NAME : SATYAM

ROLL NO: *10882*

SECTION: *B*

SUBJECT: *Computer Graphics*

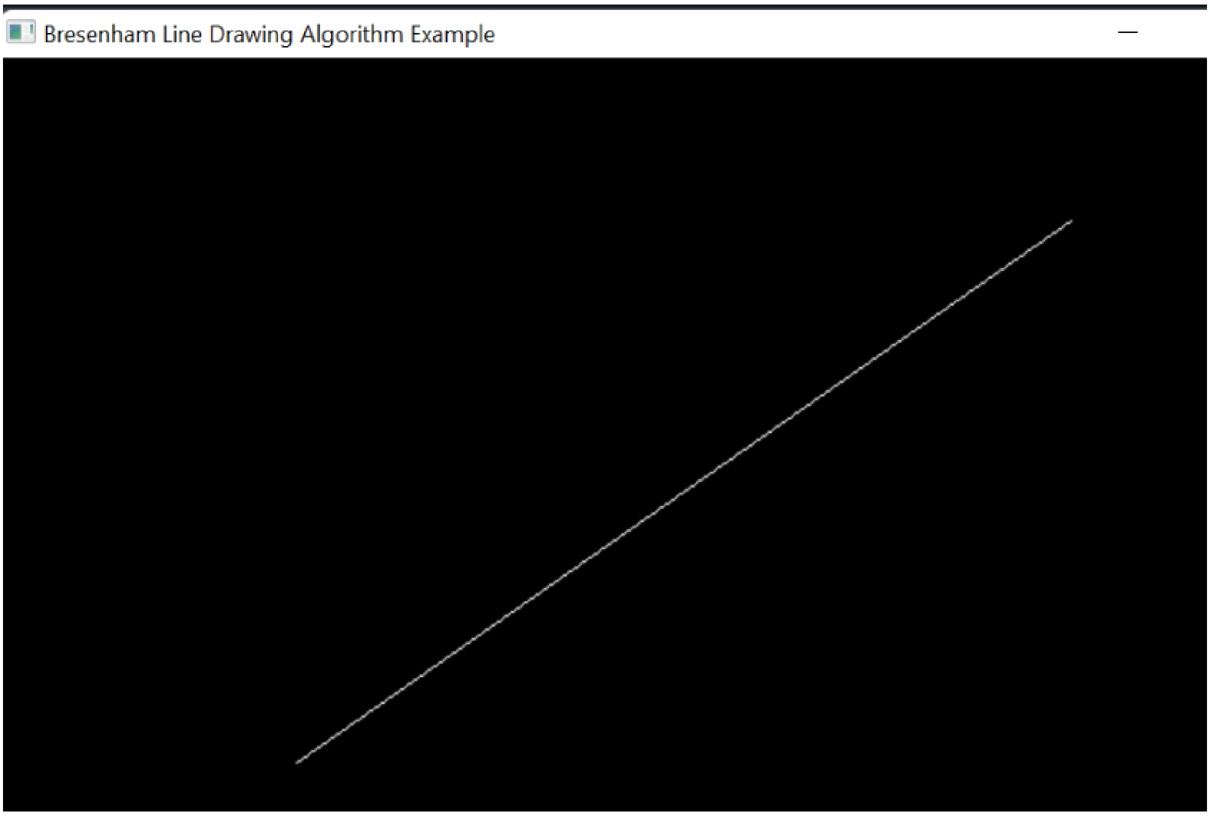
Practical 1:
Write a program to implement Bresenhams line drawing algorithm.

```
#include <iostream>
#include <iomanip>
#include <math.h>
#include <graphics.h>

using namespace std;

void BresenhamLine(int x1, int y1, int x2, int y2)
{
  // Setup
  int win = initwindow(700, 500, "Bresenham Line Drawing Algorithm Example");
  setcurrentwindow(win);

  // Get middle of window as adjusted origin
  int x_origin = getwindowwidth() / 2;
  int y_origin = getwindowheight() / 2;

  // Calculate dy, dx, a, b
  double dx = x2 - x1;
  double dy = y2 - y1;
  double a = 2*dy;
  double b = -2*dx;

  // Initial value of d
  double d = 2*dy - dx;

  // Draw initial pixel
  putpixel(x1 + x_origin, -y1 + y_origin, 15);

  // Output to terminal
  cout << "\ni\tPixel\td\tPlotted Values" << endl;
  cout << "-------------------------------------" << endl;
```

```
  cout << "0\t  \t  \t" << "(" << round(x1) << "," << round(y1) << ")" << endl;

  double x = x1;
  double y = y1;

  string pixel = "";

  for(int i = 1; ; i++) {
    double d_temp = d;

    // Choose NE pixel
    if (d>0){
      d = d + a + b;
      x = x + 1;
      y = y + 1;
      pixel = "NE";
    }
    // Choose E pixel
    else {
      d = d + a;
      x = x + 1;
      pixel = "E";
    }
    // Exit condition
    if (x > x2 || y > y2) break;

    // draw pixel
    putpixel(x + x_origin, -y + y_origin, 15);

    // Output to terminal
    cout << i << "\t" << pixel << "\t" <<  d_temp << "\t" << "(" << round(x) << "," <<
round(y) << ")" << endl;
  }

        // Clean up
  getch();
  closegraph();

  cout << endl;
}

int main()
{
  int x1 = -200;
  int y1 = -100;
  int x2 = 200;
  int y2 = 180;
  BresenhamLine(x1, y1, x2, y2);

  return 0;
```

```
}
```

OUTPUT:



Practical 2:

