UNIVERSITY OF DELHI

KALINDI COLLEGE

COMPUTER GRAPHICS PRACTICALS

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Q1 Write a program to implement Digital Differential Analyzer line drawing algorithm.

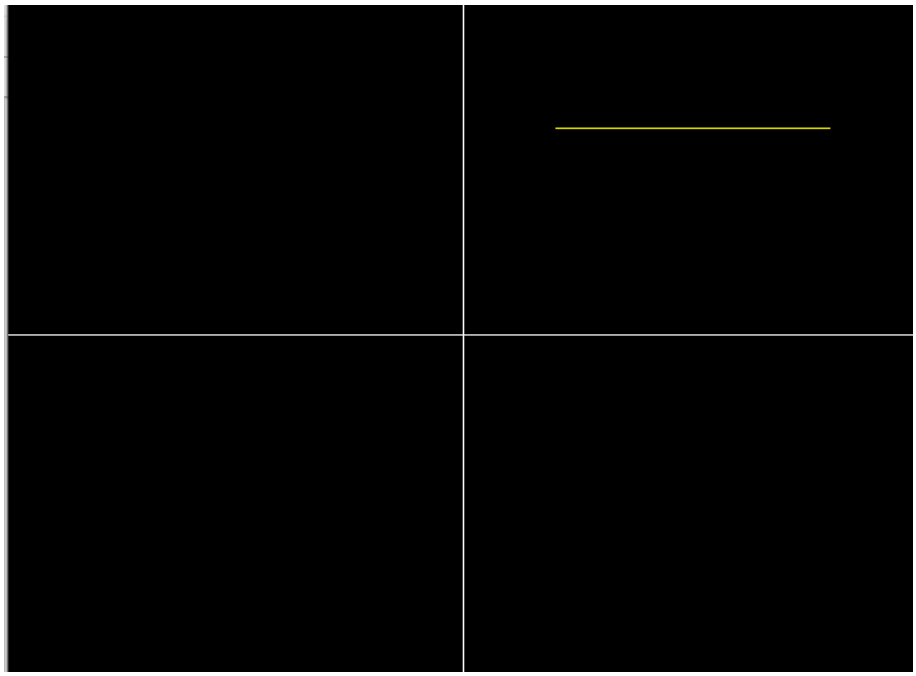
```
#include<iostream>
#include<graphics.h>
#include<windows.h>

using namespace std;
int xmid,ymid;

//Function to implement DDA line drawing algorithm
void dda(int x1,int y1,int x2,int y2)
{
	int dx,dy,steps,xinc,yinc;

	dx=x2-x1;
	dy=y2-y1;

	xmid=getmaxx()/2;
	ymid=getmaxy()/2;

	if(abs (dx) > abs(dy) )
	{
		steps =abs(dx);
	}
```

```
        else
        {
                steps=abs(dy);
        }

        xinc = dx/(float) steps;
        yinc = dy/(float)steps;

        for(int k=0;k<steps; k++)
        {
                putpixel(x1,y1,YELLOW);
                x1+= xinc;
                y1+= yinc;
        }
}

int main()
{
        int gd = DETECT , gm;
        initgraph(&gd, &gm,"C:\\Dev-Cpp\\lib");

        int x1,y1,x2,y2;
        cout<<" Digital Differential Analyzer Line Drawing Algorithm \n\n";
        cout<<" Enter the x co-ordinate of point 1: ";
        cin>>x1;
```

```
        cout<<"\n Enter the y co-ordinate of point 1: ";
        cin>>y1;

        cout<<"\n Enter the x co-ordinate of point 2: ";
        cin>>x2;

        cout<<"\nEnter the y co-ordinate of point 2: ";
        cin>>y2;

        xmid=getmaxx()/2;
    ymid=getmaxy()/2;
        line(xmid , 0 , xmid , getmaxy());
        line(0 , ymid , getmaxx() , ymid);

        dda(x1+xmid ,ymid-y1,x2+xmid,ymid-y2);

        getch();
        closegraph();
        return 0;
}
```

OUTPUT

```
Digital Differential Analyzer Line Drawing Algorithm
Enter the x co-ordinate of point 1: 65
Enter the y co-ordinate of point 1: 145
Enter the x co-ordinate of point 2: 258
Enter the y co-ordinate of point 2: 32
```



Q2 Write a program to implement Bresenham's line drawing algorithm.

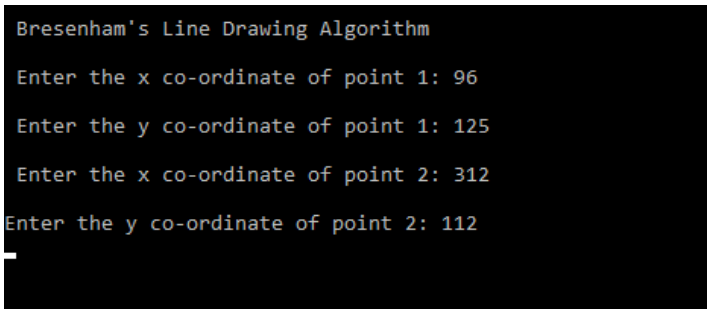
```
#include<bits/stdc++.h>
#include<graphics.h>
using namespace std;

//Function to implement Bresenham's line drawing algorithm
```

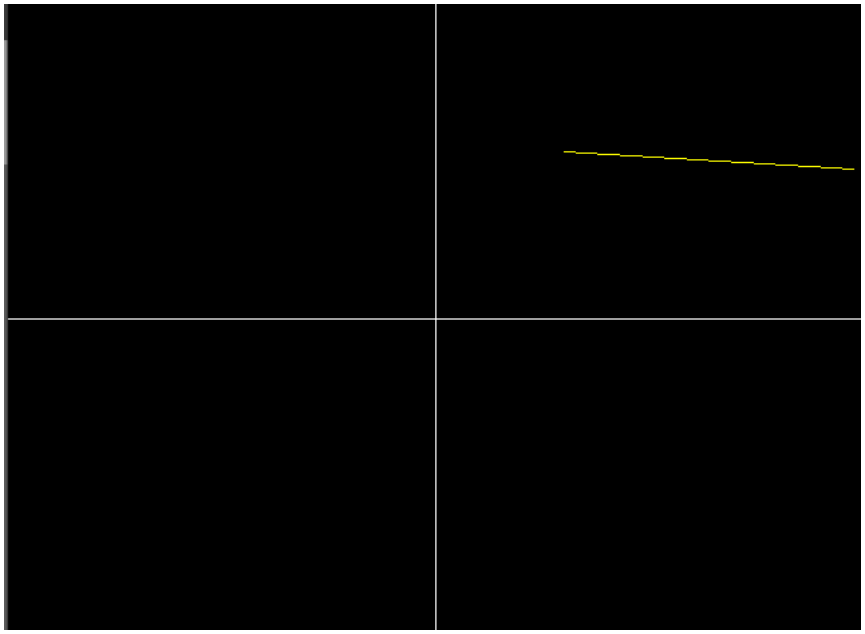
```
void bresline(int x1,int y1,int x2,int y2)
{
        int dx,dy,P,x,y;

        int xmid=getmaxx()/2;
        int ymid=getmaxy()/2;

        dx=x2-x1;
        dy=y2-y1;

        x=x1;
        y=y1;

        P=2*dy-dx;

        while(x<=x2)
        {
                if(P>=0)
        {
        putpixel(x,y,YELLOW);
        y=y+1;
        P=P+2*dy-2*dx;
        }
        else
        {
        putpixel(x,y,YELLOW);
```

```
        P=P+2*dy;}
        x=x+1;
        }
        }

int main()
{
        int gdriver = DETECT,gmode;
        initgraph(&gdriver,&gmode,"C:\\Dev-Cpp\\lib");
   setbkcolor(BLACK);
        cleardevice();
        int x1,x2,y1,y2;
        cout<<" Bresenham's Line Drawing Algorithm \n\n";
        cout<<" Enter the x co-ordinate of point 1: ";
        cin>>x1;

        cout<<"\n Enter the y co-ordinate of point 1: ";
        cin>>y1;

        cout<<"\n Enter the x co-ordinate of point 2: ";
        cin>>x2;

        cout<<"\nEnter the y co-ordinate of point 2: ";
        cin>>y2;

        cleardevice();
```

```
    int xmid = getmaxx()/2;
        int ymid = getmaxy()/2;
        line(xmid , 0 , xmid , getmaxy());
        line(0 , ymid , getmaxx() , ymid);
        bresline(x1+xmid,ymid-y1,x2+xmid,ymid-y2);

        getch();
        closegraph();
        return 0;
}
```

OUTPUT





Q3 Write a program to implement mid-point circle drawing algorithm.

