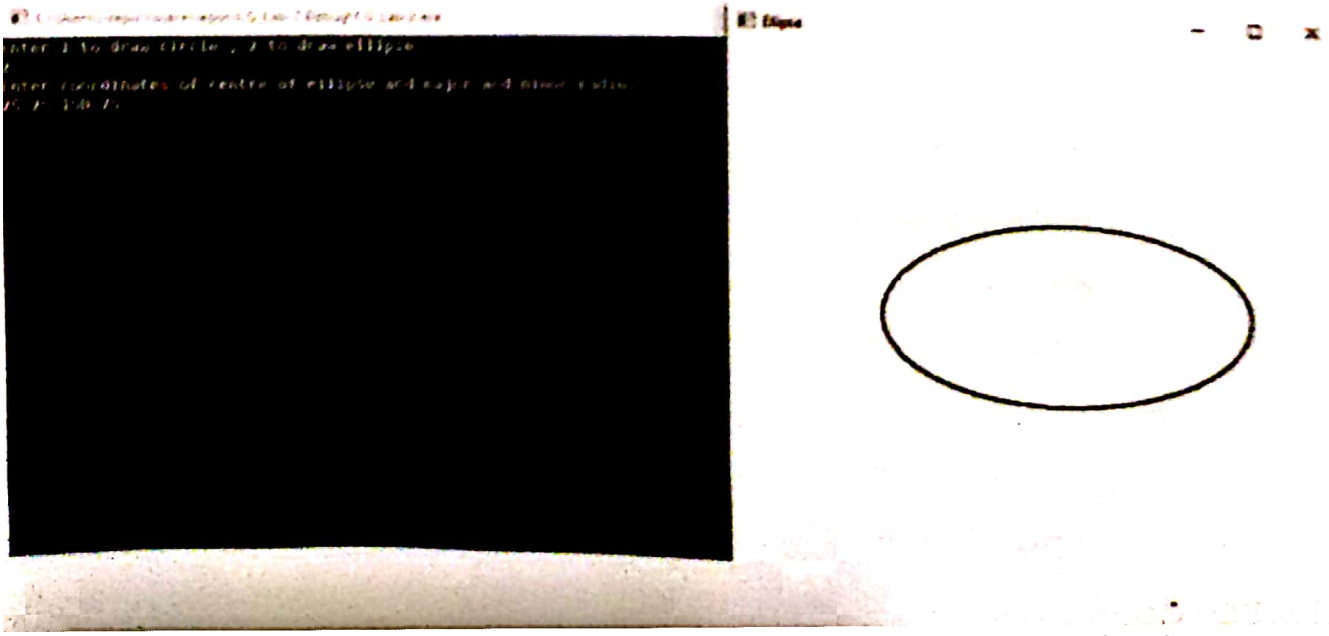
```
glutInitWindowSize(500, 500);
glutInitWindowPosition(0, 0);
/*
//FOR MOUSE
int id1 = glutCreateWindow("Circle");
glutSetWindow(id1);
glutMouseFunc(myMouseFunccircle);
glutDisplayFunc(myDrawingc);
minit();
glutInitWindowSize(500, 500);
glutInitWindowPosition(600, 100);
int id2 = glutCreateWindow("Ellipse");
glutSetWindow(id2);
glutMouseFunc(myMouseFunc);
glutDisplayFunc(myDrawing);
//END MOUSE
*/
//FOR KEYBOARD
printf("Enter 1 to draw circle , 2 to draw ellipse\n");
int ch;
scanf_s("%d", &ch);
switch (ch) {
case 1:
        printf("Enter coordinates of centre of circle and radius\n");
        scanf_s("%d%d%d", &xc, &yc, &r);
        glutCreateWindow("Circle");
        glutDisplayFunc(circlebres);
        break;
  case 2:
        printf("Enter coordinates of centre of ellipse and major and minor radius\n");
        scanf_s("%d%d%d%d", &xce, &yce, &rx, &ry);
```

```
        glutCreateWindow("Ellipse");
        glutDisplayFunc(midpteellipse);
        break;
    }
    //END KEYBOARD
    minit();
    glutMainLoop();
    return 0;
}
```

Output-1:



Output-2:



Experiment No. : 3 Date : Page No. : 12

Experiment Name : Sierpinski gasket

Write a program to recursively subdivides a tetrahedron to form 3D Sierpinski gasket. The number of recursive steps is to be specified at execution time

```
#include<gl/glut.h>
#include<stdio.h>
int m;
typedef float point[3];
point tetra[4] = { {0,100,-100}, {0,0,100}, {100,-100,-100}, {-100,-100,-100} };
void tetrahedron() {
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
    glColor3f(1.0,0.0,0.0);
    divide_triangle(tetra[0], tetra[1], tetra[2], m);
    glColor3f(0.0,1.0,0.0);
    divide_triangle(tetra[3], tetra[2], tetra[1], m);
    glColor3f(0.0,0.0,1.0);
    divide_triangle(tetra[0], tetra[3], tetra[1], m);
    glColor3f(0.0,0.0,0.0);
    divide_triangle(tetra[0], tetra[2], tetra[3], m);
    glFlush();
}
void divide_triangle(point a, point b, point c, int m) {
    point v1, v2, v3;
    int j;
    if(m>0) {
        for(j=0; j<3; j++)
            v1[j] = (a[j]+b[j])/2;
        for(j=0; j<3; j++) v2[j] = (a[j]+c[j])/2;
```

```
        for(j=0; j<3; j++) v3[j] = (b[j] + c[j])/2;
        divide_triangle (a, v1, v2, m-1);
        divide_triangle (c, v2, v3, m-1);
        divide_triangle (b, v3, v1, m-1);
    }
    else draw_triangle(a,b,c);
}
void draw_triangle (point p1, point p2, point p3)
{ glBegin(GL_TRIANGLES);
  glVertex3fv(p1); glVertex3fv(p2); glVertex3fv(p3);
  glEnd();
}
void myinit() {
  glClearColor(1,1,1,1); glOrtho(-500.0, 500.0, -500.0, 500.0, -500.0, 500.0);
}
int main(int argc, char** argv)
{ printf("Enter the number of iterations: \n");
  scanf_s("%d", &m);
  glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
  glutInitWindowPosition(100,200); glutInitWindowSize(500, 500);
  glutCreateWindow("Sierpinski Gasket");
  glutDisplayFunc(tetrahedron);
  glEnable(GL_DEPTH_TEST);
  myinit();
  glutMainLoop();
  return 0;
}
```

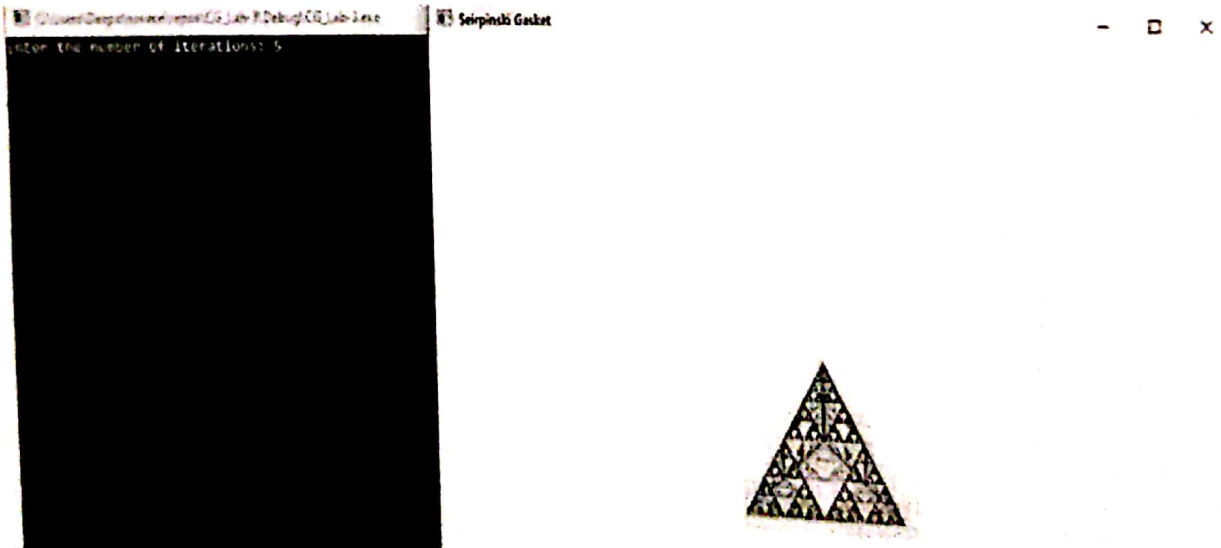
Program-3:

Write a program to recursively subdivides a tetrahedron to form 3D Sierpinski gasket. The number of recursive steps is to be specified at execution time.

```
#include<gl/glut.h>
#include<stdio.h>

int m;
typedef float point[3];
point tetra[4] = { {0,100,-100},{0,0,100},{100,-100,-100},{-100,-100,-100} };
void tetrahedron(void);
void myinit(void);
void divide_triangle(point a, point b, point c, int m);
void draw_triangle(point p1, point p2, point p3);
int main(int argv, char** argc)
{
        //int m;
        printf("Enter the number of iterations: ");
        scanf_s("%d", &m);
        glutInit(&argv, argc);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
        glutInitWindowPosition(100, 200);
        glutInitWindowSize(500, 500);
        glutCreateWindow("Seirpinski Gasket");
        glutDisplayFunc(tetrahedron);
        glEnable(GL_DEPTH_TEST);
        myinit();
        glutMainLoop();
        return 0;
}
void divide_triangle(point a, point b, point c, int m)
{
```

```
        glColor3f(0.0, 1.0, 0.0);
        divide_triangle(tetra[3], tetra[2], tetra[1], m);
        glColor3f(0.0, 0.0, 1.0);
        divide_triangle(tetra[0], tetra[3], tetra[1], m);
        glColor3f(0.0, 0.0, 0.0);
        divide_triangle(tetra[0], tetra[2], tetra[3], m);
        glFlush();
}
void draw_triangle(point p1, point p2, point p3)
{
        glBegin(GL_TRIANGLES);
        glVertex3fv(p1);
        glVertex3fv(p2);
        glVertex3fv(p3);
        glEnd();
}
```

Output:



Experiment No. : 4

Date :

Page No. : 14

Experiment Name : Scan-line area filling algorithm

Write a program to fill any given polygon using Scan-line area filling algorithm

```
#include <gl/glut.h>
#include <stdlib.h>
#include <iostream>
#include<windows.h>
#include<algorithm>
using namespace std;
float x[100], y[100];
int n,m, wx=500, wy=500;
static float intx[10] = {0};
void draw_line (float x1, float y1, float x2, float y2) {
    Sleep(100);
    glColor3f (1,0,0);
    glBegin (GL_LINES);
    glVertex2f (x1, y1);
    glVertex2f (x2,y2);
    glEnd();
    glFlush();
}
void edgeDetect (float x1, float y1, float x2, float y2, int scanline) {
  float temp;
  if(y2<y1) {
     temp = x1 ; x1=x2 ; x2=temp;
     temp = y1 ; y1=y2 ; y2=temp;
  }
  if (scanline > y1 && scanline < y2) {
```

```
    int x[m++] = x1 + (scanline-y1) * (x2-x1) / (y2-y1);
}  }
void scanfill (float x[], float y[]){
    for (int s1=0; s1<=wy; s1++) {
        m=0;
        for(int i=0; i<n; i++) {
            edgeDetect( x[i], y[i], x[(i+1)%n], y[(i+1)%n], s1); }
        Sort (int x, (int x+m));
        if (m>=2)
            for (int i=0; i<m; i=i+2)
                draw_line (int x[i], s1, int x[i+1], s1);
    }
}
void display_filled_polygon (){
    glClear(GL_COLOR_BUFFER_BIT);
    glLineWidth(2);
    glBegin(GL_LINE_LOOP);
    for (int i=0; i<n; i++)
        glVertex2f (x[i], y[i]);
    glEnd();
    scanfill (x,y);
}
void myInit(){
    glClearColor(1,1,1,1); glColor3f(0,0,1);
    glPointSize(1); gluOrtho2D (0, wx, 0, wy);
}
```

```
int main(int argc, char* argv[]){
  glutInit(&argc, argv);
  printf("Enter no. of sides : \n");
  scanf_s("%d", &n);
  printf("Enter co-ordinates of endpoints : \n");
  for(int i=0; i<n; i++)
  {  printf("X-coord  Y-coord: \n");
     scanf_s("%f %f", &x[i], y[i]);
  }
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
  glutInitWindowSize(500,500);
  glutInitWindowPosition(0,0);
  glutCreateWindow("scanLine");
  glutDisplayFunc(display_filled_polygon);
  myInit();
  glutMainLoop();
  return 0;
}
```