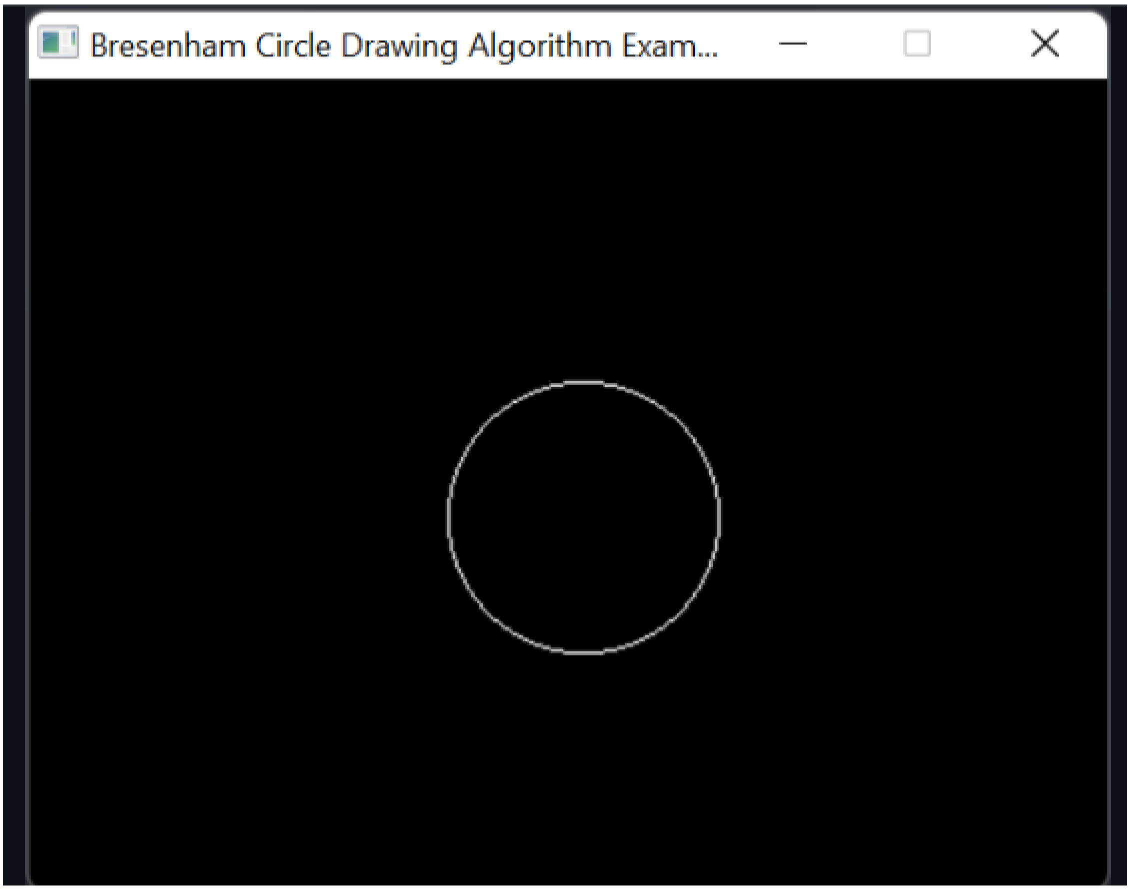
Write a program to implement mid-point circle drawing algorithm .

```
#include <cmath>
#include <cstdlib>
#include <graphics.h>
#include <iostream>

using namespace std;

void drawCirclePixels(int c_x, int c_y, int x, int y, int val)
{
  putpixel(c_x + x, c_y + y, val);
  putpixel(c_x + y, c_y + x, val);
  putpixel(c_x + y, c_y + -x, val);
  putpixel(c_x + x, c_y + -y, val);
  putpixel(c_x + -x, c_y + -y, val);
  putpixel(c_x + -y, c_y + -x, val);
  putpixel(c_x + -y, c_y + x, val);
  putpixel(c_x + -x, c_y + y, val);
  return;
```

```
}

void BresenhamCircle(int x1, int y1, int r)
{

  // Setup
  int win = initwindow(400, 300, "Bresenham Circle Drawing Algorithm Example");
  setcurrentwindow(win);

  // Get middle of window + given value as centre
  int x_c = round(x1 + getwindowwidth()/2);
  int y_c = round(-y1 + getwindowheight()/2);

  // Initial value of d
  int d = round(5/4 - r);

  // Draw initial pixel
  drawCirclePixels(x_c, y_c, 0, -r, 15);

  // Output to terminal
  cout << "\nIst OCTANT\n-------------" << endl;
  cout << "\ni\tPixel\td\tPlotted Values" << endl;
  cout << "-------------------------------------" << endl;
  cout << "0\t  \t  \t" << "(" << x1 << "," << y1+r << ")" << endl;

  int i = 0;
  string pixel = "";
  int x = 0;
  int y = r;

  while (y >= x)
  {
    i = i + 1;
    int d_temp = d;

    // Choose E pixel
    if (d < 0)
    {
      d += 2 * x + 3;
      x += 1;
      pixel = 'E';
    }
    // Choose SE pixel
    else
    {
      d += 2 * (x - y) + 5;
      x += 1;
      y -= 1;
      pixel = "SE";
    }
    drawCirclePixels(x_c, y_c, x, -y, 15);
```

```
    // Output to terminal
    cout << i << "\t" << pixel << "\t" <<  d_temp << "\t" << "(" << x << "," << y << ")" << endl;
  }
  cout << endl;

  // Clean up
  getch();
  closegraph();
}

int main(void)
{
  int x, y, r;
  cout << "Enter Centre (x y): ";
  cin >> x >> y;
  cout << "Enter Radius (r): ";
  cin >> r;

  BresenhamCircle(x, y, r);

  return 0;
}
```

OUTPUT:



PRACTICAL 3

Write a program to clip a line using Cohen and Sutherland line clipping algorithm.

```
// for line clipping.
// including libraries
#include <bits/stdc++.h>
#include <graphics.h>
using namespace std;

// Global Variables
int xmin, xmax, ymin, ymax;

// Lines where co-ordinates are (x1, y1) and (x2, y2)
struct lines {
    int x1, y1, x2, y2;
};

// This will return the sign required.
int sign(int x)
{
    if (x > 0)
        return 1;
    else
        return 0;
}

// CohenSutherLand LineClipping Algorithm As Described in theory.
// This will clip the lines as per window boundaries.
void clip(struct lines mylines)
{
    // arrays will store bits
    // Here bits implies initial Point whereas bite implies end points
    int bits[4], bite[4], i, var;
    // setting color of graphics to be RED
    setcolor(RED);

    // Finding Bits
    bits[0] = sign(xmin - mylines.x1);
    bite[0] = sign(xmin - mylines.x2);
    bits[1] = sign(mylines.x1 - xmax);
    bite[1] = sign(mylines.x2 - xmax);
    bits[2] = sign(ymin - mylines.y1);
    bite[2] = sign(ymin - mylines.y2);
    bits[3] = sign(mylines.y1 - ymax);
    bite[3] = sign(mylines.y2 - ymax);

    // initial will used for initial coordinates and end for final
    string initial = "", end = "", temp = "";
```

```
    // convert bits to string
    for (i = 0; i < 4; i++) {
        if (bits[i] == 0)
            initial += '0';
        else
            initial += '1';
    }
    for (i = 0; i < 4; i++) {
        if (bite[i] == 0)
            end += '0';
        else
            end += '1';
    }

    // finding slope of line y=mx+c as (y-y1)=m(x-x1)+c
    // where m is slope m=dy/dx;

    float m = (mylines.y2 - mylines.y1) / (float)(mylines.x2 - mylines.x1);
    float c = mylines.y1 - m * mylines.x1;

    // if both points are inside the Accept the line and draw
    if (initial == end && end == "0000") {
        // inbuild function to draw the line from(x1, y1) to (x2, y2)
        line(mylines.x1, mylines.y1, mylines.x2, mylines.y2);
        return;
    }

    // this will contain cases where line maybe totally outside for partially inside
    else {
        // taking bitwise end of every value
        for (i = 0; i < 4; i++) {

            int val = (bits[i] & bite[i]);
            if (val == 0)
                temp += '0';
            else
                temp += '1';
        }
        // as per algo if AND is not 0000 means line is completely outside hence draw nothing
and return
        if (temp != "0000")
            return;

        // Here contain cases of partial inside or outside
        // So check for every boundary one by one
        for (i = 0; i < 4; i++) {
            // if boths bit are same hence we cannot find any intersection with boundary so
continue
            if (bits[i] == bite[i])
                continue;
```

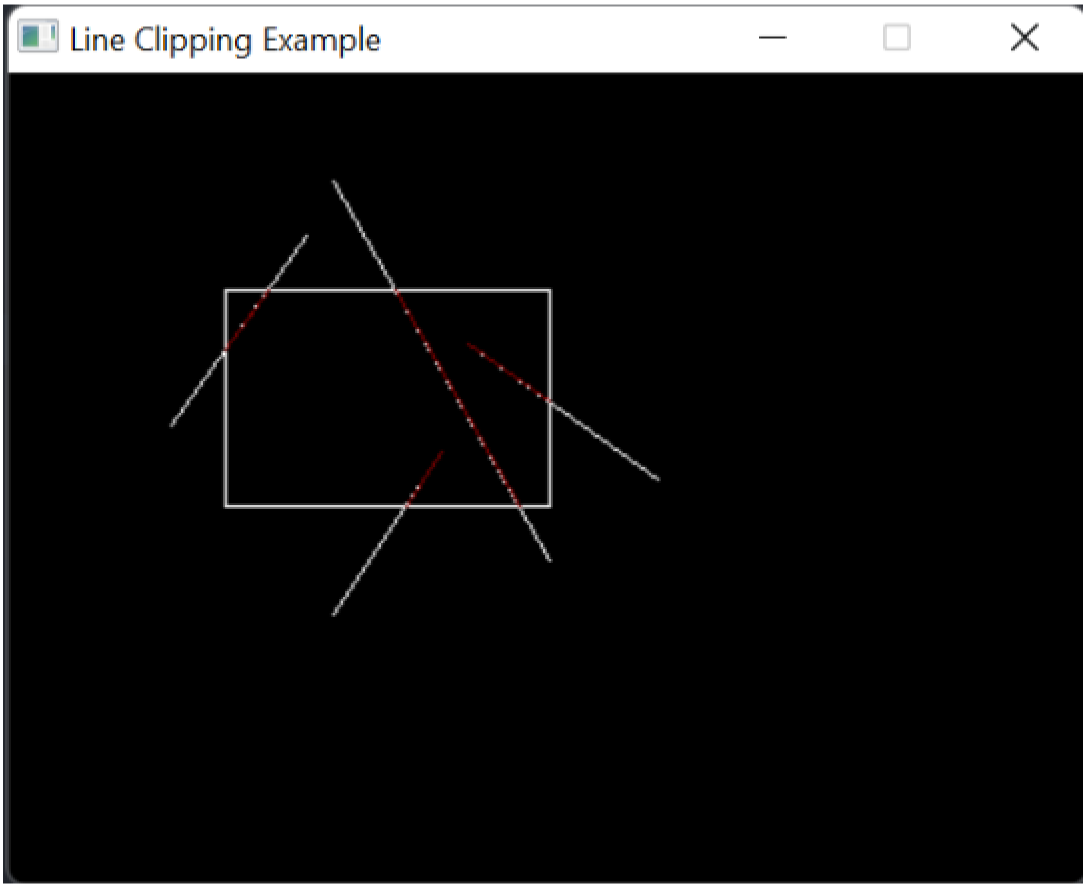
```
// Otherwise there exist a intersection

// Case when initial point is in left xmin
if (i == 0 && bits[i] == 1) {
    var = round(m * xmin + c);
    mylines.y1 = var;
    mylines.x1 = xmin;
}
// Case when final point is in left xmin
if (i == 0 && bite[i] == 1) {
    var = round(m * xmin + c);
    mylines.y2 = var;
    mylines.x2 = xmin;
}
// Case when initial point is in right of xmax
if (i == 1 && bits[i] == 1) {
    var = round(m * xmax + c);
    mylines.y1 = var;
    mylines.x1 = xmax;
}
// Case when final point is in right of xmax
if (i == 1 && bite[i] == 1) {
    var = round(m * xmax + c);
    mylines.y2 = var;
    mylines.x2 = xmax;
}
// Case when initial point is in top of ymin
if (i == 2 && bits[i] == 1) {
    var = round((float)(ymin - c) / m);
    mylines.y1 = ymin;
    mylines.x1 = var;
}
// Case when final point is in top of ymin
if (i == 2 && bite[i] == 1) {
    var = round((float)(ymin - c) / m);
    mylines.y2 = ymin;
    mylines.x2 = var;
}
// Case when initial point is in bottom of ymax
if (i == 3 && bits[i] == 1) {
    var = round((float)(ymax - c) / m);
    mylines.y1 = ymax;
    mylines.x1 = var;
}
// Case when final point is in bottom of ymax
if (i == 3 && bite[i] == 1) {
    var = round((float)(ymax - c) / m);
    mylines.y2 = ymax;
    mylines.x2 = var;
}
```

```
            // Updating Bits at every point
            bits[0] = sign(xmin - mylines.x1);
            bite[0] = sign(xmin - mylines.x2);
            bits[1] = sign(mylines.x1 - xmax);
            bite[1] = sign(mylines.x2 - xmax);
            bits[2] = sign(ymin - mylines.y1);
            bite[2] = sign(ymin - mylines.y2);
            bits[3] = sign(mylines.y1 - ymax);
            bite[3] = sign(mylines.y2 - ymax);
        } // end of for loop
        // Initialize initial and end to NULL
        initial = "", end = "";
        // Updating strings again by bit
        for (i = 0; i < 4; i++) {
            if (bits[i] == 0)
                initial += '0';
            else
                initial += '1';
        }
        for (i = 0; i < 4; i++) {
            if (bite[i] == 0)
                end += '0';
            else
                end += '1';
        }
        // If now both points lie inside or on boundary then simply draw the updated line
        if (initial == end && end == "0000") {
            line(mylines.x1, mylines.y1, mylines.x2, mylines.y2);
            return;
        }
        // else line was completely outside hence rejected
        else
            return;
    }
}

// Driver Function
int main()
{
    int gd = DETECT, gm;

    // Setting values of Clipping window
    xmin = 80;
    xmax = 200;
    ymin = 80;
    ymax = 160;

    // Setup
    int win = initwindow(400, 300, "Line Clipping Example");
    setcurrentwindow(win);
```

```
// Drawing Window using Lines
line(xmin, ymin, xmax, ymin);
line(xmax, ymin, xmax, ymax);
line(xmax, ymax, xmin, ymax);
line(xmin, ymax, xmin, ymin);

// Assume 4 lines to be clipped
struct lines mylines[4];

// Setting the coordinated of  4 lines
mylines[0].x1 = 60;
mylines[0].y1 = 130;
mylines[0].x2 = 110;
mylines[0].y2 = 60;

mylines[1].x1 = 120;
mylines[1].y1 = 40;
mylines[1].x2 = 200;
mylines[1].y2 = 180;

mylines[2].x1 = 120;
mylines[2].y1 = 200;
mylines[2].x2 = 160;
mylines[2].y2 = 140;

mylines[3].x1 = 170;
mylines[3].y1 = 100;
mylines[3].x2 = 240;
mylines[3].y2 = 150;

// Drawing Initial Lines without clipping
for (int i = 0; i < 4; i++) {
   line(mylines[i].x1, mylines[i].y1,
        mylines[i].x2, mylines[i].y2);
   delay(1000);
}

// Drawing clipped Line
for (int i = 0; i < 4; i++) {
   // Calling clip() which in term clip the line as per window and draw it
   clip(mylines[i]);
   delay(1000);
}
delay(4000);
getch();
// For Closing the graph.
closegraph();
return 0;
```

```
}
```

OUTPUT:



PRACTICAL 4:

Write a program to clip a polygon using Sutherland Hodgeman algorithm.

```
#include<iostream>
#include <graphics.h>
using namespace std;

const int MAX_POINTS = 20;

// Returns x-value of point of intersection of two
// lines
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;
```

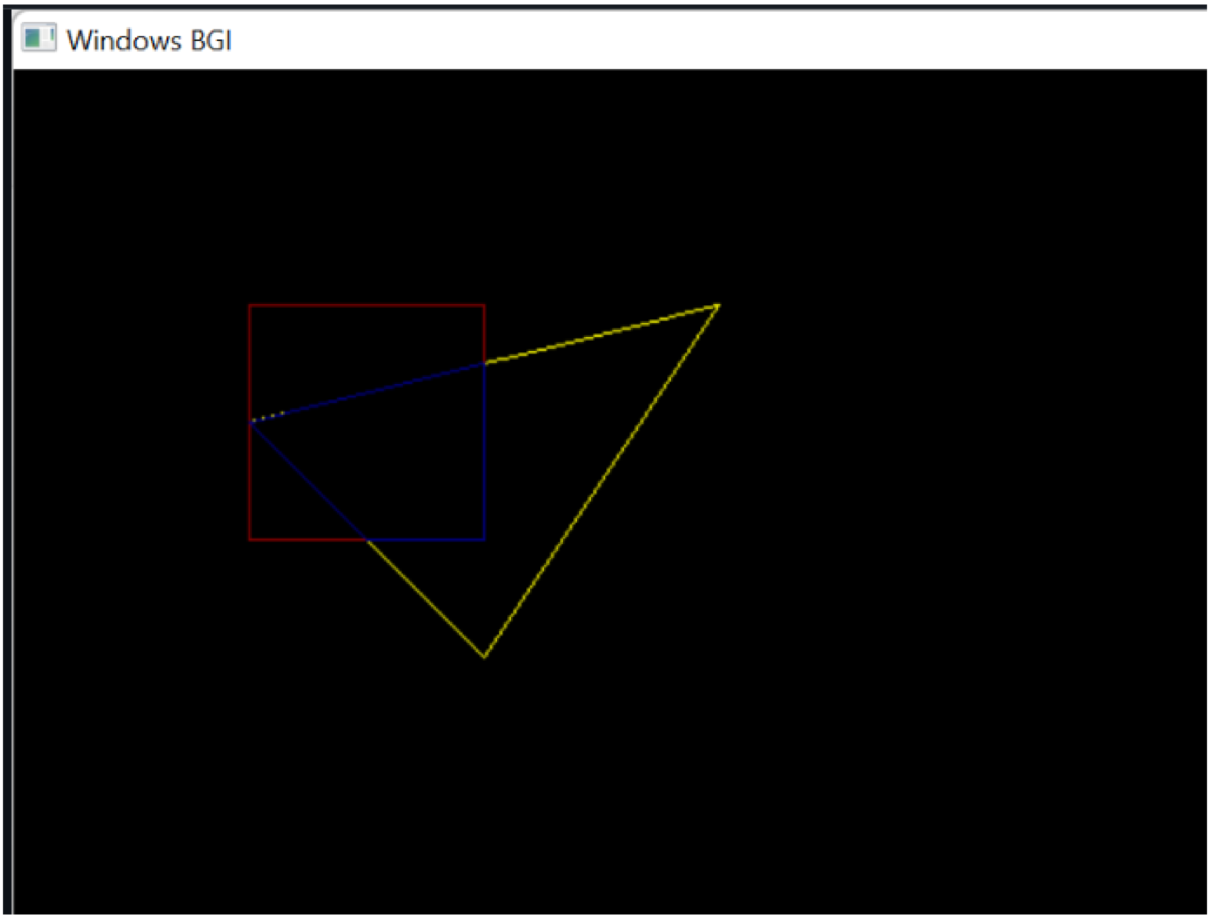
```
}

// Returns y-value of point of intersection of
// two lines
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;
}

// This functions clips all the edges w.r.t one clip
// edge of clipping area
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;

    // (ix,iy),(kx,ky) are the co-ordinate values of
    // the points
    for (int i = 0; i < poly_size; i++)
    {
        // i and k form a line in polygon
        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];

        // Calculating position of first point
        // w.r.t. clipper line
        int i_pos = (x2-x1) * (iy-y1) - (y2-y1) * (ix-x1);

        // Calculating position of second point
        // w.r.t. clipper line
        int k_pos = (x2-x1) * (ky-y1) - (y2-y1) * (kx-x1);

        // Case 1 : When both points are inside
        if (i_pos < 0  && k_pos < 0)
        {
            //Only second point is added
            new_points[new_poly_size][0] = kx;
            new_points[new_poly_size][1] = ky;
            new_poly_size++;
        }

        // Case 2: When only first point is outside
        else if (i_pos >= 0  && k_pos < 0)
        {
            // Point of intersection with edge
            // and the second point is added
            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++;
        }

        // Case 3: When only second point is outside
        else if (i_pos < 0  && k_pos >= 0)
        {
            //Only point of intersection with edge is added
            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++;
        }

        // Case 4: When both points are outside
        else
        {
            //No points are added
        }
    }

    // Copying new points into original array
    // and changing the no. of vertices
    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];
    }
}

// Implements Sutherland–Hodgman algorithm
void suthHodgClip(int poly_points[][2], int poly_size,
                  int clipper_points[][2], int clipper_size)
{
    //i and k are two consecutive indexes
    for (int i=0; i<clipper_size; i++)
    {
        int k = (i+1) % clipper_size;

        // We pass the current array of vertices, it's size
        // and the end points of the selected clipper line
        clip(poly_points, poly_size, clipper_points[i][0],
             clipper_points[i][1], clipper_points[k][0],
             clipper_points[k][1]);
    }

    // Printing vertices of clipped polygon
    cout << "\nClipped Polygon : " << endl;
    for (int i=0; i < poly_size; i++)
        cout << '(' << poly_points[i][0] <<
```

```
            ", " << poly_points[i][1] << ") ";
    cout << endl << endl;

    // Drawing Clipped Polygon
    int poly_clipped[50];
    for (int q = 0; q < poly_size; q++)
    {
        for (int t = 0; t < 2; t++)
        {
            poly_clipped[q * 2 + t] = poly_points[q][t];
        }
    }
    setcolor(BLUE);
    poly_clipped[2 * poly_size] = poly_clipped[0];
    poly_clipped[2 * poly_size + 1] = poly_clipped[1];
    drawpoly(poly_size + 1, poly_clipped);

    getch();
}

//Driver code
int main()
{
    int gd = DETECT, gm, errorcode;
    initgraph(&gd, &gm, NULL);

    // Defining polygon vertices in clockwise order
    int poly_size = 3;
    int poly_points[20][2] = {{100,150}, {200,250},
                              {300,100}};

    // Defining clipper polygon vertices in clockwise order
    // 1st Example with square clipper
    int clipper_size = 4;
    int clipper_points[][2] = {{100,100}, {100,200},
                              {200,200}, {200,100} };
    setcolor(RED);
    rectangle(100, 100, 200, 200);

    setcolor(YELLOW);
    int poly[50];
    for (int q = 0; q < poly_size; q++)
    {
        for (int t = 0; t < 2; t++)
        {
            poly[q * 2 + t] = poly_points[q][t];
        }
    }
    poly[2 * poly_size] = poly[0];
    poly[2 * poly_size + 1] = poly[1];
    drawpoly(poly_size + 1, poly);

    //Calling the clipping function
    suthHodgClip(poly_points, poly_size, clipper_points,
            clipper_size);
```

```
    getch();

    return 0;
}
```

OUTPUT:



PRACTICAL 5:

Write a program to fill a polygon using Scan line fill algorithm.

```
#include <iostream>

#include <vector>

#include <utility> // for pair

#include <algorithm>
```

```
#include <math.h>
#include "dda.cpp"
#include  <conio.h>
#include  <math.h>
#include <cmath>
#include <graphics.h>
using namespace std;

// Structure to represent a node in the adjacency list
struct Node {
   int vertex; // Index of the vertex
   pair<int, int> point; // Coordinates of the vertex
   Node(int v, pair<int, int> p) : vertex(v), point(p) {}
};
// Function to add an edge between vertices u and v in the adjacency list
void addEdge(vector<vector<Node> >& adjList, int u, int v, pair<int, int> point_u, pair<int, int>
point_v) {


   adjList[u].push_back(Node(v, point_v));
   adjList[v].push_back(Node(u, point_u));
   // For undirected graph
}
class EdgeNode
{
   public:
   int vertex1; // Index of the vertex
   int vertex2;
   double x;
   double y;
   double m_inv;
   EdgeNode *ptr;
```

```
    EdgeNode(){

        this->x = 0.0;
        this->y = 0.0;
        this->m_inv = 0.0;
        ptr = NULL;

    }

  static bool compareX(const EdgeNode* a, const EdgeNode* b) {
        return a->x < b->x;
    }
};

class vertex_ptr{

    public:
        EdgeNode *ptr;

        vertex_ptr(){
            ptr = NULL;
        }
};
class array_linked_list
{
    public:
    vertex_ptr *arr;
    int s;
    array_linked_list(int n){
        arr = new vertex_ptr[n];  //
```

```
        s = n;
    }
};
void print_global_edge_table(array_linked_list *ged,int n){
    cout<<"\n\nPRINTING GLOBAL EDGE TABLE :: "<<endl;
    for(int i=1;i<=n;i++){
        cout<<"for y is  "<<i<<" "<<endl;
        cout<<"------------------------------------------------------------------"<<endl;
        EdgeNode *temp = ged->arr[i].ptr ;
        while(temp  != NULL){  // reached to last node
            cout<<"for edge : "<<temp->vertex1<<" , "<<temp->vertex2<<" , x min : "<<temp->x<<" , y max : "<<temp->y<<" , 1/m is : "<<temp->m_inv;
          cout<<endl;
          temp = temp->ptr;
        }
        cout<<"-----------------------------------------------------------------\n\n"<<endl;
    }

}
void print_edge(vector<pair<int, int> >& edges){

//cout<<"---------------edge list---------------------------"<<endl;
    for(int i=0;i<edges.size();i++){
      // cout<<edges[i].first<<" , "<<edges[i].second<<endl;
    }
//cout<<"--------------------------------------------------"<<endl;
}
void scan_line(vector<vector<Node> >& adjList,int n,int y, array_linked_list *ged,  vector<pair<int, int> >& edges){
    // find all vertex which has y =4 , and than find adjacent edges
    // and store some flags that will be used to know that those edges, has already been used
```

```
vector <int> vertices;
    for (size_t i = 0; i < adjList.size(); ++i) {
    const Node& node = adjList[i][0];
    if(node.point.second == y){
        vertices.push_back(int(i));
    }
}
// now creating GLOBAL EDGE TABLE for each vertex
// to keep the edges which are already covered;


int flag = 0;
// ged->arr[1] is  a pointer
// y_max will be used later
int i = y;
// filling according to increasing y , and increasing x
    for(int j=0;j<vertices.size();j++){    // this access all vertex with y = 4, or i=4  , or some other


        // when j = 0 than we are at 1st vertex whose y =4
        // when j = 1 than we are at 2nd vertex whose y =4


        // for each vertex  iterate its adjacent vertex
       vector<int> temp;


        for(int k= 0; k < adjList[vertices[j]].size(); k++){  // this in 1 loop gives all adjacent to 1 vertex


            const Node& node = adjList[vertices[j]][k];
            // here  we have all ajacent edges releated to some vertex  j
            // iteration is giving all vertex , wrt j
            temp.push_back(node.vertex);  // contains the adjacent vertexs


        }
```

```
// now for each edge we will make a node
// temp has all the vertex adjacent
// vertices[j] gives vertex for which we will find edge

int x1 = adjList[vertices[j]][0].point.first;
int y1 = adjList[vertices[j]][0].point.second;

// v1 is  vertices[j]
//   v2 inside ,,  if  ( v1,v2) is found in any pair in edge  vectore than we will skip it

for(int p=0;p<temp.size();p++){

   // this is v2
   int x2 = adjList[temp[p]][0].point.first;
   int y2 = adjList[temp[p]][0].point.second;

   // check for complete list of edges for already done

   for(int c=0; c<edges.size();c++){

      if(edges[c].first == temp[p] && edges[c].second ==  vertices[j] ){
         flag = -1;
            break;
      }
       if(edges[c].first ==  vertices[j]  && edges[c].second ==  temp[p] ){
          flag = -1;
            break;
      }
   }
```

```
            if(flag == -1){
              flag =0;
               // calculate for next edge
              continue;
            }
        //    cout<<"working for :: (x1,x2) : ( "<<x1<<" , "<<y1<<" )"<<" and "<<" , ( "<<x2<<" ,
"<<y2<<" ) "<<endl;

            int minX = (y1 < y2) ? x1 : y2;  // for x which ever has minmum y
            int maxY = (y1 > y2) ? y1 : y2;

            if( ged->arr[i].ptr == NULL){

              ged->arr[i].ptr = new EdgeNode();

              ged->arr[i].ptr->x = minX;
              ged->arr[i].ptr->y = maxY;
              ged->arr[i].ptr->m_inv =  (x2*1.0 - x1*1.0)*1.0 / (y2*1.0 - y1*1.0 )*1.0 ;

            ged->arr[i].ptr->vertex1 =  vertices[j];
            ged->arr[i].ptr->vertex2 =  temp[p];
             edges.push_back(make_pair(vertices[j], temp[p]));

            }else{
              EdgeNode *tempp = ged->arr[i].ptr ;
              while(tempp->ptr  != NULL){  // reached to last node
                    tempp = tempp->ptr;
              }

              tempp->ptr = new EdgeNode();
```

```
                    tempp->ptr->x = minX;

                    tempp->ptr->y = maxY;

                    tempp->ptr->vertex1 =  vertices[j];

                    tempp->ptr->vertex2 =  temp[p];

                    tempp->ptr->m_inv =  (x2*1.0 - x1*1.0)*1.0 / (y2*1.0 - y1*1.0 )*1.0 ;

                    edges.push_back(make_pair( vertices[j], temp[p]));


                }


            }


        }

}

void move_edges(int y_min, vector<vector<Node> >& adjList, vector<EdgeNode *>& active_edges , array_linked_list *ged ){

//cout<<"==============================================================\n";

        EdgeNode *temp = ged->arr[y_min].ptr ;


        while(temp  != NULL){  // reached to last node

          //     cout<<temp->vertex1<<" , "<<temp->vertex2<<endl;

             active_edges.push_back(temp);

           temp = temp->ptr;

        }

//cout<<"================================================================\n";


}

void remove_from_active_edge(vector<EdgeNode *>& active_edges,int y){


    for(int i=0;i< active_edges.size();i++){

      // cout<<"v1 : "<<active_edges[i]->vertex1<<" , "<<active_edges[i]->vertex2<<endl;
```

```
        if(active_edges[i]->y == y){
          // remove it
        //  cout<<"remove it : "<<endl;
            int indexToRemove = i;
                if (indexToRemove >= 0 && indexToRemove < active_edges.size()) {
                    active_edges.erase(active_edges.begin() + indexToRemove);
                } else {
                  // std::cout << "Index out of range" << std::endl;
                }
        }
    }

}
void print_active_edge_table(vector<EdgeNode *>& active_edges ){

cout<<"----------------------------------------ACTIVE EDGE TABLE------------------------------------------
\n"<<endl;
    for(int i=0;i<active_edges.size();i++){
        cout<<"v1 : "<<active_edges[i]->vertex1<<" , v2 is :  "<<active_edges[i]->vertex2<<endl;
    }
cout<<"-----------------------------------------------------------------------------------------------\n"<<endl;

}

void make_pair_and_print(vector<EdgeNode *>& active_edges,int y ){

    int x1 = 0;
    int y1 = y;

    int x2 = 0;
    int y2 = y;
```

```
    for(int i =0 ;i<active_edges.size(); i +=2){

            x1 = active_edges[i]->x;
            x2 = active_edges[i+1]->x;

           cout<<"pair : "<<x1<<" , "<<y1<<"   and  "<<x2<<"  ,  "<<y2<<endl;

            dda(x1,y1,x2,y2,GREEN);

    }
}

void increment_x(vector<EdgeNode *>& active_edges){

        for(int i =0 ;i<active_edges.size(); i++){

            if(!isinf(active_edges[i]->m_inv)){
                active_edges[i]->x = active_edges[i]->x + active_edges[i]->m_inv ;
            }

        }

}
void scan_algo(array_linked_list *ged,int y_min, int y_max, vector<vector<Node> >& adjList){

    int y = y_min;
    vector<EdgeNode *> active_edges ;  // active edge table is empty

    int get = 5;
    int aet = 0;
```

```
    while(y <= y_max){   // repeat until aet and get is empty

      //move from et to aet those y_min = y
      move_edges(y,adjList, active_edges,ged);
      // remove those has y = y_max

      remove_from_active_edge(active_edges,y);

      // sort aet on x basis
     std::sort(active_edges.begin(), active_edges.end(), EdgeNode::compareX);

     //  cout<<"sorted list :============================\n";


      // cout<<"=================check if there is any changes in GLOBAL EDGE
TABLE==============\n";
      // print_global_edge_table(ged,y_max);

      // make pairs from aet using y

     //  print_active_edge_table(active_edges);
      make_pair_and_print(active_edges,y);
      y +=1;

      // increment with slope
      if(y< y_max){
         increment_x(active_edges);
      }else{
         break;
      }
```

```
    }
}

int main() {
    int gd = DETECT, gm;
            char pathtodriver[] = "";
            initgraph(&gd, &gm, pathtodriver);
    int numVertices = 6;
    // Initialize adjacency list
    vector<vector<Node> > adjList(numVertices);
    // Store points associated with each vertex
    vector<pair<int, int> > points;

    int y_min = 100;
    int y_max = 400;
    points.push_back(make_pair(200,100));
    points.push_back(make_pair(50,300));
    points.push_back(make_pair(80,400));

    points.push_back(make_pair(200,350));
    points.push_back(make_pair(300,400));
    points.push_back(make_pair(350,310));
    // Add some edges
    addEdge(adjList, 1, 0, points[0], points[1]);
    addEdge(adjList, 2, 1, points[1], points[2]);
    addEdge(adjList, 3, 2, points[2], points[3]);
    addEdge(adjList, 4, 3, points[3], points[4]);
    addEdge(adjList, 5, 4, points[4], points[5]);
    addEdge(adjList, 0, 5, points[5], points[0]);

  vector<pair<int, int> > edges;
```

```
   array_linked_list *ged =  new array_linked_list(y_max+1);


  for(int i= y_min ;i <= y_max ;i++){
       scan_line(adjList,numVertices,i,ged,edges);
  }


//print_global_edge_table(ged,y_max);
scan_algo(ged,y_min,y_max,adjList);
cout<<"done"<<endl;
getch();
closegraph();
   return 0;
}
```

PRACTICAL 6:

Write a program to apply various 2D transformations on a 2D object (use homogenous coordinates).

```
#define _USE_MATH_DEFINES
#include <cmath>
#include <cstdlib>
#include <graphics.h>
#include <iostream>
#define COORD_SHIFT 100


using namespace std;


void clrscr()
{
#ifdef _WIN32
  system("cls");
```

```
#elif __unix__
  system("clear");
#endif
}

double **inputFigure(int n)
{
  cout << "Enter the matrix for the 2-D shape (homogeneous):\n";

  double **figure = NULL;
  figure = new double *[n];

  for (int i = 0; i < n; i++)
  {
    figure[i] = new double[3];
    for (int j = 0; j < 3; j++)
    {
      cin >> figure[i][j];
    }
  }

  return figure;
}

void drawFigure(double **points, int n)
{
  setcolor(WHITE);
  for (int i = 0; i < n; i++)
  {
    line(COORD_SHIFT + points[i][0],
         COORD_SHIFT + points[i][1],
```

```
        COORD_SHIFT + points[(i + 1) % n][0],
        COORD_SHIFT + points[(i + 1) % n][1]);
  }

  delay(5e3);
  cleardevice();
}

double **translate(double **figure, int dim, int m, int n)
{
  double **_figure = NULL;
  int T[dim][3] = {{1, 0, 0}, {0, 1, 0}, {m, n, 1}};

  _figure = new double *[dim];

  for (int i = 0; i < dim; i++)
  {
    _figure[i] = new double[3];
    for (int j = 0; j < 3; j++)
    {
      for (int k = 0; k < dim; k++)
      {
        _figure[i][j] += figure[i][k] * T[k][j];
      }
    }
  }

  return _figure;
}

double **rotate(double **figure, int dim, double theta)
```

```
{
  double **_figure = NULL;
  double T[dim][3] = {{cos(theta * M_PI / 180.0), sin(theta * M_PI / 180.0), 0},
                     {-sin(theta * M_PI / 180.0), cos(theta * M_PI / 180.0), 0},
                     {0, 0, 1}};

  _figure = new double *[dim];

  for (int i = 0; i < dim; i++)
  {
    _figure[i] = new double[3];
    for (int j = 0; j < 2; j++)
    {
      for (int k = 0; k < dim; k++)
      {
        _figure[i][j] += figure[i][k] * T[k][j];
      }
    }
  }

  return _figure;
}

double **scale(double **figure, int dim, int m, int n)
{
  double **_figure = NULL;
  int T[dim][3] = {{m, 0, 0}, {0, n, 0}, {0, 0, 1}};

  _figure = new double *[dim];

  for (int i = 0; i < dim; i++)
```

```
 {
   _figure[i] = new double[3];
   for (int j = 0; j < 3; j++)
   {
     for (int k = 0; k < dim; k++)
     {
       _figure[i][j] += figure[i][k] * T[k][j];
     }
   }
 }

 return _figure;
}

double **reflect(double **figure, int dim, int c)
{
 double **_figure = NULL;
 int T[dim][3] = {{1, 0, 0}, {0, 1, 0}, {0, 0, 1}};

 switch (c)
 {
 case 1:
   T[1][1] = -1;
   break;
 case 2:
   T[0][0] = -1;
   break;
 case 3:
   T[0][0] = 0;
   T[0][1] = 1;
   T[1][0] = 1;
```

```
    T[1][1] = 0;
    break;
  case 4:
    T[0][0] = -1;
    T[1][1] = -1;
    break;
  default:
    return NULL;
    break;
  }

  _figure = new double *[dim];

  for (int i = 0; i < dim; i++)
  {
    _figure[i] = new double[3];
    for (int j = 0; j < 3; j++)
    {
      for (int k = 0; k < dim; k++)
      {
        _figure[i][j] += figure[i][k] * T[k][j];
      }
    }
  }

  return _figure;
}

double **shear(double **figure, int dim, int m, int n)
{
  double **_figure = NULL;
```

```
  int T[dim][3] = {{1, n, 0}, {m, 1, 0}, {0, 0, 1}};

  _figure = new double *[dim];

  for (int i = 0; i < dim; i++)
  {
    _figure[i] = new double[3];
    for (int j = 0; j < 3; j++)
    {
      for (int k = 0; k < dim; k++)
      {
        _figure[i][j] += figure[i][k] * T[k][j];
      }
    }
  }

  return _figure;
}

void menu(double **figure, int dim)
{
  int ch = 0;
  double **_figure;

  do
  {
    clrscr();
    cout << "\nMenu\n-------\n(1) Translation\n(2) Rotation";
    cout << "\n(3) Scaling\n(4) Reflection\n(5) Shearing";
    cout << "\n(6) View Figure\n(7) Exit\n\nEnter Choice: ";
    cin >> ch;
```

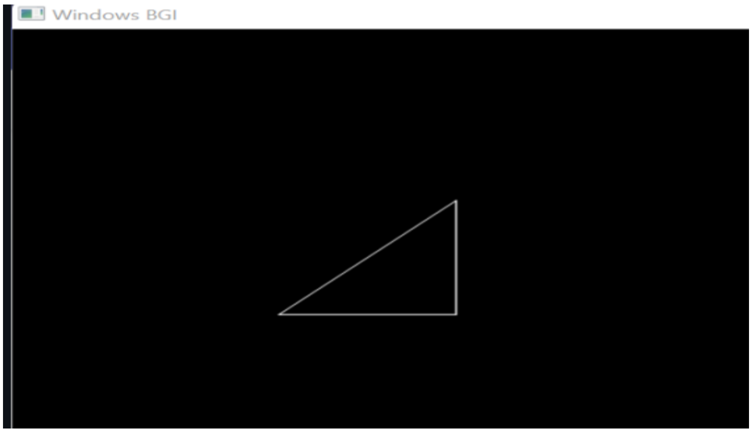
```
cout << endl;
switch (ch)
{
case 1:
  int m, n;

  cout << "Enter translation in x-axis: ";
  cin >> m;
  cout << "Enter translation in y-axis: ";
  cin >> n;

  _figure = translate(figure, dim, m, n);

  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);

  cout << "Drawing Transformed Figure...\n";
  drawFigure(_figure, dim);
  break;
case 2:
  double theta;

  cout << "Enter rotation angle (degrees): ";
  cin >> theta;

  _figure = rotate(figure, dim, theta);

  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);

  cout << "Drawing Transformed Figure...\n";
```

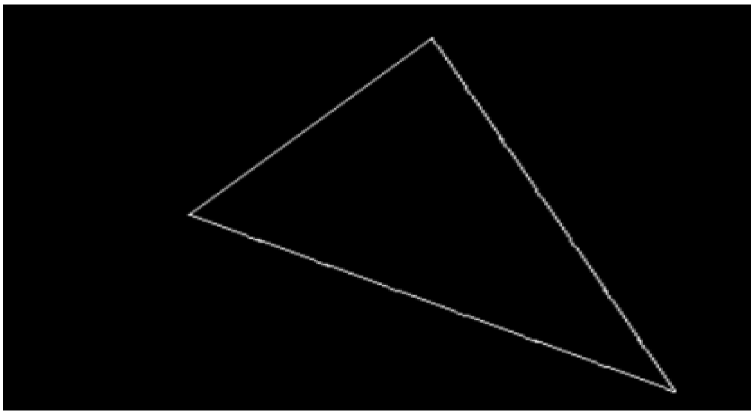
```
  drawFigure(_figure, dim);
  break;
case 3:
  cout << "Enter scaling in x-axis: ";
  cin >> m;
  cout << "Enter scaling in y-axis: ";
  cin >> n;

  _figure = scale(figure, dim, m, n);

  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);

  cout << "Drawing Transformed Figure...\n";
  drawFigure(_figure, dim);
  break;
case 4:
  cout << "Reflect along\n(1) x-axis\n(2) y-axis\n(3) y = x\n(4) y = -x\n"
     << "\nEnter Choice: ";
  cin >> m;

  _figure = reflect(figure, dim, m);

  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);

  cout << "Drawing Transformed Figure...\n";
  drawFigure(_figure, dim);
  break;
case 5:
  cout << "Enter shearing in x-axis: ";
```

```
  cin >> m;
  cout << "Enter shearing in y-axis: ";
  cin >> n;

  _figure = shear(figure, dim, m, n);

  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);

  cout << "Drawing Transformed Figure...\n";
  drawFigure(_figure, dim);
  break;
case 6:
  cout << "Drawing Original Figure...\n";
  drawFigure(figure, dim);
  break;
case 7:
default:
  break;
}

delete _figure;

cout << endl
    << "Finished..."
    << endl;

if (ch != 7)
{
  cout << "\nPress Enter to continue ...\n";
  cin.ignore();
```

```
      cin.get();
    }
  } while (ch != 7);
};

int main(void)
{
  int n;
  double **fig;
  int gd = DETECT, gm;

  initgraph(&gd, &gm, NULL);

  cout << "Enter number of points in the figure: ";
  cin >> n;

  fig = inputFigure(n);

  menu(fig, n);

  delete fig;
  closegraph();

  return 0;
}
```

OUTPUT:





PRACTICAL 7:

Write a program to apply various 3D transformations on a 3D object and then apply parallel and perspective projection on it.

```
#include <iostream>

#include <direct.h>

#include <stdio.h>

#include <math.h>

#include <conio.h>

#include <graphics.h>

#include <process.h>

using namespace std;


int gd = DETECT, gm;

double x1, x2, y2;


void draw_cube(double edge[20][3])

{

  double y1;

  initgraph(&gd, &gm, NULL);

  int i;

  clearviewport();

  for (i = 0; i < 19; i++)

  {

    x1 = edge[i][0] + edge[i][2] * (cos(2.3562));

    y1 = edge[i][1] - edge[i][2] * (sin(2.3562));

    x2 = edge[i + 1][0] + edge[i + 1][2] * (cos(2.3562));

    y2 = edge[i + 1][1] - edge[i + 1][2] * (sin(2.3562));

    line(x1 + 320, 240 - y1, x2 + 320, 240 - y2);

  }

  line(320, 240, 320, 25);

  line(320, 240, 550, 240);
```

```
  line(320, 240, 150, 410);
  getch();
  closegraph();
}

void scale(double edge[20][3])
{
  double a, b, c;
  int i;
  cout << "Enter The Scaling Factors: ";
  cin >> a >> b >> c;
  initgraph(&gd, &gm, NULL);
  clearviewport();
  for (i = 0; i < 20; i++)
  {
    edge[i][0] = edge[i][0] * a;
    edge[i][1] = edge[i][1] * b;
    edge[i][2] = edge[i][2] * c;
  }
  draw_cube(edge);
  closegraph();
}

void translate(double edge[20][3])
{
  int a, b, c;
  int i;
  cout << "Enter The Translation Factors: ";
  cin >> a >> b >> c;
  initgraph(&gd, &gm, NULL);
  clearviewport();
```

```
  for (i = 0; i < 20; i++)
  {
    edge[i][0] += a;
    edge[i][0] += b;
    edge[i][0] += c;
  }
  draw_cube(edge);
  closegraph();
}

void rotate(double edge[20][3])
{
  int ch;
  int i;
  double temp, theta, temp1;
  cout << "-=[ Rotation About ]=-" << endl;
  cout << "1:==> X-Axis " << endl;
  cout << "2:==> Y-Axis" << endl;
  cout << "3:==> Z-Axis " << endl;
  cout << "Enter Your Choice: ";
  cin >> ch;
  switch (ch)
  {
  case 1:
    cout << "Enter The Angle: ";
    cin >> theta;
    theta = (theta * 3.14) / 180;
    for (i = 0; i < 20; i++)
    {
      edge[i][0] = edge[i][0];
      temp = edge[i][1];
```

```
    temp1 = edge[i][2];
    edge[i][1] = temp * cos(theta) - temp1 * sin(theta);
    edge[i][2] = temp * sin(theta) + temp1 * cos(theta);
  }
  draw_cube(edge);
  break;

case 2:
  cout << "Enter The Angle: ";
  cin >> theta;
  theta = (theta * 3.14) / 180;
  for (i = 0; i < 20; i++)
  {
    edge[i][1] = edge[i][1];
    temp = edge[i][0];
    temp1 = edge[i][2];
    edge[i][0] = temp * cos(theta) + temp1 * sin(theta);
    edge[i][2] = -temp * sin(theta) + temp1 * cos(theta);
  }
  draw_cube(edge);
  break;

case 3:
  cout << "Enter The Angle: ";
  cin >> theta;
  theta = (theta * 3.14) / 180;
  for (i = 0; i < 20; i++)
  {
    edge[i][2] = edge[i][2];
    temp = edge[i][0];
    temp1 = edge[i][1];
```

```
    edge[i][0] = temp * cos(theta) - temp1 * sin(theta);
    edge[i][1] = temp * sin(theta) + temp1 * cos(theta);
   }
   draw_cube(edge);
   break;
  }
}

void reflect(double edge[20][3])
{
  int ch;
  int i;
  cout << "-=[ Reflection About ]=-" << endl;
  cout << "1:==> X-Axis" << endl;
  cout << "2:==> Y-Axis " << endl;
  cout << "3:==> Z-Axis " << endl;
  cout << "Enter Your Choice: ";
  cin >> ch;
  switch (ch)
  {
  case 1:
   for (i = 0; i < 20; i++)
   {
    edge[i][0] = edge[i][0];
    edge[i][1] = -edge[i][1];
    edge[i][2] = -edge[i][2];
   }
   draw_cube(edge);
   break;

  case 2:
```

```
    for (i = 0; i < 20; i++)
    {
      edge[i][1] = edge[i][1];
      edge[i][0] = -edge[i][0];
      edge[i][2] = -edge[i][2];
    }
    draw_cube(edge);
    break;

  case 3:
    for (i = 0; i < 20; i++)
    {
      edge[i][2] = edge[i][2];
      edge[i][0] = -edge[i][0];
      edge[i][1] = -edge[i][1];
    }
    draw_cube(edge);
    break;
  }
}

void perspect(double edge[20][3])
{
  int ch;
  int i;
  double p, q, r;
  cout << "-=[ Perspective Projection About ]=-" << endl;
  cout << "1:==> X-Axis " << endl;
  cout << "2:==> Y-Axis " << endl;
  cout << "3:==> Z-Axis" << endl;
  cout << "Enter Your Choice := ";
```

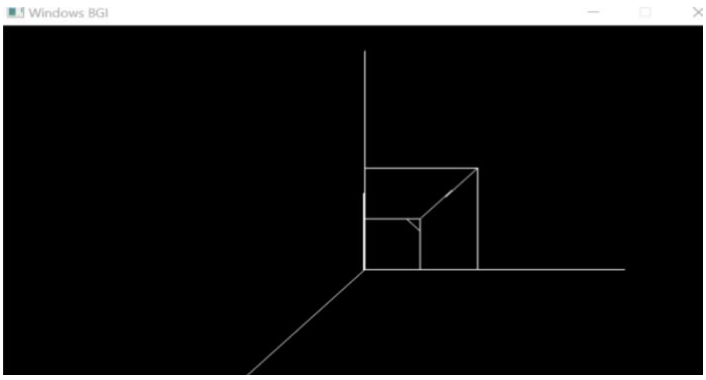
```
cin >> ch;
switch (ch)
{
case 1:
 cout << " Enter P := ";
 cin >> p;
 for (i = 0; i < 20; i++)
 {
   edge[i][0] = edge[i][0] / (p * edge[i][0] + 1);
   edge[i][1] = edge[i][1] / (p * edge[i][0] + 1);
   edge[i][2] = edge[i][2] / (p * edge[i][0] + 1);
 }
 draw_cube(edge);
 break;

case 2:
 cout << " Enter Q := ";
 cin >> q;
 for (i = 0; i < 20; i++)
 {
   edge[i][1] = edge[i][1] / (edge[i][1] * q + 1);
   edge[i][0] = edge[i][0] / (edge[i][1] * q + 1);
   edge[i][2] = edge[i][2] / (edge[i][1] * q + 1);
 }
 draw_cube(edge);
 break;

case 3:
 cout << " Enter R := ";
 cin >> r;
 for (i = 0; i < 20; i++)
```

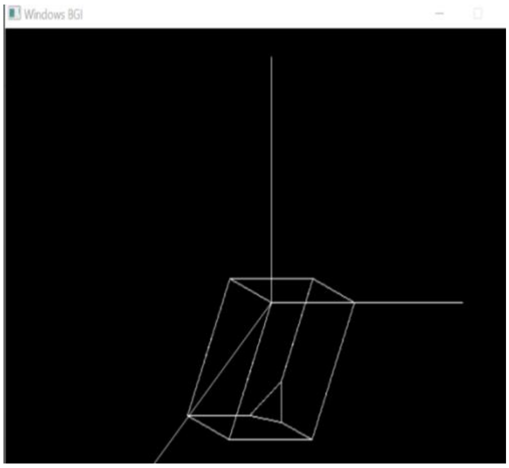
```
    {
      edge[i][2] = edge[i][2] / (edge[i][2] * r + 1);
      edge[i][0] = edge[i][0] / (edge[i][2] * r + 1);
      edge[i][1] = edge[i][1] / (edge[i][2] * r + 1);
    }
    draw_cube(edge);
    break;
  }
  closegraph();
}

int main()
{
  int choice;
  double edge[20][3] = {
      100, 0, 0,
      100, 100, 0,
      0, 100, 0,
      0, 100, 100,
      0, 0, 100,
      0, 0, 0,
      100, 0, 0,
      100, 0, 100,
      100, 75, 100,
      75, 100, 100,
      100, 100, 75,
      100, 100, 0,
      100, 100, 75,
      100, 75, 100,
      75, 100, 100,
      0, 100, 100,
```

```
    0, 100, 0,
    0, 0, 0,
    0, 0, 100,
    100, 0, 100};
  while (1)
  {
   cout << "1:==> Draw Cube " << endl;
   cout << "2:==> Scaling " << endl;
   cout << "3:==> Rotation " << endl;
   cout << "4:==> Reflection " << endl;
   cout << "5:==> Translation " << endl;
   cout << "6:==> Perspective Projection " << endl;
   cout << "7:==> Exit " << endl;
   cout << "Enter Your Choice := ";
   cin >> choice;
   switch (choice)
   {
   case 1:
    draw_cube(edge);
    break;

   case 2:
    scale(edge);
    break;

   case 3:
    rotate(edge);
    break;

   case 4:
    reflect(edge);
```

```
    break;

  case 5:
    translate(edge);
    break;

  case 6:
    perspect(edge);
    break;

  case 7:
    exit(0);

  default:
    cout << "\nPress A Valid Key...!!! ";
    getch();
    break;
  }
  closegraph();
 }

 return 0;
}
```

OUTPUT:





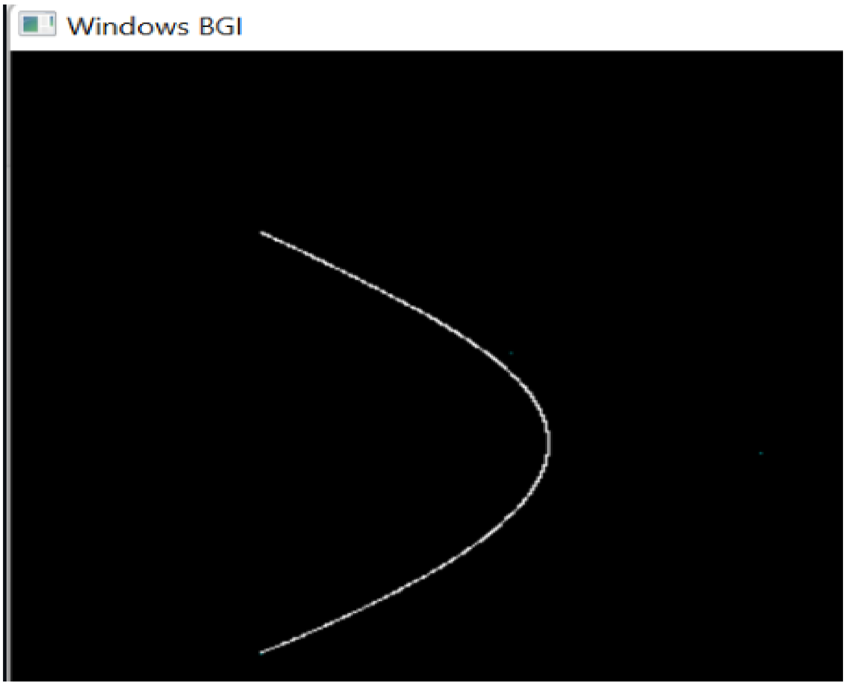
PRACTICAL 7:

Write a program to draw Hermite/Bezier curve.

BEZIER CURVE:

```
#include<graphics.h>
#include<math.h>
#include<conio.h>
#include<stdio.h>
int main()
{
int x[4],y[4],i;
double put_x,put_y,t;
int gr=DETECT,gm;
initgraph(&gr,&gm,NULL);
printf("\n****** Bezier Curve ***********");
printf("\n Please enter x and y coordinates ");
for(i=0;i<4;i++)
{
scanf("%d%d",&x[i],&y[i]);
putpixel(x[i],y[i],3);               // Control Points
}

for(t=0.0;t<=1.0;t=t+0.001)             // t always lies between 0 and 1
{
put_x = pow(1-t,3)*x[0] + 3*t*pow(1-t,2)*x[1] + 3*t*t*(1-t)*x[2] + pow(t,3)*x[3]; //
Formula to draw curve
put_y =  pow(1-t,3)*y[0] + 3*t*pow(1-t,2)*y[1] + 3*t*t*(1-t)*y[2] + pow(t,3)*y[3];
putpixel(put_x,put_y, WHITE);            // putting pixel
}
getch();
closegraph();

return 0;
}
```

OUTPUT:



HERMITE CURVE:

```
#include <iostream>

#include <graphics.h>

#include <conio.h>

#include <stdio.h>

#include <stdlib.h>

using namespace std;


struct point

{

  int x, y;

};


void hermite(point p1, point p4, double r1, double r4)

{

  float x, y, t;

  for (t = 0.0; t <= 1.0; t += 0.001)
```

```
  {
    x = (2 * t * t * t - 3 * t * t + 1) * p1.x + (-2 * t * t * t + 3 * t * t) * p4.x + (t * t * t - 2 * t * t + t) * r1 +
(t * t * t - t * t) * r4;
    y = (2 * t * t * t - 3 * t * t + 1) * p1.y + (-2 * t * t * t + 3 * t * t) * p4.y + (t * t * t - 2 * t * t + 1) * r1 +
(t * t * t - t * t) * r4;
    putpixel(x, y, YELLOW);
  }
}

int main()
{
  /* request auto detection */
  int gdriver = DETECT, gmode, errorcode;

  /* initialize graphics and local variables */
  initgraph(&gdriver, &gmode, NULL);

  /* read result of initialization */
  errorcode = graphresult();

  /* an error occurred */
  if (errorcode != grOk)
  {
    printf("Graphics error: %s\n", grapherrormsg(errorcode));
    printf("Press any key to halt:");
    getch();
    exit(1);
  }

  double r1, r4;
  point p1, p2;
  cout << "Enter 2 hermite points: " << endl;
```

```
  cin >> p1.x >> p1.y >> p2.x >> p2.y;
  cout << "Enter tangents at p1 and p4: " << endl;
  cin >> r1 >> r4;
  hermite(p1, p2, r1, r4);
  putpixel(p1.x, p1.y, WHITE);
  putpixel(p2.x, p2.y, WHITE);
  getch();
  closegraph();

  return 0;
}
```

OUTPUT: