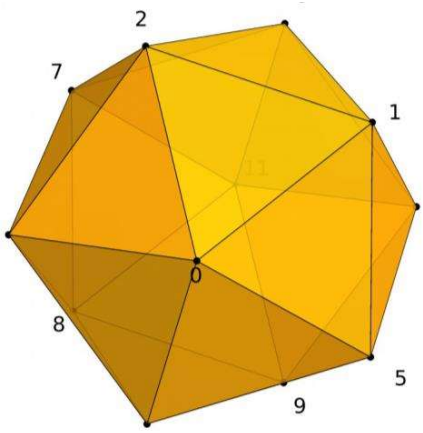
Atma Ram Sanatan Dharma College
University of Delhi



Computer Graphics

Practical File for Paper Code 32341602

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INDEX

PRACTICAL 1

Objective

Write a program to implement the DDA line drawing algorithm.

Code

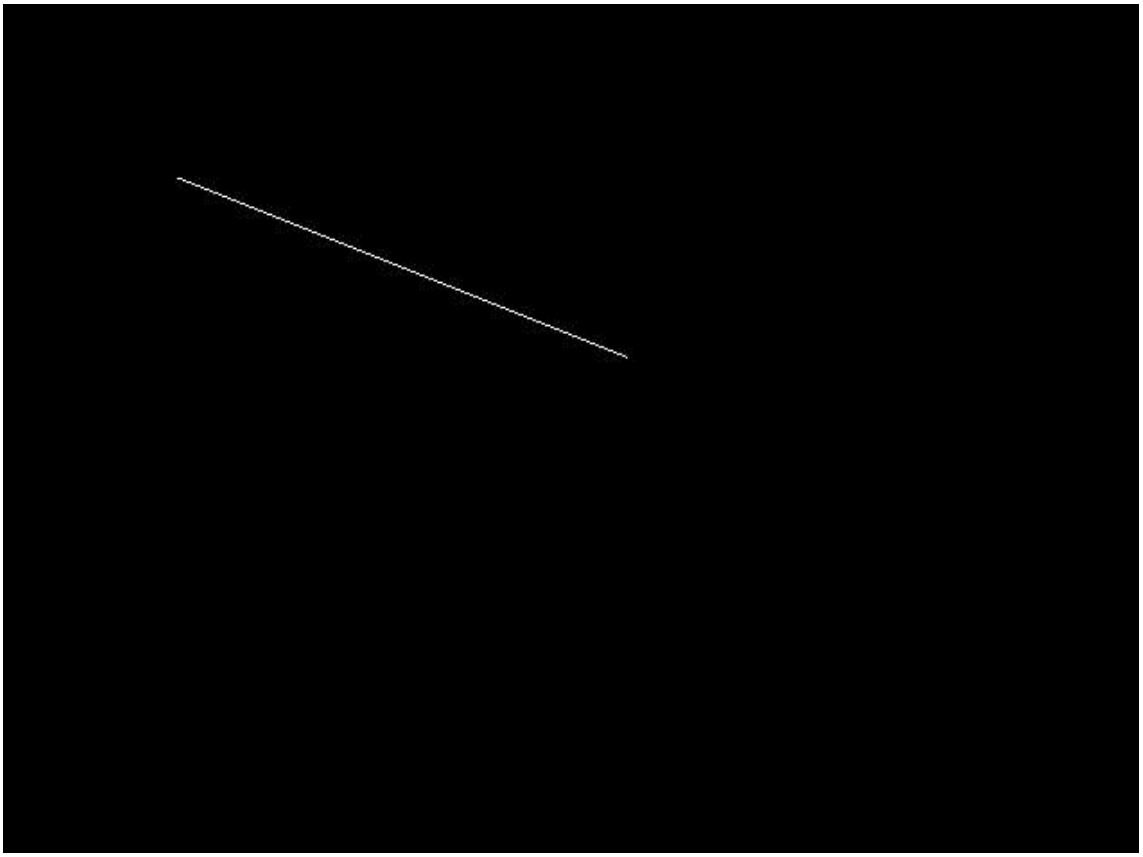
```
/**
 * Write a program to implement and draw a line using the Digital
 * Differential Analyzer (DDA) algorithm.
 *
 * Written by Sudipto Ghosh for the University of Delhi
 */

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

using namespace std;

void ddaLine(int x0, int y0, int x1, int y1, int val)
{
  if (x0 == x1 && y0 == y1)
  {
    putpixel(x1, y1, val);
  }
  else
  {
    double x, y;
    int dx = x1 - x0;
    int dy = y1 - y0;
    bool isRTL = !(x1 > x0);
    float m = float(dy) / (float)(dx);

    if (abs(m) <= 1)
    {
      if (!isRTL)
      {
        for (x = x0, y = y0; x <= x1; x++)
        {
          putpixel(x, y, val);
          y += m;
        }
      }
      else
      {
        for (x = x1, y = y1; x >= x0; x--)
        {
```

```
            putpixel(x, y, val);
            y -= m;
          }
        }
      }
      else if (abs(m) > 1)
      {
        if (!isRTL)
        {
          for (x = x0, y = y0; y <= x1; y++)
          {
            putpixel(x, y, val);
            x += 1 / m;
          }
        }
        else
        {
          for (x = x1, y = y1; y >= x0; y--)
          {
            putpixel(x, y, val);
            x -= 1 / m;
          }
        }
      }
    }

    return;
}

int main(void)
{
    int x0, y0, x1, y1;
    cout << "Enter Left Endpoint (x0 y0): ";
    cin >> x0 >> y0;
    cout << "Enter Right Endpoint (x1 y1): ";
    cin >> x1 >> y1;

    cout << "Drawing Line..." << endl;

    int gd = DETECT, gm;
    initgraph(&gd, &gm, NULL);
    ddaLine(x0, y0, x1, y1, WHITE);
    delay(10e3);
    closegraph();

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

```
  return 0;
}
```

Output

```
g++ main.cpp -o main -lgraph
./main 2> /dev/null
Enter Left Endpoint (x0 y0): 100 100
Enter Right Endpoint (x1 y1): 350 200
Drawing Line...
Finished...
```



PRACTICAL 2

Objective

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

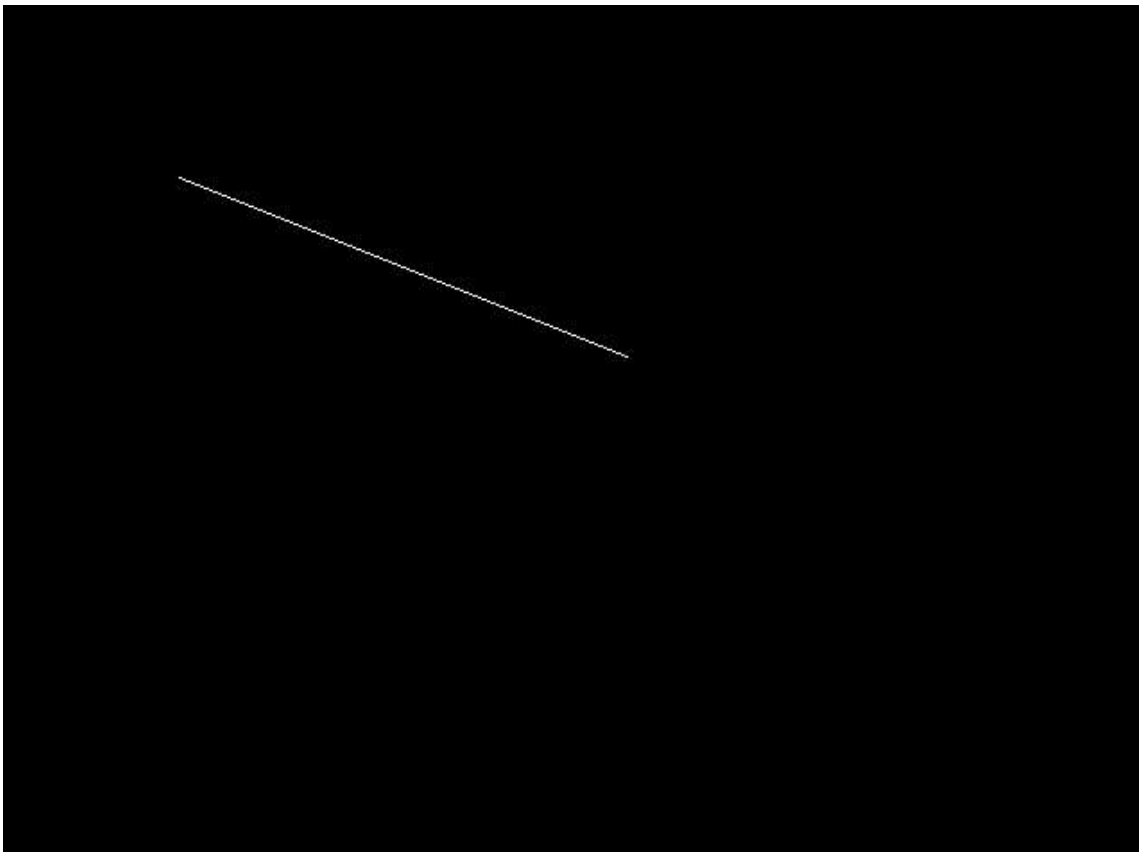
Code

```
/**
 * Write a program to implement Bresenham's line drawing algorithm.
 *
 * Written by Sudipto Ghosh for the University of Delhi
 */

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

using namespace std;

void bresenhamLine(int x0, int y0, int x1, int y1, int val)
{
  if (x0 == x1 && y0 == y1)
  {
    putpixel(x1, y1, val);
  }
  else
  {
    int dx = x1 - x0;
    int dy = y1 - y0;

    float m = float(dy) / (float)(dx);

    if (m >= 1 || m <= 0)
    {
      cout << "ERROR: Slope must be between 0 and 1." << endl;
      exit(1);
    }

    int d = 2 * dy - dx;
    int del_E = 2 * dy;
    int del_NE = 2 * (dy - dx);

    int x = x0;
    int y = y0;
    putpixel(x, y, val);

    while (x < x1)
    {
```

```
      if (d <= 0)
      {
        d += del_E;
        x += 1;
      }
      else
      {
        d += del_NE;
        x += 1;
        y += 1;
      }

      putpixel(x, y, val);
    }
  }

  return;
}

int main(void)
{
  int x0, y0, x1, y1;
  cout << "Enter Left Endpoint (x0 y0): ";
  cin >> x0 >> y0;
  cout << "Enter Right Endpoint (x1 y1): ";
  cin >> x1 >> y1;

  cout << "Drawing Line..." << endl;

  int gd = DETECT, gm;
  initgraph(&gd, &gm, NULL);
  bresenhamLine(x0, y0, x1, y1, WHITE);
  delay(5e3);
  closegraph();

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

  return 0;
}
```

Output

```
g++ main.cpp -o main -lgraph
./main 2> /dev/null
Enter Left Endpoint (x0 y0): 100 100
Enter Right Endpoint (x1 y1): 350 200
Drawing Line...
Finished...
```



PRACTICAL 3

Objective

Write a program to implement the Bresenham's circle drawing algorithm.

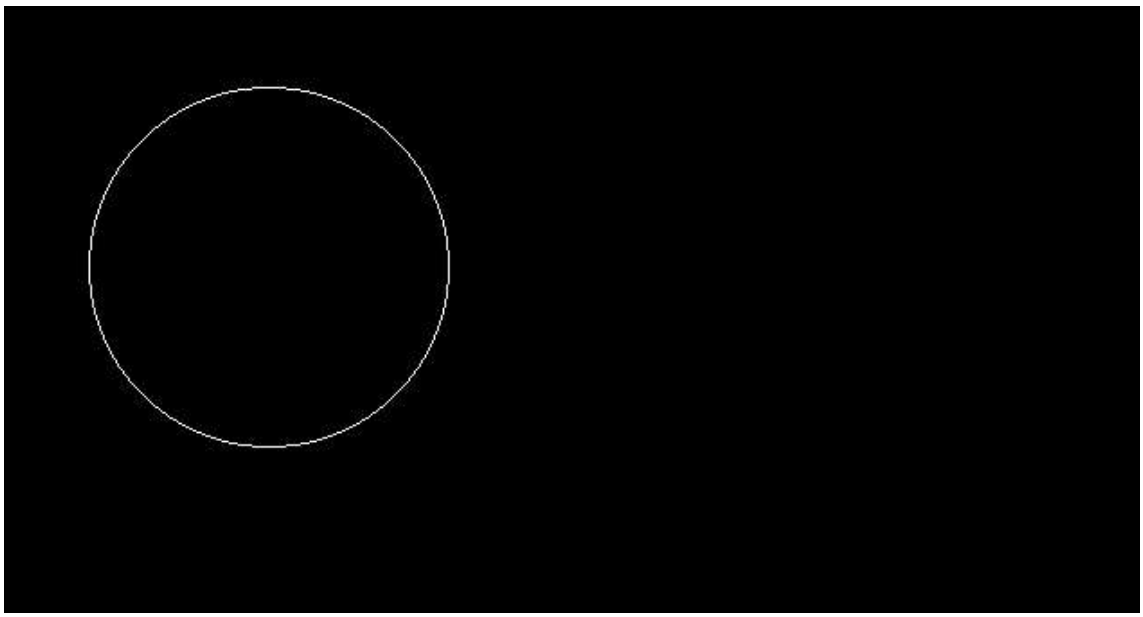
Code

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

using namespace std;

void drawCirclePoints(int x, int y, int val, int c_x, int c_y)
{
  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 midpointCircle(int r, int val, int c_x = 0, int c_y = 0)
{
  int x = 0;
  int y = r;
  int d = 1 - r;
  drawCirclePoints(x, y, val, c_x, c_y);
  while (y > x)
  {
    if (d < 0)
    {
      d += 2 * x + 3;
      x += 1;
    }
    else
    {
      d += 2 * (x - y) + 5;
      x += 1;
      y -= 1;
    }
    drawCirclePoints(x, y, val, c_x, c_y);
  }
  return;
```

```
}

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

  cout << "Drawing Circle..." << endl;

  int gd = DETECT, gm;
  initgraph(&gd, &gm, NULL);
  midpointCircle(r, WHITE, x, y);
  delay(5e3);
  closegraph();

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

  return 0;
}
```

Output

```
g++ main.cpp -o main -lgraph
./main 2> /dev/null
Enter Centre (x y): 150 150
Enter Radius (r): 100 100
Drawing Circle...
Finished...
```



PRACTICAL 4

Objective

Write a menu-driven program to perform 2D transformations.

Code

```
/**
 * Write a menu-driven program to perform 2D transformations.
 *
 * Written by Sudipto Ghosh for the University of Delhi
 */

#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): ";
```

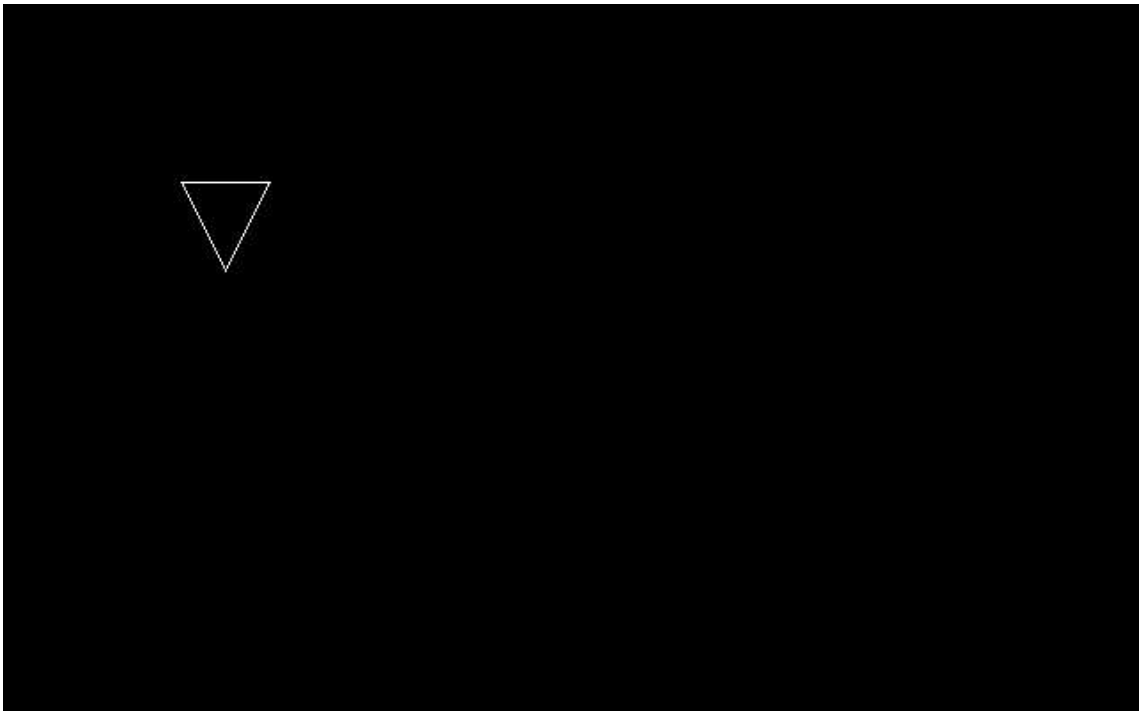
```
      cin >> theta;

      _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";
```

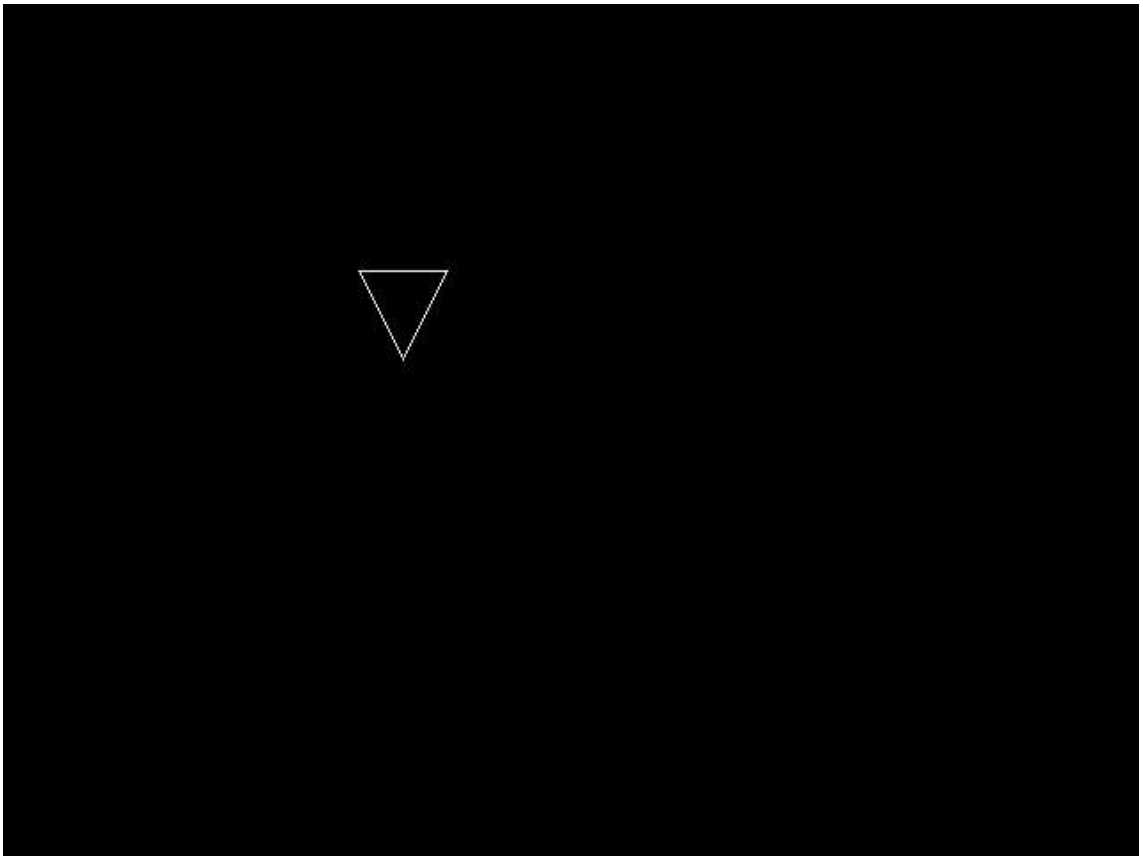
```
      drawFigure(figure, dim);

      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;
}
```

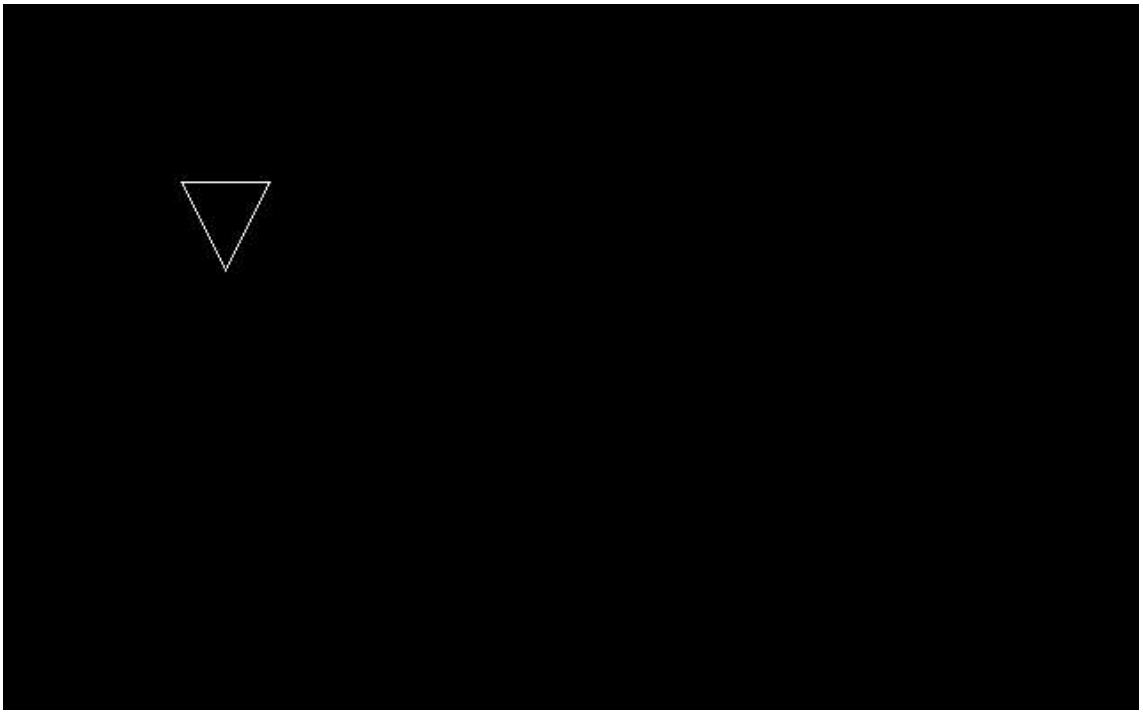
Output

```
$ ./main 2> /dev/null
Enter number of points in the figure: 3
Enter the matrix for the 2-D shape (homogeneous):
0 0 1
50 0 1
25 50 1

Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) Shearing
(6) View Figure
(7) Exit

Enter Choice: 1

Enter translation in x-axis: 100
Enter translation in y-axis: 50
Drawing Original Figure ...
Drawing Transformed Figure ...

Finished ...

Press Enter to continue  ...
```

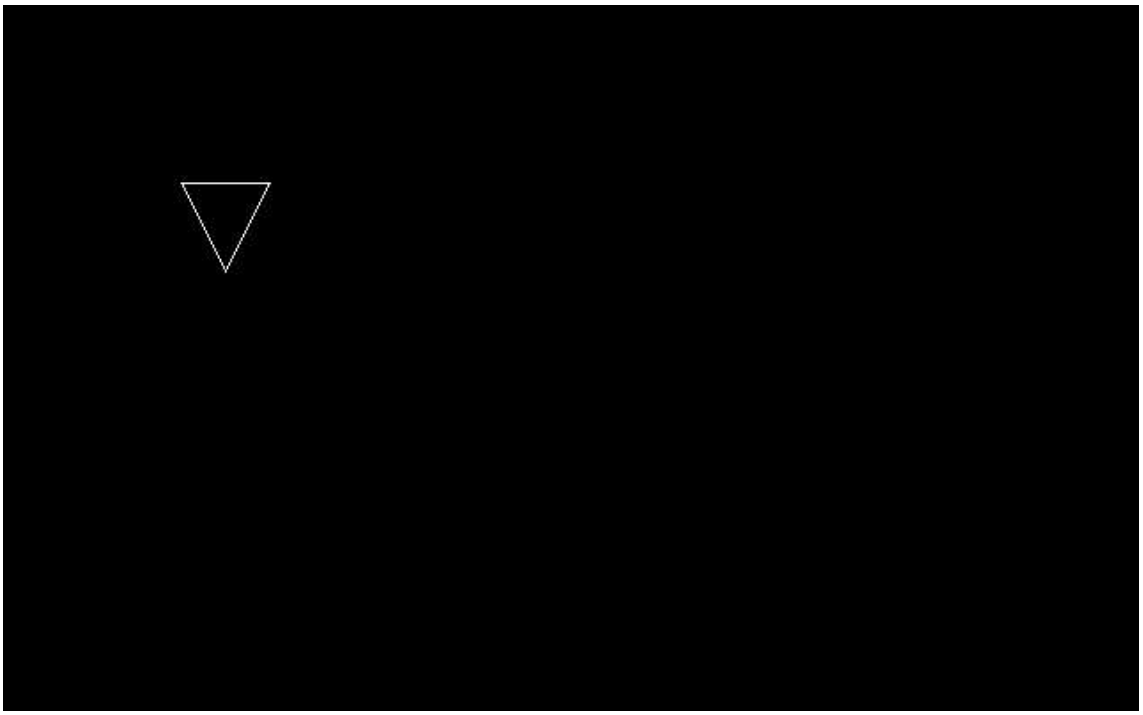


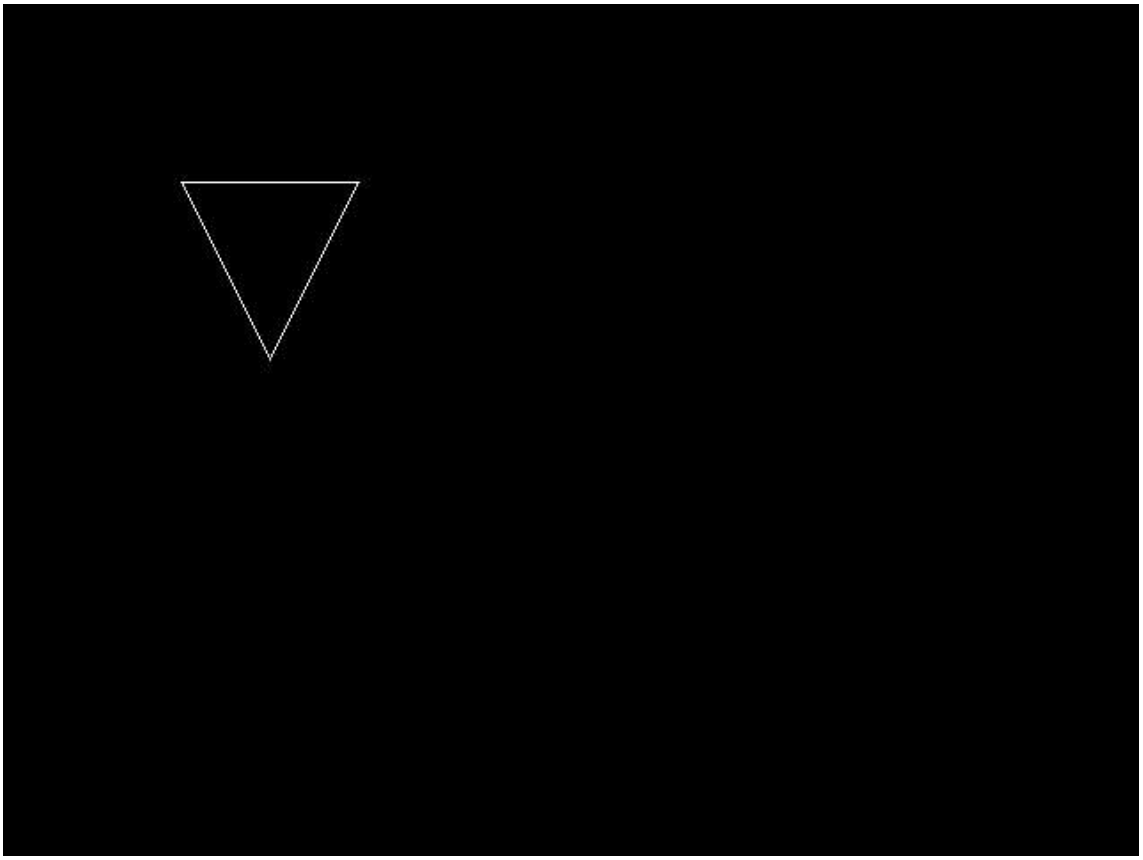


```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) Shearing
(6) View Figure
(7) Exit

Enter Choice: 2

Enter rotation angle (degrees): 30
Drawing Original Figure ...
Drawing Transformed Figure ...

Finished ...

Press Enter to continue  ...
```

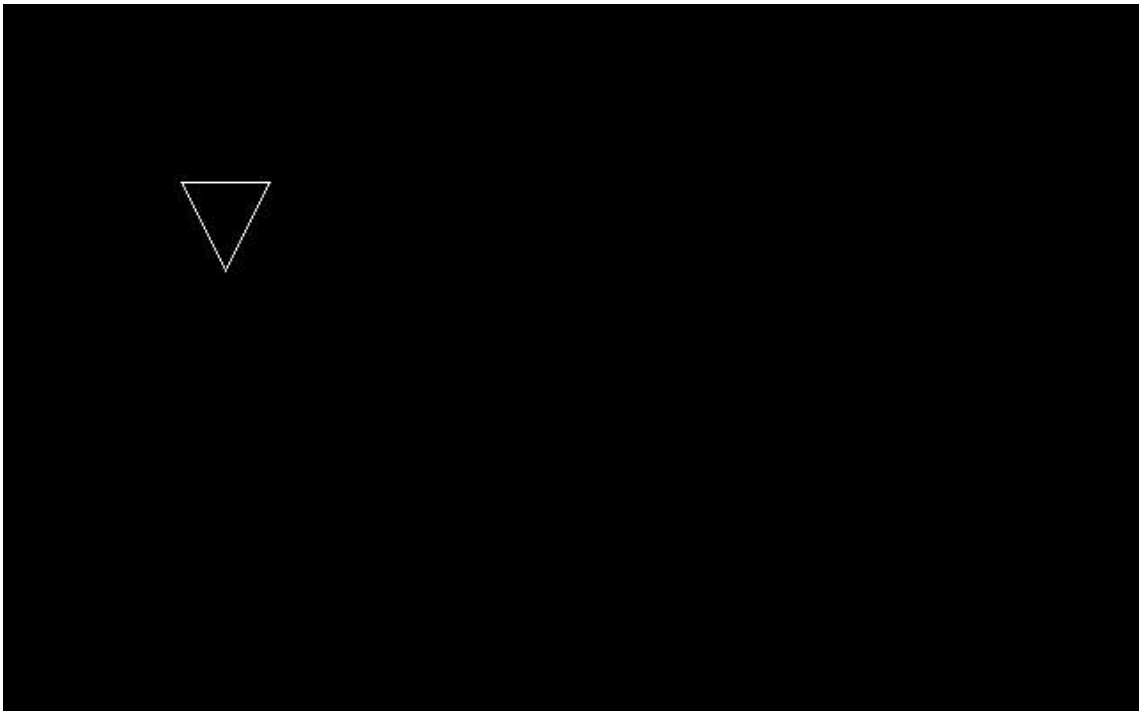


```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) Shearing
(6) View Figure
(7) Exit

Enter Choice: 3

Enter scaling in x-axis: 2
Enter scaling in y-axis: 2
Drawing Original Figure ...
Drawing Transformed Figure ...

Finished ...

Press Enter to continue  ...
```

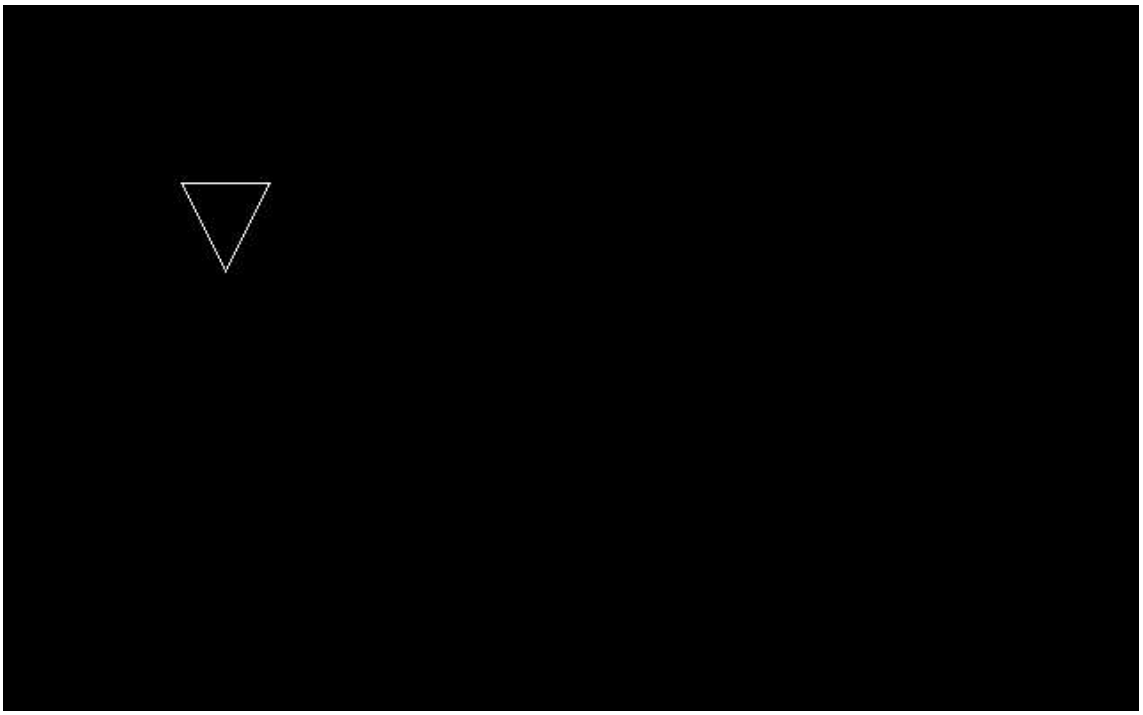




```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) Shearing
(6) View Figure
(7) Exit

Enter Choice: 4

Reflect along
(1) x-axis
(2) y-axis
(3) y = x
(4) y = -x

Enter Choice: 1
Drawing Original Figure ...
Drawing Transformed Figure ...

Finished ...

Press Enter to continue  ...
```



```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) Shearing
(6) View Figure
(7) Exit

Enter Choice: 5

Enter shearing in x-axis: 2
Enter shearing in y-axis: 1
Drawing Original Figure ...
Drawing Transformed Figure ...

Finished ...

Press Enter to continue  ...
```



PRACTICAL 5

Objective

Write a menu-driven program to perform 3D transformations on a 3D object and then apply parallel and perspective projection on it.

Code

```
#define _USE_MATH_DEFINES
#include <conio.h>
#include <dos.h>
#include <graphics.h>
#include <iostream.h>
#include <math.h>
#include <process.h>
#include <stdio.h>

int gd = DETECT, gm;
double x1, x2, y1, y2;

void drawObj(double edges[20][3])
{
  int choice, i;
  double p, q, r, temp, temp1, theta;

  double _edges[20][3];
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] = edges[i][0];
    _edges[i][1] = edges[i][1];
    _edges[i][2] = edges[i][2];
  }

  cout << "\nProjection:" << endl;
  cout << "1. Orthographic Projection on xy-plane" << endl;
  cout << "2. Axonometric Projection (Isometric)" << endl;
  cout << "3. Perspective Projection" << endl;

  cout << "\nEnter your choice: ";
  cin >> choice;

  initgraph(&gd, &gm, "..\\bgi");

  switch (choice)
  {
  case 1:
    // Orthographic Parallel Projection - xy plane
    for (i = 0; i < 19; i++)
    {
```

```
    x1 = edges[i][0];
    y1 = edges[i][1];
    x2 = edges[i + 1][0];
    y2 = edges[i + 1][1];

    line(x1 + 320, 240 - y1, x2 + 320, 240 - y2);
  }
  break;
case 2:
  // Axonometric Projection - Isometric
  for (i = 0; i < 19; i++)
  {
    x1 = edges[i][0] + edges[i][2] * (cos(2.3562));
    y1 = edges[i][1] - edges[i][2] * (sin(2.3562));
    x2 = edges[i + 1][0] + edges[i + 1][2] * (cos(2.3562));
    y2 = edges[i + 1][1] - edges[i + 1][2] * (sin(2.3562));

    line(x1 + 320, 240 - y1, x2 + 320, 240 - y2);
  }
  setcolor(YELLOW);
  line(320, 240, 320, 25);
  line(320, 240, 550, 240);
  line(320, 240, 150, 410);
  setcolor(WHITE);
  break;
case 3:
  // Perspective Projection
  cout << "\nEnter p, q and r: ";
  cin >> p >> q >> r;

  for (i = 0; i < 20; i++)
  {
    _edges[i][0] /= (p * _edges[i][0] +
                     q * _edges[i][1] +
                     r * _edges[i][2] + 1);
    _edges[i][1] /= (p * _edges[i][0] +
                     q * _edges[i][1] +
                     r * _edges[i][2] + 1);
    _edges[i][2] /= (p * _edges[i][0] +
                     q * _edges[i][1] +
                     r * _edges[i][2] + 1);
  }

  for (i = 0; i < 19; i++)
  {
    x1 = _edges[i][0] + _edges[i][2] * (cos(2.3562));
    y1 = _edges[i][1] - _edges[i][2] * (sin(2.3562));
```

```
      x2 = _edges[i + 1][0] + _edges[i + 1][2] * (cos(2.3562));
      y2 = _edges[i + 1][1] - _edges[i + 1][2] * (sin(2.3562));

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

  getch();
  closegraph();
}

void scale(double edges[20][3])
{
  int i;
  double a, b, c;

  double _edges[20][3];
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] = edges[i][0];
    _edges[i][1] = edges[i][1];
    _edges[i][2] = edges[i][2];
  }

  cout << "Enter Scaling Factors (in x y z): ";
  cin >> a >> b >> c;
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] *= a;
    _edges[i][1] *= b;
    _edges[i][2] *= c;
  }
  drawObj(_edges);
}

void translate(double edges[20][3])
{
  int i, a, b, c;

  double _edges[20][3];
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] = edges[i][0];
    _edges[i][1] = edges[i][1];
    _edges[i][2] = edges[i][2];
  }
```

```
  cout << "\nEnter Translation Factors (in x y z): ";
  cin >> a >> b >> c;
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] += a;
    _edges[i][0] += b;
    _edges[i][0] += c;
  }
  drawObj(_edges);
}

void rotate(double edges[20][3])
{
  int i, ch;
  double temp, theta, temp1;

  double _edges[20][3];
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] = edges[i][0];
    _edges[i][1] = edges[i][1];
    _edges[i][2] = edges[i][2];
  }

  cout << "\nRotation About:" << endl;
  cout << "1. x-axis " << endl;
  cout << "2. z-axis" << endl;
  cout << "3. y-axis " << endl;
  cout << "Enter Choice: ";
  cin >> ch;
  cout << "\nEnter Angle: ";
  cin >> theta;

  theta = (theta * M_PI) / 180;

  switch (ch)
  {
  case 1:
    for (i = 0; i < 20; i++)
    {
      _edges[i][0] = _edges[i][0];
      temp = _edges[i][1];
      temp1 = _edges[i][2];
      _edges[i][1] = temp * cos(theta) - temp1 * sin(theta);
      _edges[i][2] = temp * sin(theta) + temp1 * cos(theta);
    }
```

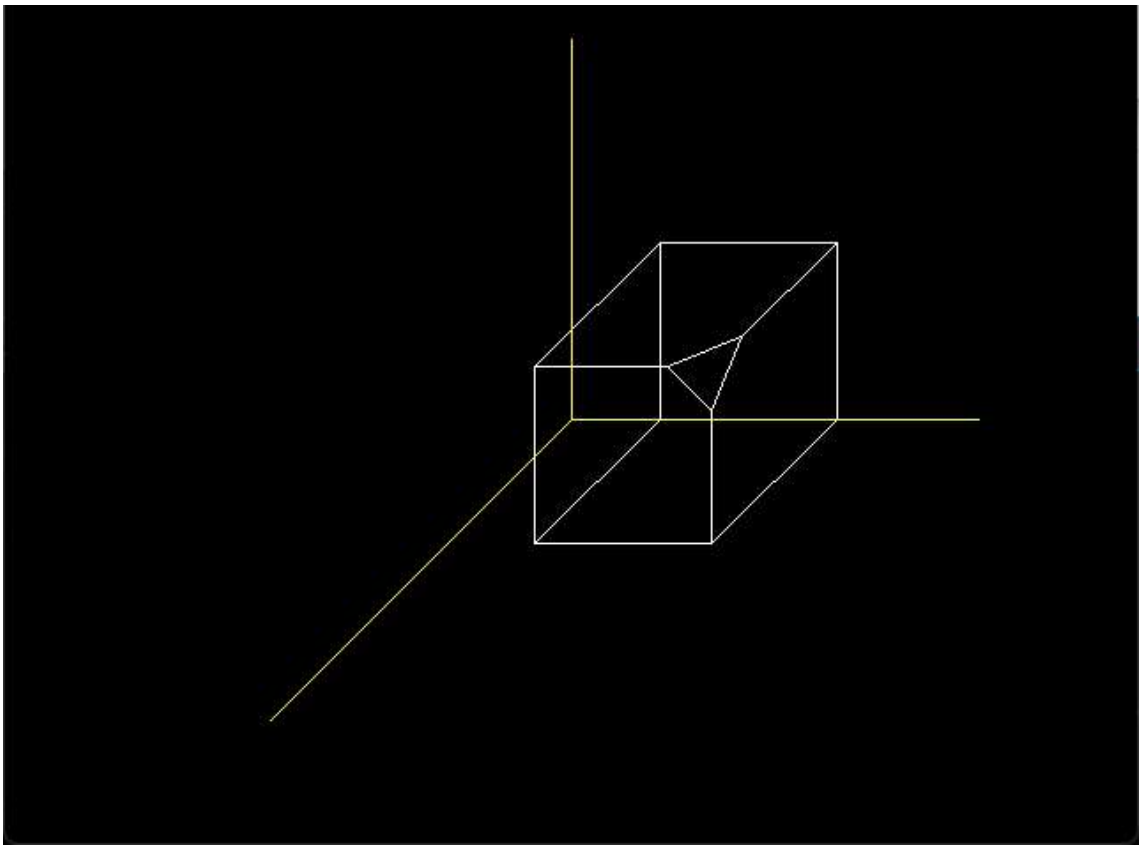
```
    break;
  case 2:
    for (i = 0; i < 20; i++)
    {
      _edges[i][1] = _edges[i][1];
      temp = _edges[i][0];
      temp1 = _edges[i][2];
      _edges[i][0] = temp * cos(theta) + temp1 * sin(theta);
      _edges[i][2] = -temp * sin(theta) + temp1 * cos(theta);
    }
    break;
  case 3:
    for (i = 0; i < 20; i++)
    {
      _edges[i][2] = _edges[i][2];
      temp = _edges[i][0];
      temp1 = _edges[i][1];
      _edges[i][0] = temp * cos(theta) - temp1 * sin(theta);
      _edges[i][1] = temp * sin(theta) + temp1 * cos(theta);
    }
    break;
  }

  drawObj(_edges);
}

void reflect(double edges[20][3])
{
  int i, ch;

  double _edges[20][3];
  for (i = 0; i < 20; i++)
  {
    _edges[i][0] = edges[i][0];
    _edges[i][1] = edges[i][1];
    _edges[i][2] = edges[i][2];
  }

  cout << "\nReflection About:" << endl;
  cout << "1. x-axis " << endl;
  cout << "2. y-axis" << endl;
  cout << "3. z-axis " << endl;
  cout << "Enter Choice: ";
  cin >> ch;

  clrscr();
```

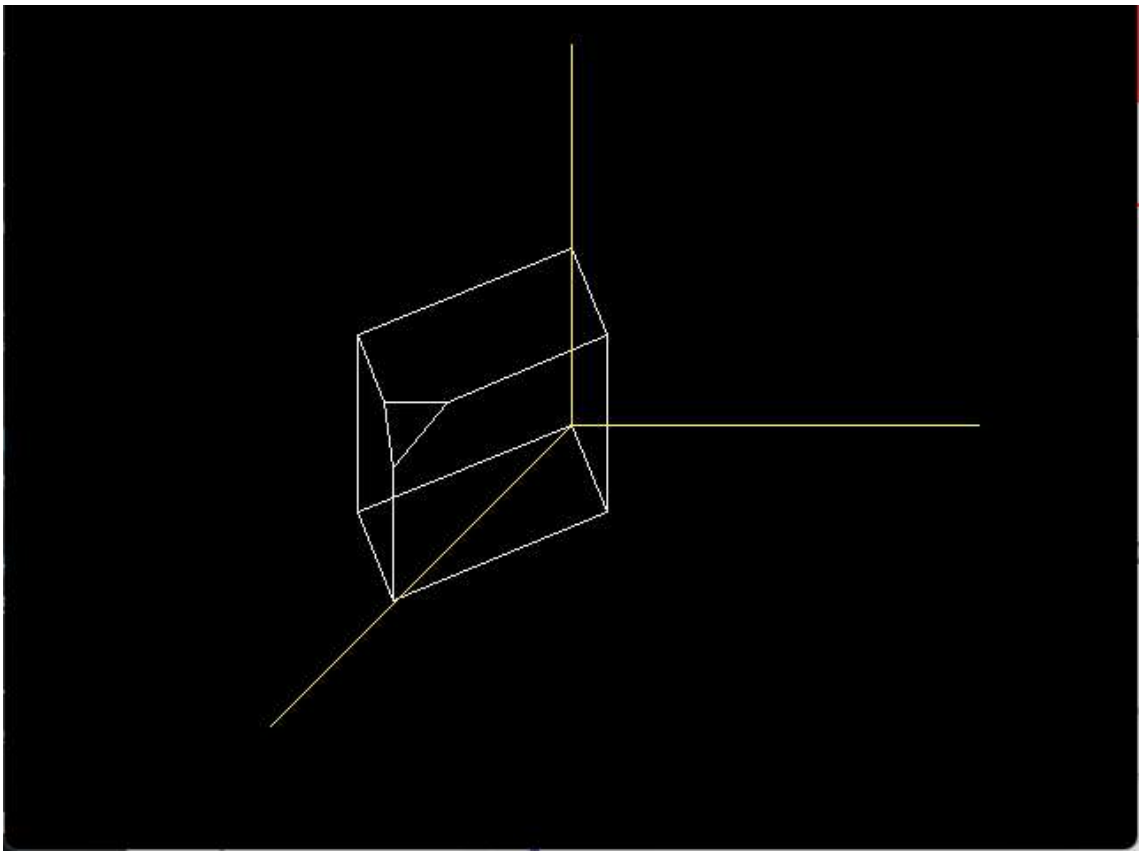
```
  switch (ch)
  {
  case 1:
    for (i = 0; i < 20; i++)
    {
      _edges[i][0] = _edges[i][0];
      _edges[i][1] = -_edges[i][1];
      _edges[i][2] = -_edges[i][2];
    }
    break;

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

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

void main()
{
  int choice;
  double edges[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,
```

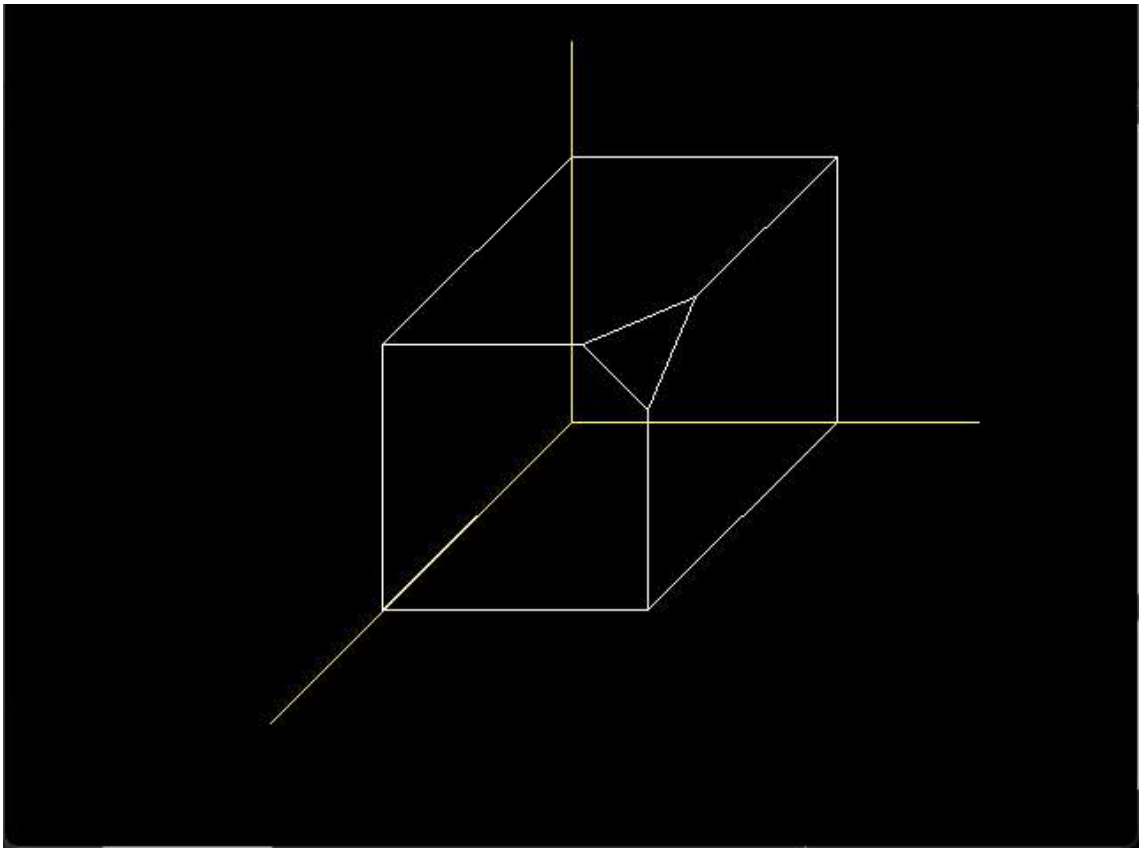
```
                        100, 100, 75,
                        100, 75, 100,
                        75, 100, 100,
                        0, 100, 100,
                        0, 100, 0,
                        0, 0, 0,
                        0, 0, 100,
                        100, 0, 100};

  while (1)
  {
    clrscr();

    cout << "\nMenu\n-------\n(1) Translation\n(2) Rotation";
    cout << "\n(3) Scaling\n(4) Reflection\n(5) View Figure";
    cout << "\n(6) Exit\n\nEnter Choice: ";
    cin >> choice;

    switch (choice)
    {
    case 1:
      translate(edges);
      break;
    case 2:
      rotate(edges);
      break;
    case 3:
      scale(edges);
      break;
    case 4:
      reflect(edges);
      break;
    case 5:
      drawObj(edges);
      break;
    case 6:
      exit(0);
    default:
      break;
    }
  }
  closegraph();
}
```

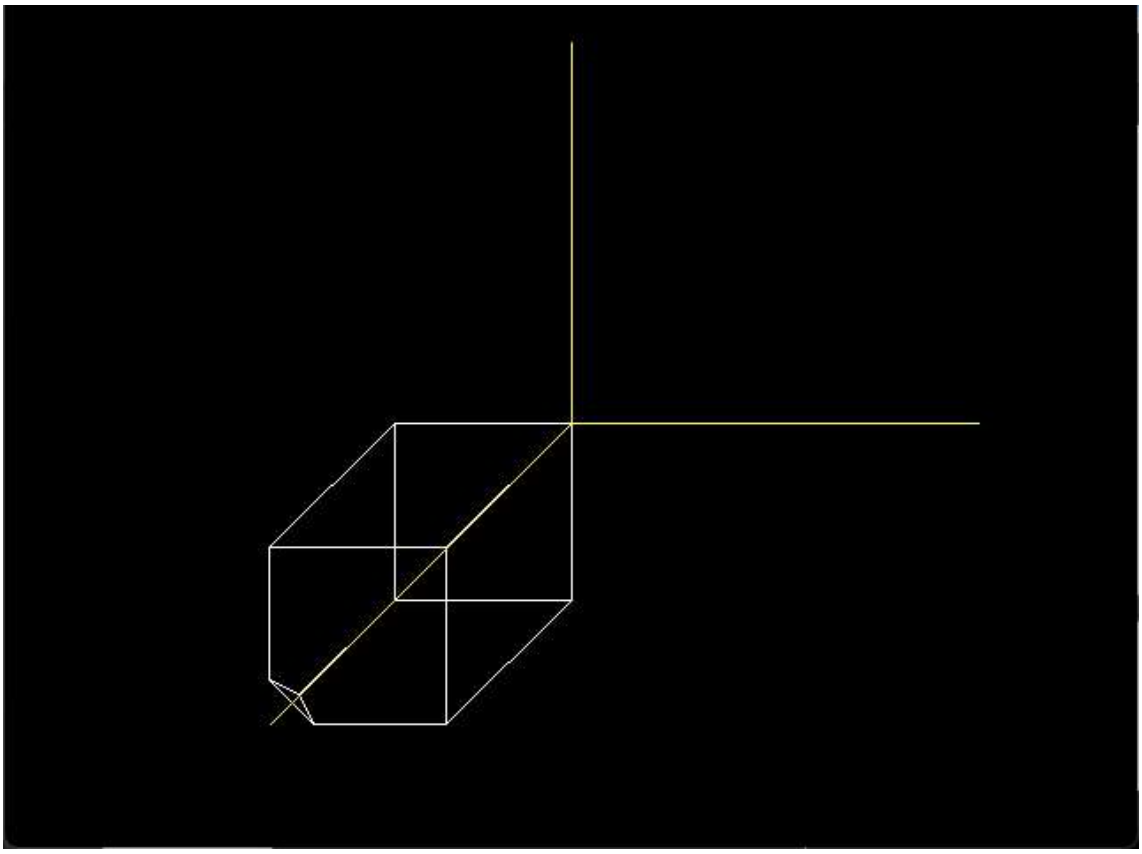
Output

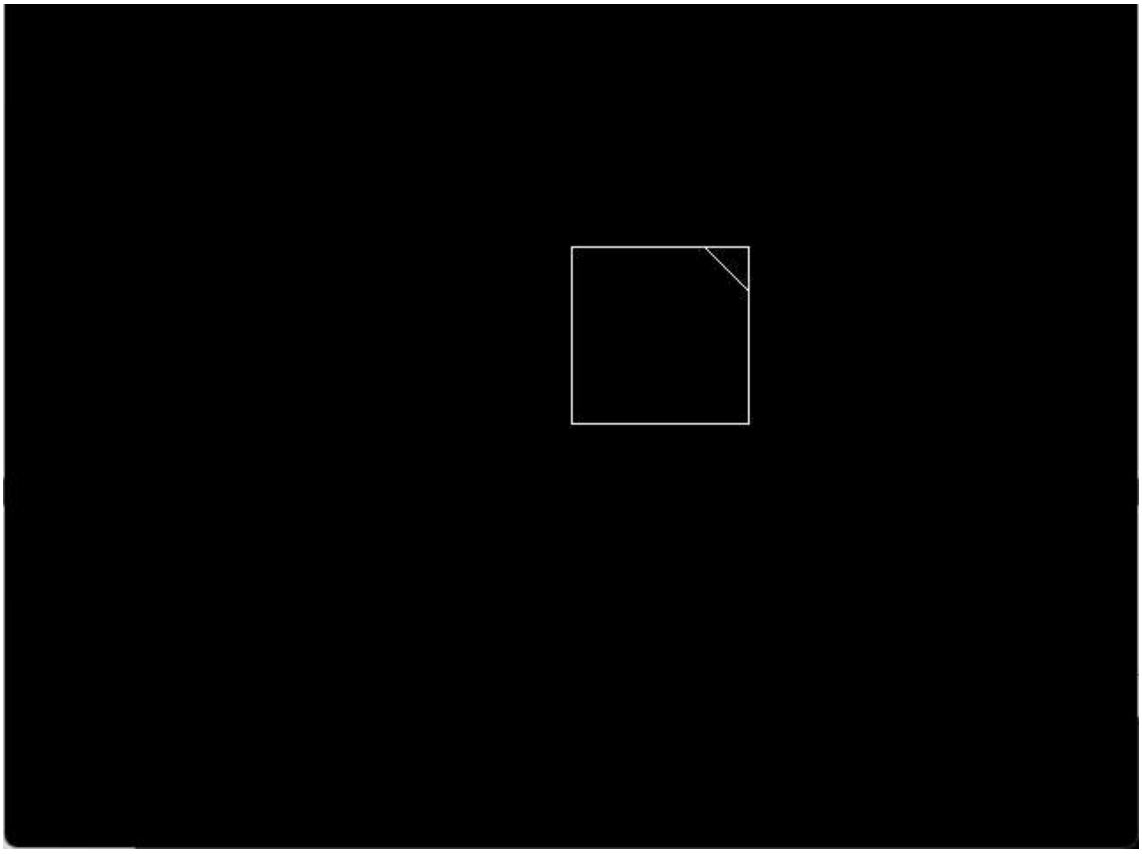
```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) View Figure
(6) Exit

Enter Choice: 2

Rotation About:
1. x-axis
2. z-axis
3. y-axis
Enter Choice: 2

Enter Angle: 30
```

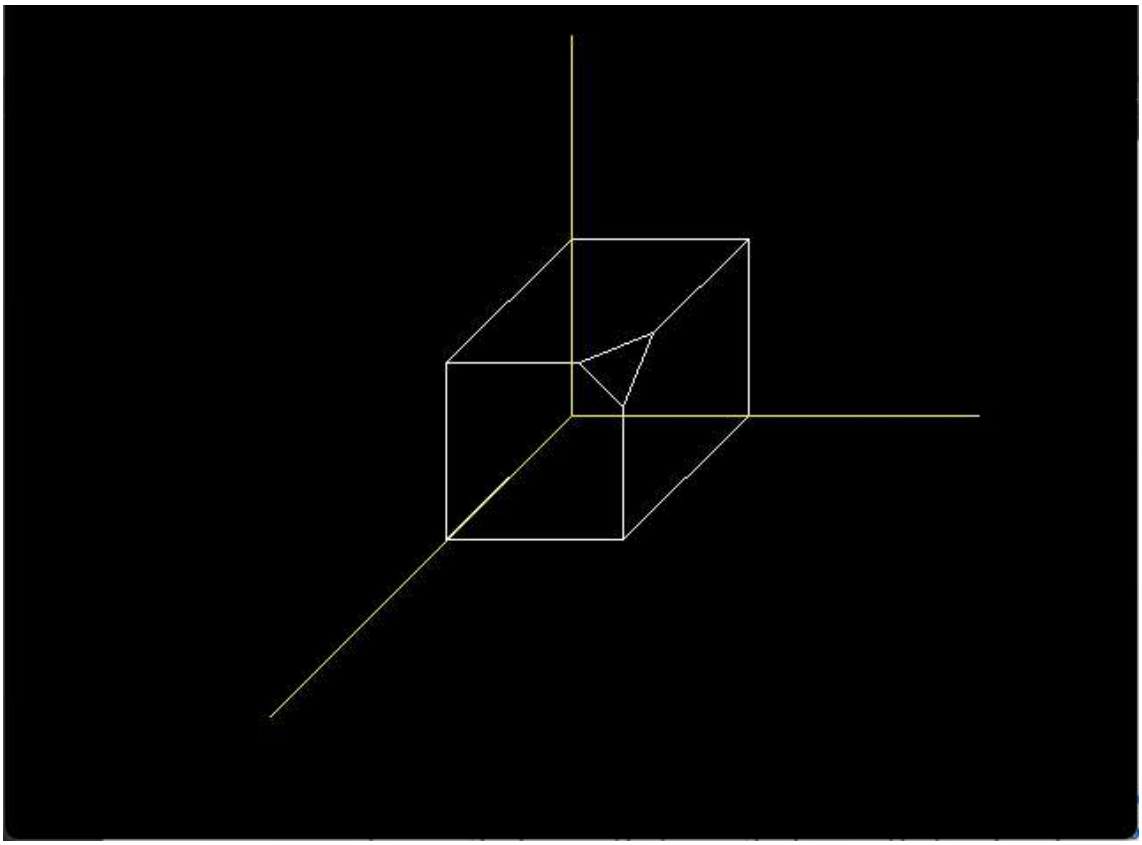


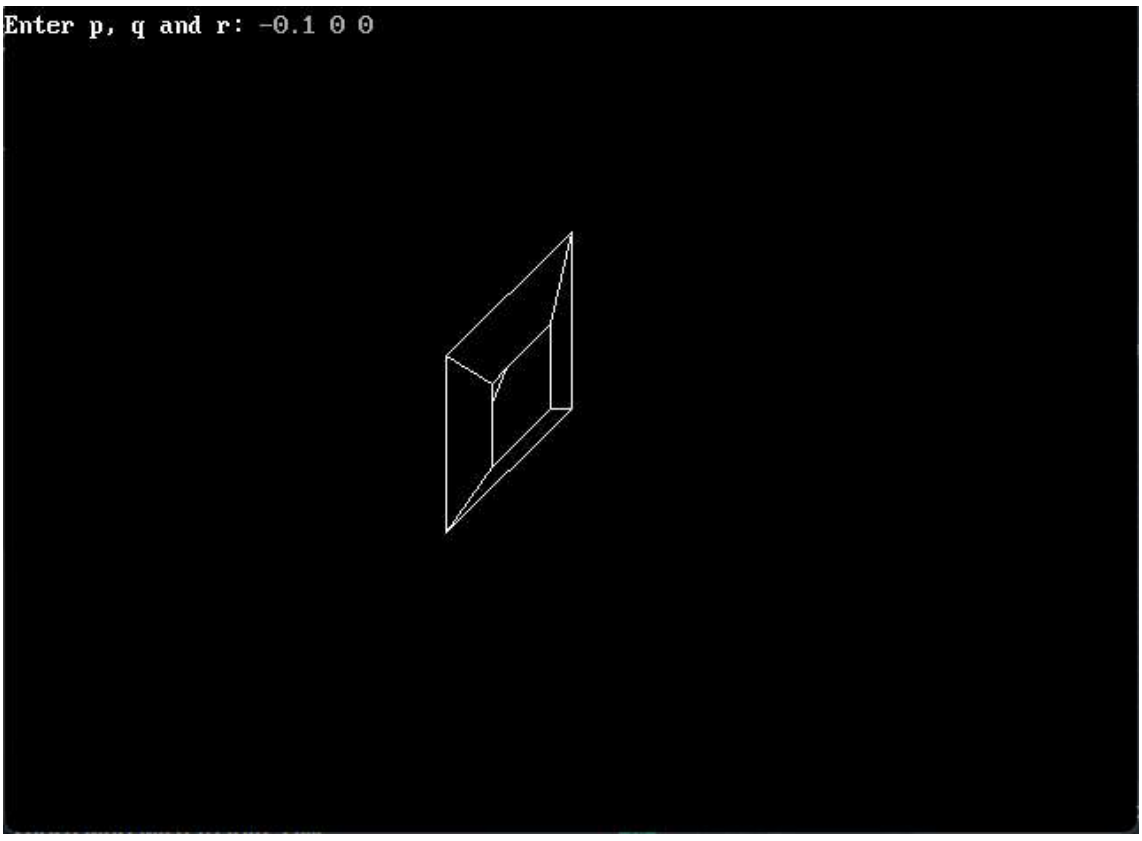




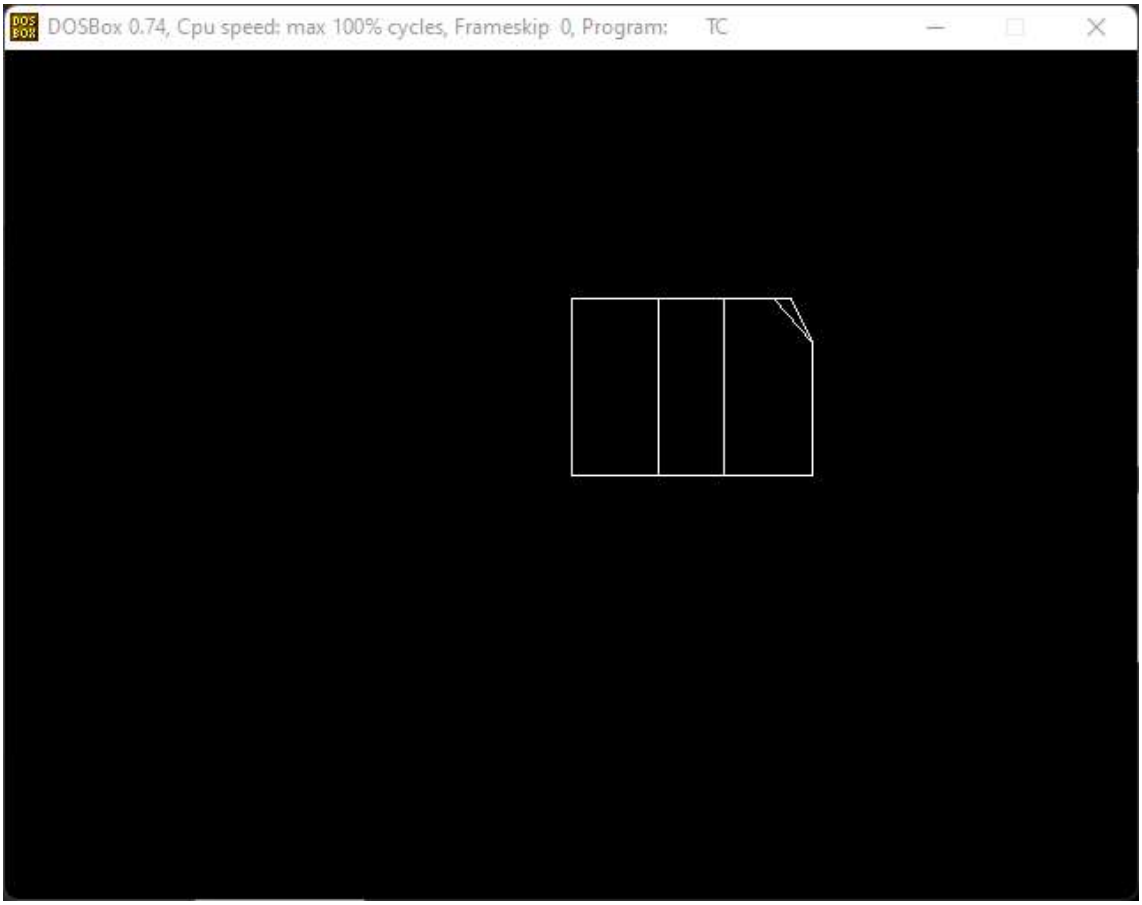







Enter p, q and r: -0.1 0 0

```
Menu
-------
(1) Translation
(2) Rotation
(3) Scaling
(4) Reflection
(5) View Figure
(6) Exit

Enter Choice: 2

Rotation About:
1. x-axis
2. z-axis
3. y-axis
Enter Choice: 2

Enter Angle: 30

Projection:
1. Orthographic Projection on xy-plane
2. Axonometric Projection (Isometric)
3. Perspective Projection

Enter your choice: 1_
```



PRACTICAL 6

Objective

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

Code

```
#include <conio.h>
#include <graphics.h>
#include <iostream.h>
#include <stdio.h>
#include <stdlib.h>

typedef unsigned int outcode;
enum
{
  TOP = 0x1,
  BOTTOM = 0x2,
  RIGHT = 0x4,
  LEFT = 0x8
};

outcode computeOutcode(double x, double y, double xmin, double xmax,
double ymin, double ymax)
{
  outcode code = 0;

  if (y > ymax)
    code |= TOP;

  else if (y < ymin)
    code |= BOTTOM;

  if (x > xmax)
    code |= RIGHT;

  else if (x < xmin)
    code |= LEFT;

  return code;
}

void clipLine(double x0, double yo, double x1, double y1, double
xmin, double xmax, double ymin, double ymax)
{
  int accept = 0, done = 0;
  outcode outcode0, outcode1, outcodeout;

  outcode0 = computeOutcode(x0, yo, xmin, xmax, ymin, ymax);
```

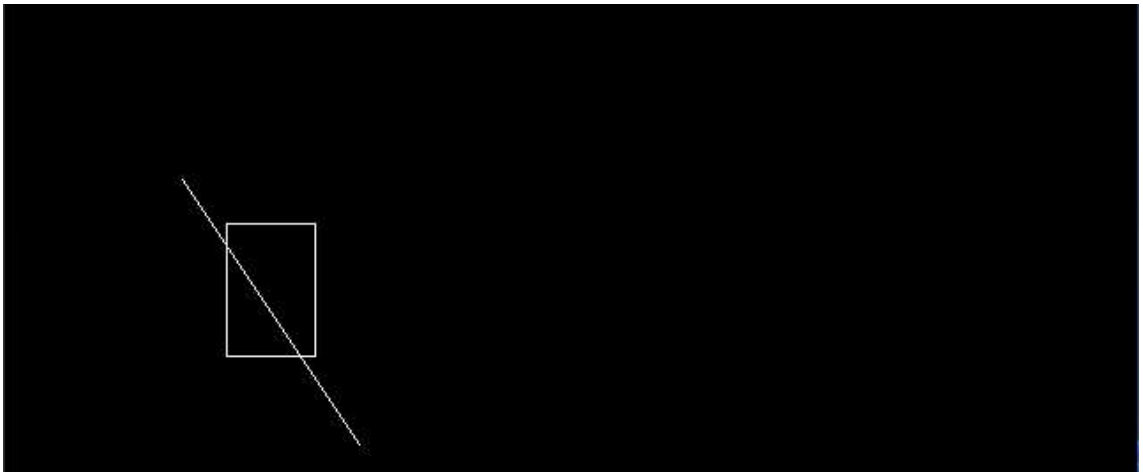
```
outcode1 = computeOutcode(x1, y1, xmin, xmax, ymin, ymax);

do
{
  if (!(outcode0 | outcode1))
  {
    accept = 1;
    done = 1;
  }

  else if (outcode0 & outcode1)
  {
    done = 1;
  }

  else
  {
    double x, y;
    outcodeout = outcode0 ? outcode0 : outcode1;

    if (outcodeout & TOP)
    {
      x = x0 + (ymax - yo) * (x1 - x0) / (y1 - yo);
      y = ymax;
    }
    else if (outcodeout & BOTTOM)
    {
      x = x0 + (ymin - yo) * (x1 - x0) / (y1 - yo);
      y = ymin;
    }
    else if (outcodeout & LEFT)
    {
      y = yo + (xmin - x0) * (y1 - yo) / (x1 - x0);
      x = xmin;
    }
    else
    {
      y = yo + (xmax - x0) * (y1 - yo) / (x1 - x0);
      x = xmax;
    }

    if (outcodeout == outcode0)
    {
      x0 = x;
      yo = y;
      outcode0 = computeOutcode(x0, yo, xmin, xmax, ymin, ymax);
    }
```

```
      else
      {
        x1 = x;
        y1 = y;
        outcode1 = computeOutcode(x1, y1, xmin, xmax, ymin, ymax);
      }
    }
  } while (done == 0);

  if (accept)
    line(x0, yo, x1, y1);
}

int main(void)
{
  int gd = DETECT, gm;
  double x0, x1, y0, y1;
  double xmin, ymin, xmax, ymax;

  initgraph(&gd, &gm, "..\\BGI");

  cout << "Enter Point A (x0, y0): ";
  cin >> x0 >> y0;

  cout << "Enter Point B (x1, y1): ";
  cin >> x1 >> y1;

  cout << "Enter Bounds of Clipping Rectangle : ";
  cout << "\n\txmin: ";
  cin >> xmin;
  cout << "\tymin: ";
  cin >> ymin;
  cout << "\txmax: ";
  cin >> xmax;
  cout << "\tymax: ";
  cin >> ymax;

  cleardevice();

  line(xmin, ymin, xmax, ymin);
  line(xmin, ymin, xmin, ymax);
  line(xmin, ymax, xmax, ymax);
  line(xmax, ymin, xmax, ymax);
  line(x0, y0, x1, y1);

  getch();
  cleardevice();
```

```
  line(xmin, ymin, xmax, ymin);
  line(xmin, ymin, xmin, ymax);
  line(xmin, ymax, xmax, ymax);
  line(xmax, ymin, xmax, ymax);
  clipLine(x0, y0, x1, y1, xmin, xmax, ymin, ymax);

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

Output

```
Enter Point A (x0, y0): 100 100
Enter Point B (x1, y1): 200 250
Enter Bounds of Clipping Rectangle :
        xmin: 125
        ymin: 125
        xmax: 175
        ymax: 200
```



PRACTICAL 7

Objective

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

Code

```
#include <conio.h>
#include <graphics.h>
#include <iostream.h>
#include <math.h>
#include <stdio.h>
#include <stdlib.h>

typedef unsigned int outcode;
outcode compOutcode(double x, double y);
enum
{
  TOP = 0x1,
  BOTTOM = 0x2,
  RIGHT = 0x4,
  LEFT = 0x8
};

double xmin, xmax, ymin, ymax;

outcode compOutcode(double x, double y)
{
  outcode code = 0;
  if (y > ymax)
    code |= TOP;
  else if (y < ymin)
    code |= BOTTOM;
  if (x > xmax)
    code |= RIGHT;
  else if (x < xmin)
    code |= LEFT;
  return code;
}

void clipPolygon(int x0, int y0, int x1, int y1)
{
  int accept = 0, done = 0;
  outcode outcode0, outcode1, outcodeOut;

  outcode0 = compOutcode(x0, y0);
  outcode1 = compOutcode(x1, y1);

  do
```

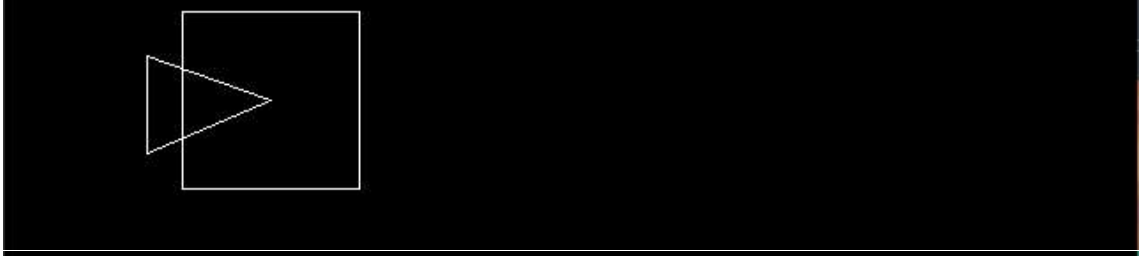
```
{
  if (!(outcode0 | outcode1))
  {
    accept = 1;
    done = 1;
  }
  else if (outcode0 & outcode1)
    done = 1;
  else
  {
    double x, y;
    outcodeOut = outcode0 ? outcode0 : outcode1;
    if (outcodeOut & TOP)
    {
      x = x0 + (x1 - x0) * (ymax - y0) / (y1 - y0);
      y = ymax;
    }
    else if (outcodeOut & BOTTOM)
    {
      x = x0 + (x1 - x0) * (ymin - y0) / (y1 - y0);
      y = ymin;
    }
    else if (outcodeOut & RIGHT)
    {
      y = y0 + (y1 - y0) * (xmax - x0) / (x1 - x0);
      x = xmax;
    }
    else
    {
      y = y0 + (y1 - y0) * (xmin - x0) / (x1 - x0);
      x = xmin;
    }

    if (outcodeOut == outcode0)
    {
      x0 = x;
      y0 = y;
      outcode0 = compOutcode(x0, y0);
    }
    else
    {
      x1 = x;
      y1 = y;
      outcode1 = compOutcode(x1, y1);
    }
  }
} while (done == 0);
```

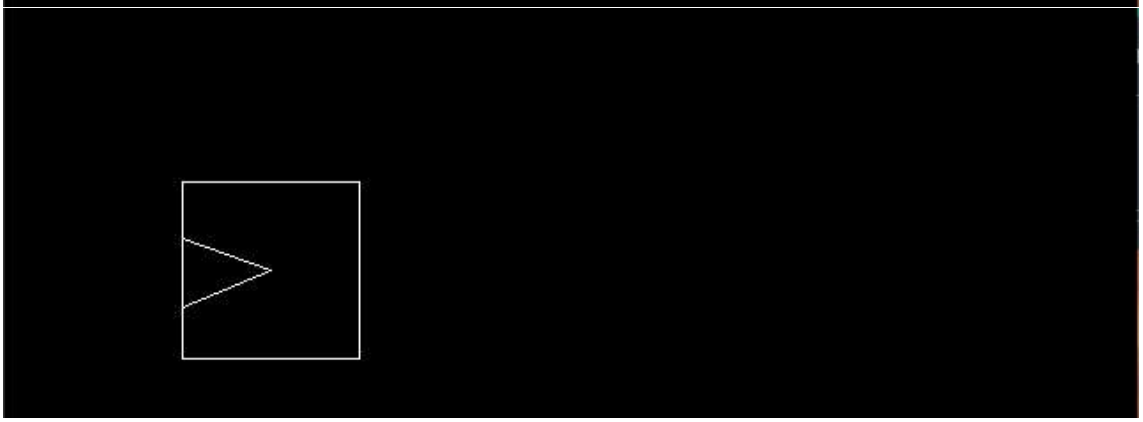
```
  if (accept)
    line(x0, y0, x1, y1);
}

void main()
{
  int i, n;
  int gd = DETECT, gm;
  int poly[24];

  initgraph(&gd, &gm, "..\\BGI");

  cout << "Enter Bounds of Clipping Rectangle : ";
  cout << "\n\txmin: ";
  cin >> xmin;
  cout << "\tymin: ";
  cin >> ymin;
  cout << "\txmax: ";
  cin >> xmax;
  cout << "\tymax: ";
  cin >> ymax;

  cout << "Enter Number of Edges in Polygon : ";
  cin >> n;

  cout << "Enter Coordinates of the Polygon : ";
  for (i = 0; i < 2 * n; i++)
    cin >> poly[i];

  poly[2 * n] = poly[0];
  poly[2 * n + 1] = poly[1];

  cleardevice();

  rectangle(xmin, ymin, xmax, ymax);
  drawpoly(n + 1, poly);

  getch();
  cleardevice();

  rectangle(xmin, ymin, xmax, ymax);

  for (i = 0; i < n; i++)
    clipPolygon(poly[2 * i], poly[(2 * i) + 1], poly[(2 * i) + 2],
poly[(2 * i) + 3]);
```

```
  getch();
  closegraph();
}
```

Output

```
Enter Bounds of Clipping Rectangle:
        xmin: 100
        ymin: 100
        xmax: 200
        ymax: 200
Enter Number of Edges in Polygon: 3
Enter Coordinates of the Polygon:
80 125
150 150
80 180
```





PRACTICAL 8

Objective

Write a program to draw Hermite/Bezier curve.

Code

Hermite Curve

```
#include <conio.h>
#include <graphics.h>
#include <iostream.h>
#include <math.h>
#include <stdio.h>
#include <stdlib.h>

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 += 0.00005)
  {
    x = (2 * pow(t, 3) - 3 * pow(t, 2) + 1) * p1.x +
        (-2 * pow(t, 3) + 3 * pow(t, 2)) * p4.x +
        (pow(t, 3) - 2 * pow(t, 2) + t) * r1 +
        (pow(t, 3) - pow(t, 2)) * r4;
    y = (2 * pow(t, 3) - 3 * pow(t, 2) + 1) * p1.y +
        (-2 * pow(t, 3) + 3 * pow(t, 2)) * p4.y +
        (pow(t, 3) - 2 * pow(t, 2) + 1) * r1 +
        (pow(t, 3) - pow(t, 2)) * r4;
    putpixel(x, y, WHITE);
  }

  circle(p1.x, p1.y, 3);
  circle(p4.x, p4.y, 3);
}

void main()
{
  point p1, p4;
  double r1, r4;

  int gd = DETECT, gm;
  initgraph(&gd, &gm, "..\\BGI");
```

```
  cout << "Enter Point 1 (x, y): ";
  cin >> p1.x >> p1.y;
  cout << "Enter Point 2 (x, y): ";
  cin >> p4.x >> p4.y;
  cout << "Enter Tangent at Point 1: ";
  cin >> r1;
  cout << "Enter Tangent at Point 4: ";
  cin >> r4;

  hermite(p1, p4, r1, r4);

  getch();
  closegraph();
}
```

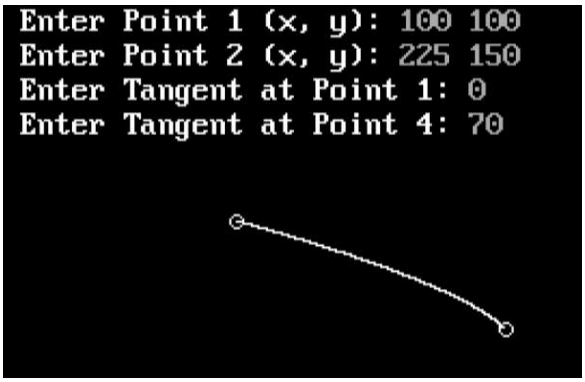
Bezier Curve

```
#include <conio.h>
#include <graphics.h>
#include <iostream.h>
#include <math.h>
#include <stdio.h>
#include <stdlib.h>

void bezier(int x[4], int y[4])
{
  for (double t = 0.0; t < 1.0; t += 0.00005)
  {
    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, WHITE);
  }

  for (int i = 0; i < 4; i++)
  {
    circle(x[i], y[i], 3);
  }

  getch();
  closegraph();
  return;
}

void main()
{
  int i;
```

```
  int x[4], y[4];
  int gd = DETECT, gm, errorcode;

  initgraph(&gd, &gm, "..\\BGI");

  for (i = 0; i < 4; i++)
  {
    cout << "Enter Point " << i + 1 << " (x, y): ";
    cin >> x[i] >> y[i];
  }

  bezier(x, y);
  return;
}
```

Output

Hermite Curve



Bezier Curve