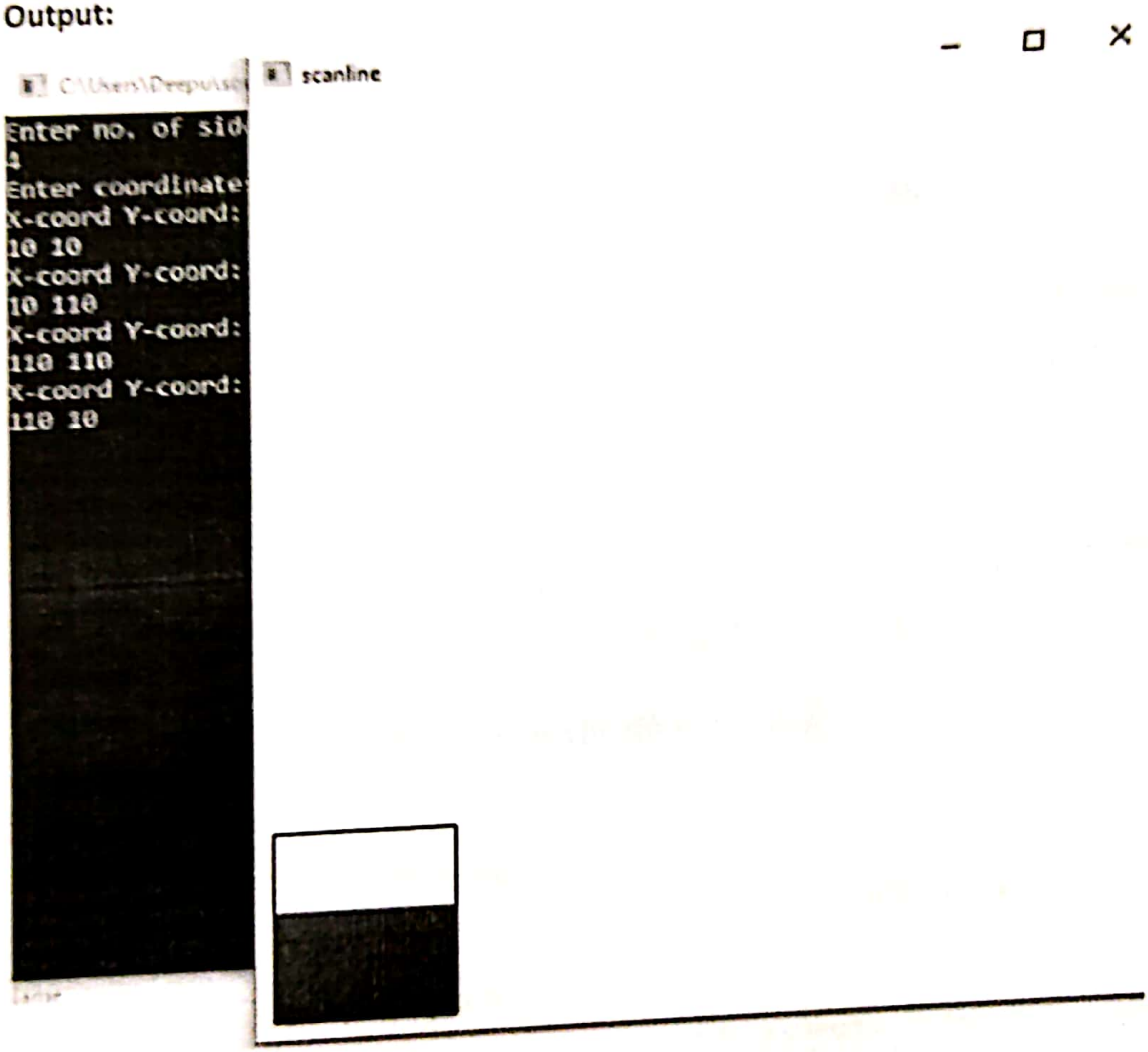
Program-4:

Write a program to fill any given polygon using scan-line area filling algorithm.

```
#include<stdlib.h>
#include<gl/glut.h>
#include<algorithm>
#include<iostream>
#include<windows.h>

using namespace std;
float x[100], y[100]; //= { 0,0,20,100,100 }, y[] = { 0,100,50,100,0 };

int n, m;
int wx = 500, wy = 500;
static float intx[10] = { 0 };

void draw_line(float x1, float y1, float x2, float y2) {
        Sleep(100);
        glColor3f(1, 0, 0);
        glBegin(GL_LINES);
        glVertex2f(x1, y1);
        glVertex2f(x2, y2);
        glEnd();
        glFlush();

}

void edgeDetect(float x1, float y1, float x2, float y2, int scanline) {

        float temp;
        if (y2 < y1) {
```

```
    glutMainLoop();
    return 0;
}
```

Output:



Experiment No. : 5 Date : Page No. : 17

Experiment Name : House Rotation & Reflection

Write a program to create a house like figure and perform the following operations: (i) Rotate it about a given fixed point using OpenGL transformation functions. (ii) Reflect it about an axis y=mx+c using OpenGL transformation functions.

```
#include<gl/glut.h>
#include<math.h>
#include<stdio.h>
//Right Click to Show Reflected house
float house[11][2] = { {100,200}, {200,250}, {300,200}, {100,200}, {100,100}, {175,100},
  {175,150}, {225,150}, {225,100}, {300,100}, {300,200} };
int angle;
float m,c,theta;
void display(){
 glClearColor(1,1,1,0);
 glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
 glMatrixMode(GL_PROJECTION); glLoadIdentity();
 gluOrtho2D(-450,450,-450,450); glMatrixMode(GL_MODELVIEW);
 glLoadIdentity(); glColor3f(1,0,0);
 glBegin(GL_LINE_LOOP);
 for(int i=0; i<11; i++)
     glVertex2f(house[i]);
 glEnd();
 glFlush();
 //ROTATED HOUSE
 glPushMatrix();
 glTranslatef(100,100,0);
 glRotatef(angle,0,0,1);
```

```
    glTranslatef(-100, -100, 0);
    glColor3f(1,1,0);
    glBegin(GL_LINE_LOOP);
    for(int i=0; i<11; i++)
        glVertex2fv(house[i]);
    glEnd();
    glPopMatrix();
    glFlush();
}
void display2(){
    glClearColor(1,1,1,0);
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
    glMatrixMode(GL_PROJECTION); glLoadIdentity();
    gluOrtho2D(-450,450,-450,450); glMatrixMode(GL_MODELVIEW);
    gluLoadIdentity();
    //normal house
    glColor3f(1,0,0);
    glBegin(GL_LINE_LOOP);
    for(int i=0; i<11; i++)
        glVertex2fv(house[i]);
    glEnd();
    glFlush();
    // line
    float x1=0, x2=500;
    float y1= m*x1+c, y2= m*x2+c;
    glColor3f(1,1,0);
    glBegin(GL_LINES);
```

```
        glVertex2f(x1,y1);
        glVertex2f(x2,y2);
        glEnd();
        glFlush();
        //Reflected
        glPushMatrix();
        glTranslatef(0,c,0);
        theta = atan(m);
        theta = theta*180/3.14;
        glRotatef(theta,0,0,1);
        glScalef(1,-1,1);
        glRotatef(-theta,0,0,1);
        glTranslatef(0,-c,0);
        glBegin(GL_LINE_LOOP);
        for(int i=0; i<11; i++)
            glVertex2fv(house[i]);
        glEnd();
        glPopMatrix();
        glFlush();
}
void myInit(){
    glClearColor(1.0,1.0,1.0,1.0);
    glColor3f(1.0,0.0,0.0);
    glLineWidth(2.0);
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluOrtho2D(-450,450,-450,450);
}
```

Experiment No. :

Experiment Name :

Date :


```
void mouse(int btn, int state, int x, int y)
{
    if(btn == GLUT_LEFT_BUTTON && state == GLUT_DOWN)
        display();
    else if(btn == GLUT_RIGHT_BUTTON && state == GLUT_DOWN)
        display2();
}

void main(int argc, char** argv)
{
printf("Enter the rotation angle\n");
scanf_s("%d", &angle);
printf("Enter m and c value for line y=mx+c \n");
scanf_s("%d%d", &m, &c);
glutInit(&argc, argv);
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(900, 900);
glutInitWindowPosition(100, 100);
glutCreateWindow("House Rotation & Reflection");
glutDisplayFunc(display);
glutMouseFunc(mouse);
myInit();
glutMainLoop();
}
```

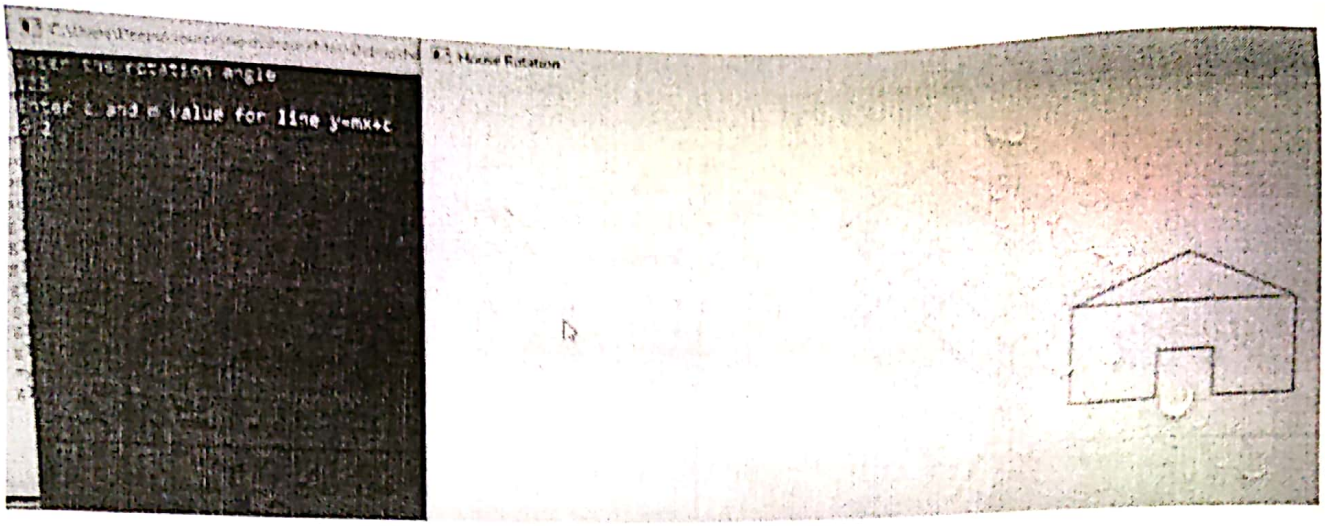
Program-5:

Write a program to create a house like figure and perform the following operations.

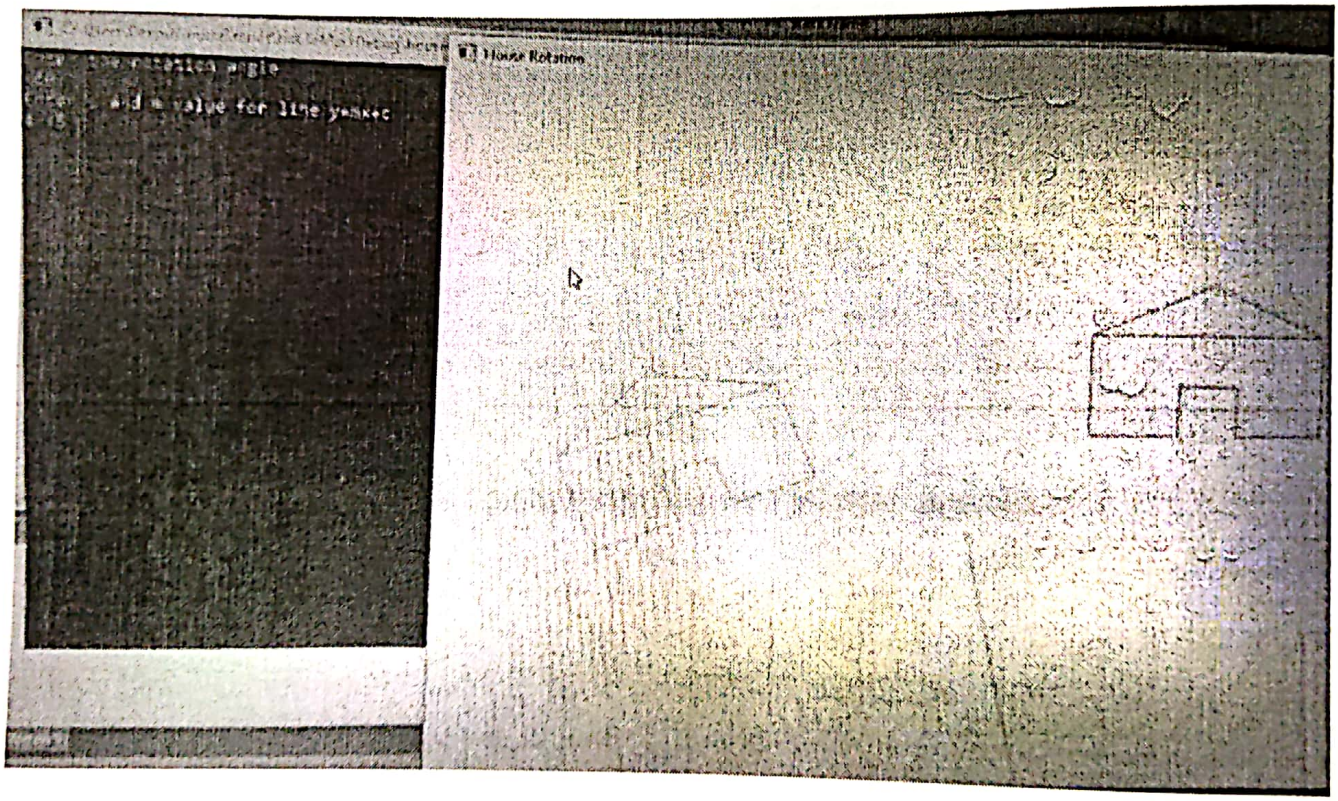
i. Rotate it about a given fixed point using OpenGL transformation functions.
ii. Reflect it about an axis y=mx+c using OpenGL transformation functions.

```
#include<gl/glut.h>

#include <math.h>

//#include<stdlib.h>

#include<stdio.h>

//RIGHT CLICK TO SHOW REFLECTED HOUSE

float house[11][2] = { { 100,200 },{ 200,250 },{ 300,200 },{ 100,200 },{ 100,100 },{ 175,100 },{ 175,150
},{ 225,150 },{ 225,100 },{ 300,100 },{ 300,200 } };

int angle;

float m, c, theta;

void display()

{

        glClearColor(1, 1, 1, 0);

        glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);

        glMatrixMode(GL_PROJECTION);

        glLoadIdentity();

        gluOrtho2D(-450, 450, -450, 450);

        glMatrixMode(GL_MODELVIEW);

        glLoadIdentity();

        //NORMAL HOUSE

        glColor3f(1, 0, 0);

        glBegin(GL_LINE_LOOP);

        for (int i = 0; i < 11; i++)

                glVertex2fv(house[i]);

        glEnd();

        glFlush();

        //ROTATED HOUSE

        glPushMatrix();
```