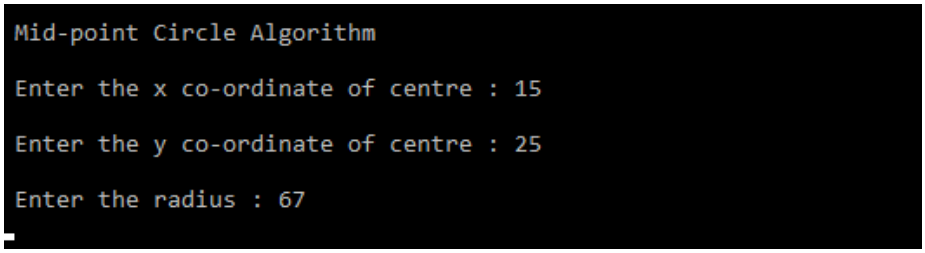
```
#include<iostream>
#include<graphics.h>
#include<math.h>

using namespace std;
void circlePlotPoints (int, int, int, int);
int xmid, ymid;
void circleMidpoint(int xCenter, int yCenter, int radius)
{
        int x = 0;
        int y = radius;
```

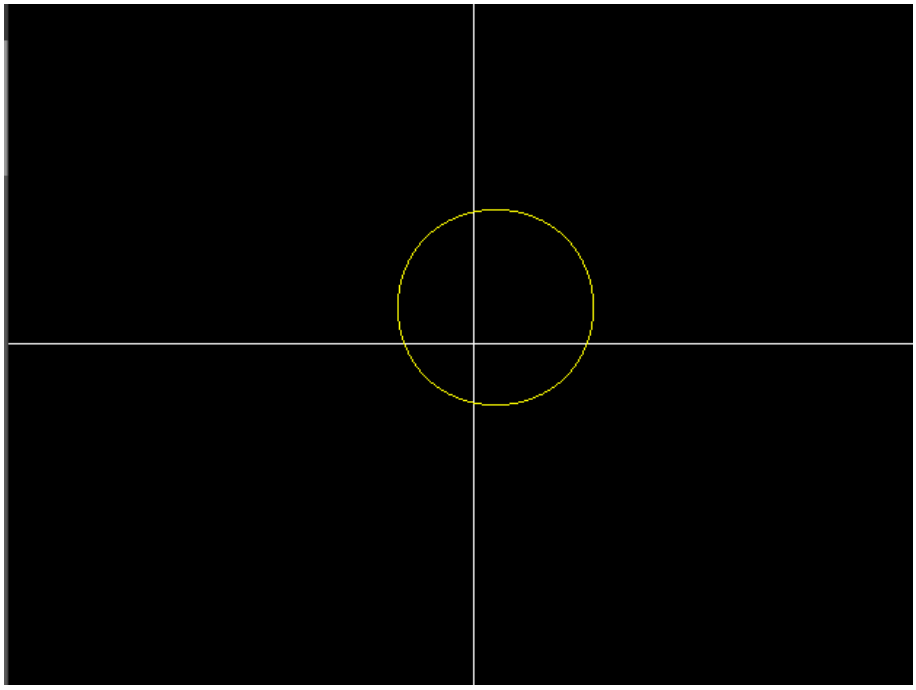
```
        int p = 1 - radius;

   //circlePlotPoints (x, y, xCenter, yCenter);
        while (x <= y)
        {
          circlePlotPoints (x, y, xCenter, yCenter);
                if (p < 0)
                {
                  p += (2*x)+1;
                }

                else
        {
          p +=(2*(x-y))+1;
          y--;
      }
      x++ ;
        }
 }

void circlePlotPoints(int x, int y, int xCenter, int yCenter){
        putpixel (xCenter + x, yCenter + y, YELLOW);
        putpixel (xCenter - x, yCenter + y, YELLOW);
        putpixel (xCenter + x, yCenter - y, YELLOW);
        putpixel (xCenter - x, yCenter - y, YELLOW);
        putpixel (xCenter + y, yCenter + x, YELLOW);
```

```
        putpixel (xCenter - y, yCenter + x, YELLOW);
        putpixel (xCenter + y, yCenter - x, YELLOW);
        putpixel (xCenter - y, yCenter - x, YELLOW);
}


int main()
{
        int x , y;
   float r;
   int gd = DETECT , gm;
        initgraph(&gd, &gm, (char*)"");

        cout<<" Mid-point Circle Algorithm \n\n";

        cout<<" Enter the x co-ordinate of centre : ";
        cin>>x;

        cout<<"\n Enter the y co-ordinate of centre : ";
        cin>>y;

        cout<<"\n Enter the radius : ";
        cin>>r;

        xmid = getmaxx()/2;
        ymid = getmaxy()/2;
```

```
        line(xmid , 0 , xmid , getmaxy());
        line(0 , ymid , getmaxx() , ymid);
        circleMidpoint(x + xmid , ymid - y , r);

    getch();
    closegraph();
    return 0;

}
```

OUTPUT





Q4 Write a program to implement Ellipse mid-point drawing algorithm.

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

using namespace std;
#define ROUND(a) ((int) (a+0.5))

void ellipsePlotPoints(int, int, int, int);

//Function plotting points of Ellipse
void ellipseMidpoint (int xCenter, int yCenter, int Rx, int Ry)
```

```
{
  int Rx2 = Rx*Rx;
  int Ry2 = Ry*Ry;
  int twoRx2 = 2*Rx2;
  int twoRy2 = 2*Ry2;
  int p;
  int x = 0;
  int y = Ry;
  int px = 0;
  int py = twoRx2 *y;


  ellipsePlotPoints(xCenter, yCenter, x, y);

  p = ROUND(Ry2 - (Rx2 * Ry) + (0.25 * Rx2));

  while (px < py)
  {
   x++;
   px += twoRy2;

        if (p < 0)
   {
          p += Ry2 + px;
```

```
    }

        else
        {
                y--;
       py -= twoRx2;
       p += Ry2 + px - py;
        }
    ellipsePlotPoints(xCenter, yCenter, x,y);
  }
/* Region 2 */
    p = ROUND (Ry2*(x+0.5)*(x+0.5) + Rx2*(y-1)*(y-1) - Rx2*Ry2);
    while (y > 0)
        {
      y--;
      py -= twoRx2;

          if (p > 0)
      {
                        p += Rx2 - py;
          }

         else
         {
```

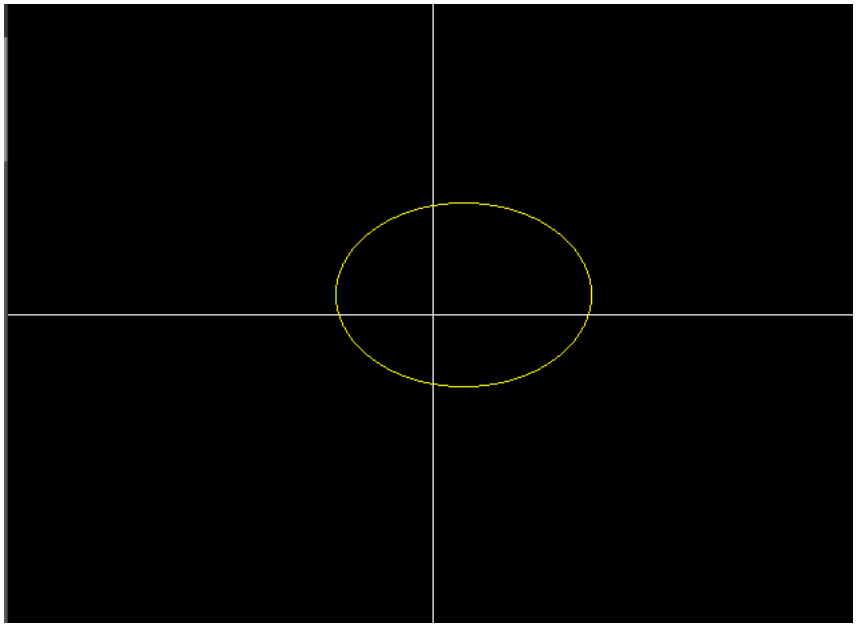
```
        x++;
        px += twoRy2;
        p += Rx2 - py + px;
      }

      ellipsePlotPoints(xCenter, yCenter, x, y);
      }
  }

void ellipsePlotPoints (int xCenter, int yCenter, int x, int y)
{
        putpixel (xCenter + x, yCenter + y, YELLOW);
        putpixel (xCenter- x, yCenter + y, YELLOW);
        putpixel (xCenter+ x, yCenter - y, YELLOW);
        putpixel (xCenter - x, yCenter - y, YELLOW);

}

int main()
{
        int x , y,xmid,ymid;
    float r,r2;
    int gd = DETECT , gm;
        initgraph(&gd, &gm, (char*)"");
```

```
    cout<<" Ellipse Mid-point Algorithm \n\n";

    cout<<" Enter the x co-ordinate of centre : ";
    cin>>x;

    cout<<"\n Enter the y co-ordinate of centre : ";
    cin>>y;

    cout<<"\n Enter the  radius1 : ";
    cin>>r;

    cout<<"\n Enter the  radius2 : ";
    cin>>r2;

    xmid = getmaxx()/2;
    ymid = getmaxy()/2;
    line(xmid , 0 , xmid , getmaxy());
    line(0 , ymid , getmaxx() , ymid);
ellipseMidpoint(x + xmid , ymid - y , r,r2);
getch();
closegraph();
return 0;
```

}

OUTPUT

```
Ellipse Mid-point Algorithm

Enter the x co-ordinate of centre : 23

Enter the y co-ordinate of centre : 15

Enter the  radius1 : 96

Enter the  radius2 : 69
```



Q5 Write a program to implement Cohen-Sutherland Line Clipping algorithm.

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

float x_mid, y_mid;

// Defining region codes
const int TOP = 1;    // 0001
const int BOTTOM = 2; // 0010
const int RIGHT = 4;  // 0100
const int LEFT = 8;   // 1000

// Defining x_max, y_max and x_min, y_min for clipping rectangle.
const int x_max = 300;
const int y_max = 300;
const int x_min = 80;
const int y_min = 80;

// Function to compute region code for a point(x, y).
int ComputeOutCode(double x, double y)
{
   // Point initialized as being inside the clipping window.
```

```
    int code = 0;

    if (y > y_max)
        code |= TOP;
            else if (y < y_min)
        code |= BOTTOM;
    if (x > x_max)
        code |= RIGHT;
            else if (x < x_min)
        code |= LEFT;

    return code;
}

//  Implementing Cohen-Sutherland algorithm.
void CohenSutherlandLineClipAndDraw(double x1, double y1, double x2,
double y2)
{
            // Initialize line as outside the clipping window.
    bool accept = false, done = false;

    // Compute region codes for P1, P2.
    int code1 = ComputeOutCode(x1, y1);
    int code2 = ComputeOutCode(x2, y2);

    do
            {
```

```
if (!(code1 | code2))
        {
   // Trivial accept and exit.
   accept = true;
   done = true;
   break;
}
else if (code1 & code2)
        {
   // If both endpoints are outside clipping window, so trivial reject.
   break;
}
else
        {
   /*   Failed both tests, so calculate the line segment to clip:
        from an outside point to an intersection with clip edge.
                */
   double x, y;
                int code_out;

   // At least one endpoint is outside the clip rectangle, pick it.
   code_out =(code1 != 0)? code1 : code2;

   // Now, find intersection point.
   // Using formulas: y = y1 + slope * (x - x1), x = x1 + (1 / slope) * (y - y1).
   if (code_out & TOP)
```

```
                {
   // Point is above the clipping window.
   x = x1 + (x2 - x1) * (y_max - y1) / (y2 - y1);
   y = y_max;
}
else if (code_out & BOTTOM)
                {
   // Point is below the clipping window.
   x = x1 + (x2 - x1) * (y_min - y1) / (y2 - y1);
   y = y_min;
}
else if (code_out & RIGHT)
                {
   // Point is to the right of clipping window.
   y = y1 + (y2 - y1) * (x_max - x1) / (x2 - x1);
   x = x_max;
}
else if (code_out & LEFT)
                {
   // Point is to the left of clipping window.
   y = y1 + (y2 - y1) * (x_min - x1) / (x2 - x1);
   x = x_min;
}

// Now we move outside point to intersection point to clip.
if (code_out == code1)
```

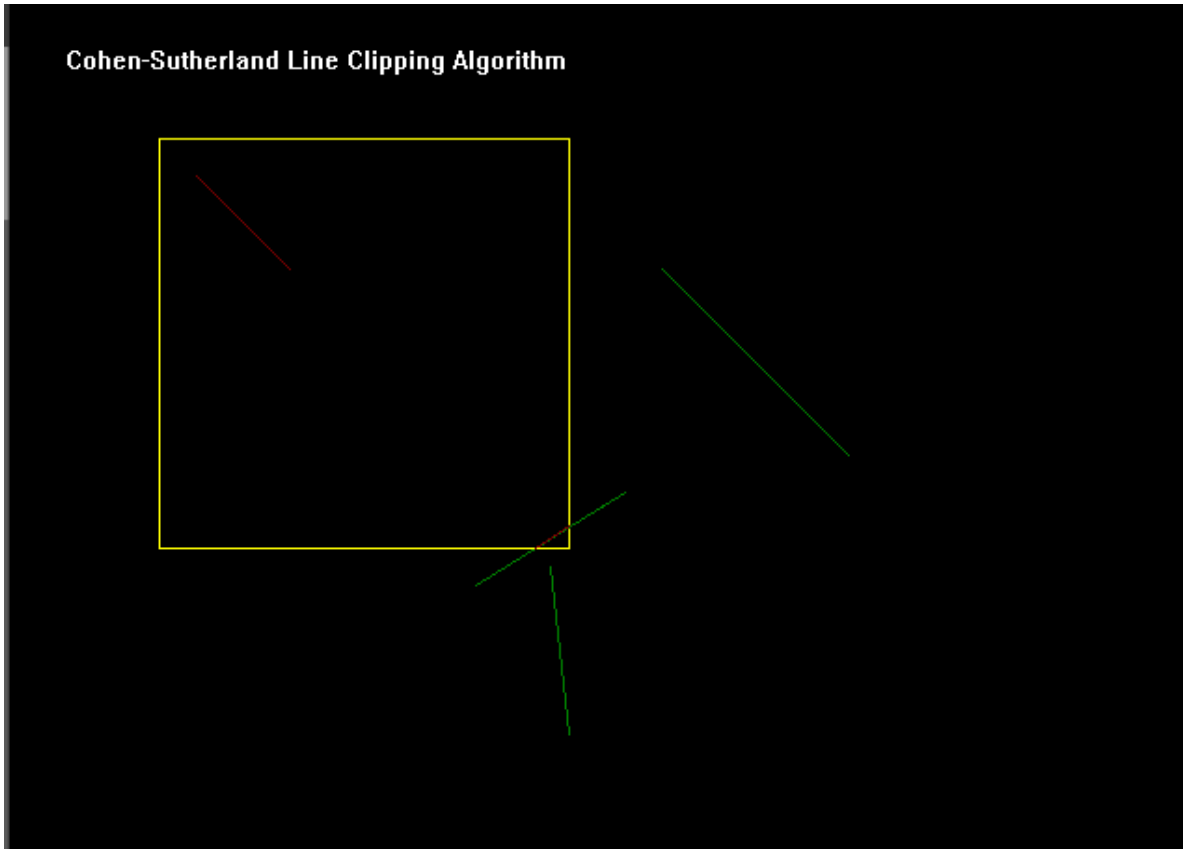
```
                        {
            x1 = x;
            y1 = y;
            code1 = ComputeOutCode(x1, y1);
         }
         else
                        {
            x2 = x;
            y2 = y;
            code2 = ComputeOutCode(x2, y2);
         }
      }
   } while(done == false);
   if (accept)
         {
      // Drawing the clipped line.
                cout << "Line accepted from (" << x1 << ", " << y1 << ") to (" << x2
<< ", " << y2 << ")" << endl;
      setcolor(RED);
                line(x1, y1, x2, y2);
   }
   else
      cout << "Line rejected" << endl;
}

// Driver code
int main()
```

```
{
        int gd = DETECT, gm;
        initgraph(&gd, &gm, (char*)"");

        float X = getmaxx(), Y = getmaxy();
        float x_mid = X / 2;
        float y_mid = Y / 2;

        setcolor(WHITE);
        outtextxy(30, 30, "Cohen-Sutherland Line Clipping Algorithm");

        // Drawing Window using Lines
        setcolor(YELLOW);
   line(x_min, y_min, x_max, y_min);
   line(x_max, y_min, x_max, y_max);
   line(x_max, y_max, x_min, y_max);
   line(x_min, y_max, x_min, y_min);

        setcolor(GREEN);
   // First Line segment
   // P1 = (250, 320), P2 = (330, 270)
   line(250, 320, 330, 270);
   CohenSutherlandLineClipAndDraw(250, 320, 330, 270);

   // Second Line segment
   // P1 = (80, 80), P2 = (150, 150)
```

```
    CohenSutherlandLineClipAndDraw(100, 100, 150, 150);

    // Third Line segment
    // P1 = (290, 310), P2 = (320, 500)
    setcolor(GREEN);
    line(290, 310, 300, 400);
    CohenSutherlandLineClipAndDraw(290, 310, 320, 400);

    // Fourth Line segment
    // P1 = (450, 450), P2 = (500, 500)
    setcolor(GREEN);
    line(350, 150, 450, 250);
    CohenSutherlandLineClipAndDraw(350, 150, 450, 250);

        getch();
        closegraph();

    return 0;
}
```

OUTPUT

```
Line accepted from (282, 300) to (300, 288.75)
Line accepted from (100, 100) to (150, 150)
Line rejected
Line rejected
```



Q6 Write a program to implement Sutherland Hodgeman Clipping program.

```
#include<iostream>
#include<conio.h>
#include<graphics.h>
using namespace std;
#define round(a) ((int)(a+0.5))
int k;
float xmin,ymin,xmax,ymax,arr[20],m;
void clipl(float x1,float y1,float x2,float y2)
```

```
{
   if(x2-x1)
      m=(y2-y1)/(x2-x1);
   else
      m=100000;
   if(x1 >= xmin && x2 >= xmin)
   {
      arr[k]=x2;
      arr[k+1]=y2;
      k+=2;
   }
   if(x1 < xmin && x2 >= xmin)
   {
      arr[k]=xmin;
      arr[k+1]=y1+m*(xmin-x1);
      arr[k+2]=x2;
      arr[k+3]=y2;
      k+=4;
   }
   if(x1 >= xmin  && x2 < xmin)
   {
      arr[k]=xmin;
      arr[k+1]=y1+m*(xmin-x1);
      k+=2;
   }
}
```

```
void clipt(float x1,float y1,float x2,float y2)
{
   if(y2-y1)
      m=(x2-x1)/(y2-y1);
   else
      m=100000;
   if(y1 <= ymax && y2 <= ymax)
   {
      arr[k]=x2;
      arr[k+1]=y2;
      k+=2;
   }
   if(y1 > ymax && y2 <= ymax)
   {
      arr[k]=x1+m*(ymax-y1);
      arr[k+1]=ymax;
      arr[k+2]=x2;
      arr[k+3]=y2;
      k+=4;
   }
   if(y1 <= ymax  && y2 > ymax)
   {
      arr[k]=x1+m*(ymax-y1);
      arr[k+1]=ymax;
      k+=2;
```

```
    }
}

void clipr(float x1,float y1,float x2,float y2)
{
    if(x2-x1)
        m=(y2-y1)/(x2-x1);
    else
        m=100000;
    if(x1 <= xmax && x2 <= xmax)
    {
        arr[k]=x2;
        arr[k+1]=y2;
        k+=2;
    }
    if(x1 > xmax && x2 <= xmax)
    {
        arr[k]=xmax;
        arr[k+1]=y1+m*(xmax-x1);
        arr[k+2]=x2;
        arr[k+3]=y2;
        k+=4;
    }
    if(x1 <= xmax  && x2 > xmax)
    {
        arr[k]=xmax;
```

```
        arr[k+1]=y1+m*(xmax-x1);
        k+=2;
    }
}

void clipb(float x1,float y1,float x2,float y2)
{
    if(y2-y1)
        m=(x2-x1)/(y2-y1);
    else
        m=100000;
    if(y1 >= ymin && y2 >= ymin)
    {
        arr[k]=x2;
        arr[k+1]=y2;
        k+=2;
    }
    if(y1 < ymin && y2 >= ymin)
    {
        arr[k]=x1+m*(ymin-y1);
        arr[k+1]=ymin;
        arr[k+2]=x2;
        arr[k+3]=y2;
        k+=4;
    }
    if(y1 >= ymin  && y2 < ymin)
```

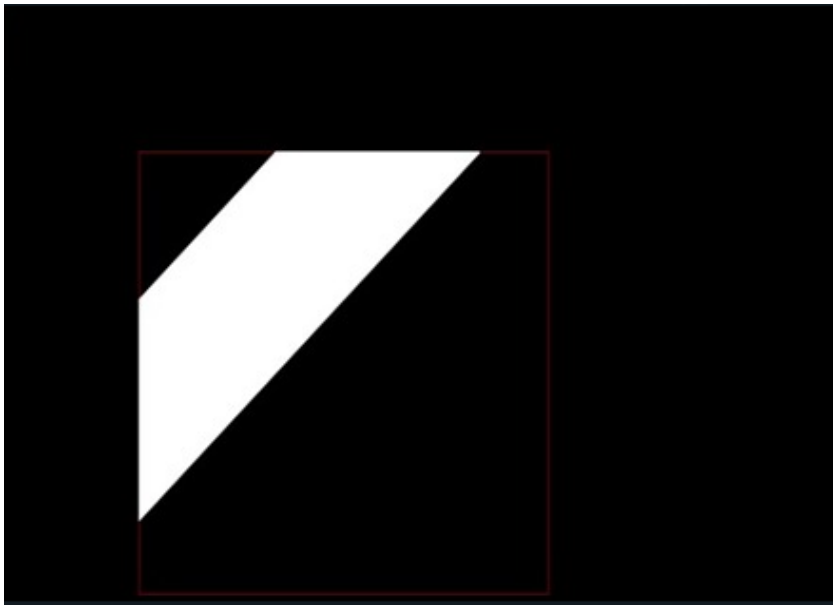
```
    {
        arr[k]=x1+m*(ymin-y1);
        arr[k+1]=ymin;
        k+=2;
    }
}

int main()
{
    int gd=DETECT,gm,n,poly[20];
    initgraph(&gd,&gm,(char*)"");
    float xi,yi,xf,yf,polyy[20];

    cout<<"Coordinates of rectangular clip window :\nxmin,ymin            :";
    cin>>xmin>>ymin;
    cout<<"xmax,ymax            :";
    cin>>xmax>>ymax;
    cout<<"\n\nPolygon to be clipped :\nNumber of sides      :";
    cin>>n;
    cout<<"Enter the coordinates :";
    int i;
    for(i=0;i < 2*n;i++)
                cin>>polyy[i];
    polyy[i]=polyy[0];
    polyy[i+1]=polyy[1];
    for(i=0;i < 2*n+2;i++)
```

```
                poly[i]=round(polyy[i]);


setcolor(RED);
rectangle(xmin,ymax,xmax,ymin);
cout<<"\t\tUNCLIPPED POLYGON";
setcolor(WHITE);
fillpoly(n,poly);
      getch();
cleardevice();
k=0;
for(i=0;i < 2*n;i+=2)
                clipl(polyy[i],polyy[i+1],polyy[i+2],polyy[i+3]);
n=k/2;
for(i=0;i < k;i++)
                polyy[i]=arr[i];
polyy[i]=polyy[0];
polyy[i+1]=polyy[1];
k=0;
for(i=0;i < 2*n;i+=2)
                clipt(polyy[i],polyy[i+1],polyy[i+2],polyy[i+3]);
n=k/2;
for(i=0;i < k;i++)
                polyy[i]=arr[i];
polyy[i]=polyy[0];
polyy[i+1]=polyy[1];
k=0;
```

```
    for(i=0;i < 2*n;i+=2)
                clipr(polyy[i],polyy[i+1],polyy[i+2],polyy[i+3]);
    n=k/2;
    for(i=0;i < k;i++)
                polyy[i]=arr[i];
    polyy[i]=polyy[0];
    polyy[i+1]=polyy[1];
    k=0;
    for(i=0;i < 2*n;i+=2)
                clipb(polyy[i],polyy[i+1],polyy[i+2],polyy[i+3]);
    for(i=0;i < k;i++)
                poly[i]=round(arr[i]);
    if(k)
                fillpoly(k/2,poly);
    setcolor(RED);
    rectangle(xmin,ymax,xmax,ymin);
    cout<<"\tCLIPPED POLYGON";
    getch();
    closegraph();
}
```

OUTPUT

```
Coordinates of rectangular clip window :
xmin,ymin             :100 100
xmax,ymax             :400 400


Polygon to be clipped :
Number of sides       :4
Enter the coordinates :350 100
100 350
200 100
100 200
                UNCLIPPED POLYGON
```



Q7 Write a program to implement Scan-Line Polygon fill algorithm.

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

const int WINDOW_HEIGHT = 1000;

typedef struct tdcPt
{
        int x;
        int y;
}dcPt;

typedef struct tEdge
{
        int yUpper;
        float xIntersect, dxPerScan;
        struct tEdge *next;
}Edge;

// Vertices: Array of structures.
dcPt vertex[5] = {{200, 500}, {300, 250}, {270, 230}, {320, 200}, {360, 290}};

void insertEdge(Edge *list, Edge *edge)
```

```
{
        Edge *p, *q = list;
        p = q->next;

        while (p != NULL)
        {
                if (edge->xIntersect < p->xIntersect)
                        p = NULL;
                else
                {
                        q = p;
                        p = p->next;
                }
        }
        edge->next = q->next;
        q->next = edge;
}

int yNext(int k, int cnt, dcPt *pts)
{
        int j;

        if ((k + 1) > (cnt - 1))
                j = 0;
        else
                j = k + 1;
```

```
        while(pts[k].y == pts[j].y)
        {
                if ((j + 1) > (cnt - 1))
                        j = 0;
                else
                        j++;
        }
        return (pts[j].y);
}

void makeEdgeRec(dcPt lower, dcPt upper, int yComp, Edge *edge, Edge
*edges[])
{
        edge->dxPerScan = (float) (upper.x - lower.x) / (upper.y - lower.y);
        edge->xIntersect = lower.x;
        if (upper.y < yComp)
                edge->yUpper = upper.y - 1;
        else
                edge->yUpper = upper.y;
        insertEdge(edges[lower.y], edge);
}

void buildEdgeList(int cnt, dcPt *pts, Edge *edges[])
{
        Edge *edge;
        dcPt v1, v2;
```

```
	int i, yPrev = pts[cnt - 2].y;

	v1.x = pts[cnt - 1].x; v1.y = pts[cnt - 1].y;
	for(int i = 0; i < cnt; i++)
	{
		v2 = pts[i];
		if (v1.y != v2.y)                                   // non-
horizontal line
		{
			edge = (Edge *) malloc (sizeof(Edge));
			if (v1.y < v2.y)                                // up-
going edge
				makeEdgeRec(v1, v2, yNext(i, cnt, pts), edge, edges);
			else                                                //
down-going edge
				makeEdgeRec(v2, v1 , yPrev, edge, edges);
		}
		yPrev = v1.y;
		v1 = v2;
	}
}

void buildActiveList(int scan, Edge *active, Edge *edges[])
{
	Edge *p, *q;

	p = edges[scan]->next;
```

```
        while (p)
        {
                q = p->next;
                insertEdge(active, p);
                p = q;
        }
}

void fillScan(int scan, Edge *active)
{
        Edge *p1, *p2 ;
        int i;

        p1 = active->next;
        while (p1)
        {
                p2 = p1->next;
                for(i = p1->xIntersect; i < p2->xIntersect; i++)
                        putpixel((int) i, scan, GREEN);
                p1 = p2->next;
        }
}

void deleteAfter(Edge *q)
{
        Edge *p = q->next;
```

```
        q->next = p->next;
        free(p);
}

void updateActiveList(int scan, Edge *active)
{
        Edge *q = active, *p = active->next;

        while (p)
        {
                if (scan >= p->yUpper)
                {
                        p = p->next;
                        deleteAfter(q);
                }
                else
                {
                        p->xIntersect = p->xIntersect + p->dxPerScan;
                        q = p;
                        p = p->next;
                }
        }
}

void resortActiveList(Edge *active)
{
```

```
	Edge *q, *p = active->next;
	active->next = NULL;
	while (p)
	{
		q = p->next;
		insertEdge(active, p);
		p = q;
	}
}

void scanFill(int cnt, dcPt *pts)
{
	Edge *edges[WINDOW_HEIGHT], *active;
	int i, scan;

	for (i = 0; i < WINDOW_HEIGHT; i++)
	{
		edges[i] = (Edge *) malloc (sizeof(Edge));;
		edges[i]->next = NULL;
	}

	buildEdgeList(cnt, pts, edges);
	active = (Edge *) malloc (sizeof(Edge));;
	active->next = NULL;

	for (scan = 0; scan < WINDOW_HEIGHT; scan++)
```

```
	{
		buildActiveList(scan, active, edges);
		if (active->next)
		{
			fillScan(scan, active);
			updateActiveList(scan, active) ;
			resortActiveList(active);
		}
	}
	free(edges[WINDOW_HEIGHT]);
	free(active);
}

int main()
{
	int gd = DETECT, gm;
	initgraph(&gd, &gm, (char*)"");

	float X = getmaxx(), Y = getmaxy();
	float x_mid = X / 2;
	float y_mid = Y / 2;

	cleardevice();
	scanFill(5, vertex);

	getch();
```

```
        closegraph();
        return 0;
}
```

OUTPUT

Q8 Write a program to apply various 2D transformations on 2D object (use homogeneous objects).

```
#include<graphics.h>
#include<stdlib.h>
#include<stdio.h>
#include<iostream>
#include<conio.h>
#include<math.h>
using namespace std;

int mat[3][3];
void dda_line(int x1 , int y1 , int x2 , int y2 , int col){
int dx , dy , st;
dx = x2 - x1;
dy = y2 - y1;
float y , x , xinc , yinc;
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
if(abs(dx) > abs(dy)){
st = abs(dx);
}
else{
st = abs(dy);
}
```

```
xinc = dx / st;
yinc = dy / st;
x = x1;
y = y1;
for(int i=0 ; i<st ; i++){
x += xinc;
y += yinc;
putpixel(ceil(x) + xmid , ymid - ceil(y),col);
}
}
void rotate(){
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
line(xmid , 0 , xmid , getmaxy());
line(0 , ymid , getmaxx() , ymid);
int c[3][2] ,l , m, i , j , k;
int a[3][2]={{200,200},{200,100},{100,200}};
int t[2][2]={{0,1},{-1,0}};
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j<2 ; j++){
c[i][j]=0;
}
}
dda_line(a[0][0],a[0][1],a[1][0],a[1][1],YELLOW);
dda_line(a[1][0],a[1][1],a[2][0],a[2][1],YELLOW);
```

```
dda_line(a[2][0],a[2][1],a[0][0],a[0][1],YELLOW);
for ( i=0;i<3;i++){
for ( j=0;j<2;j++){
for ( k=0;k<2;k++){
c[i][j]=c[i][j]+(a[i][k]*t[k][j]);
}
}
}
dda_line(c[0][0],c[0][1],c[1][0],c[1][1],GREEN);
dda_line(c[1][0],c[1][1],c[2][0],c[2][1],GREEN);
dda_line(c[2][0],c[2][1],c[0][0],c[0][1],GREEN);
}
void reflection(){
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
line(xmid , 0 , xmid , getmaxy());
line(0 , ymid , getmaxx() , ymid);
int c[3][2] ,l , m, i , j , k;
int a[3][2]={{200,200},{200,100},{100,200}};
int t[2][2]={{0,-1},{-1,0}};
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j<2 ; j++){
c[i][j]=0;
}
}
```

```
dda_line(a[0][0],a[0][1],a[1][0],a[1][1],YELLOW);
dda_line(a[1][0],a[1][1],a[2][0],a[2][1],YELLOW);
dda_line(a[2][0],a[2][1],a[0][0],a[0][1],YELLOW);
for ( i=0;i<3;i++){
for ( j=0;j<2;j++){
for ( k=0;k<2;k++){
c[i][j]=c[i][j]+(a[i][k]*t[k][j]);
}
}
}
dda_line(c[0][0],c[0][1],c[1][0],c[1][1],GREEN);
dda_line(c[1][0],c[1][1],c[2][0],c[2][1],GREEN);
dda_line(c[2][0],c[2][1],c[0][0],c[0][1],GREEN);
}
void scaling(){
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
line(xmid , 0 , xmid , getmaxy());
line(0 , ymid , getmaxx() , ymid);
int c[3][2] ,l , m, i , j , k;
int a[3][2]={{20,20},{20,10},{10,20}};
int t[2][2]={{5,0},{0,5}};
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j<2 ; j++){
c[i][j]=0;
```

```
}
}
dda_line(a[0][0],a[0][1],a[1][0],a[1][1],YELLOW);
dda_line(a[1][0],a[1][1],a[2][0],a[2][1],YELLOW);
dda_line(a[2][0],a[2][1],a[0][0],a[0][1],YELLOW);
for ( i=0;i<3;i++){
for ( j=0;j<2;j++){
for ( k=0;k<2;k++){
c[i][j]=c[i][j]+(a[i][k]*t[k][j]);
}
}
}
dda_line(c[0][0],c[0][1],c[1][0],c[1][1],GREEN);
dda_line(c[1][0],c[1][1],c[2][0],c[2][1],GREEN);
dda_line(c[2][0],c[2][1],c[0][0],c[0][1],GREEN);
}
void multi(int a[3][3] , int b[3][3] ){
int i , j ,k;
int c[3][3];
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j< 3 ; j++){
c[i][j]=0;
}
}
for ( i=0;i<3;i++){
for ( j=0;j<3;j++){
```

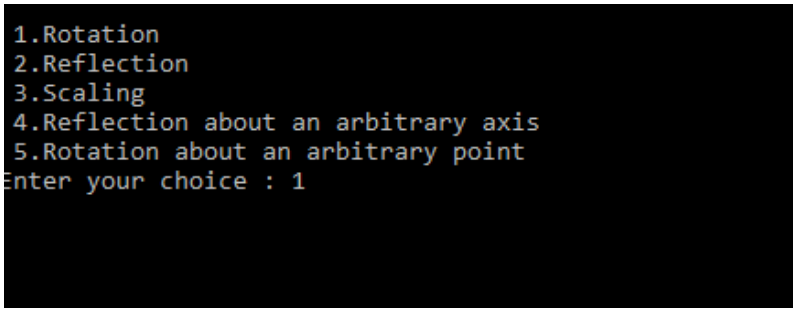
```
for ( k=0;k<3;k++){
c[i][j]=c[i][j]+(a[i][k]*b[k][j]);
}
}
}
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j< 3 ; j++){
mat[i][j]=c[i][j];
}
}
}
void reflection_arbitrary(){
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
line(xmid , 0 , xmid , getmaxy());
line(0 , ymid , getmaxx() , ymid);
int a[3][3]={{200,200,1},{200,100,1},{100,200,1}};
int t[3][3]={{1,0,0},{0,1,0},{0,0,1}};
int r[3][3]={{-1,0,0},{0,-1,0},{0,0,1}};
int ref[3][3]={{1,0,0},{0,-1,0},{0,0,1}};
int rinv[3][3]={{-1,0,0},{0,-1,0},{0,0,1}};
int tinv[3][3]={{1,0,0},{0,1,0},{0,1,1}};
dda_line(a[0][0],a[0][1],a[1][0],a[1][1],YELLOW);
dda_line(a[1][0],a[1][1],a[2][0],a[2][1],YELLOW);
dda_line(a[2][0],a[2][1],a[0][0],a[0][1],YELLOW);
```

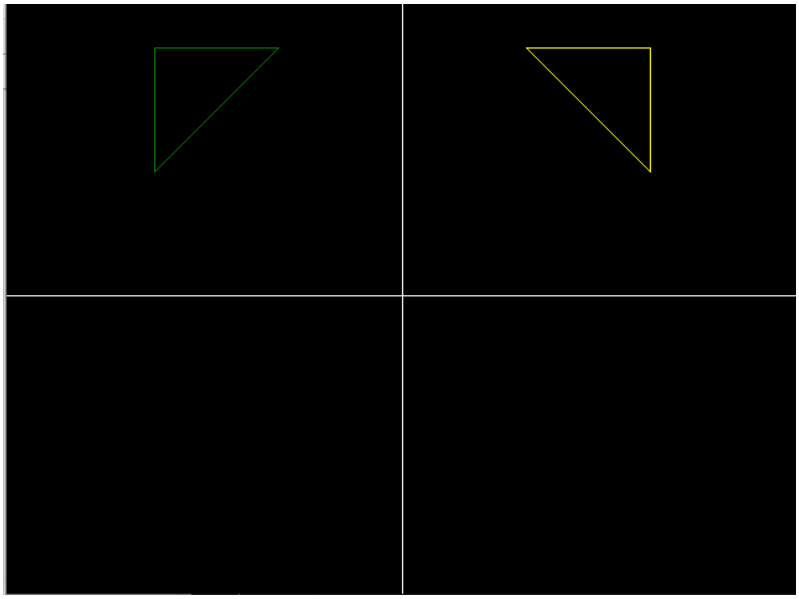
```
multi(t,r);
multi(mat,ref);
multi(mat,rinv);
multi(mat,tinv);
multi(a,mat);
dda_line(mat[0][0],mat[0][1],mat[1][0],mat[1][1],GREEN);
dda_line(mat[1][0],mat[1][1],mat[2][0],mat[2][1],GREEN);
dda_line(mat[2][0],mat[2][1],mat[0][0],mat[0][1],GREEN);
}
void rotation_arbitrary(){
int xmid , ymid;
xmid = getmaxx()/2;
ymid = getmaxy()/2;
line(xmid , 0 , xmid , getmaxy());
line(0 , ymid , getmaxx() , ymid);
int c[3][3] , i , j , k;
int l[1][3]={{200,200,1}};
int a[3][3]={{200,200,1},{200,100,1},{100,200,1}};
int t[3][3]={{1,0,0},{0,1,0},{-133,-133,1}};
int r[3][3]={{-1,0,0},{0,-1,0},{0,0,1}};
int tinv[3][3]={{1,0,0},{0,1,0},{133,133,1}};
dda_line(a[0][0],a[0][1],a[1][0],a[1][1],YELLOW);
dda_line(a[1][0],a[1][1],a[2][0],a[2][1],YELLOW);
dda_line(a[2][0],a[2][1],a[0][0],a[0][1],YELLOW);
multi(t,r);
multi(mat,tinv);
```

```
for( i = 0 ; i < 3 ; i++){
for(j=0 ; j<3 ; j++){
c[i][j]=0;
}
}
for ( i=0;i<3;i++){
for ( j=0;j<3;j++){
for ( k=0;k<3;k++){
c[i][j]=c[i][j]+(a[i][k]*mat[k][j]);
}
}
}
dda_line(c[0][0],c[0][1],c[1][0],c[1][1],GREEN);
dda_line(c[1][0],c[1][1],c[2][0],c[2][1],GREEN);
dda_line(c[2][0],c[2][1],c[0][0],c[0][1],GREEN);
}
int main()
{

int gdriver = DETECT , gmode , errorcode;
initgraph(&gdriver, &gmode, "C:\\TURBOC3\\BGI");
int n , m;
cout<<" 1.Rotation \n 2.Reflection \n 3.Scaling \n 4.Reflection about an
arbitrary axis \n";
cout<<" 5.Rotation about an arbitrary point\n";
cout<<"Enter your choice : ";
cin>>n;
```

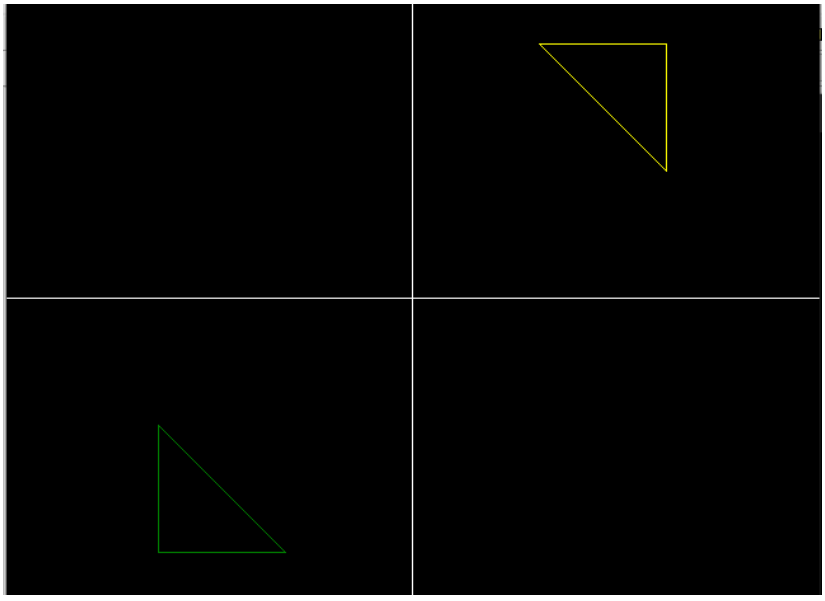
```
switch(n){
case 1 : rotate();
break;
case 2 : reflection();
break;
case 3 : scaling();
break;
case 4 : reflection_arbitrary();
break;
case 5 : rotation_arbitrary();
break;
default : cout<<"Invalid Choice\n";
}
getch();
}
```

OUTPUT

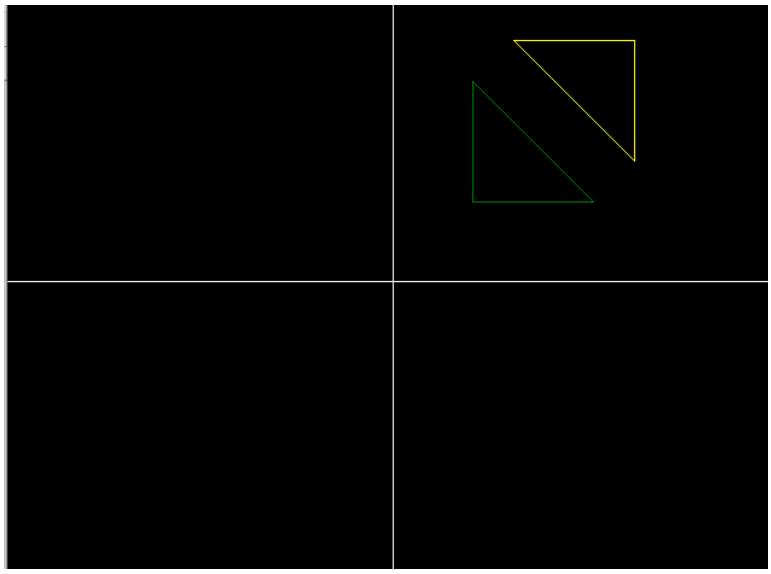




```
 1.Rotation
 2.Reflection
 3.Scaling
 4.Reflection about an arbitrary axis
 5.Rotation about an arbitrary point
Enter your choice : 2
```



```
 1.Rotation
 2.Reflection
 3.Scaling
 4.Reflection about an arbitrary axis
 5.Rotation about an arbitrary point
Enter your choice : 5
```



Q9 Write a program to apply various 3D transformations on a 3D object and then apply parallel and perspective projection on it.

```
#include<iostream>
#include<dos.h>
#include<stdio.h>
#include<math.h>
#include<conio.h>
#include<graphics.h>
#include<process.h>
double x1,x2,y1,y2;
```

```
void draw_cube(double edge[20][3]){
int i;
cleardevice();
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);
}
void translate(double edge[20][3]){
int a,b,c;
int i;
cout<<"Enter the Translation Factors : ";
cin>>a>>b>>c;
cleardevice();
for(i=0;i<20;i++){
edge[i][0]+=a;
edge[i][0]+=b;
edge[i][0]+=c;
}
draw_cube(edge);
```

```
}
void rotate(double edge[20][3]){
int n;
int i;
double temp,theta,temp1;
cleardevice();
cout<<" 1.X-Axis \n 2.Y-Axis \n 3.Z-Axis \n";
cout<<"Enter your choice : ";
cin>>n;
switch(n){
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 n;
int i;
cleardevice();
```

```
cout<<" 1.X-Axis \n 2.Y-Axis \n 3.Z-Axis \n";
cout<<" Enter Your Choice : ";
cin>>n;
switch(n){
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;
}
```

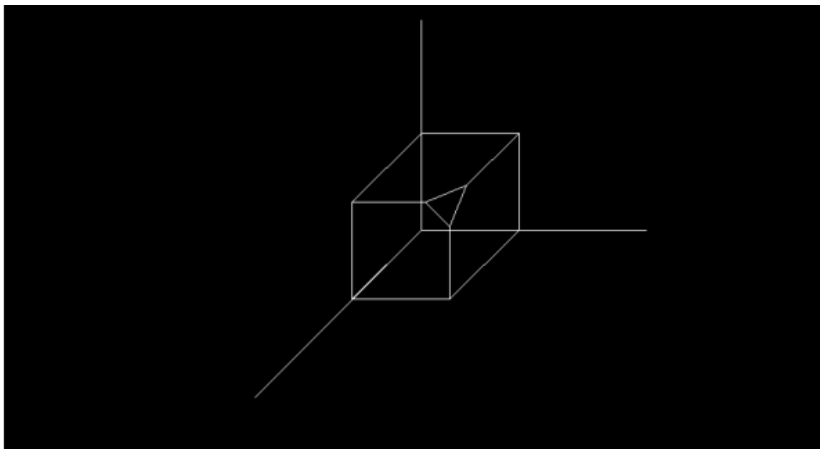
```
}
void perspect(double edge[20][3]){
int n;
int i;
double p,q,r;
cleardevice();
cout<<" 1.X-Axis \n 2.Y-Axis \n 3.Z-Axis\n";
cout<<" Enter Your Choice : ";
cin>>n;
switch(n){
case 1: cout<<" Enter P : ";
cin>>p;
for(i=0;i<20;i++){
edge[i][0]=edge[i][0]/(p*edge[i][0]+1);
edge[i][1]=edge[i][1]/(p*edge[i][0]+1);
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;
}
}
void main(){
clrscr();
int gdriver = DETECT , gmode , errorcode;
initgraph(&gdriver, &gmode, "C:\\TURBOC3\\BGI");
int n;
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};
cout<<" 1.Draw Cube \n 2.Rotation \n 3.Reflection \n";
cout<<" 4.Translation \n 5.Perspective Projection \n";
cout<<" Enter Your Choice : ";
```

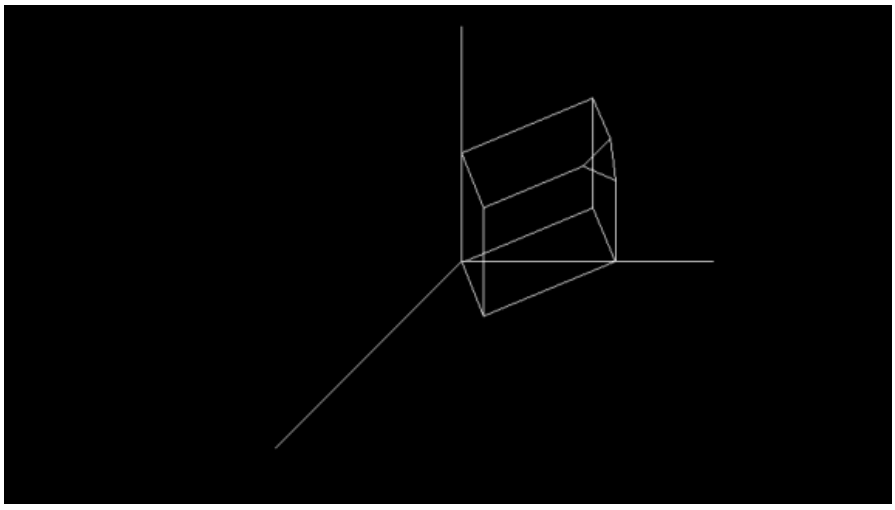
```
cin>>n;
switch(n){
case 1: draw_cube(edge);
break;
case 2: rotate(edge);
break;
case 3: reflect(edge);
break;
case 4: translate(edge);
break;
case 5: perspect(edge);
break;
default: cout<<" Invalid Choice\n ";
}
getch();
}
```

OUTPUT

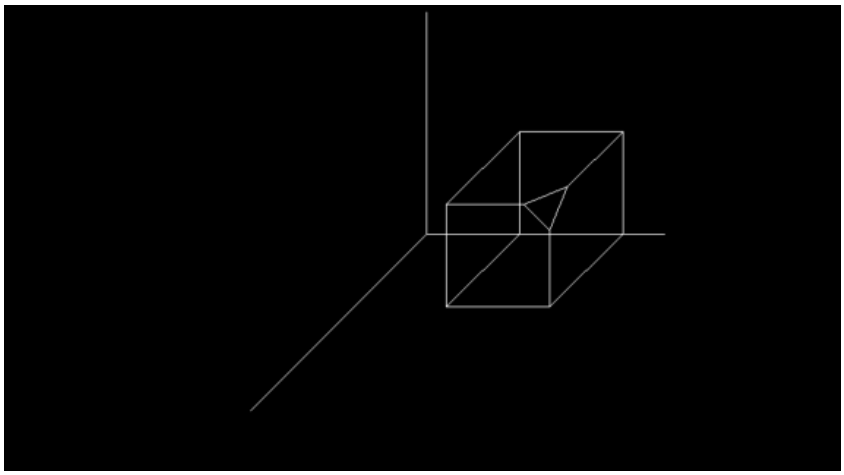
ORIGINAL CUBE:



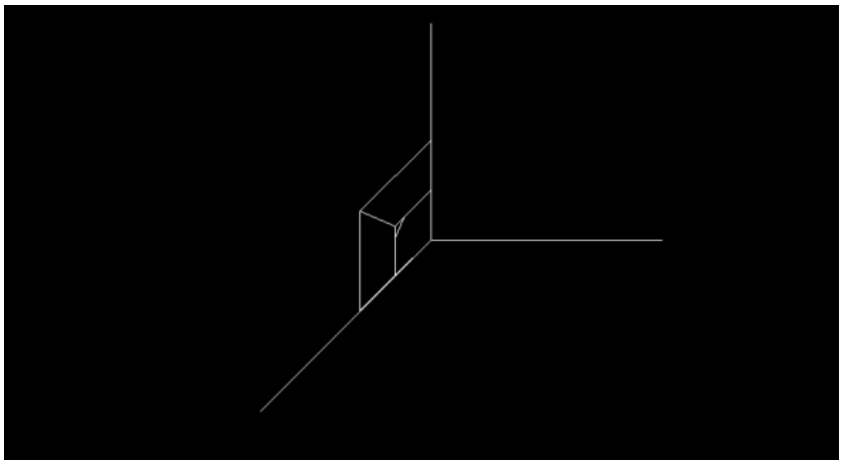
ROTATION ABOUT Y-AXIS BY AN ANGLE OF 45 DEGREE:



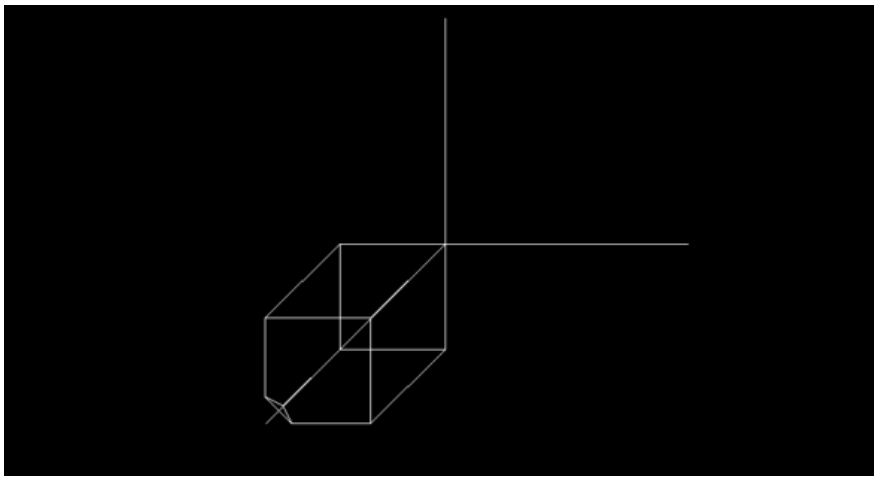
TRANSLATION FACTORS AS 20, 30, 40:



PERSPECTIVE PROJECTION ABOUT X-AXIS WHEN P=50:



REFLECTION ABOUT Z-AXIS:



Q10 Write a program to draw Hermite/Bezier curve.

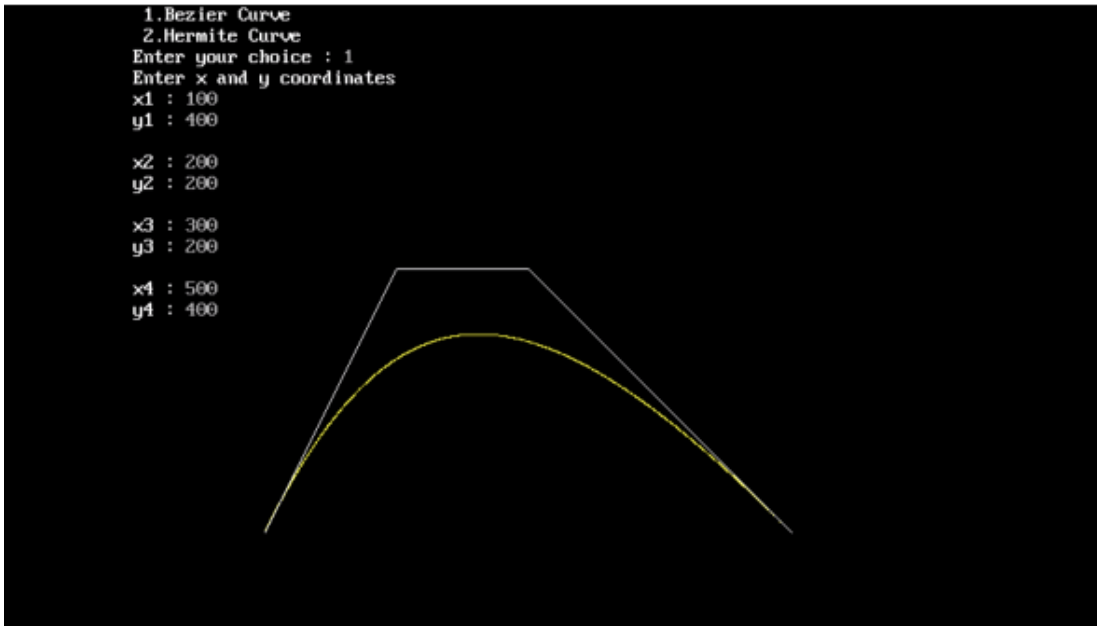
```
#include<iostream>
#include<conio.h>
#include<graphics.h>
#include<math.h>
void bezier_curve(int x[4],int y[4]){
double t;
for(t=0.0;t<1.0;t=t+0.0005){
double xt=pow(1-t,3)*x[0]+3*t*pow(1-
t,2)*x[1]+3*pow(t,2)*(1-t)*x[2]+pow(t,3)*x[3];
double yt=pow(1-t,3)*y[0]+3*t*pow(1-
t,2)*y[1]+3*pow(t,2)*(1-t)*y[2]+pow(t,3)*y[3];
putpixel(xt,yt,YELLOW);
}
```

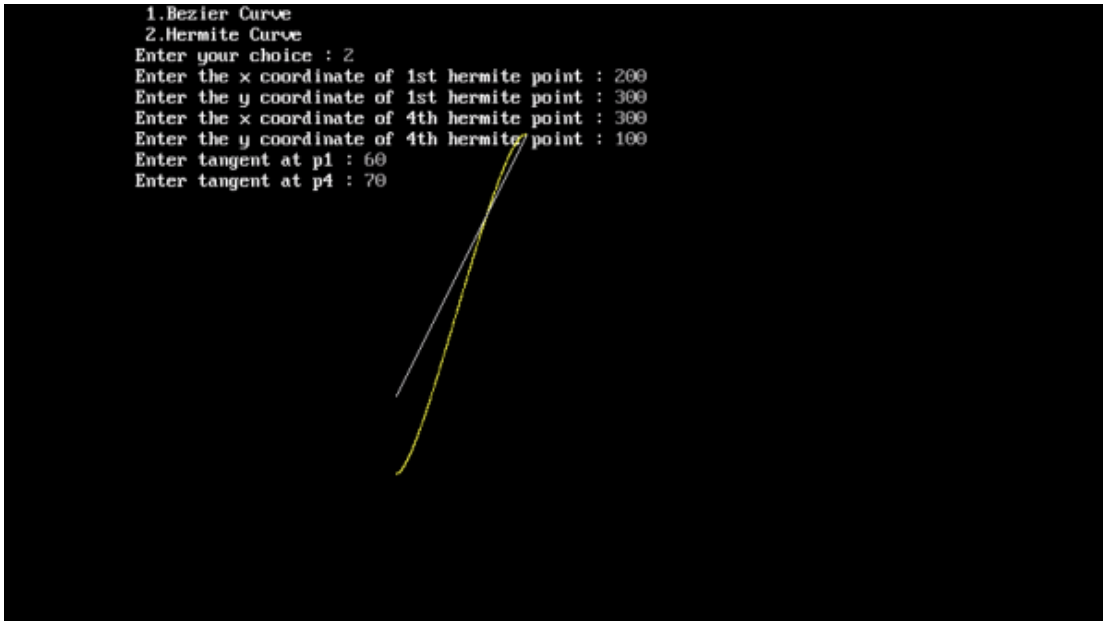
```
for(int i=0;i<3;i++){
line(x[i],y[i],x[i+1],y[i+1]);
}
}
void hermite_curve(int x1,int y1,int x2,int y2,double t1,double
t4){
float x,y,t;
for(t=0.0;t<=1.0;t+=0.001){
x=(2*t*t*t-3*t*t+1)*x1+(-2*t*t*t+3*t*t)*x2+(t*t*t-
2*t*t+t)*t1+(t*t*t-t*t)*t4;
y=(2*t*t*t-3*t*t+1)*y1+(-2*t*t*t+3*t*t)*y2+(t*t*t-
2*t*t+1)*t1+(t*t*t-t*t)*t4;
putpixel(x,y,YELLOW);
}
putpixel(x1,y1,GREEN);
putpixel(x2,y2,GREEN);
line(x1,y1,x2,y2);
}
voidmain()
{
clrscr();
int gdriver=DETECT,gmode,errorcode;
int x1,y1,x2,y2,n;
double t1,t4;
initgraph(&gdriver,&gmode,"C:\\TURBOC3\\BGI");
int x[4],y[4];
```

```
int i;
cout<<"1.BezierCurve\n2.HermiteCurve\n";
cout<<"Enteryourchoice:";
cin>>n;
if(n==1){
cout<<"Enterxandycoordinates\n";
for(i=0;i<4;i++){
cout<<"x"<<i+1<<":";
cin>>x[i];
cout<<"y"<<i+1<<":";
cin>>y[i];
cout<<endl;
}
bezier_curve(x,y);
}
elseif(n==2){
cout<<"Enterthexcoordinateof1sthermitepoint:";
cin>>x1;
cout<<"Entertheycoordinateof1sthermitepoint:";
cin>>y1;
cout<<"Enterthexcoordinateof4thhermitepoint:";
cin>>x2;
cout<<"Entertheycoordinateof4thhermitepoint:";
cin>>y2;
cout<<"Entertangentatp1:";
cin>>t1;
```

```
cout<<"Entertangentatp4:";
cin>>t4;
hermite_curve(x1,y1,x2,y2,t1,t4);
}
else{
cout<<"\nInvalidChoice";
}
getch();
}
```

OUPUT




1.Bezier Curve
2.Hermite Curve
Enter your choice : 2
Enter the x coordinate of 1st hermite point : 200
Enter the y coordinate of 1st hermite point : 300
Enter the x coordinate of 4th hermite point : 300
Enter the y coordinate of 4th hermite point : 100
Enter tangent at p1 : 60
Enter tangent at p4 : 70