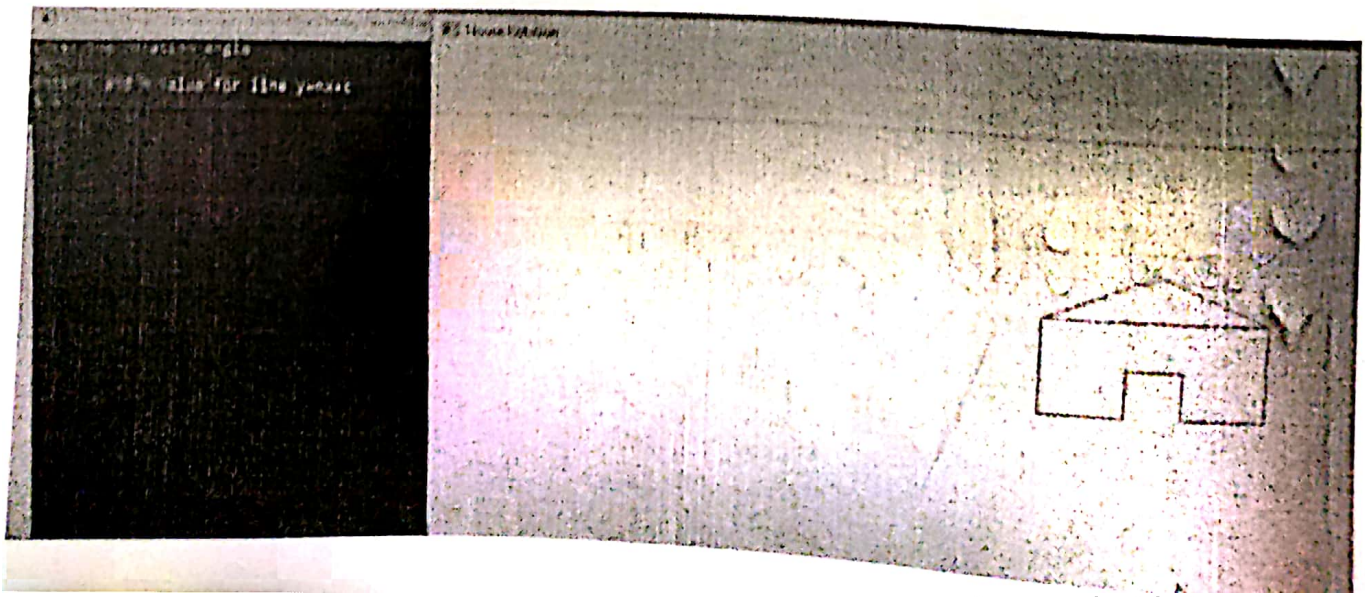
Output-1:



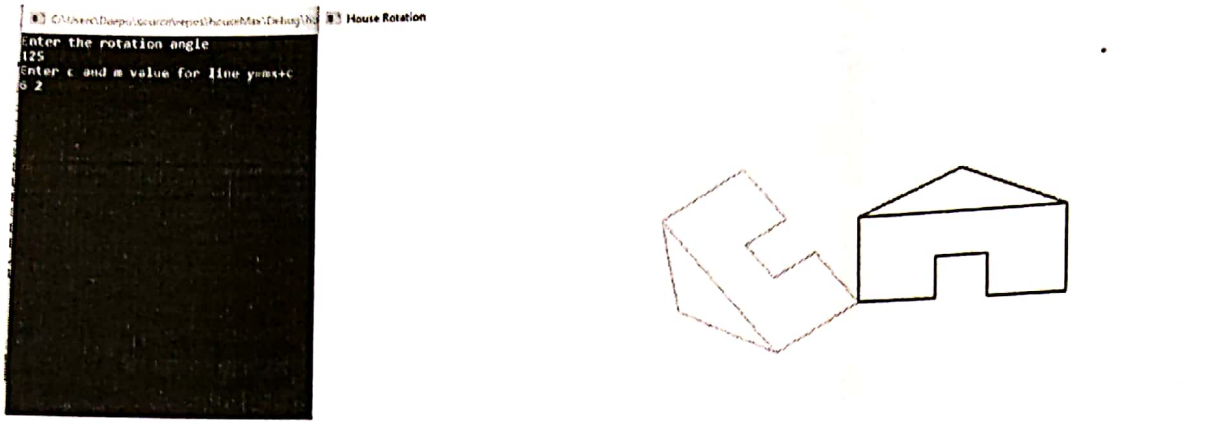
Output-2:



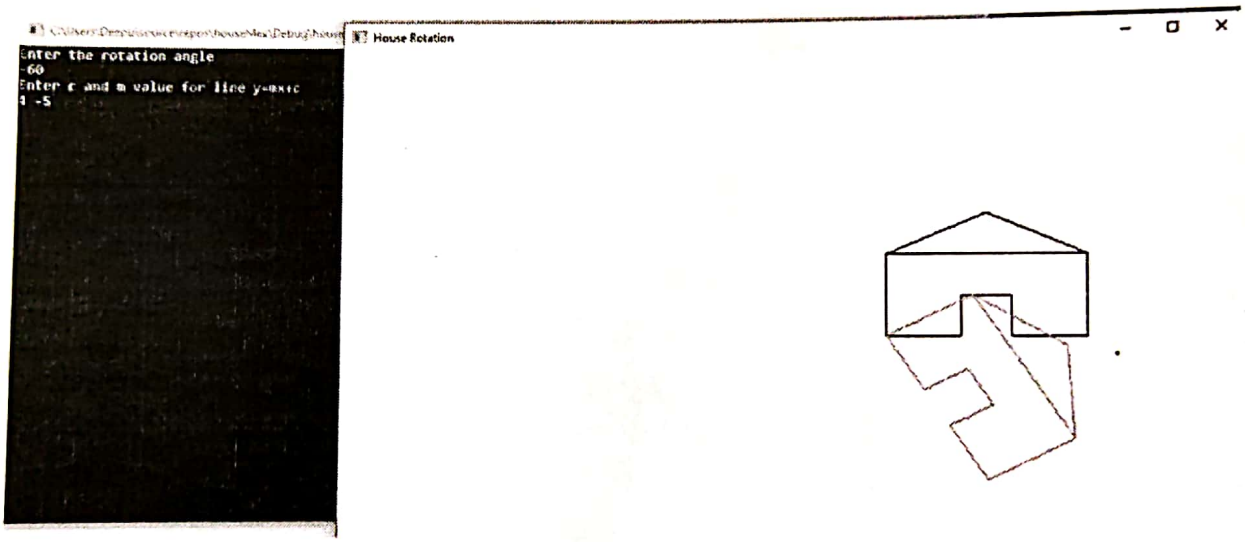
Output-3:



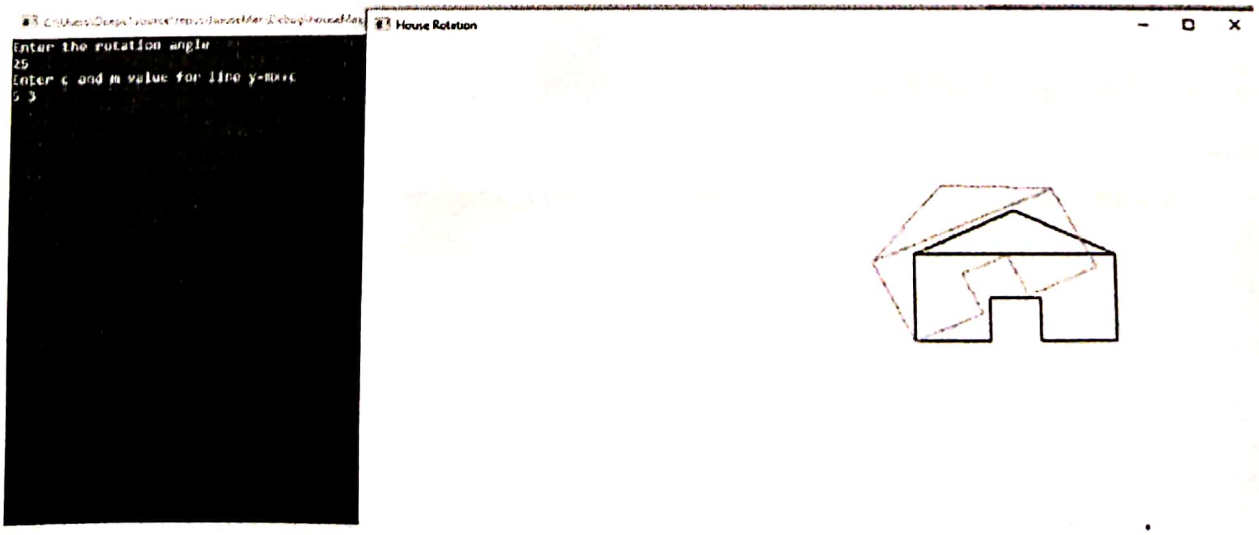
Output-4:



Output-5:



Output-6:



Experiment No. : 6 Date : Page No. : 21

Experiment Name : Cohen - Sutherland Line Clipping Algorithm

Write a program to implement the Cohen-Sutherland line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped image.

```
#include <stdio.h>
#include< GL/glut.h>
#define outcode GLint
GLfloat xmin, ymin, xmax, ymax; //Window boundaries
GLfloat xvmin, yvmin, xvmax, yvmax; //Viewport boundaries
//bit codes for the right, left, top & bottom
GLint n;
struct line_segment {
        GLfloat x0; GLfloat y0; GLfloat x1; GLfloat y1; };
Struct line_segment ls[10];
const GLint RIGHT = 8;
const GLint LEFT = 2;
const GLint TOP = 4;
const GLint BOTTOM = 1;
outcode ComputeOutCode(GLfloat x, GLfloat y) //used to compute bit code of a point
{ outcode code=0;
   if(y > ymax) //above the Clip window
        code = code | TOP;
   else if(y < ymin) //below the clip window
        code = code | BOTTOM;
  if(x > xmax) //to the right of Clip window
        code = code | RIGHT;
  else if(x < xmin) //to the left of Clip window
```

```
        Code = code | LEFT;
    return code;
}
void CohenSutherland(GLfloat x0, GLfloat y0, GLfloat x1, GLfloat y1)
{ outcode outcode0, outcode1, outcodeOut;
    bool accept = false, done = false;
    outcode0 = ComputeOutCode(x0, y0);
    outcode1 = ComputeOutCode(x1, y1);
    do{
        if(!(outcode0 | outcode1)) // Trivially accept & exit
        {
            accept = true;
            done = true;
        }
        else if(outcode0 && outcode1) // Trivially reject and exit
            done = true;
        else {
            GLfloat x, y;
            outcodeOut = outcode0 ? outcode0 : outcode1;
            if(outcodeOut & TOP) //point is above the clip rectangle
            {
                x = x0 + (x1-x0) * (ymax - y0)/(y1-y0);
                y = ymax;
            }
            else if(outCodeOut & BOTTOM) //point is below the clip rectangle
            {   x = x0 + (x1-x0) * (ymin-y0)/(y1-y0);
                y = ymin;
            }
```

```
else if (outCodeOut & RIGHT) //point is to the right of clip rectangle
{   y = y0 + (y1-y0) * (xmax-x0) / (x1-x0);
    x = xmax;
}
else { // point is to the left of clip rectangle
y = y0 + (y1-y0) * (xmin-x0) / (x1-x0);
x = xmin;
}
if (outcodeOut == outcode0)
{ x0 = x;   y0 = y;
  outcode0 = ComputeOutCode(x0, y0);
}
else { x1 = x;  y1 = y;
  outcode1 = ComputeOutCode(x1, y1);
}
} while(!done);
if(accept)
{ GLfloat sx = (xvmax - xvmin) / (xmax - xmin); // scale parameters
  GLfloat sy = (yvmax - yvmin) / (ymax - ymin);
  GLfloat vx0 = xvmin + (x0 - xmin) * sx;
  GLfloat vy0 = yvmin + (y0 - ymin) * sy;
  GLfloat vx1 = xvmin + (x1 - xmin) * sx;
  GLfloat vy1 = yvmin + (y1 - ymin) * sy;
  // drawing a red color viewport
  glColor3f(1.0, 0.0, 0.0);
  glBegin(GL_LINE_LOOP);
```

```
        glVertex2f (xvmin, yvmin);
        glVertex2f (xvmax, yvmin);
        glVertex2f (xvmax, yvmax);
        glVertex2f (xvmin, yvmax);
        glEnd();
        glColor3f (0.0, 0.0, 1.0); //draw blue colored Clipped Line
        glBegin(GL_LINES);
        glVertex2d (vx0, vy0);
        glVertex2d (vx1, vy1);
        glEnd();
    }
}

void display() {
    glClear (GL_COLOR_BUFFER_BIT);
    glColor3f (1.0, 0.0, 0.0);
    for(int i=0; i<n; i++)
    { glBegin(GL_LINES);
      glVertex2d (ls[i].x0, ls[i].y0);
      glVertex2d (ls[i].x1, ls[i].y1);
      glEnd();
    }
    glColor3f (0.0, 0.0, 1.0);
    glBegin (GL_LINE_LOOP);
    glVertex2f (xmin, ymin);
    glVertex2f (xmax, ymin);
    glVertex2f (xmin, ymax);
    glVertex2f (xmax, ymax);
    glEnd();
```

```
    for (int i=0; i<n; i++)
        CohenSutherland (ls[i].x0, ls[i].y0, ls[i].x1, ls[i].y1);
    glFlush();
}

void myinit() {
    glClearColor(1.0,1.0,1.0,1.0); glColor3f(1.0,0.0,0.0); glPointSize(1.0);
    glMatrixMode(GL_PROJECTION); glLoadIdentity();
    gluOrtho2D(0.0, 499.0, 0.0, 499.0);
}

int main (int argc, char** argv)
{ printf("Enter window co-ordinates (xmin, ymin, xmax, ymax): \n");
  scanf_s("%f %f %f %f", &xmin, &ymin, &xmax, &ymax);
  printf("Enter viewport co-ordinates (xvmin, yvmin, xvmax, yvmax): \n");
  scanf_s("%f %f %f %f", &xvmin, &yvmin, &xvmax, &yvmax);
  printf("No. of lines: \n");
  scanf_s("%d", &n);
  for(int i=0; i<n; i++) {
      printf("Enter line-%d endpoints (x1, x2, y1, y2): \n", (i+1));
      scanf_s("%f %f %f %f", &ls[i].x0, &ls[i].x1, &ls[i].y0, &ls[i].y1);
  }
  glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
  glutWindowSize(500,500); glutWindowPosition(0,0);
  glutCreateWindow("Cohen Sutherland");
  glutDisplayFunc(display);
  myinit();
  glutMainLoop();
  return 0;
}
```

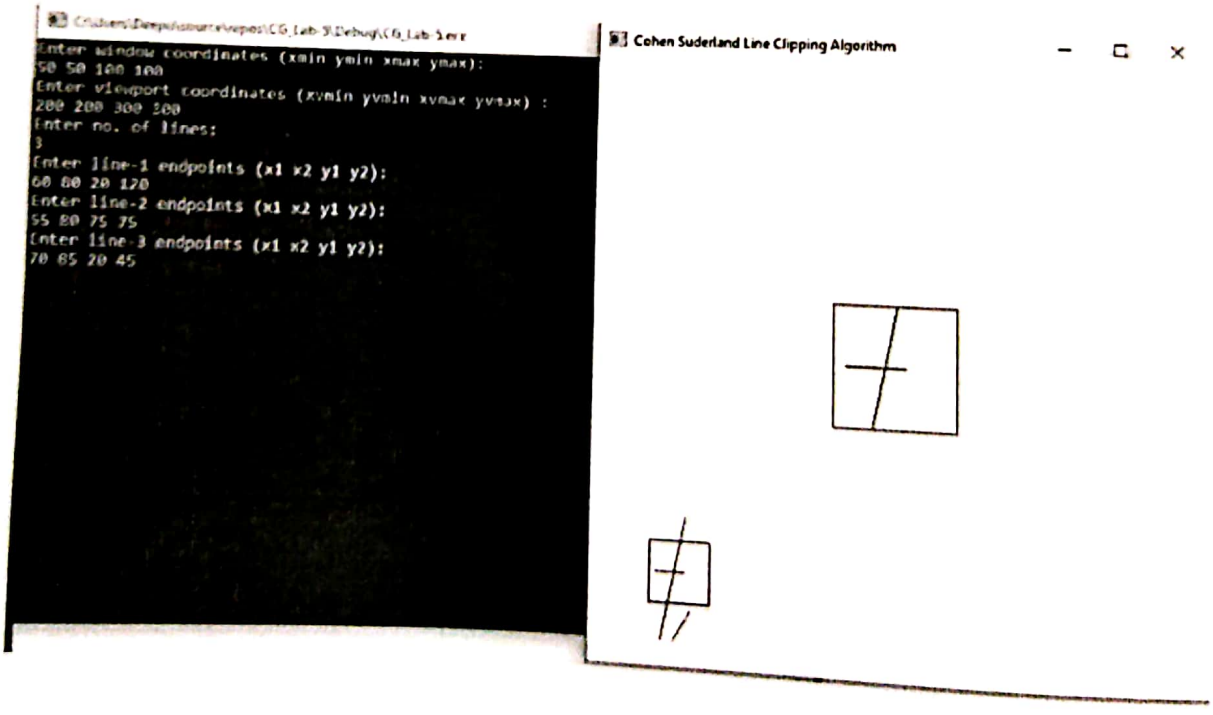
Program-6:

Write a program to implement the Cohen-Sutherland line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped image.

```
#include <stdio.h>
#include <GL/glut.h>
#define outcode GLint
//GLfloat xmin = 50, ymin = 50, xmax = 100, ymax = 100; // Window boundaries
//GLfloat xvmin = 200, yvmin = 200, xvmax = 300, yvmax = 300; // Viewport boundaries
//GLfloat x1, x0, y1, y0;
//bit codes for the right, left, top, & bottom
GLfloat xmin, ymin, xmax, ymax; // Window boundaries
GLfloat xvmin, yvmin, xvmax, yvmax; // Viewport boundaries
GLint n;
struct line_segment {
        GLfloat x0;
        GLfloat y0;
        GLfloat x1;
        GLfloat y1;
};
struct line_segment ls[10];

const GLint RIGHT = 8;
const GLint LEFT = 2;
const GLint TOP = 4;
const GLint BOTTOM = 1;
//used to compute bit codes of a point
outcode ComputeOutCode(GLfloat x, GLfloat y);
//Cohen-Sutherland clipping algorithm clips a line from
//P0 = (x0, y0) to P1 = (x1, y1) against a rectangle with
//diagonal from (xmin, ymin) to (xmax, ymax).
```

```
            scanf_s("%f%f%f%f", &ls[i].x0, &ls[i].x1, &ls[i].y0, &ls[i].y1);
        }

        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
        glutInitWindowSize(500, 500);
        glutInitWindowPosition(0, 0);
        glutCreateWindow("Cohen Suderland Line Clipping Algorithm");
        glutDisplayFunc(display);
        myinit();
        glutMainLoop();
        return 0;
}
```

Output:



Experiment No. : 7

Date :

Page No. : 26

Experiment Name : Liang - Barsky Line Clipping Algorithm.

#Write a program to implement the Liang-Barsky line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped Image.

```
#include<stdio.h>
#include<GL/glut.h>
double xmin, ymin, xmax, ymax;
double xvmin, yvmin, xvmax, yvmax;
int n;
Struct line_segment {
   int x1; int y1; int x2; int y2;
};
struct line_segment ls[10];
int cliptest(double p, double q, double* u1, double * u2)
{ double r;
  if(p)  r=q/p;
  if(p<0.0) //potentially entry point, hence update te
  { if(r>*u1) *u1=r;
    if(r>*u2) return (false); //line-portion is outside
  }
  else
    if(p>0.0)  //potentially leaving point, update tl
    { if(r<*u2) *u2=r;
      if(r<*u1) return (false); //line portion is outside
    }
    else
      if(p==0.0)
      {
```

```
        if(q<0.0) return (false); //line parallel to edge but outside
      }
    return (true);
}
void LiangBarsky(double x0, double y0, double x1, double y1)
{ double dx=x1-x0, dy=y1-y0, u1=0.0, u2=1.0;
  glColor3f(1.0, 0.0, 0.0);
  glBegin(GL_LINE_LOOP);
  glVertex2f(xvmin, yvmin);
  glVertex2f(xvmax, yvmin);
  glVertex2f(xvmin, yvmax);
  glVertex2f(xvmax, yvmax);
  glEnd();
  if(cliptest(-dx, x0-xmin, &u1, &u2)) //inside test wrt left edge
    if(cliptest(dx, xmax-x0, &u1, &u2)) //inside test wrt right edge
      if(cliptest(-dy, y0-ymin, &u1, &u2)) //inside test wrt bottom edge
        if(cliptest(dy, ymax-y0, &u1, &u2)) //inside test wrt top edge
          { if(u2<1.0)
              { x1 = x0+u2*dx;
                y1 = y0+u2*dy;
              }
            if(u1>0.0)
              { x0 = x0+u1*dx;
                y0 = y0+u1*dy;
              }
            //Window to viewport mappings
            double sx=(xvmax-xvmin)/(xmax-xmin); //Scale parameters
```

```
        double sy = (yvmax - yvmin) / (ymax - ymin);
        double vx0 = xvmin + (x0 - xmin) * sx;
        double vy0 = yvmin + (y0 - ymin) * sy;
        double vx1 = xvmin + (x1 - xmin) * sx;
        double vy1 = yvmin + (y1 - ymin) * sy;
        glColor3f(0.0, 0.0, 1.0);
        glBegin(GL_LINES);
        glVertex2d(vx0, vy0);
        glVertex2d(vx1, vy1);
        glEnd();
      }
}
void display()
{ glClear(GL_COLOR_BUFFER_BIT);
  glColor3f(1.0, 0.0, 0.0);
  for(int i=0; i<n; i++)
  { glBegin(GL_LINES);
    glVertex2d(ls[i].x1, ls[i].y1);
    glVertex2d(ls[i].x2, ls[i].y2);
    glEnd();
  }
  glColor3f(0.0, 0.0, 1.0);
  glBegin(GL_LINE_LOOP);
  glVertex2f(xmin, ymin);
  glVertex2f(xmax, ymin);
  glVertex2f(xmin, ymax);
  glVertex2f(xmax, ymax);
```

```
    glEnd();
    glColor3f(1.0,0.0,0.0);
    glRasterPos2f(210, 310);
    const char *string = "Output";
    while (*string)
    { glutBitmapCharacter (GLUT_BITMAP_8_BY_13, *string++);
    }
    for(int i=0; i<n; i++)
        LiangBarsky(ls[i].x1, ls[i].y1, ls[i].x2, ls[i].y2);
    glFlush();
}
Void myinit() {
    glClearColor(1.0,1.0,1.0,1.0);
    glColor3f (1.0,0.0,0.0);
    glLineWidth (2.0);
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluOrtho2D(0.0, 499.0, 0.0, 499.0);
}
int main(int argc, char** argv)
{ glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(500,500);
    glutInitWindowPosition(0,0);
    printf("Enter window co-ordinates : (xmin, ymin, xmax, ymax)\n");
    scanf("%lf %lf %lf %lf", &xmin, &ymin, &xmax, &ymax);
    printf("Enter viewport co-ordinates : (xvmin, yvmin, xvmax, yvmax)\n");
```

```
scanf_s("%lf %lf %lf %lf", &xvmin, &yvmin, &xvmax, &yvmax);
printf("Enter no of lines\n");
scanf_s("%d", &n);
for(int i=0; i<n; i++){
  printf("Enter x1 y1 x2 y2 \n");
  scanf_s("%d %d %d %d", &ls[i].x1, &ls[i].y1, &ls[i].x2, &ls[i].y2);
}
glutCreateWindow("Liang Barsky");
glutDisplayFunc(display);
myinit();
glutMainLoop();
}
```

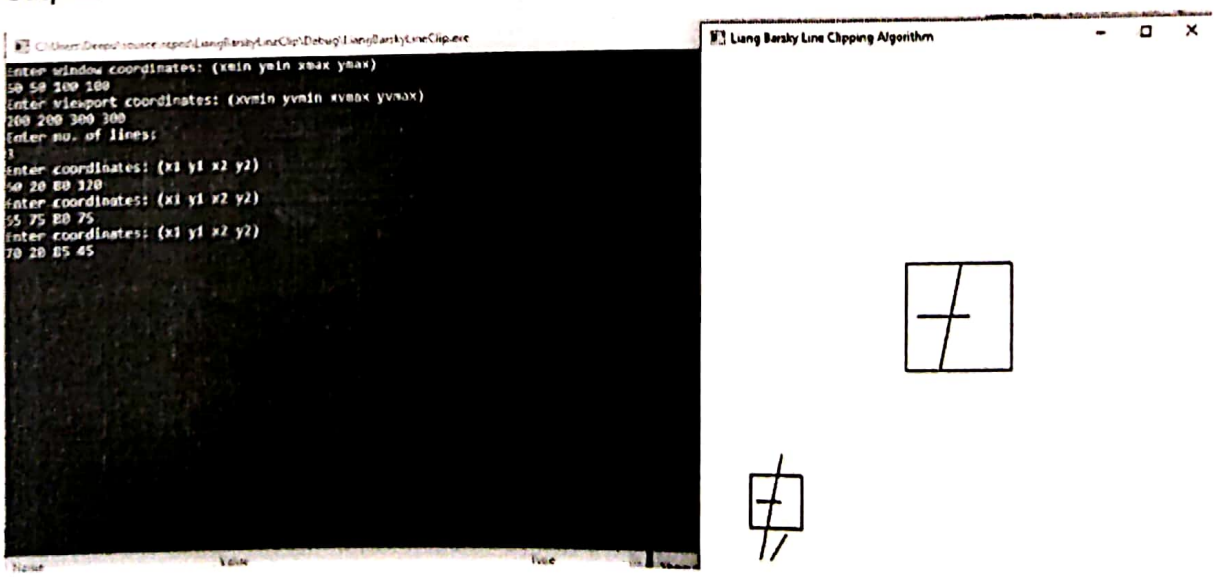
Program-7:

Write a program to implement the Liang-Barsky line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped image.

```
#include <stdio.h>
#include <GL/glut.h>
double xmin, ymin, xmax, ymax; //50 50 100 100
double xvmin, yvmin, xvmax, yvmax; //200 200 300 300
int n;
struct line_segment {
        int x1;
        int y1;
        int x2;
        int y2;
};
struct line_segment ls[10];
int cliptest(double p, double q, double* u1, double* u2)
{
        double r;
        if (p) r = q / p;  // to check whether p
        if (p < 0.0)   // potentially entry point, update te
        {
                if (r > * u1)* u1 = r;
                if (r > * u2) return(false); // line portion is outside
        }
        else
                if (p > 0.0)   //  Potentially leaving point, update tl
                {
                        if (r < *u2)* u2 = r;
                        if (r < *u1) return(false); // line portion is outside
                }
```

```
    printf("Enter window coordinates: (xmin ymin xmax ymax) \n");
    scanf_s("%lf%lf%lf%lf", &xmin, &ymin, &xmax, &ymax);
    printf("Enter viewport coordinates: (xvmin yvmin xvmax yvmax) \n");
    scanf_s("%lf%lf%lf%lf", &xvmin, &yvmin, &xvmax, &yvmax);
    printf("Enter no. of lines:\n");
    scanf_s("%d", &n);

    for (int i = 0; i < n; i++)
    {
        printf("Enter coordinates: (x1 y1 x2 y2)\n");
        scanf_s("%d%d%d%d", &ls[i].x1, &ls[i].y1, &ls[i].x2, &ls[i].y2);
    }
    glutCreateWindow("Liang Barsky Line Clipping Algorithm");
    glutDisplayFunc(display);
    myinit();
    glutMainLoop();
}
```

Output:



Experiment No. : 8 Date : Page No. : 31

Experiment Name : Cohen-Hodgeman Polygon Clipping Algorithm

Write a program to implement the Cohen-Hodgeman polygon clipping algorithm. Make provision to specify the input polygon and window for clipping.

```
#include<iostream>
#include<GL/glut.h>
using namespace std;
int poly_size, poly_points[20][2], org_poly_size, org_poly_points[20][2], clipper_size,
    clipper_points[20][2];
const int MAX_POINTS = 20;
void drawPoly(int p[][2], int n) {
        glBegin(GL_POLYGON);
    for(int i=0; i<n; i++)
        glVertex2f(p[i][0], p[i][1]);
    glEnd();
}
int x_intersect(int x1, int y1, int x2, int y2, int x3, int y3, int x4, int y4)
{ int num = (x1*y2-y1*x2) * (x3-x4) - (x1-x2) * (x3*y4-y3*x4);
  int den = (x1-x2) * (y3-y4) - (y1-y2) * (x3-x4);
  return num/den;
}
int y_intersect(int x1, int y1, int x2, int y2, int x3, int y3, int x4, int y4){
  int num = (x1*y2 - y1*x2) * (y3-y4) - (y1-y2) * (x3*y4-y3*x4);
  int den = (x1-x2) * (y3-y4) - (y1-y2) * (x3-x4);
  return num/den;
}
void clip(int poly_points[][2], int &poly_size, int x1, int y1, int x2, int y2)
{ int new_points[MAX_POINTS][2], new_poly_size = 0;
```

```
for(int i=0 ; i<poly_size ;i++)
{  int k = (i+1) %. poly_size ;
   int ix = poly_points [i] [0] , iy = poly_points [i] [1];
   int kx = poly_points [k] [0] , ky = poly_points [k] [1];
   int i_pos = (x2-x1) * (iy-y1) - (y2-y1) * (ix-x1) ;
   int k_pos = (x2-x1) * (ky-y1) - (y2-y1) * (kx-x1) ;
   if( i_pos >=0 && k_pos >=0)
    {
      new_points [new_poly_size] [0] = kx ;
      new_points [new_poly_size] [1] = ky ;
      new_poly_size++ ;
    }
   else if( i_pos <0 && k pos >=0)
   {
      new_points [new_poly_size] [0] = x_intersect (x1,y1, x2, y2, ix,iy , kx, ky);
      new_points [new_poly_size] [1] = y_intersect ( x1, y1, x2, y2, ix, iy, kx, ky);
      new_poly_size++ ;
      new_points [new_poly_size] [0] = kx ;
      new_points [new_poly_size] [1] = ky ;
      new_poly_size++ ;
    }
   else if( i_pos >=0 && k_pos <0)
   { new_points [new_poly_size] [0] = x_intersect ( x1, y1, x2, y2, ix, iy, kx, ky);
     new_points [new_poly_size] [1] = y_intersect ( x1, y1, x2, y2, ix, iy, kx, ky);
     new_poly_size++ ;
    }
   else { }
}
```

```
    poly_size = new_poly_size;
    for(int i=0; i<poly_size; i++)
    {
        poly_points[i][0] = new_points[i][0];
        poly_points[i][1] = new_points[i][1];
    }
}
void init()
{ glClearColor(0.0f, 0.0f, 0.0f, 0.0f);
  glMatrixMode(GL_PROJECTION);
  glLoadIdentity();
  glOrtho(0.0, 500.0, 0.0, 500.0, 0.0, 500.0);
  glClear(GL_COLOR_BUFFER_BIT);
}
void display()
{ init();
  glColor3f(1.0f, 0.0f, 0.0f);
  drawPoly(clipper_points, clipper_size);
  glColor3f(0.0f, 1.0f, 0.0f);
  drawPoly(org_poly_points, org_poly_size);
  for(int i=0; i<clipper_size; i++)
  { int k=(i+1)%clipper_size;
    clip(poly_points, poly_size, clipper_points[i][0], clipper_points[i][1],
         clipper_points[k][0], clipper_points[k][1]);
  }
  glColor3f(0.0f, 0.0f, 1.0f);
  draw_poly(poly_points, poly_size);
  glFlush();
}
```

```
int main(int argc, char* argv[])
{ printf("Enter no. of vertices :\n");
  scanf_s ("%d",&poly_size);
  org_poly_size =poly_size;
  for(int i=0; i<poly_size; i++)
   { printf("Polygon Vertex:\n");
     scanf_s("%d%d", &poly_points[i][0], &poly_points[i][1]);
     org_poly_points[i][0] = poly_points[i][0];
     org_poly_points[i][1] = poly_points[i][1];
   }
  printf("Enter no. of vertices of clipping window\n");
  scanf_s("%d", &clipper_size);
  for(int i=0; i<clipper_size; i++)
  { printf("Clip vertex:\n");
    scanf_s("%d%d", &clipper_points[i][0], &clipper_points[i][1]);
  }
  glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
  glutInitWindowSize(400,400);
  glutInitWindowPosition(100,100);
  glutCreateWindow("Polygon Clipping");
  glutDisplayFunc(display);
  glutMainLoop();
  return 0;
}
```

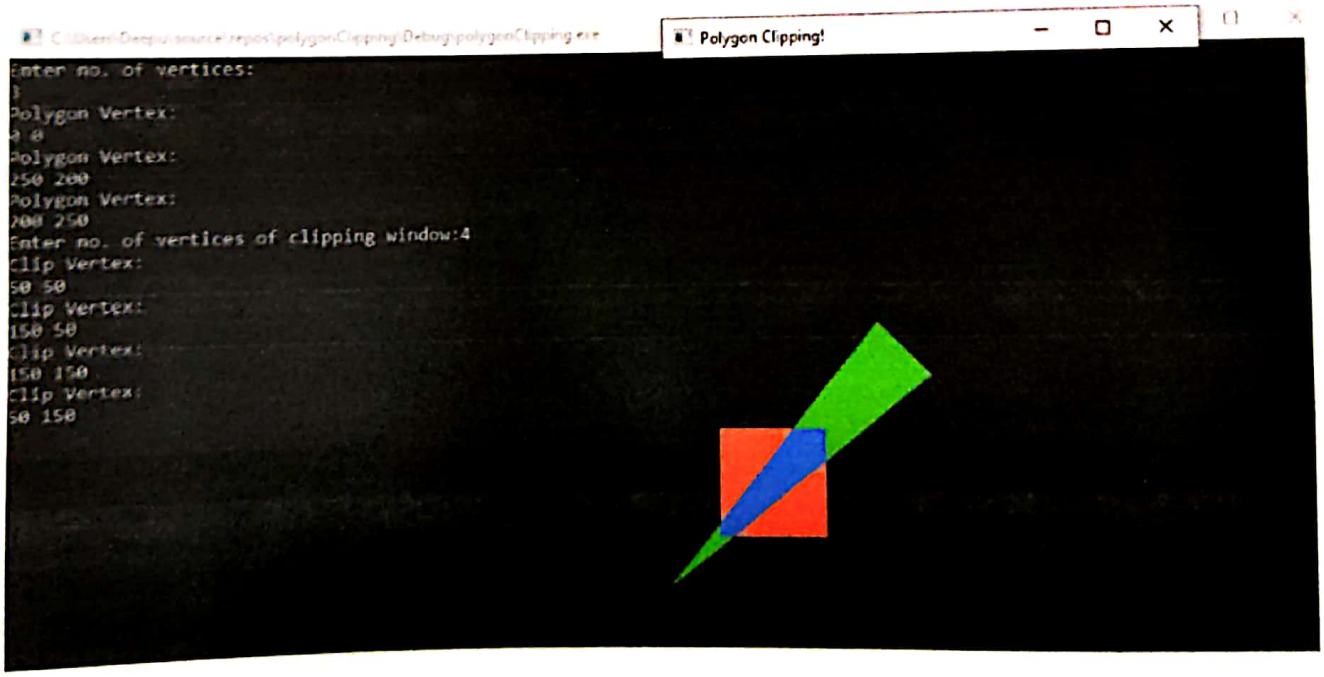
Program-8:

Write a program to implement the Cohen-Hodgeman polygon clipping algorithm. Make provision to specify the input polygon and window for clipping.

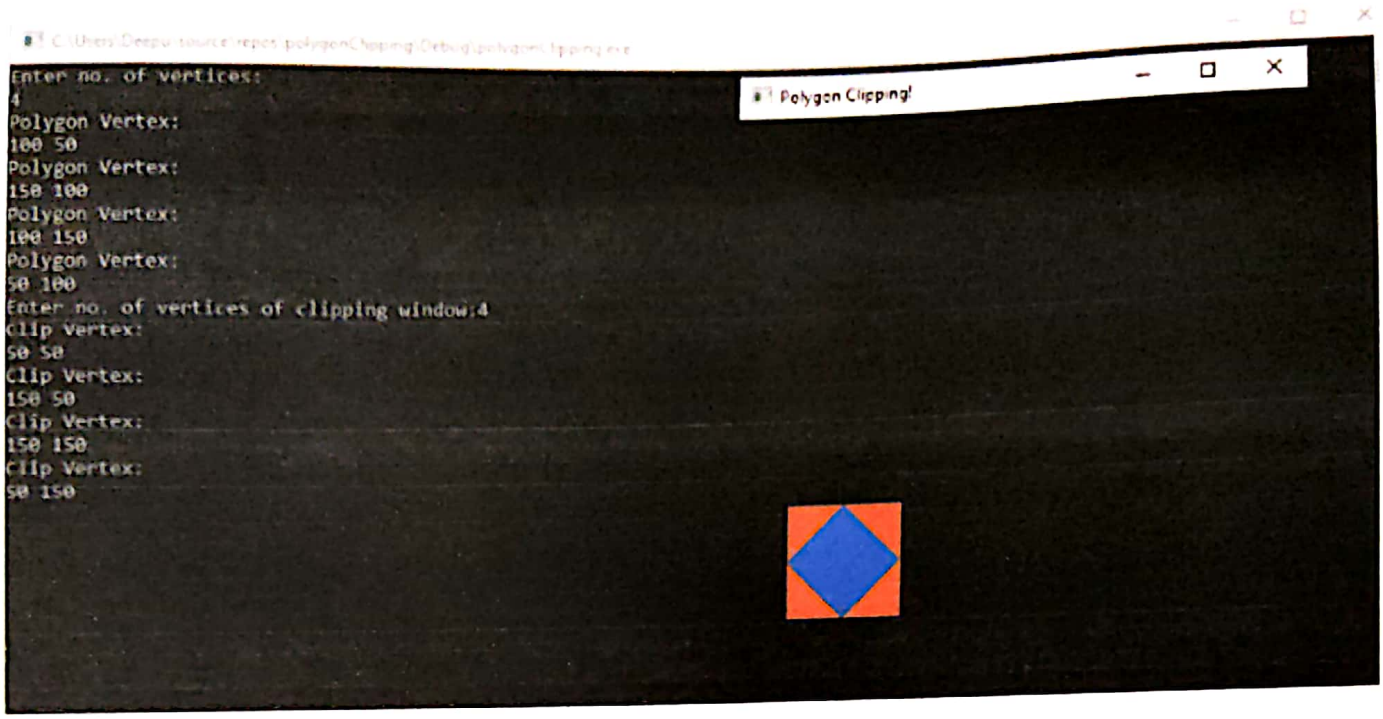
```
// C++ program for implementing Sutherland Hodgman
// algorithm for polygon clipping
#include<iostream>
#include<GL/glut.h>
using namespace std;
int poly_size, poly_points[20][2], org_poly_size, org_poly_points[20][2], clipper_size,
clipper_points[20][2];
const int MAX_POINTS = 20;
// Returns x-value of point of intersection of two
// lines
void drawPoly(int p[][2], int n) {
        glBegin(GL_POLYGON);
        for (int i = 0; i < n; i++)
                glVertex2f(p[i][0], p[i][1]);
        glEnd();
}
int x_intersect(int x1, int y1, int x2, int y2,
        int x3, int y3, int x4, int y4)
{
        int num = (x1 * y2 - y1 * x2) * (x3 - x4) -
                (x1 - x2) * (x3 * y4 - y3 * x4);
        int den = (x1 - x2) * (y3 - y4) - (y1 - y2) * (x3 - x4);
        return num / den;
}
// Returns y-value of point of intersectipn of
// two lines
int y_intersect(int x1, int y1, int x2, int y2,
        int x3, int y3, int x4, int y4)
{
```

```
        {
                printf("Clip Vertex:\n");
                scanf_s("%d%d", &clipper_points[i][0], &clipper_points[i][1]);
        }
        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
        glutInitWindowSize(400, 400);
        glutInitWindowPosition(100, 100);
        glutCreateWindow("Polygon Clipping!");
        glutDisplayFunc(display);
        glutMainLoop();
        return 0;
}
```

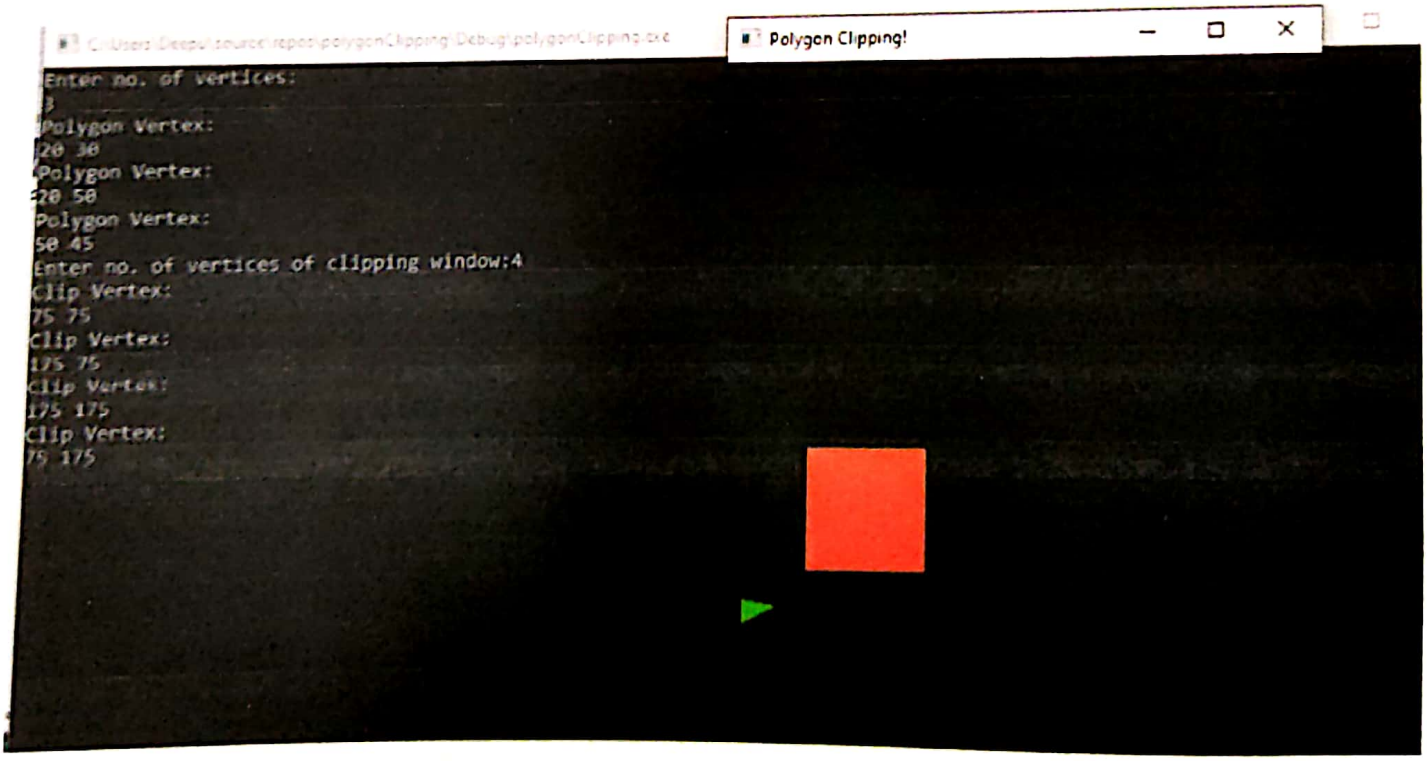
Output-1:



Output-2:



Output-3:



Experiment No. : 9 Date : Page No. : 35

Experiment Name : Car Model

Write a program to model a car like figure using display lists and move a car from one end of the screen to other end. User is able to control the speed with mouse.

```
#include<GL/glut.h>
#include<math.h>
#define CAR 1
#define WHEEL 2
float s=1.;
void carlist(){
    glNewList(CAR, GL_COMPILE);
    glColor3f(1,1,1);
    glBegin(GL_POLYGON);
    glVertex3f(0,25,0);
    glVertex3f(90,25,0);
    glVertex3f(90,55,0);
    glVertex3f(80,55,0);
    glVertex3f(20,75,0);
    glVertex3f(0,55,0);
    glEnd();
    glEndList();
}
void wheellist(){
    glNewList(WHEEL, GL_COMPILE_AND_EXECUTE);
    glColor3f(0,1,1);
    glutSolidSphere(10,25,25);
    glEndList();
}
```

```
void mykeyboard(unsigned char key, int x, int y)
{ switch (key) {
        case 'l' : glutPostRedisplay();
                   break;
        case 'q' : exit(0);
        default : break;
    }
}

void myInit(){
    glClearColor(0,0,0,0);
    glOrtho(0,600,0,600,0,600);
}

void draw_wheel(){
    glColor3f(0,1,1);
    glutSolidSphere(10,25,25);
}

void moveCar(float s){
    glTranslatef(s,0.0,0.0);
    glCallList(CAR);
    glPushMatrix();
    glTranslatef(25,25,0.0);
    glCallList(WHEEL);
    glPopMatrix();
    glPushMatrix();
    glTranslatef(75,25,0.0);
    glCallList(WHEEL);
    glPopMatrix();
```

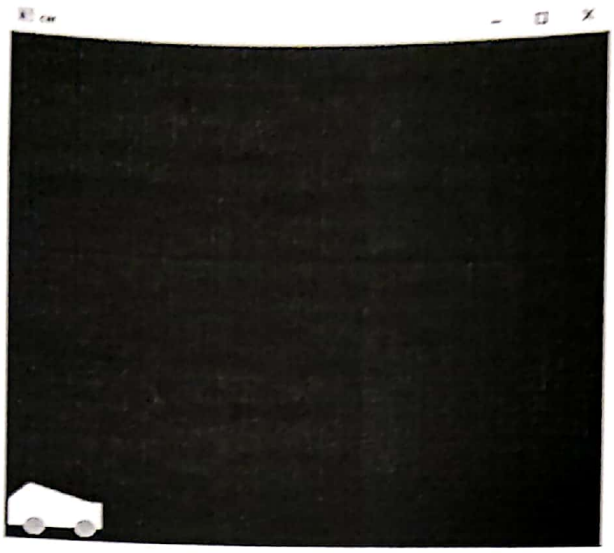
```
        glFlush();
}
void myDisp(){
    glClear(GL_COLOR_BUFFER_BIT);
    carList();
    moveCar(s);
    wheelList();
}
Void mouse(int btn, int state, int x, int y)
  { if(btn==GLUT_LEFT_BUTTON && state=GLUT_DOWN)
      { s=s+5;
        myDisp();
      }
    else if(btn==GLUT_RIGHT_BUTTON && state==GLUT_DOWN)
      {
        s=s+2;
        myDisp();
      }
}
int main(int argc, char** argv)
{ glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
  glutInitWindowSize(500, 500);
  glutInitWindowPosition(100,100);
  glutCreateWindow("car");
  myInit();
  glutDisplayFunc(myDisp);
  glutMouseFunc(mouse);
  glutKeyboardFunc(mykeyboard);
  glutMainLoop();
  return 0;
}
```

Program-9:

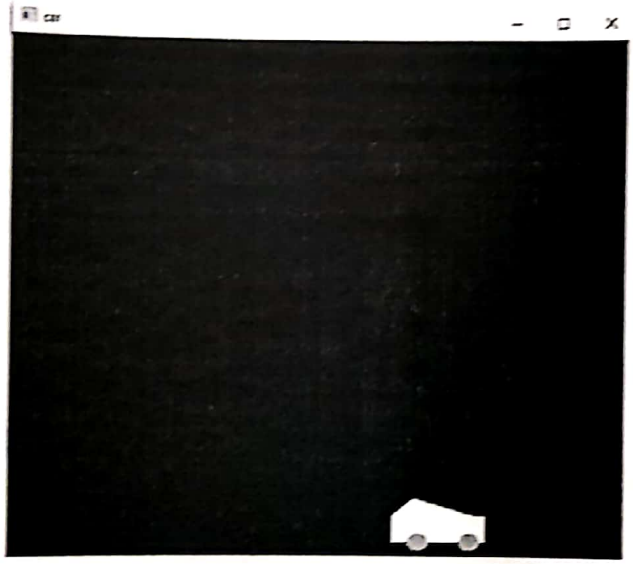
Write a program to model a car like figure using display lists and move a car from one end of the screen to other end. User is able to control the speed with mouse.

```
#include<GL/glut.h>
#include<math.h>
#include<stdio.h>
#define CAR 1
#define WHEEL 2
float s = 1;
void carlist() {

        glNewList(CAR, GL_COMPILE);
        glColor3f(1, 1, 1);
        glBegin(GL_POLYGON);
        glVertex3f(0, 25, 0);
        glVertex3f(90, 25, 0);
        glVertex3f(90, 55, 0);
        glVertex3f(80, 55, 0);
        glVertex3f(20, 75, 0);
        glVertex3f(0, 55, 0);
        glEnd();
        glEndList();

}
void wheellist() {
        glNewList(WHEEL, GL_COMPILE_AND_EXECUTE);
        glColor3f(0, 1, 1);
        glutSolidSphere(10, 25, 25);
        glEndList();
}
void mykeyboard(unsigned char key, int x, int y) {
```

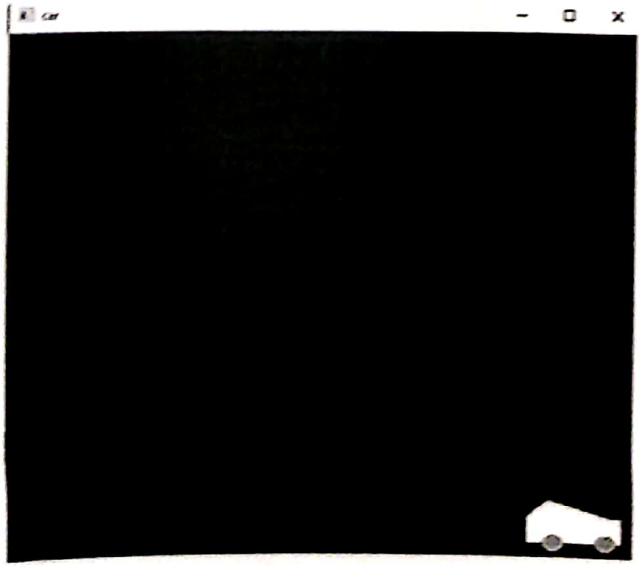
Output-1:



Output-2:



Output-3:



Experiment No. : 10 Date : Page No. : 38

Experiment Name : COLOR CUBE & SPIN

Write a program to create a color cube and spin it using OpenGL transformations.

```
#include <stdlib.h>
#include <GL/glut.h>
#include <time.h>
GLfloat vertices[] = {-1.0,-1.0,-1.0,+1.0,-1.0,-1.0,1.0,1.0,-1.0,-1.0,1.0,-1.0,-1.0,
-1.0,1.0,1.0,-1.0,1.0,1.0,1.0,1.0,-1.0,1.0,1.0};
GLfloat normals[] = {-1.0,-1.0,-1.0,1.0,-1.0,-1.0,1.0,1.0,-1.0,-1.0,1.0,-1.0,-1.0,-1.0,
1.0,1.0,-1.0,1.0,1.0,1.0,1.0,-1.0,1.0,1.0};
GLfloat colors[] = {0.0,0.0,0.0,1.0,0.0,0.0,1.0,1.0,0.0,0.0,1.0,0.0,0.0,0.0,1.0,1.0,
0.0,1.0,1.0,1.0,1.0,0.0,1.0,1.0};
GLubyte cubeIndices[] = {0,3,2,1,2,3,7,6,0,4,7,3,1,2,6,5,4,5,6,7,0,1,5,4};
Static GLfloat theta[] = {0.0,0.0,0.0};
Static GLfloat beta[] = {0.0,0.0,0.0};
Static GLint axis = 2;
void delay(float secs) {
    float end = clock() / CLOCKS_PER_SEC + secs;
    while((clock()/ CLOCKS_PER_SEC) < end);
}
void displaySingle(void)
{ glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
  glLoadIdentity();
  glRotatef(theta[0], 1.0,0.0,0.0);
  glRotatef(theta[1], 0.0,1.0,0.0);
  glRotatef(theta[2], 0.0,0.0,1.0);
  glDrawElements(GL_QUADS, 24, GL_UNSIGNED_BYTE, cubeIndices);
  glBegin(GL_LINES);
```

```
        glVertex3f(0.0, 0.0, 0.0);
        glVertex3f(1.0, 1.0, 1.0);
        glEnd();
        glFlush();
    }

void spinCube()
    { delay(0.01);
      theta[axis] += 2.0;
      if(theta[axis] > 360.0) theta[axis] -= 360.0;
      glutPostRedisplay();
    }

void mouse(int btn, int state, int x, int y)
{ if(btn == GLUT_LEFT_BUTTON && state == GLUT_DOWN) axis = 0;
  if(btn == GLUT_MIDDLE_BUTTON && state == GLUT_DOWN) axis = 1;
  if(btn == GLUT_RIGHT_BUTTON && state == GLUT_DOWN) axis = 2;
}

void myReshape(int w, int h)
{ glViewport(0,0,w,h);
  glMatrixMode(GL_PROJECTION);
  glLoadIdentity();
  if(w <= h)
      glOrtho(-2.0, +2.0, -2.0 * (GLfloat)h / (GLfloat)w, 2.0 * (GLfloat)h /
              (GLfloat)w, -10.0, 10.0);
  else
      glOrtho(-2.0 * (GLfloat)w / (GLfloat)h, 2.0 * (GLfloat)w / (GLfloat)h, -2.0,
              2.0, -10.0, 10.0);
  glMatrixMode(GL_MODELVIEW);
}
```

```
int main(int argc, char** argv)
{
    glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowPosition(100,100);
    glutInitWindowSize(500,500);
    glutCreateWindow("colorcube");
    glutReshapeFunc(myReshape);
    glutDisplayFunc(displaySingle);
    glutIdleFunc(spinCube);
    glutMouseFunc(mouse);
    glEnable(GL_DEPTH_TEST);
    glEnableClientState(GL_COLOR_ARRAY);
    glEnableClientState(GL_NORMAL_ARRAY);
    glEnableClientState(GL_VERTEX_ARRAY);
    glVertexPointer(3, GL_FLOAT, 0, vertices);
    glColorPointer(3, GL_FLOAT, 0, colors);
    glNormalPointer(3, GL_FLOAT, 0, normals);
    glColor3f(1.0, 1.0, 1.0);
    glutMainLoop();
    return 0;
}
```

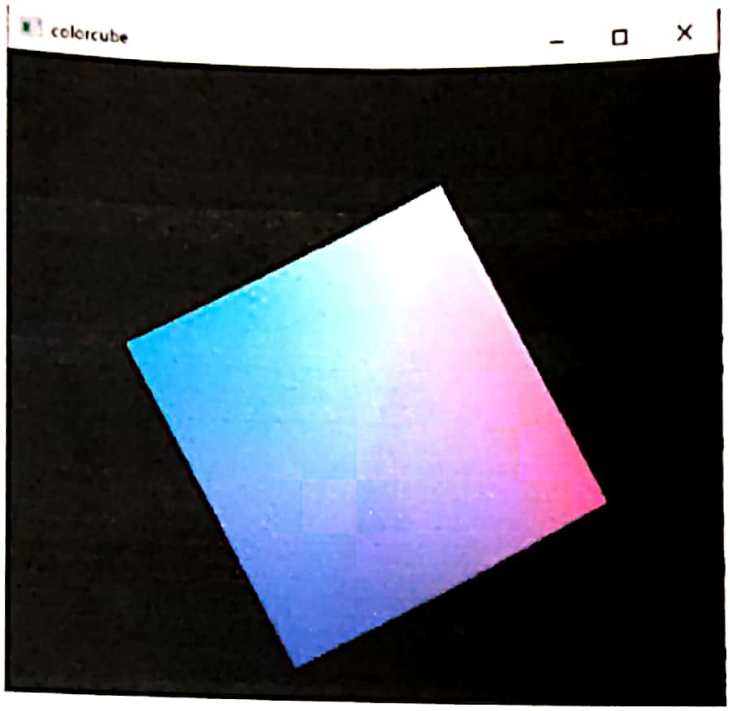
Program-10:

Write a program to create a color cube and spin it using OpenGL transformations.

```
#include <stdlib.h>
#include <GL/glut.h>
#include<gl\GL.h>
#include<gl\GLU.h>
#include <time.h>
GLfloat vertices[] = { -1.0,-1.0,-1.0,1.0,-1.0,-1.0,
1.0,1.0,-1.0, -1.0,1.0,-1.0, -1.0,-1.0,1.0,
1.0,-1.0,1.0, 1.0,1.0,1.0, -1.0,1.0,1.0 };
GLfloat normals[] = { -1.0,-1.0,-1.0,1.0,-1.0,-1.0,
1.0,1.0,-1.0, -1.0,1.0,-1.0, -1.0,-1.0,1.0,
1.0,-1.0,1.0, 1.0,1.0,1.0, -1.0,1.0,1.0 };
GLfloat colors[] = { 0.0,0.0,0.0,1.0,0.0,0.0,
1.0,1.0,0.0, 0.0,1.0,0.0, 0.0,0.0,1.0,
1.0,0.0,1.0, 1.0,1.0,1.0, 0.0,1.0,1.0 };
GLubyte cubeIndices[] = { 0,3,2,1,2,3,7,6,0,4,7,3,1,2,6,5,4,5,6,7,0,1,5,4 };
static GLfloat theta[] = { 0.0,0.0,0.0 };
static GLfloat beta[] = { 0.0,0.0,0.0 };
static GLint axis = 2;
void delay(float secs)
{
        float end = clock() / CLOCKS_PER_SEC + secs;
        while ((clock() / CLOCKS_PER_SEC) < end);
}

void displaySingle(void)
{
        /* display callback, clear frame buffer and z buffer,
          rotate cube and draw, swap buffers */
        glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
```

```
    glutMainLoop();
    return 0;
}
```

Output-1:



Output-2:

Output-3:

Output-4:

Experiment No. : 11

Experiment Name : MENU

Date :

Page No. : 41

Create a menu with three entries named curves, colors and quit. The entry curves has a submenu with four entries namely Limacon, Cardiod, Three-leaf and Spiral. The Color menu has sub menus with 8 colors of RGB Color model. Write program to create the above hierarchical menu and attach appropriate services to each menu entries with mouse button.

```
#include<gl/glut.h>
#include<math.h>
#include<stdio.h>
Struct screenPt {
    int x, int y;
};
typedef enum{ limacon=1, cardioid=2, threeleaf=3, spiral=4} curveName;
int w=600, h=500;
int curve=1, red=0, green=0, blue=0;
void myinit(void){
   glClearColor(1.0,1.0,1.0,1.0);
   glMatrixMode(GL_PROJECTION);
   gluOrtho2D(0.0,200.0,0.0,150.0);
}

void lineSegment(screenPt p1, screenPt p2)
{  glBegin(GL_LINES);
   glVertex2i(p1.x,p1.y);
   glVertex2i(p2.x,p2.y);
   glEnd();
   glFlush();
}
```

```
void drawCurve(int curveNum)
{ const double twoPi = 6.283185;
  const int a=175, b=60;
  float r, theta, dtheta = 1.0 / float(a);
  int x0 = 200, y0=250;
  screenPt curvePt[2];
  curve = curveNum;
  glColor3f (red, green, blue);
  curvePt[0].x = x0;
  curvePt[0].y = y0;
  glClear(GL_COLOR_BUFFER_BIT);
  switch(curveNum)
  { case limacon: curvePt[0].x += a+b; break;
    case cardioid: curvePt[0].x += a+a; break;
    case threeLeaf: curvePt[0].x += a; break;
    case spiral : break;
    default : break;
  }
  theta = dtheta;
  while( theta < twoPi) {
      switch(curveNum)
      { case limacon : r = a * cos(theta) + b; break;
        case cardioid : r = a * (1+ cos(theta)); break;
        case threeLeaf : r = a * ( cos(3 * theta)); break;
        case spiral : r = (a/4.0) * theta; break;
        default : break;
      }
```

```
curvePt[1].x = x0 + r * cos(theta);
curvePt[1].y = y0 + r * sin(theta);
lineSegment(curvePt[0], curvePt[1]);
curvePt[0].x = curvePt[1].x;
curvePt[0].y = curvePt[1].y;
theta += dtheta;
}
}
void colorMenu(int id){
switch(id){
case 0: break;
case 1: red = 0;
        green = 0;
        blue = 1;
        break;
case 2: red = 0;
        green = 1;
        blue = 0;
        break;
case 3: red = 0;
        green = 1;
        blue = 1;
        break;
case 4: red = 1;
        green = 0;
        blue = 0;
        break;
```

```
        Case 5: red = 1;
                green = 0;
                blue = 1;
                break;
        Case 6: red = 1;
                green = 1;
                blue = 0;
                break;
        case 7: red = 1;
                green = 1;
                blue = 1;
                break;
        default: break;
    }
    drawCurve(curve);
}
void main_menu(int id)
{   switch(id)
    {   case 3: exit(0);
        default: break;
    }
}
void myDisplay() { }
void myreshape(int nw, int nh)
{   glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluOrtho2D(0.0, (double)nw, 0.0, (double)nh);
```

```
    glClear(GL_COLOR_BUFFER_BIT);
}
int main(int argc, char** argv){
glutInit(&argc, argv);
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(w,h);
glutInitWindowPosition(100,100);
glutCreateWindow("Drawing Curves");
GLint curveId = glutCreateMenu(drawCurve);
glutAddMenuEntry("Limacon",1);
glutAddMenuEntry("Cardioid",2);
glutAddMenuEntry("Three Leaf",3);
glutAddMenuEntry("Spiral",4);
glutAttachMenu(GLUT_LEFT_BUTTON);
GLint colorId = glutCreateMenu(colorMenu);
glutAddMenuEntry("Red",4);
glutAddMenuEntry("Green",2);
glutAddMenuEntry("Blue",1);
glutAddMenuEntry("Black",0);
glutAddMenuEntry("Yellow",6);
glutAddMenuEntry("Cyan",3);
glutAddMenuEntry("Magenta",5);
glutAddMenuEntry("White",7); glutAttachMenu(GLUT_LEFT_BUTTON);
glutCreateMenu(main_menu);
glutAddSubMenu("drawCurve", curveId);
glutAddSubMenu("colors", colorId);
glutAddSubMenu("quit",3);
```

```
glutAttachMenu(GLUT_LEFT_BUTTON);
myinit();
glutDisplayFunc(myDisplay);
glutReshapeFunc(myreshape);
glutMainLoop();
return 0;
}
```

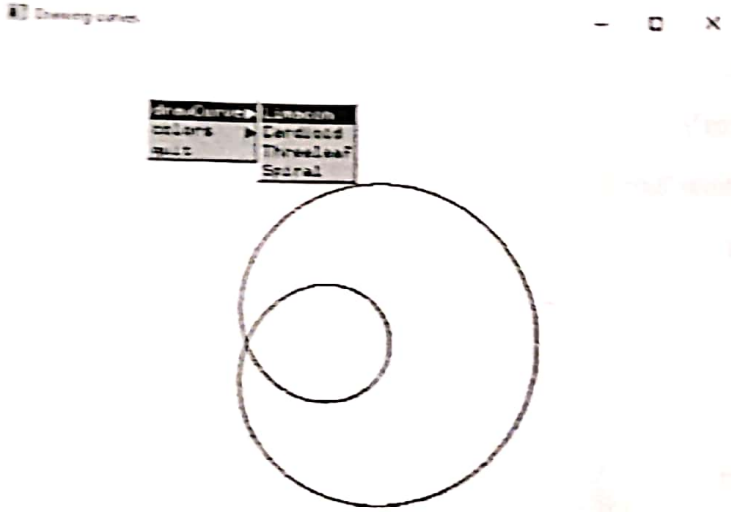
Program-11:

Create a menu with three entries named curves, colors and quit. The entry curves has a sub menu which has four entries namely Limacon, Cardiod, Three-Leaf, and Spiral. The color menu has sub menu with all eight colors of RGB color model. Write program to create the above hierarchical menu and attach appropriate services to each menu entries with mouse buttons.

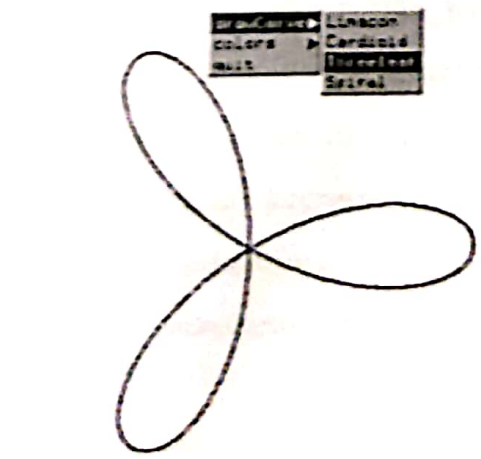
```
#include<gl/glut.h>
#include<math.h>
#include<stdio.h>
struct screenPt {
        int x;
        int y;
};
typedef enum { limacon = 1, cardioid = 2, threeLeaf = 3, spiral = 4 } curveName;
int w = 600, h = 500;
int curve = 1;
int red = 0, green = 0, blue = 0;
void myInit(void) {
        glClearColor(1.0, 1.0, 1.0, 1.0);
        glMatrixMode(GL_PROJECTION);
        gluOrtho2D(0.0, 200.0, 0.0, 150.0);
}
void lineSegment(screenPt p1, screenPt p2) {
        glBegin(GL_LINES);
        glVertex2i(p1.x, p1.y);
        glVertex2i(p2.x, p2.y);
        glEnd();
        glFlush();
}
void drawCurve(int curveNum) {
        const double twoPi = 6.283185;
        const int a = 175, b = 60;
        float r, theta, dtheta = 1.0 / float(a);
```

```
    glutAddSubMenu("drawCurve", curveId);
    glutAddSubMenu("colors", colorId);
    glutAddMenuEntry("quit", 3);
    glutAttachMenu(GLUT_LEFT_BUTTON);
    myinit();
    glutDisplayFunc(mydisplay);
    glutReshapeFunc(myreshape);
    glutMainLoop();
    return 0;
}
```

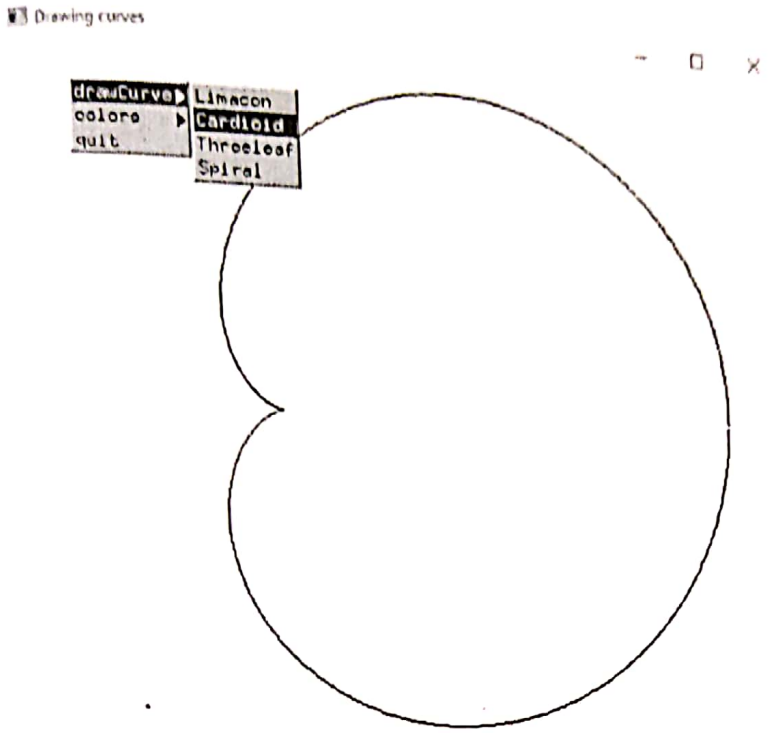
Output-1:



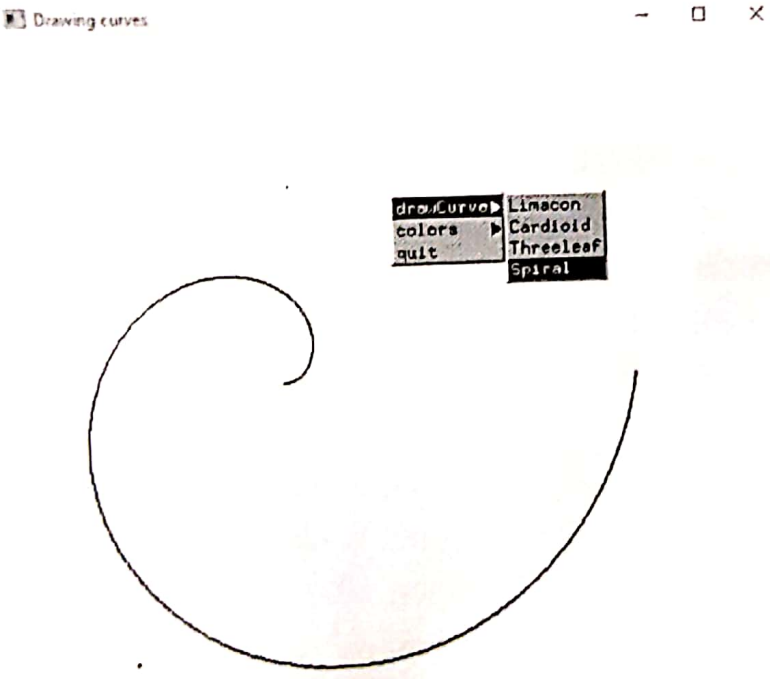
Output-2:



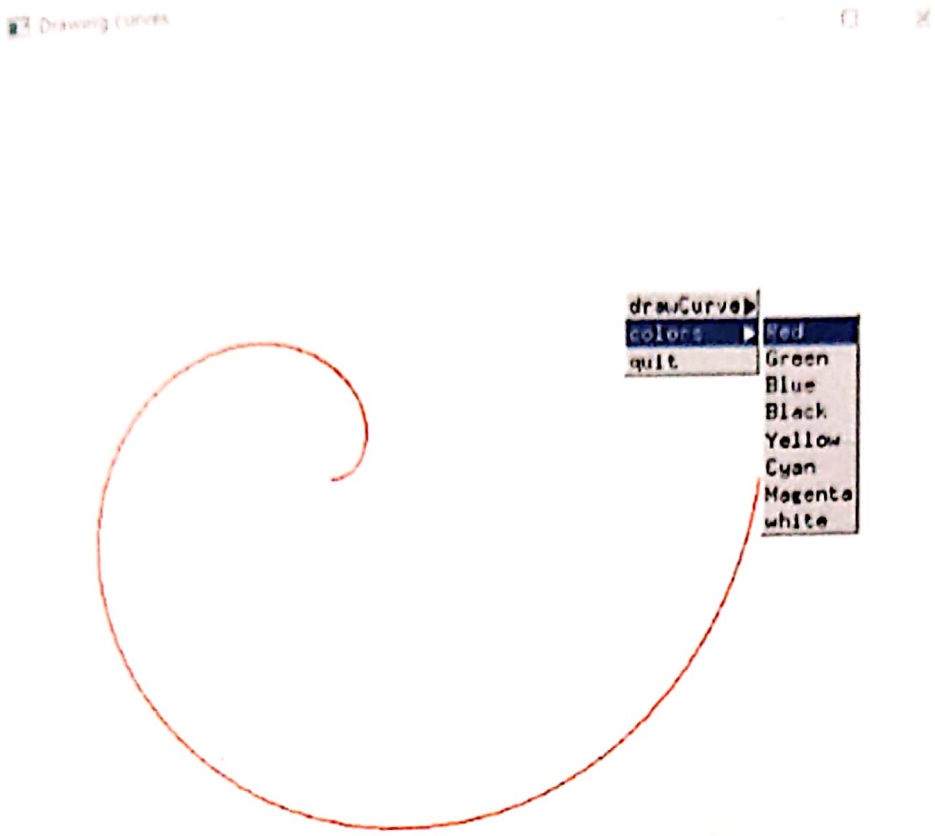
Output-3:



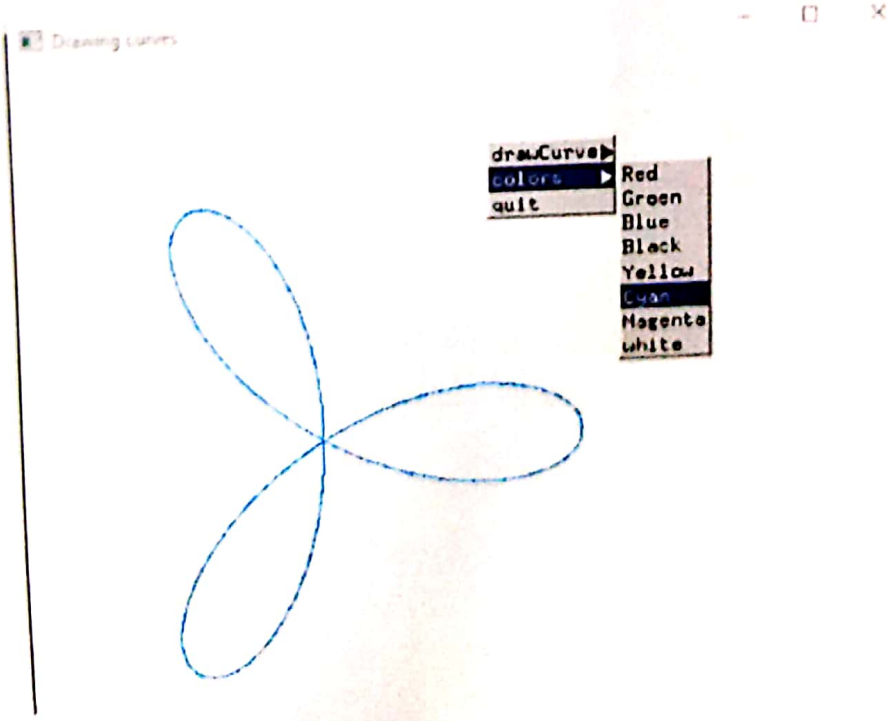
Output-4:



Output-5:



Output-6:



Experiment No. : 12

Date :

Page No. : 47

Experiment Name : Bezier Curve

Write a program to construct Bezier curve. Control points are supplied through keyboard / mouse.

```
#include<iostream>
#include<math.h>
#include<gl/glut.h>
using namespace std;
float f,g,r, x1[4], y[4];
int flag=0;
void myInit(){
  glClearColor(1,1,1,1);
  glColor3f(1,1,1);
  glPointSize(5);
  gluOrtho2D(0,500,0,500);
}
void drawPixel(float x, float y){
    glBegin(GL_POINTS);
    glVertex2f(x,y);
    glEnd();
}
void display(){
    glClear(GL_COLOR_BUFFER_BIT);
    int i;
    double t;
    glColor3f(0,0,0);
    glBegin(GL_POINTS);
```

```
for( t=0; t<1; t=t+0.005) {
    double xt = pow(1-t,3)*x1[0] + 3*t*pow(1-t,2)*x1[1] + 3*pow(t,2)*
                (1-t)*x1[2] + pow(t,3)*x1[3];
    double yt = pow(1-t,3)*yc[0] + 3*t*pow(1-t,2)*yc[1] + 3*pow(t,2)*
                (1-t)*yc[2] + pow(t,3)*yc[3];
    glVertex2f(xt,yt);
}
glColor3f(1,1,0);
for(i=0;i<4;i++) {
    glVertex2f(x1[i], yc[i]);
    glEnd();
    glFlush();
}
}
void mymouse(int btn, int state, int x, int y) {
    if(btn==GLUT_LEFT_BUTTON && state==GLUT_DOWN && flag<4)
    { x1[flag] = x;
      yc[flag] = 500-y;
      cout << "x" << x << "y" << 500-y;
      glPointSize(3);
      glColor3f(1,1,0);
      glBegin(GL_POINTS);
      glVertex2i(x, 500-y);
      glEnd();
      glFlush();
      flag++;
    }
```

```
if(flag>=4 && btn==GLUT_LEFT_BUTTON)
{ glColor3f(0,0,1);
  display();
  flag=0;
 }
}
int main(int argc, char* argv[])
{ glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
  glutInitWindowSize(500,500);
  glutInitWindowPosition(0,0);
  glutCreateWindow("Bz");
  glutDisplayFunc(display);
  glutMouseFunc(mymouse); // Include for mouse, Remove for Keyboard
  myInit();
  glutMainLoop();
  /*//USE KEYBOARD
  cout<<"Enter x co-ordinates";
  cin >> x1[0] >> x1[1] >> x1[2] >> x1[3];
  cout<<"Enter y co-ordinates";
  cin >> yc[0] >> yc[1] >> yc[2] >> yc[3];
  //END KEYBOARD
  */
  return 0;
}
```

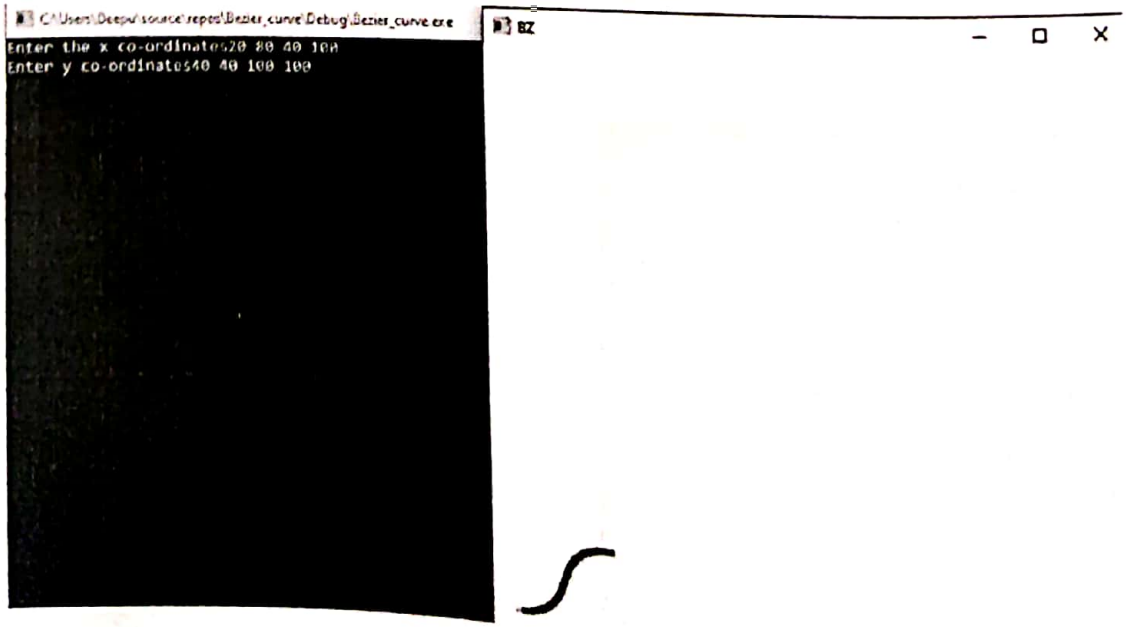
Program-12:

Write a program to construct Bezier curve. Control points are supplied through keyboard/ mouse.

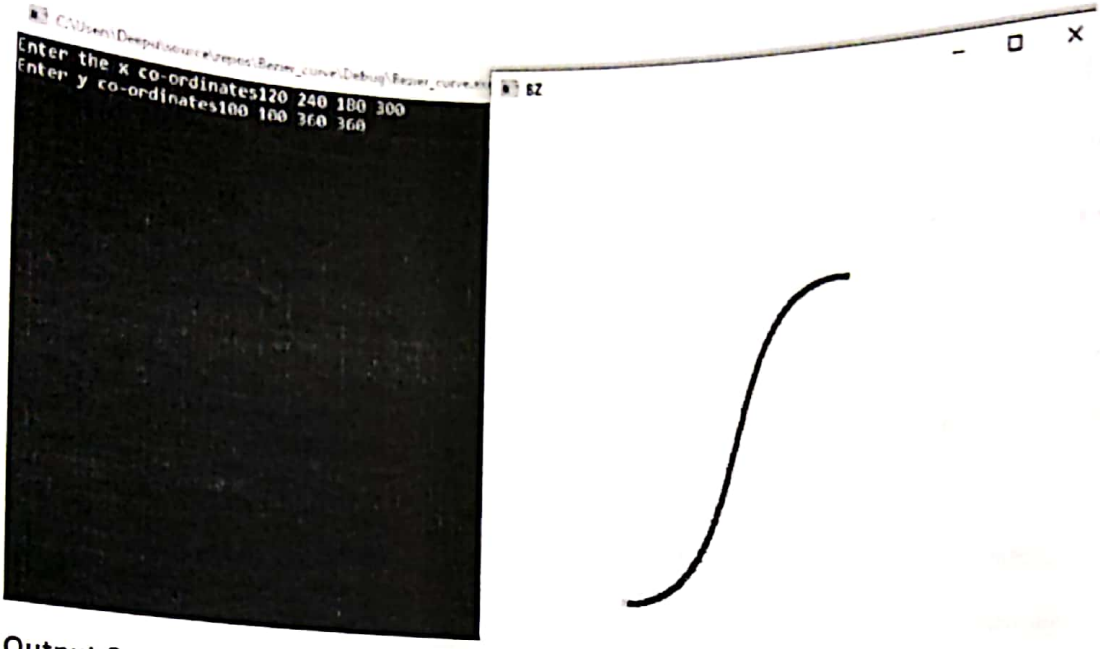
```
#include<iostream>
#include<math.h>
#include<gl/glut.h>
using namespace std;
float f, g, r, x1[4], yc[4];
int flag = 0;
void myInit() {
        glClearColor(1, 1, 1, 1);
        glColor3f(1, 1, 1);
        glPointSize(5);
        gluOrtho2D(0, 500, 0, 500);
}
void drawPixel(float x, float y) {
        glBegin(GL_POINTS);
        glVertex2f(x, y);
        glEnd();
}
void display() {
        glClear(GL_COLOR_BUFFER_BIT);
        int i;
        double t;
        glColor3f(0, 0, 0);
        glBegin(GL_POINTS);
        for (t = 0; t < 1; t = t + 0.005) {
                double xt = pow(1 - t, 3) * x1[0] + 3 * t * pow(1 - t, 2) * x1[1] + 3 * pow(t, 2) * (1 - t) *
x1[2] + pow(t, 3) * x1[3];
                double yt = pow(1 - t, 3) * yc[0] + 3 * t * pow(1 - t, 2) * yc[1] + 3 * pow(t, 2) * (1 - t) *
yc[2] + pow(t, 3) * yc[3];
                glVertex2f(xt, yt);
```

```
    glutInit(&argc, argv);
    /*
    //USE KEYBOARD
    cout << "Enter the x co-ordinates";
    cin >> x1[0] >> x1[1] >> x1[2] >> x1[3];
    cout << "Enter y co-ordinates";
    cin >> yc[0] >> yc[1] >> yc[2] >> yc[3];
    //END KEYBOARD
    */
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(500, 500);
    glutInitWindowPosition(0, 0);
    glutCreateWindow("BZ");
    glutDisplayFunc(display);
    glutMouseFunc(mymouse); //INCLUDE FOR MOUSE, REMOVE FOR KEYBOARD
    myInit();
    glutMainLoop();
    return 0;
}
```

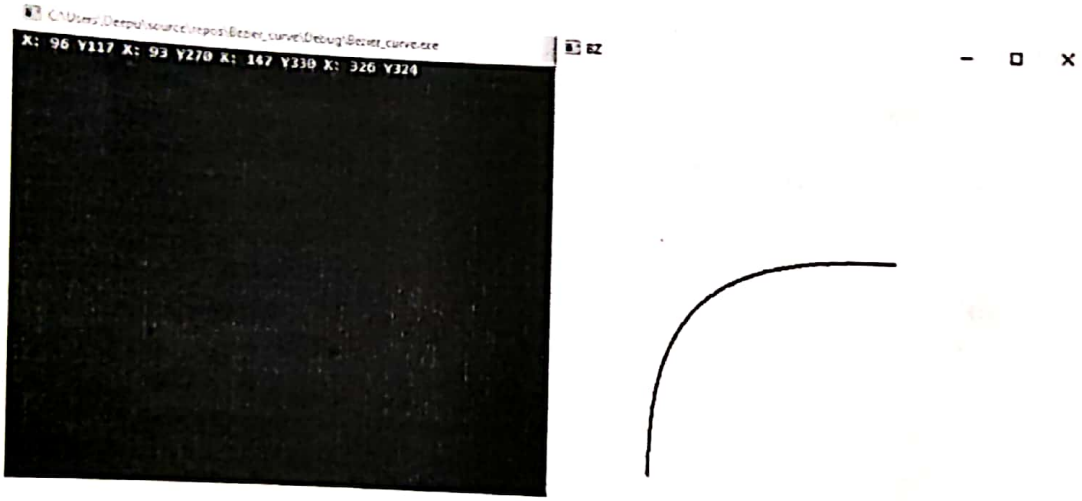
Output-1:



Output-2:



Output-3:



Output-4: