KVG COLLEGE OF ENGINEERING

VI SEMESTER CS & E

COMPUTER GRAPHICS LABORATORY WITH MINI PROJECT

Subject Code: 18CSL58

(Choice Based Credit System (CBCS) & Outcome Based Education (OBE))

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

KVG COLLEGE OF ENGINEERING

Kurunjibag-574327, Sullia D.K

VISION

To be a notable engineering college recognized for Academic, innovation and the societal relevance and impact of its pursuits.

MISSION

M1: Educate our students committed to the service and ethical application of science and technology.

M2: Provide resource to our Faculty and Student to enhance Engineering Knowledge through Industry-Institute Interactions.

M3: Practice Diversity and Inclusion amongst Our stakeholders through rural and social Outreach.

Vision

To produce qualified Computer Science and Engineering graduates with human values and ethical Skills.

Mission

M1: Impart students with strong fundamental concepts, analytical capability, programming and problem-solving skills.

M2: Encourage an ambience of education through faculty training, self-learning, sound academic practices and Industry related endeavors.

M3: Imbibe environment Conciseness, social awareness and responsibility in students to serve the society.

PEO's	Program Educational Objectives Statements
PEO1	**Apply Engineering Basics:** Analyze Engineering Challenges through application of mathematical and Algorithmic principles for real life technology projects.
PEO2	**Engineering Skills and techniques:** Apply skills like Analyzing, Designing, Implementing and Testing of Major and Minor Projects.
PEO3	**Individual and Team Work: Exhibit** collaborative abilities in the engineering projects like Communication Skill, work as individual or in a team with a sense of Social Responsibility.
PEO3	**Life Long Learning**: Initiate technological and skills required for comprehensive contribution as experts in the Chosen Profession.

PSO's	Program Specific Outcome Statements
PSO1	**Problem Solving Skills:** Specify, design, build and test analog, digital and embedded systems for signal processing
PSO2	**Professional Skills**: Understand and architect wired and wireless analog and digital communication systems as per specifications, and determine their performance
PSO3	**Ethics And Career Development:** Exhibit skills required for a successful career in the industry based on principles of software project management, teamwork, ethical practices, develop the spirit of free enterprise and provide innovative ideas towards analysis.

KVG COLLEGE OF ENGINEERING

Department of Computer Science and Engineering

Program Outcomes

PO1: Engineering Knowledge: To apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate considerations for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a member of leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

COMPUTER GRAPHICS LABORATORY WITH MINI PROJECT

(Effective from the academic year 2018 -2019)

SEMESTER – VI

Course Code	**18CSL67**	**CIE Marks**	40
Number of Contact Hours/Week	0:2:2	**SEE Marks**	60
Total Number of Lab Contact Hours	36	**Exam Hours**	03

Credits – 2

Course Learning Objectives: This course (18CSL67) will enable students to:

- Demonstrate simple algorithms using OpenGL Graphics Primitives and attributes.
- Implementation of line drawing and clipping algorithms using OpenGL functions
- Design and implementation of algorithms Geometric transformations on both 2D and 3D objects.

Descriptions (if any): --

Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

Programs List:

PART A

Design, develop, and implement the following programs using OpenGL API

1.	Implement Brenham's line drawing algorithm for all types of slope. Refer:Text-1: Chapter 3.5 Refer:Text-2: Chapter 8
2.	Create and rotate a triangle about the origin and a fixed point. **Refer:Text-1: Chapter 5-4**
3.	Draw a colour cube and spin it using OpenGL transformation matrices. **Refer:Text-2: Modelling a Coloured Cube**
4.	Draw a color cube and allow the user to move the camera suitably to experiment with perspective viewing. **Refer:Text-2: Topic: Positioning of Camera**
5.	Clip a lines using Cohen-Sutherland algorithm **Refer:Text-1: Chapter 6.7** **Refer:Text-2: Chapter 8**
6.	To draw a simple shaded scene consisting of a tea pot on a table. Define suitably the position and properties of the light source along with the properties of the surfaces of the solid object used in the scene. **Refer:Text-2: Topic: Lighting and Shading**
7.	Design, develop and implement recursively subdivide a tetrahedron to form 3D sierpinski gasket. The number of recursive steps is to be specified by the user. **Refer: Text-2: Topic:** sierpinski gasket.
8.	Develop a menu driven program to animate a flag using Bezier Curve algorithm **Refer: Text-1: Chapter** 8-10
9.	Develop a menu driven program to fill the polygon using scan line algorithm

PART B MINI PROJECT

Student should develop mini project on the topics mentioned below or similar applications using Open GL API. Consider all types of attributes like color, thickness, styles, font, background, speed etc., while doing mini project.

(**During the practical exam: the students should demonstrate and answer Viva-Voce**)

Sample Topics:

Simulation of concepts of OS, Data structures, algorithms etc.

Laboratory Outcomes: The student should be able to:

- Apply the concepts of computer graphics

- Implement computer graphics applications using OpenGL
- Animate real world problems using OpenGL

Conduct of Practical Examination:

- Experiment distribution
    - For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.
    - For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.
- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution *(Courseed to change in accoradance with university regulations)*

    o) For laboratories having only one part – Procedure + Execution + Viva-Voce: 15+70+15 = 100 Marks

    p) For laboratories having PART A and PART B

    i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks

    ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

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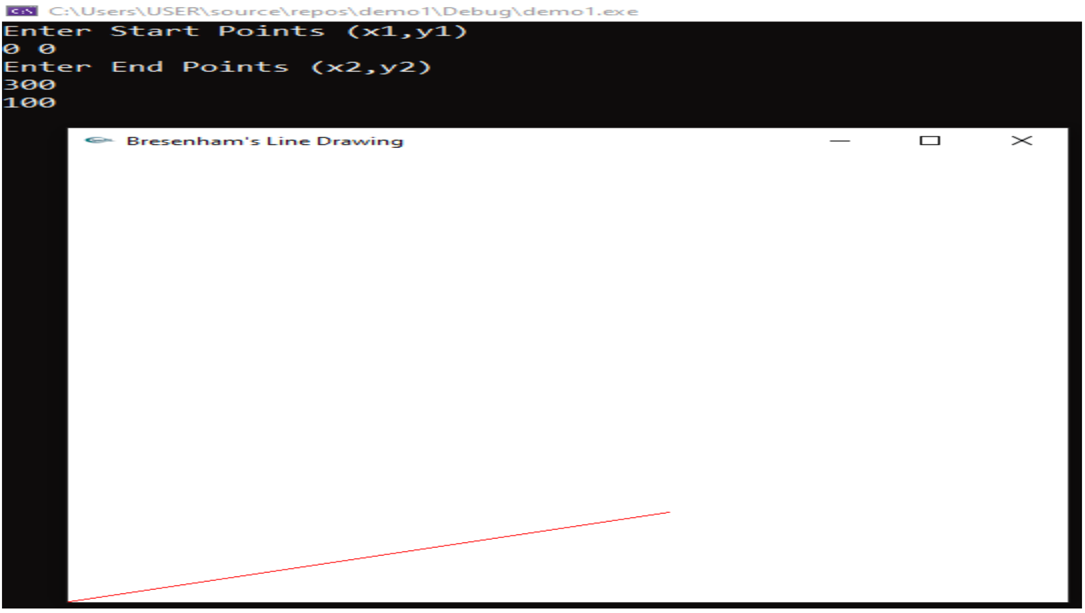
COMPUTER GRAPHICS LABORATORY WITH MINI PROJECT   18CSL58

1.Implement Brenham’s line drawing algorithm for all types of slope.
Refer:Text-1: Chapter 3.5
Refer:Text-2: Chapter 8

```
#include<glut.h>
#include<stdio.h>
int x1, y1, x2, y2;
void draw_pixel(int x, int y)
{
        glColor3f(1.0, 0.0, 0.0);
        glBegin(GL_POINTS);
        glPointSize(2.0);
        glVertex2i(x, y);
        glEnd();
        glFlush();
}
void bresenhams_line_draw(int x1, int y1, int x2, int y2)
{
        int x, y;
        int dx = x2 - x1; // x difference
        int dy = y2 - y1; // y difference
        int m = dy / dx; // slope
        if (x1 > x2)
        {
                x = x2;
                y = y2;
                x2 = x1;
        }
        else
        {
                x = x1;
                y = y1;

        }
        if (m < 1)
        {
                int decision_parameter = 2 * dy - dx;
                draw_pixel(x, y); // plot a point
                while (x < x2) // from 1st point to 2nd point
                {
                        if (decision_parameter >= 0)
                        {
                                x = x + 1;
                y = y + 1;
        decision_parameter = decision_parameter + 2 * dy - 2 * dx * (y + 1 - y);
            }
            else
            {
                x = x + 1;
                y = y;
        decision_parameter = decision_parameter + 2 * dy - 2 * dx * (y - y);
            }
            draw_pixel(x, y);
        }
    }
    else if (m > 1)
    {
        int decision_parameter = 2 * dx - dy;
        draw_pixel(x, y);
        while (y < y2)
        {
            if (decision_parameter >= 0)
            {
                x = x + 1;
                y = y + 1;
        decision_parameter = decision_parameter + 2 * dx - 2 * dy * (x + 1 - x);
            }
            else
            {
                y = y + 1;
                x = x;
        decision_parameter = decision_parameter + 2 * dx - 2 * dy * (x - x);
            }
            draw_pixel(x, y);
        }
    }
    else if (m == 1)
    {
        draw_pixel(x, y);
        while (x < x2)
        {
            x = x + 1;
            y = y + 1;
            draw_pixel(x, y);
        }
    }
```

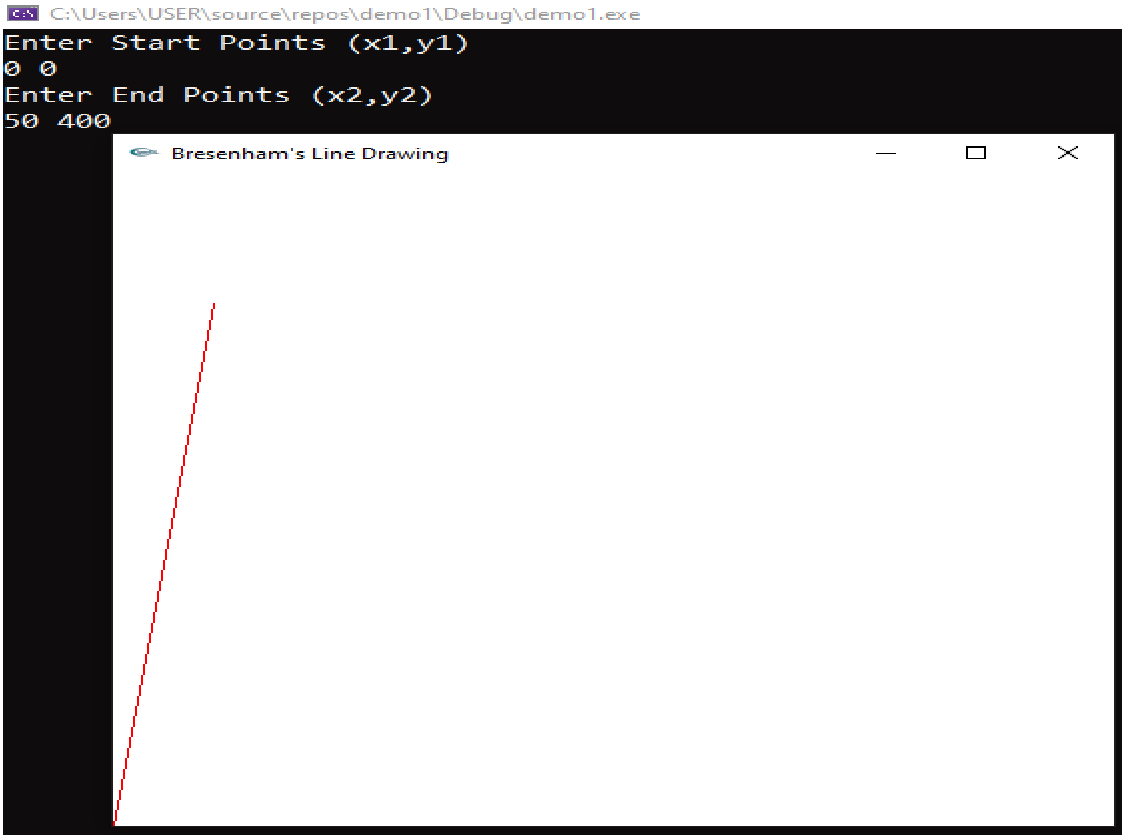
```
}
void init()
{
        glClearColor(1, 1, 1, 1);
gluOrtho2D(0.0, 500.0, 0.0, 500.0); // left ->0, right ->500, bottom ->0, top ->500
}
void display()
{
        glClear(GL_COLOR_BUFFER_BIT);
        bresenhams_line_draw(x1, y1, x2, y2);
        glFlush();
}
int main(int argc, char** argv)
{
        printf("Enter Start Points (x1,y1)\n");
        scanf_s("%d %d", &x1, &y1); // 1st point from user
        printf("Enter End Points (x2,y2)\n");
        scanf_s("%d %d", &x2, &y2); // 2nd point from user
        glutInit(&argc, argv); // initialize graphics system
        glutInitWindowSize(500, 500); // 500 by 500 window size
        glutInitWindowPosition(220, 200); // where do you wanna see your window
        glutCreateWindow("Bresenham's Line Drawing"); // the title of your window
        init(); // initialize the canvas
        glutDisplayFunc(display); // call display function
        glutMainLoop(); // run forever
        return 0;
}
```

OUTPUT:

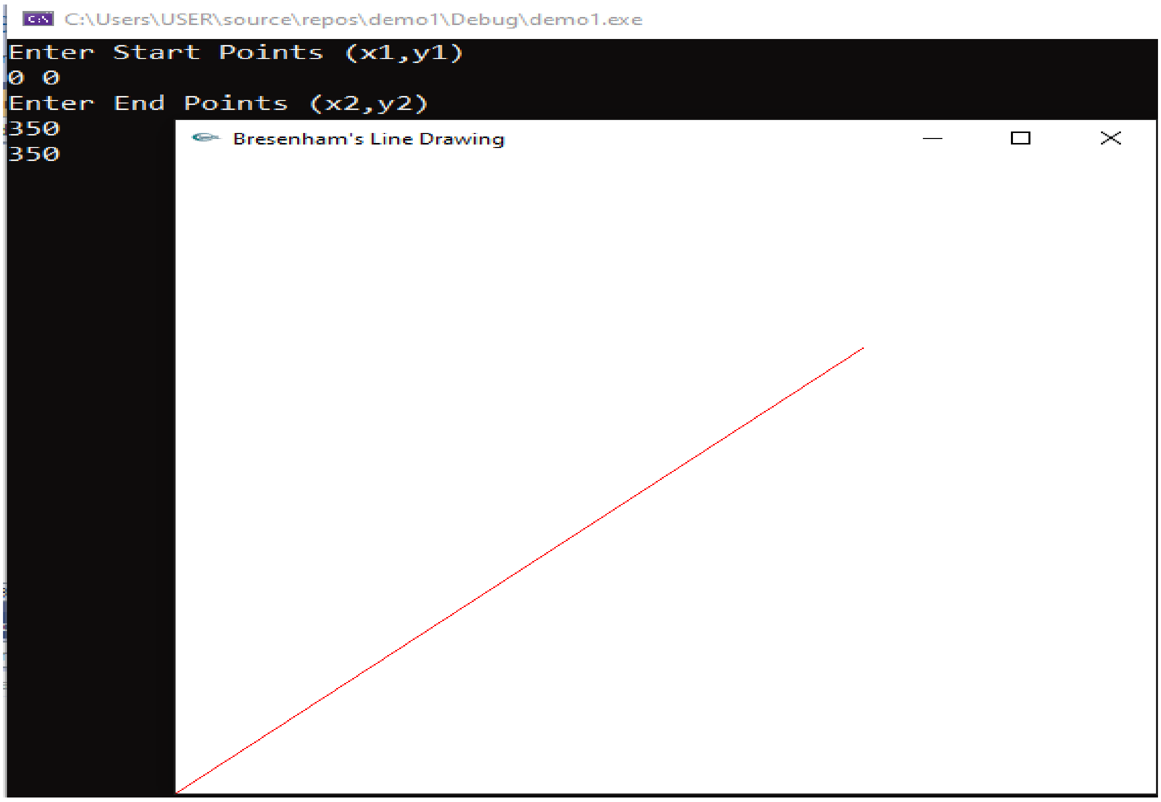


```
Enter Start Points (x1,y1)
0 0
Enter End Points (x2,y2)
300
100
```

}



```
Enter Start Points (x1,y1)
0 0
Enter End Points (x2,y2)
50 400
```



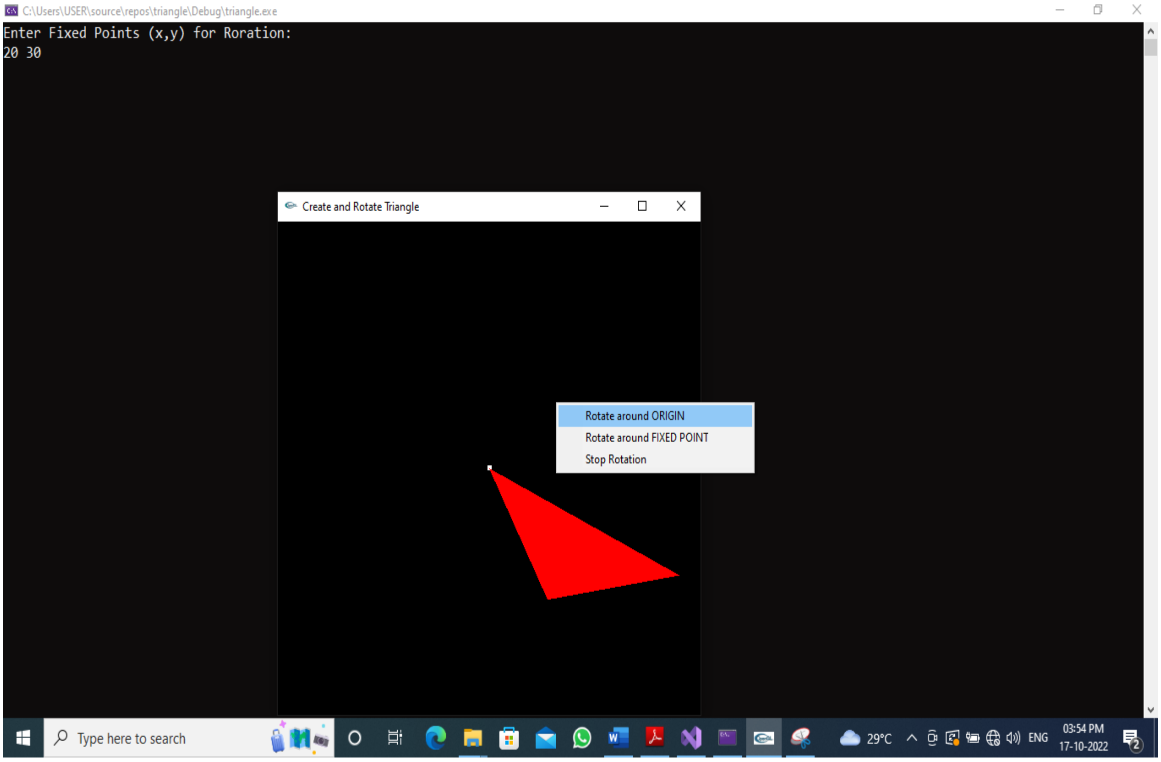
```
Enter Start Points (x1,y1)
0 0
Enter End Points (x2,y2)
350
350
```

2.Create and rotate a triangle about the origin and a fixed point.

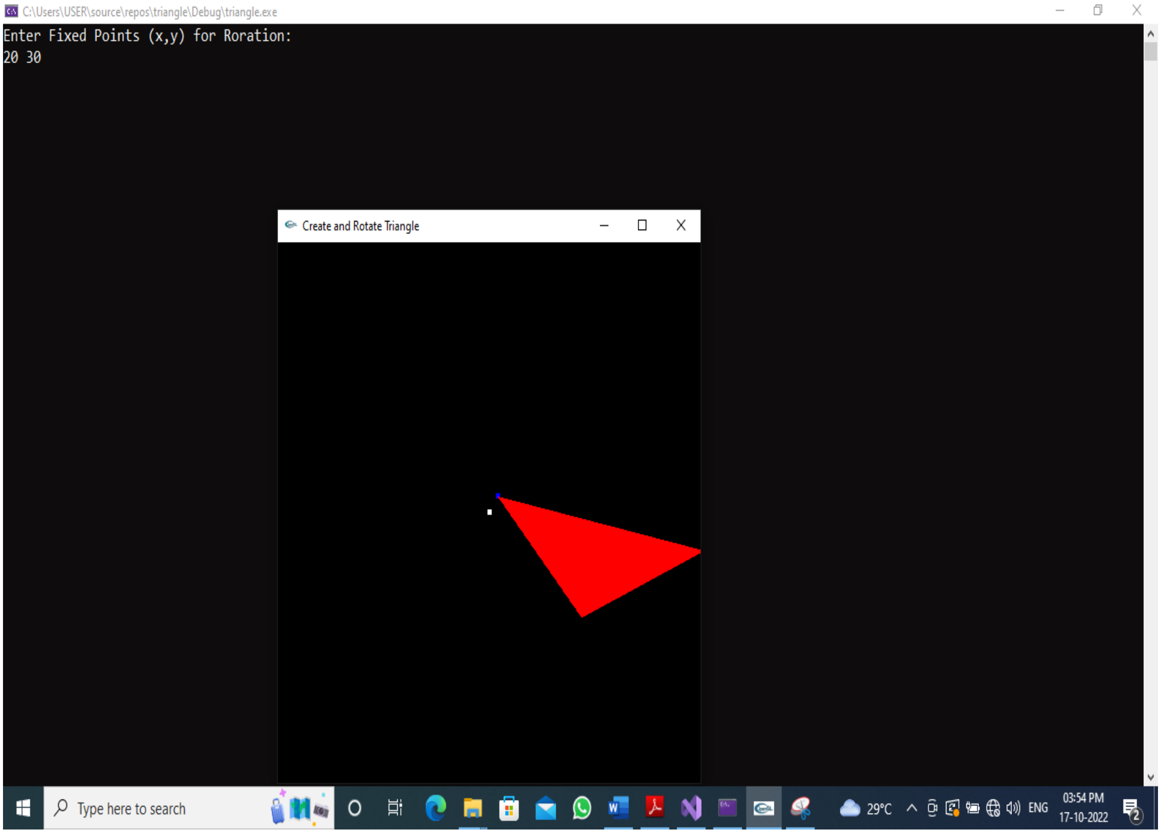
Refer: Text-1: Chapter 5-4

```
#include<glut.h>
#include<stdio.h>
int x, y;
int rFlag = 0;// don't rotate initially
float th = 0.0; // initial angle
float trX = 0.0, trY = 0.0;// initial translation
void draw_pixel(float x1, float y1)
{
        glPointSize(5.0);
        glBegin(GL_POINTS);
        glVertex2f(x1, y1);
        glEnd();
}
void triangle(int x, int y)
{
        glColor3f(1, 0, 0);
        glBegin(GL_POLYGON); // drawing a Triangle
        glVertex2f(x, y);
        glVertex2f(x + 400, y + 300);
        glVertex2f(x + 300, y + 0);
        glEnd();
}
void display()
{
        glClear(GL_COLOR_BUFFER_BIT);
        glLoadIdentity();
        glColor3f(1, 1, 1); // mark origin point as white dot
        draw_pixel(0, 0); // plot origin - white colour
        if (rFlag == 1) //Rotate Around origin
        {
                trX = 0.0; // no translation for rotation around origin
                trY = 0.0;
                th += 0.1; // the amount of rotation angle
        }
        if (rFlag == 2) //Rotate Around Fixed Point
        {
                trX = x;// SET the translation to wherever the user says
                trY = y;
                th += 0.1; // the amount of rotation angle
                glColor3f(0, 0, 1);// mark the user coordinate as blue dot
                draw_pixel(x, y);// plot the user coordinate - blue colour
        }
        glTranslatef(trX, trY, 0.0);// ACTUAL translation +ve
        glRotatef(th, 0.0, 0.0, 1.0);// rotate
        glTranslatef(-trX, -trY, 0.0);// ACTUAL translation -ve
        triangle(trX,trY); // what to rotate ? – TRIANGLE boss
        glutPostRedisplay(); // call display function again and again
        glutSwapBuffers();// show the output
}
void myInit()
{
        glClearColor(0.0, 0.0, 0.0, 1.0);
        glMatrixMode(GL_PROJECTION);
        glLoadIdentity();
        gluOrtho2D(-500.0, 500.0, -500.0, 500.0);
        glMatrixMode(GL_MODELVIEW);
}
void rotateMenu(int option)
{
        if (option == 1)
                rFlag = 1;
        if (option == 2)
                rFlag = 2;
        if (option == 3)
                rFlag = 3;
}
void main(int argc, char** argv)
{
        printf("Enter Fixed Points (x,y) for Roration: \n");
        scanf_s("%d %d", &x, &y);
        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGB);
        glutInitWindowSize(500, 500);
        glutInitWindowPosition(0, 0);
        glutCreateWindow("Create and Rotate Triangle");
        myInit();
        glutDisplayFunc(display);
        glutCreateMenu(rotateMenu);
        glutAddMenuEntry("Rotate around ORIGIN", 1);
        glutAddMenuEntry("Rotate around FIXED POINT", 2);
        glutAddMenuEntry("Stop Rotation", 3);
        glutAttachMenu(GLUT_RIGHT_BUTTON);
        glutMainLoop(); // run forever
}
```

OUTPUT:



```
C:\Users\USER\source\repos\triangle\Debug\triangle.exe
Enter Fixed Points (x,y) for Roration:
20 30
```



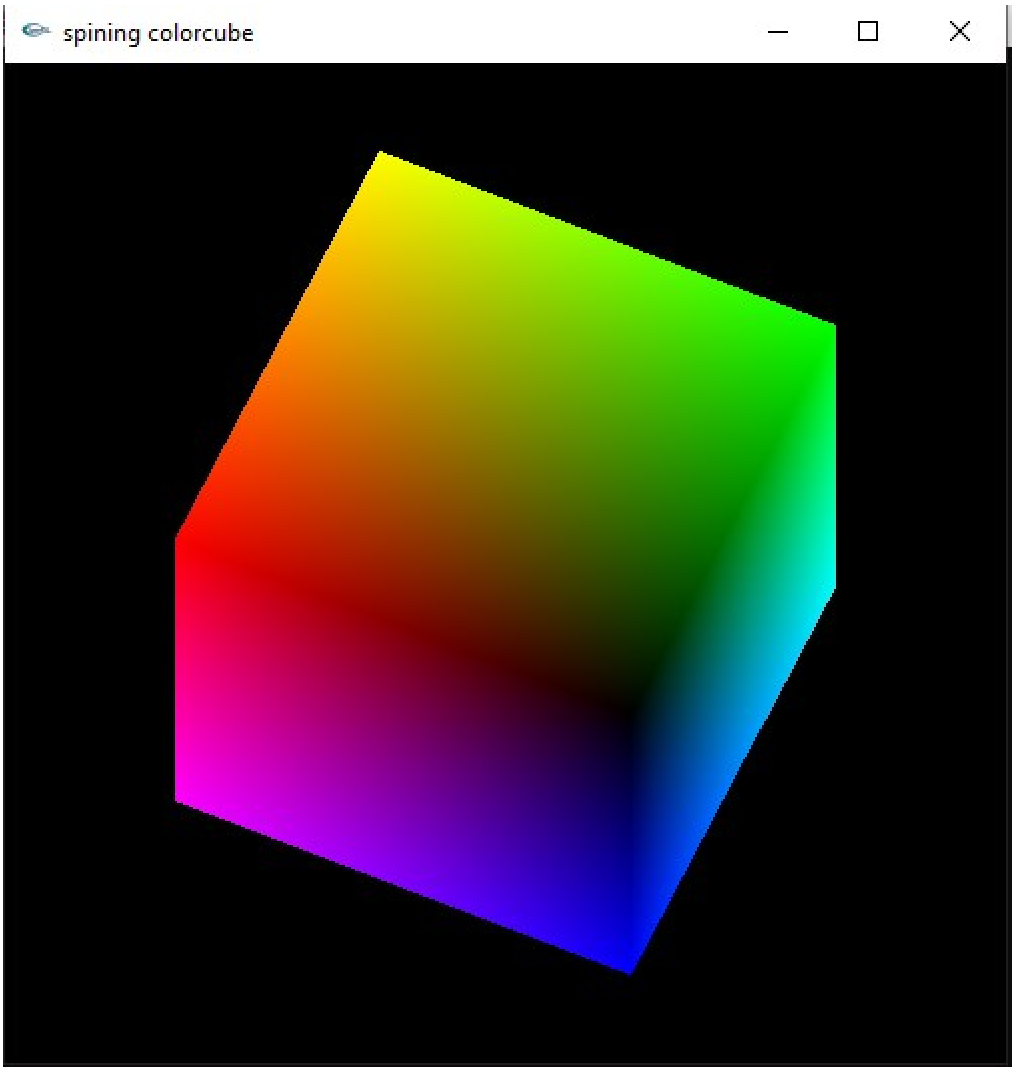
```
C:\Users\USER\source\repos\triangle\Debug\triangle.exe
Enter Fixed Points (x,y) for Roration:
20 30
```

3.Draw a colour cube and spin it using OpenGL transformation matrices.
Refer:Text-2: Modelling a Coloured Cube

```
#include <stdlib.h>
#include <glut.h>
GLfloat vertices[][3] = {
                                                        {-1.0,-1.0,-1.0},
                                                        { 1.0,-1.0,-1.0},
                                                        { 1.0, 1.0,-1.0},
                                                        {-1.0, 1.0,-1.0},

                                                        {-1.0,-1.0, 1.0},
                                                        { 1.0,-1.0, 1.0},
                                                        { 1.0, 1.0, 1.0},
                                                        {-1.0, 1.0, 1.0}
};
//cube vertices
GLfloat colors[][3] = {
                                                {0.0,0.0,0.0},
                                                {1.0,0.0,0.0},
                                                {1.0,1.0,0.0},
                                                {0.0,1.0,0.0},

                                                {0.0,0.0,1.0},
                                                {1.0,0.0,1.0},
                                                {1.0,1.0,1.0},
                                                { 0.0,1.0,1.0 }
};

void face(int a, int b, int c, int d)
{
        glBegin(GL_POLYGON);
        glColor3fv(colors[a]);
        glVertex3fv(vertices[a]);

        glColor3fv(colors[b]);
        glVertex3fv(vertices[b]);

        glColor3fv(colors[c]);
        glVertex3fv(vertices[c]);

        glColor3fv(colors[d]);
        glVertex3fv(vertices[d]);
```

```
	glEnd();
}
void colorcube(void)
{
	face(4, 5, 6, 7);//front face
	face(0, 1, 2, 3); //back
	face(0, 4, 7, 3);//left
	face(1, 2, 6, 5);//right
	face(2, 3, 7, 6);//top
	face(0, 4, 5, 1);//bottom
}
GLfloat theta[] = { 0.0,0.0,0.0 };
GLint axis = 2;
void display(void)
{
	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glLoadIdentity();
	glRotatef(theta[0], 1.0, 0.0, 0.0);
	glRotatef(theta[1], 0.0, 1.0, 0.0);
	glRotatef(theta[2], 0.0, 0.0, 1.0);
	colorcube();
	glutSwapBuffers();
}
void spinCube()
{
	theta[axis] += 0.15;
	if (theta[axis] > 360.0) theta[axis] -= 360.0;
	glutPostRedisplay();
}
void mouse(int btn, int state, int x, int y)
{
	if (btn == GLUT_LEFT_BUTTON && state == GLUT_DOWN)
		axis = 0;
	if (btn == GLUT_MIDDLE_BUTTON && state == GLUT_DOWN)
		axis = 1;
	if (btn == GLUT_RIGHT_BUTTON && state == GLUT_DOWN)
		axis = 2;
}
void myReshape(int w, int h)
{
	glViewport(0, 0, w, h);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	if (w <= h)
		glOrtho(-2.0, 2.0, -2.0 * (GLfloat)h / (GLfloat)w, 2.0 * (GLfloat)h /
(GLfloat)w, -10.0, 10.0);
	else
		glOrtho(-2.0 * (GLfloat)w / (GLfloat)h, 2.0 * (GLfloat)w / (GLfloat)h, -
2.0, 2.0, -10.0, 10.0);
	glMatrixMode(GL_MODELVIEW);
}
void MyInit()
{
	glClearColor(0, 0, 0, 1);
	glEnable(GL_DEPTH_TEST);//enable z buffer to view back buffer
}
void main(int argc, char** argv)
{
	glutInit(&argc, argv);
	glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGB | GLUT_DEPTH);
	glutInitWindowSize(500, 500);
	glutCreateWindow("spining colorcube");
	MyInit();
	glutReshapeFunc(myReshape);
	glutDisplayFunc(display);
	glutIdleFunc(spinCube);
	glutMouseFunc(mouse);
	glutMainLoop();
}
```

OUTPUT:

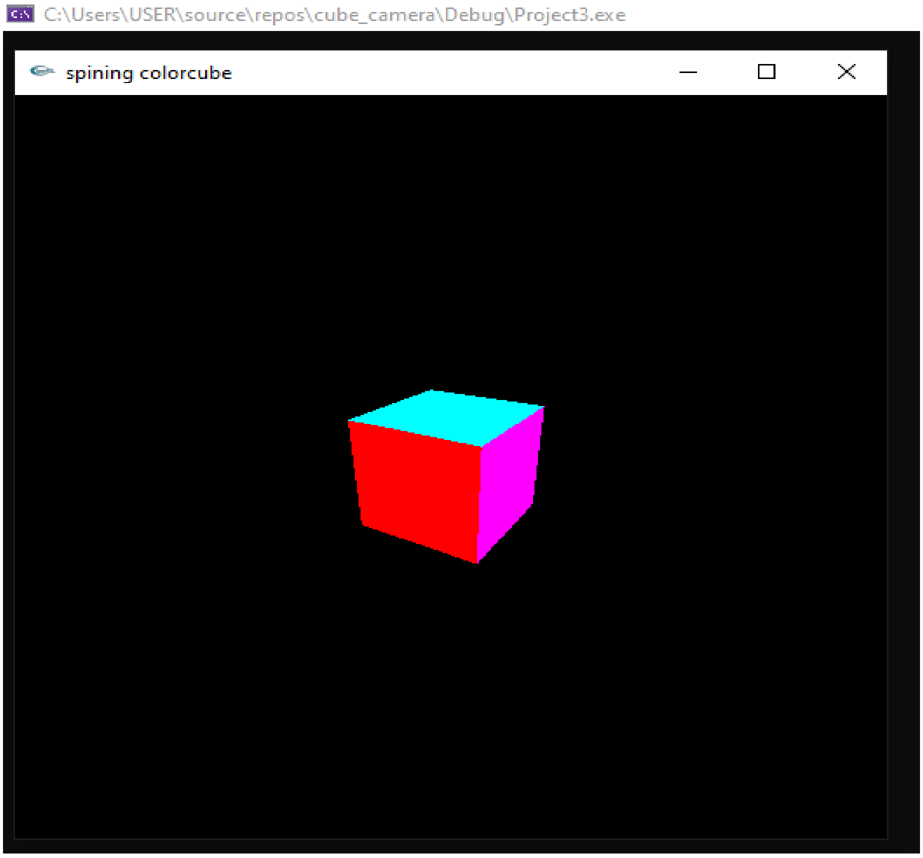

spining colorcube

4. Draw a color cube and allow the user to move the camera suitably to experiment with perspective viewing.

Refer:Text-2: Topic: Positioning of Camera

```
#include <stdlib.h>
#include <glut.h>
static GLdouble viewer[] = { 0.0,0.0,5.0 };
GLfloat vertices[][3] = {
                                                        {-1.0,-1.0,-1.0},
                                                        { 1.0,-1.0,-1.0},
                                                        { 1.0, 1.0,-1.0},
                                                        {-1.0, 1.0,-1.0},

                                                        {-1.0,-1.0, 1.0},
                                                        { 1.0,-1.0, 1.0},
                                                        { 1.0, 1.0, 1.0},
                                                        {-1.0, 1.0, 1.0}
};
//cube vertices

GLfloat colors[][3] = {
                                                {0.0,0.0,0.0},
                                                {1.0,0.0,0.0},
                                                {1.0,1.0,0.0},
                                                {0.0,1.0,0.0},

                                                {0.0,0.0,1.0},
                                                {1.0,0.0,1.0},
                                                {1.0,1.0,1.0},
                                                { 0.0,1.0,1.0 }
};

void face(int a, int b, int c, int d)
{
        glBegin(GL_POLYGON);
        //glColor3fv(colors[a]);

        glVertex3fv(vertices[a]);
        //glColor3fv(colors[b]);

        glVertex3fv(vertices[b]);
        //glColor3fv(colors[c]);

        glVertex3fv(vertices[c]);
        //glColor3fv(colors[d]);

        glVertex3fv(vertices[d]);
        glEnd();
}
void colorcube(void)
{
        glColor3f(1.0, 0.0, 0.0);
        face(4, 5, 6, 7);//front

        glColor3f(0.0, 1.0, 0.0);
        face(0, 3, 2, 1);//back

        glColor3f(1.0, 1.0, 0.0);
        face(0, 4, 7, 3);//left

        glColor3f(0.0, 0.0, 1.0);
        face(5, 4, 0, 1);//bottom

        glColor3f(0.0, 1.0, 1.0);
        face(2, 3, 7, 6);//top
        glColor3f(1.0, 0.0, 1.0);
        face(1, 2, 6, 5);//right
}
void display(void)
{
        glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
        glLoadIdentity();
        gluLookAt(viewer[0], viewer[1], viewer[2], 0.0, 0.0, 0.0, 0.0, 1.0, 0.0);
        colorcube();
        glutSwapBuffers();
}
void keys(unsigned char key, int x, int y)
{
        if (key == 'x')viewer[0] -= 1.0;
        if (key == 'X')viewer[0] += 1.0;
        if (key == 'y')viewer[1] -= 1.0;
        if (key == 'Y')viewer[1] += 1.0;
        if (key == 'z')viewer[2] -= 1.0;
        if (key == 'Z')viewer[2] += 1.0;
        glutPostRedisplay();
}
void myReshape(int w, int h)
```

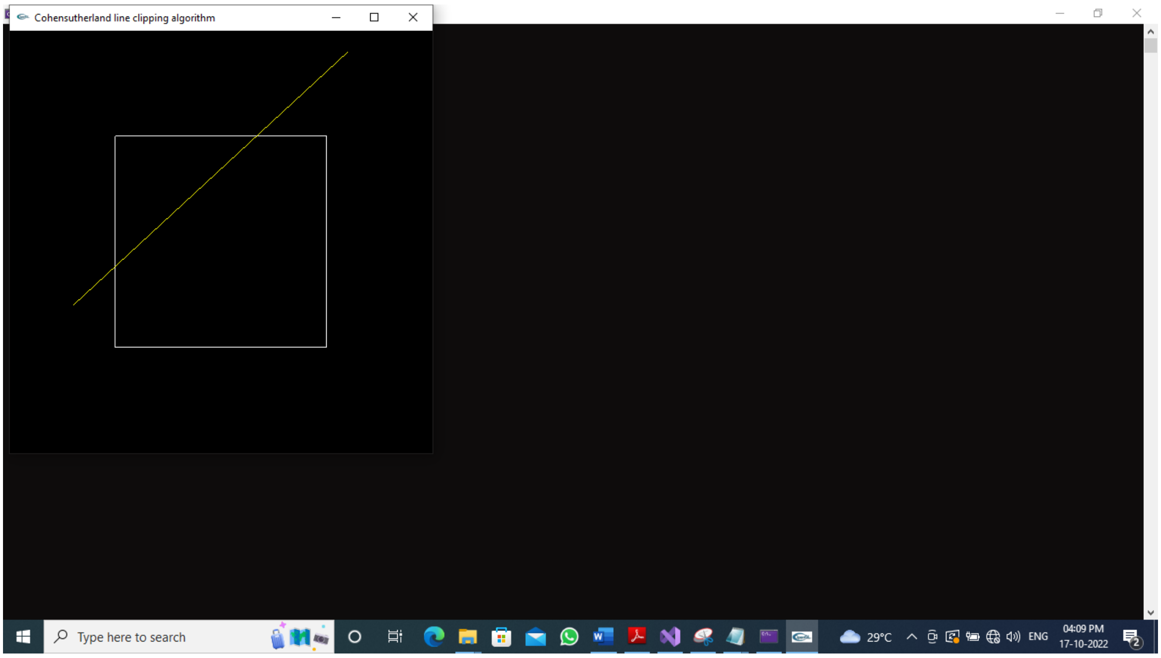
```
{
        glViewport(0, 0, w, h);
        glMatrixMode(GL_PROJECTION);
        glLoadIdentity();
        if (w <= h)
                glFrustum(-2.0, 2.0, -2.0 * (GLfloat)h / (GLfloat)w, 2.0 * (GLfloat)h /
(GLfloat)w, 2.0, 20.0);
        else
                glFrustum(-2.0, 2.0, -2.0 * (GLfloat)w / (GLfloat)h, 2.0 * (GLfloat)w /
(GLfloat)h, 2.0, 20.0);
        glMatrixMode(GL_MODELVIEW);
}
void MyInit()
{
        glClearColor(0, 0, 0, 1);
        glEnable(GL_DEPTH_TEST);//enable z buffer to view back buffer
}
void main(int argc, char** argv)
{
        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGB | GLUT_DEPTH);
        glutInitWindowSize(500, 500);
        glutCreateWindow("spining colorcube");
        MyInit();
        glutReshapeFunc(myReshape);
        glutDisplayFunc(display);
        glutKeyboardFunc(keys);
        glutMainLoop();
}
```


C:\Users\USER\source\repos\cube_camera\Debug\Project3.exe
spining colorcube

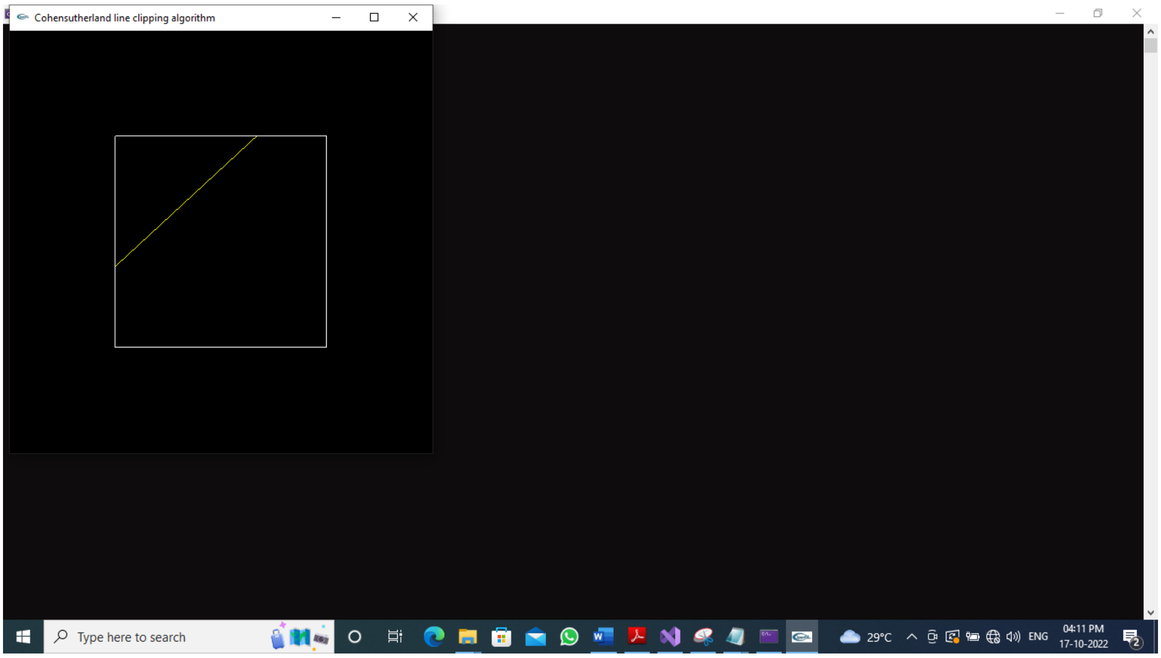
5. Clip a lines using Cohen-Sutherland algorithm
Refer:Text-1: Chapter 6.7
Refer:Text-2: Chapter 8

```
#include<stdio.h>
#include<glut.h>
GLfloat xmin = -0.5, ymin = -0.5, xmax = 0.5, ymax = 0.5;
GLfloat x1 = -0.7, y1 = -0.3, x2 = 0.6, y2 = 0.9;
int LEFT = 1, RIGHT = 2, BOTTOM = 4, TOP = 8;
int c1, c2;
int clip_flag = 0, flag = 1;
int get_code(GLfloat x, GLfloat y)//to compute the region code
{
        int code = 0;
        if (y > ymax)
                code = code | TOP;
        else if (y < ymin)
                code = code | BOTTOM;
        if (x > xmax)
                code = code | RIGHT;
        else if (x < xmin)
                code = code | LEFT;
        return code;
}
void clip()
{
        int c;
        GLfloat x, y;
        if (c1)
                c = c1;
        else
                c = c2;

        if (c & LEFT)
        {
                x = xmin;
                y = y1 + (y2 - y1) * ((xmin - x1) / (x2 - x1));
        }
        if (c & RIGHT)
        {
                x = xmax;
                y = y1 + (y2 - y1) * ((xmax - x1) / (x2 - x1));
        }
        if (c & BOTTOM)
        {
                y = ymin;
                x = x1 + (x2 - x1) * ((ymin - y1) / (y2 - y1));
        }
        if (c & TOP)
        {
                y = ymax;
                x = x1 + (x2 - x1) * ((ymax - y1) / (y2 - y1));
        }
        if (c == c1)
        {
                x1 = x;
                y1 = y;
        }
        else
        {
                x2 = x;
                y2 = y;
        }
}
void display()
{
        glClear(GL_COLOR_BUFFER_BIT);
        glColor3f(1, 1, 1);
        glBegin(GL_LINE_LOOP);
        glVertex2f(xmin, ymin);
        glVertex2f(xmax, ymin);
        glVertex2f(xmax, ymax);
        glVertex2f(xmin, ymax);
        glEnd();
        glColor3f(1, 1, 0);
        if (flag == 1)
        {
                glBegin(GL_LINES);
                glVertex2f(x1, y1);
                glVertex2f(x2, y2);
                glEnd();
        }
        while (1 && clip_flag == 1)
        {
                c1 = get_code(x1, y1);
                c2 = get_code(x2, y2);
                if ((c1 | c2) == 0)
                break;
            else if ((c1 & c2) != 0)
            {
                flag = 0;
                break;
            }
            else clip();
        }
        glFlush();
}
void key(unsigned char ch, int x, int y)
{
        clip_flag = 1;
        glutPostRedisplay();
}
void main(int argc, char** argv)
{
        glutInit(&argc, argv);
        glutInitWindowSize(500, 500);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
        glutCreateWindow("Cohensutherland line clipping algorithm");
        glutDisplayFunc(display);
        glutKeyboardFunc(key);
        glutMainLoop();
}
```

OUTPUT:



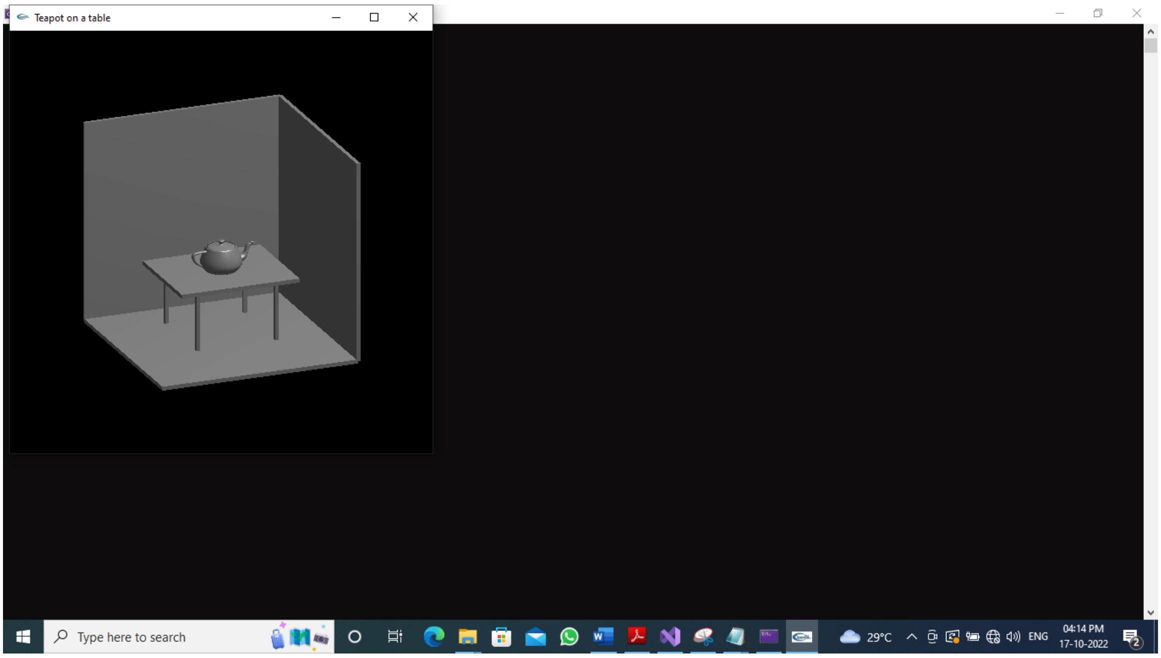
Press any key


Cohensutherland line clipping algorithm
Type here to search
29°C
ENG
04:11 PM
17-10-2022

6.To draw a simple shaded scene consisting of a tea pot on a table. Define suitably the position and properties of the light source along with the properties of the surfaces of the solid object used in the scene.
Refer:Text-2: Topic: Lighting and Shading

```
#include<glut.h>
void teapot(GLfloat x, GLfloat y, GLfloat z)
{
        glPushMatrix(); //save the current state
        glTranslatef(x, y, z); //move your item appropriately
        glutSolidTeapot(0.1); //render your teapot
glPopMatrix(); //get back your state with the recent changes that you have done
}
void tableTop(GLfloat x, GLfloat y, GLfloat z) // table top which is actually a CUBE
{
        glPushMatrix();
        glTranslatef(x, y, z);
        glScalef(0.6, 0.02, 0.5);
        glutSolidCube(1);
        glPopMatrix();
}
void tableLeg(GLfloat x, GLfloat y, GLfloat z) // table leg which is actually a CUBE
{
        glPushMatrix();
        glTranslatef(x, y, z);
        glScalef(0.02, 0.3, 0.02);
        glutSolidCube(1);
        glPopMatrix();
}
void wall(GLfloat x, GLfloat y, GLfloat z) // wall which is actually a CUBE
{
        glPushMatrix();
        glTranslatef(x, y, z);
        glScalef(1, 1, 0.02);
        glutSolidCube(1);
        glPopMatrix();
}
void light() // set the lighting arrangements
{
        GLfloat mat_ambient[] = { 1, 1, 1, 1 }; // ambient colour
        GLfloat mat_diffuse[] = { 0.5, 0.5, 0.5, 1 };
        GLfloat mat_specular[] = { 1, 1, 1, 1 };
        GLfloat mat_shininess[] = { 50.0f }; // shininess value
        glMaterialfv(GL_FRONT, GL_AMBIENT, mat_ambient);
        glMaterialfv(GL_FRONT, GL_DIFFUSE, mat_diffuse);
        glMaterialfv(GL_FRONT, GL_SPECULAR, mat_specular);
        glMaterialfv(GL_FRONT, GL_SHININESS, mat_shininess);
        GLfloat light_position[] = { 2, 6, 3, 1 };
        GLfloat light_intensity[] = { 0.7, 0.7, 0.7, 1 };
        glLightfv(GL_LIGHT0, GL_POSITION, light_position);
        glLightfv(GL_LIGHT0, GL_DIFFUSE, light_intensity);
}
void display()
{
        GLfloat teapotP = -0.07, tabletopP = -0.15, tablelegP = 0.2, wallP = 0.5;
        glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
        glLoadIdentity();
        gluLookAt(-2, 2, 5, 0, 0, 0, 0, 1, 0); // camera position & viewing
        light(); //Adding light source to your project
        teapot(0, teapotP, 0); //Create teapot
        tableTop(0, tabletopP, 0); //Create table’s top
        tableLeg(tablelegP, -0.3, tablelegP); //Create 1st leg
        tableLeg(-tablelegP, -0.3, tablelegP); //Create 2nd leg
        tableLeg(-tablelegP, -0.3, -tablelegP); //Create 3rd leg
        tableLeg(tablelegP, -0.3, -tablelegP); //Create 4th leg
        wall(0, 0, -wallP); //Create 1st wall
        glRotatef(90, 1, 0, 0);
        wall(0, 0, wallP); //Create 2nd wall
        glRotatef(90, 0, 1, 0);
        wall(0, 0, wallP); //Create 3rd wall
        glFlush(); // show the output to the user
}
void init()
{
        glClearColor(0, 0, 0, 1); // black colour background
        glMatrixMode(GL_PROJECTION);
        glLoadIdentity();
        glOrtho(-1, 1, -1, 1, -1, 10);
        glMatrixMode(GL_MODELVIEW);
}
int main(int argc, char** argv)
{
        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
        glutInitWindowSize(500, 500);
        glutInitWindowPosition(0, 0);
        glutCreateWindow("Teapot on a table");
        init();
        glutDisplayFunc(display);
        glEnable(GL_LIGHTING); // enable the lighting properties
        glEnable(GL_LIGHT0); // enable the light source
glShadeModel(GL_SMOOTH); // for smooth shading (select flat or smooth shading)
glEnable(GL_NORMALIZE); // If enabled and no vertex shader is active, normal
//vectors  are normalized to unit length after transformationand beforelighting.
glEnable(GL_DEPTH_TEST); // do depth comparisons and update the depth buffer.
        glutMainLoop();
}
```

OUTPUT:

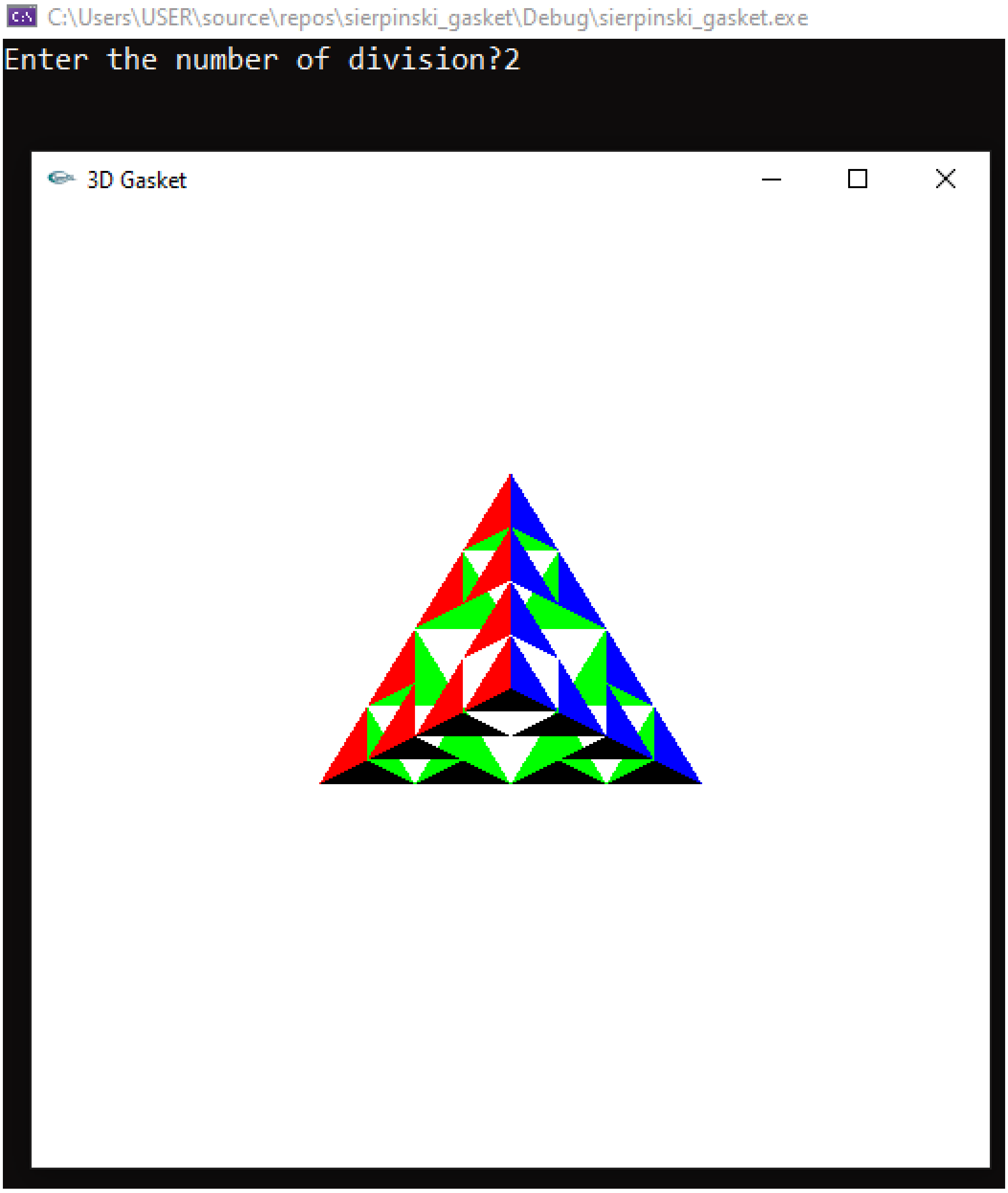


7.Design, develop and implement recursively subdivide a tetrahedron to form 3D sierpinski gasket. The number of recursive steps is to be specified by the user.
Refer: Text-2: Topic: sierpinski gasket.

```
#include<stdlib.h>
#include<stdio.h>
#include<glut.h>

typedef float point[3];
point v[] = { {0.0,0.0,1.0},
                    {0.0,0.9,0.3},
                    {-0.8,-0.4,-0.3},
                    {0.8,-0.4,-0.3} };
int n;
void triangle(point a, point b, point c)
{
        glBegin(GL_POLYGON);
        glVertex3fv(a);
        glVertex3fv(b);
        glVertex3fv(c);
        glEnd();
}
void divide_triangle(point a, point b, point c, int m)
{
        point v1, v2, v3;
        int j;
        if (m > 0)
        {
                for (j = 0; j < 3; j++)
                        v1[j] = (a[j] + b[j]) / 2;
                for (j = 0; j < 3; j++)
                        v2[j] = (a[j] + c[j]) / 2;
                for (j = 0; j < 3; j++)
                        v3[j] = (b[j] + c[j]) / 2;
                divide_triangle(a, v1, v2, m - 1);
                divide_triangle(c, v2, v3, m - 1);
                divide_triangle(b, v3, v1, m - 1);
        }
        else(triangle(a, b, c));
}
void tetrahedron(int m)
{
        glColor3f(1.0, 0.0, 0.0);
        divide_triangle(v[0], v[1], v[2], m);
```

```
	glColor3f(0.0, 1.0, 0.0);
	divide_triangle(v[3], v[2], v[1], m);
	glColor3f(0.0, 0.0, 1.0);
	divide_triangle(v[0], v[3], v[1], m);
	glColor3f(0.0, 0.0, 0.0);
	divide_triangle(v[0], v[2], v[3], m);
}
void display(void)
{
	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glLoadIdentity();
	tetrahedron(n);
	glFlush();
}
void myReshape(int w, int h)
{
	glViewport(0, 0, w, h);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	if (w <= h)glOrtho(-2.0, 2.0, -2.0 * (GLfloat)h / (GLfloat)w, 2.0 * (GLfloat)h /
(GLfloat)w, -10.0, 10.0);
	else
glOrtho(-2.0 * (GLfloat)w / (GLfloat)h, 2.0 * (GLfloat)w / (GLfloat)h, -.0, 2.0, -10.0,
10.0);
	glMatrixMode(GL_MODELVIEW);
	glutPostRedisplay();
}
int main(int argc, char** argv)
{
	printf("Enter the number of division?");
	scanf_s("%d", &n);
	glutInit(&argc, argv);
	glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
	glutInitWindowSize(500, 500);
	glutCreateWindow("3D Gasket");
	glutReshapeFunc(myReshape);
	glutDisplayFunc(display);
	glEnable(GL_DEPTH_TEST);
	glClearColor(1.0, 1.0, 1.0, 1.0);
	glutMainLoop();
}
```

OUTPUT:



C:\Users\USER\source\repos\sierpinski_gasket\Debug\sierpinski_gasket.exe

```
Enter the number of division?2
```

8.Develop a menu driven program to animate a flag using Bezier Curve algorithm

Refer: Text-1: Chapter 8-10

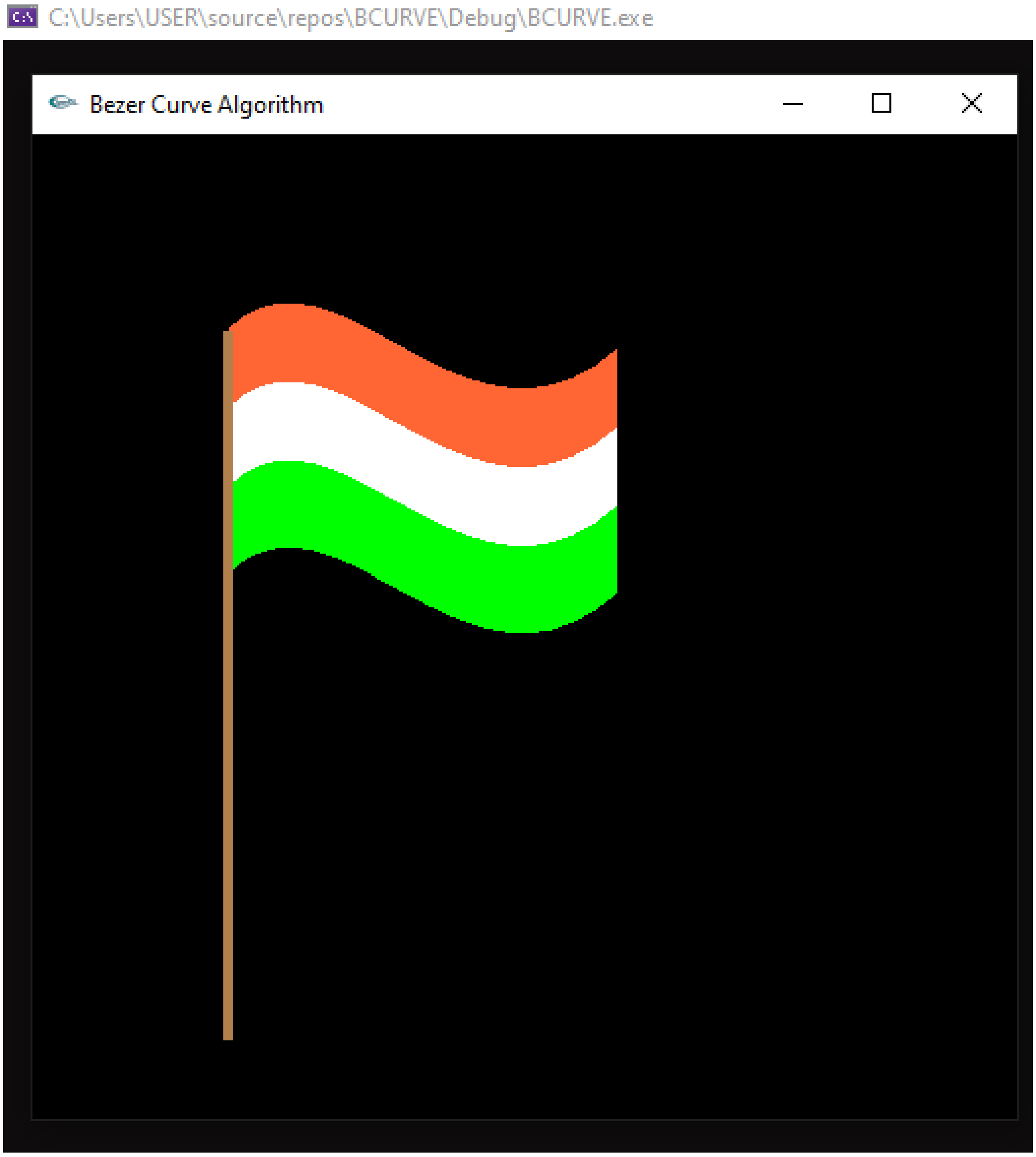
```
#include<stdio.h>
#include<glut.h>
#include<math.h>
#define Pi 3.1416
typedef struct point
{
        GLfloat x, y, z;
};
void bino(int n, int* c)
{
        int k, j;
        for (k = 0; k <= n; k++)
        {
                c[k] = 1;
                for (j = n; j >= k + 1; j--)
                        c[k] *= j;
                for (j = n - k; j >= 2; j--)
                        c[k] /= j;
        }
}
void computebezPt(float u, point* pt1, int cPt, point* pt2, int* c)
{
        int k, n = cPt - 1;
        float bFcn;
        pt1->x = pt1->y = pt1->z = 0.0;
        for (k = 0; k < cPt; k++)
        {
                bFcn = c[k] * pow(u, k) * pow(1 - u, n - k);
                pt1->x += pt2[k].x * bFcn;
                pt1->y += pt2[k].y * bFcn;
                pt1->z += pt2[k].z * bFcn;
        }
}
void bezier(point* pt1, int cPt, int bPt)
{
        point bcPt;
        float u;
        int* c, k;
        c = new int[cPt];
        bino(cPt - 1, c);
        glBegin(GL_LINE_STRIP);
```

```
    for (k = 0; k <= bPt; k++)
    {
        u = float(k) / float(bPt);
        computebezPt(u, &bcPt, cPt, pt1, c);
        glVertex2f(bcPt.x, bcPt.y);
    }
    glEnd();
    delete[]c;
}
float theta = 0;
void display()
{
    glClear(GL_COLOR_BUFFER_BIT);
    int nctrlPts = 4, nBcPts = 20;
    point ctrlPts[4] = { {100,400,0},{150,450,0},{250,350,0},{300,400,0} };
    // for animating the flag
    ctrlPts[1].x += 50 * sin(theta * Pi / 180.0);
    ctrlPts[1].y += 25 * sin(theta * Pi / 180.0);

    ctrlPts[2].x -= 50 * sin((theta + 30) * Pi / 180.0);
    ctrlPts[2].y -= 50 * sin((theta + 30) * Pi / 180.0);

    ctrlPts[3].x -= 25 * sin((theta)*Pi / 180.0);
    ctrlPts[3].y += 25 * sin((theta - 30) * Pi / 180.0);

    theta += 0.2; //animating speed
    glClear(GL_COLOR_BUFFER_BIT);
    glColor3f(1.0, 1.0, 1.0);
    glPointSize(5);
    glPushMatrix();
    glLineWidth(5);
    glColor3f(1.0, 0.4, 0.2); //Indian flag: Saffron color code
    for (int i = 0; i < 50; i++)
    {
        glTranslatef(0.0, -0.8, 0.0);
        bezier(ctrlPts, nctrlPts, nBcPts);
    }
    glColor3f(1, 1, 1);
    for (int i = 0; i < 50; i++)
    {
        glTranslatef(0, -0.8, 0);
        bezier(ctrlPts, nctrlPts, nBcPts);
    }
```

```
        glColor3f(0, 1, 0);
        for (int i = 0; i < 50; i++)
        {
                glTranslatef(0, -0.8, 0);
                bezier(ctrlPts, nctrlPts, nBcPts);
        }
        glPopMatrix();
        glColor3f(0.7, 0.5, 0.3); //pole colour
        glLineWidth(5);
        glBegin(GL_LINES);
        glVertex2f(100, 400);
        glVertex2f(100, 40);
        glEnd();
        glutPostRedisplay();
        glutSwapBuffers();
}
void init()
{
        glMatrixMode(GL_PROJECTION);
        glLoadIdentity();
        gluOrtho2D(0, 500, 0, 500);
}
int main(int argc, char** argv)
{
        glutInit(&argc, argv);
        glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGB);
        glutInitWindowPosition(0, 0);
        glutInitWindowSize(500, 500);
        glutCreateWindow("Bezer Curve Algorithm");
        init();
        glutDisplayFunc(display);
        glutMainLoop();
        return 0;
}
```

O

OUTPUT:


C:\Users\USER\source\repos\BCURVE\Debug\BCURVE.exe
Bezer Curve Algorithm

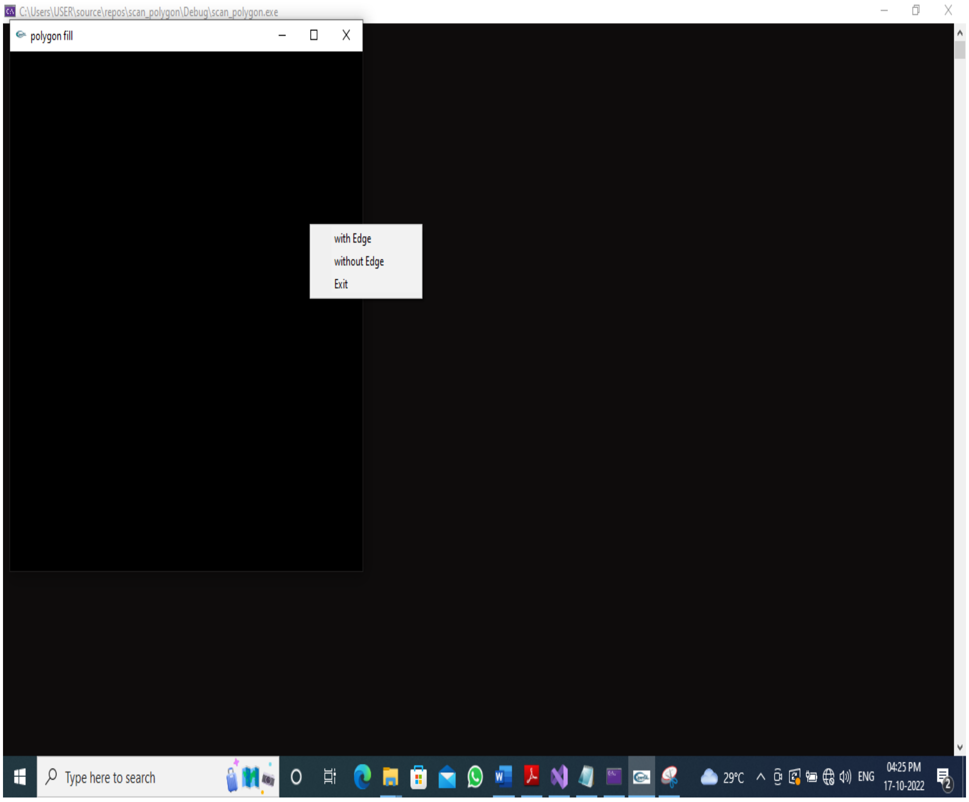
9. Develop a menu driven program to fill the polygon using scan line algorithm

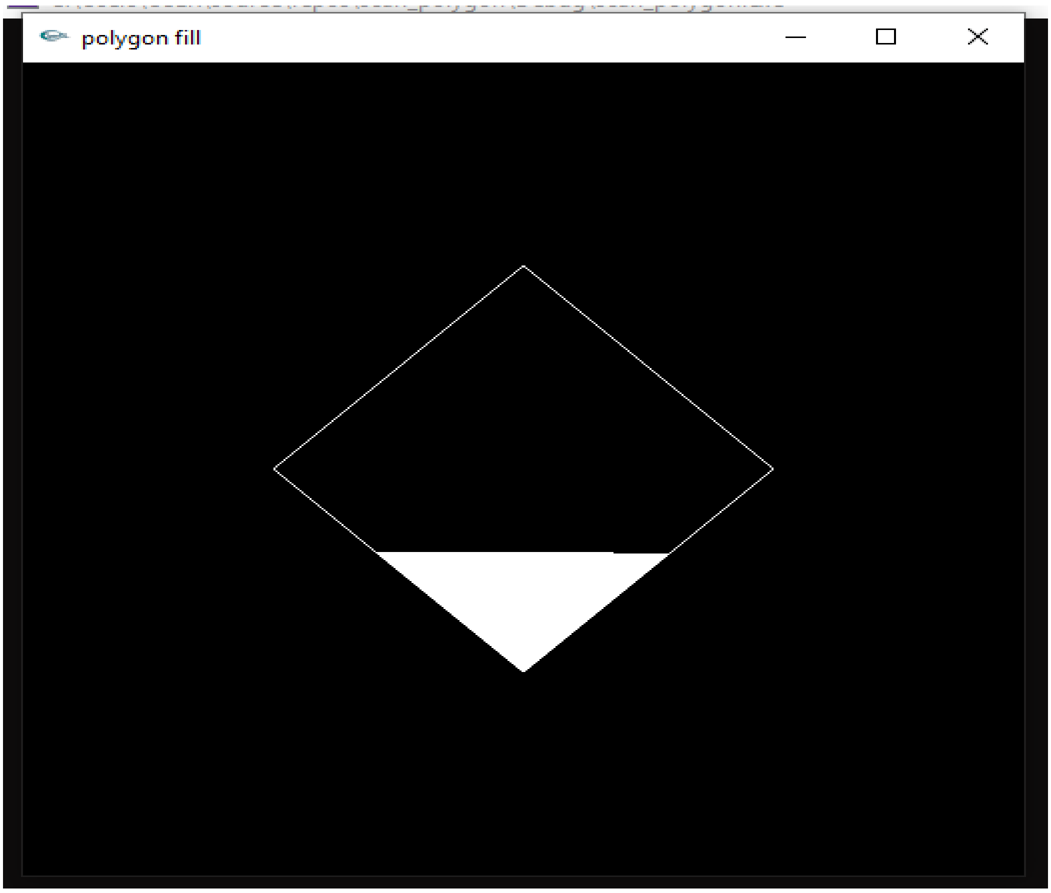
```
#include<stdio.h>
#include<glut.h>
#include<stdlib.h>
float LE[500], RE[500];
int  Edgeflag = 0, FillFlag = 0;
void Menu(int id)
{
	if (id == 1)
		Edgeflag = 1;
	else if (id == 2)
		Edgeflag = 0;
	else if (id == 3)
		exit(0);
	FillFlag = 1;
	glutPostRedisplay();
}
void MyInit()
{
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	gluOrtho2D(0, 500, 0, 500);
	glMatrixMode(GL_MODELVIEW);
	glutCreateMenu(Menu);
	glutAddMenuEntry("with Edge", 1);
	glutAddMenuEntry("without Edge", 2);
	glutAddMenuEntry("Exit", 3);
	glutAttachMenu(GLUT_RIGHT_BUTTON);
}
void intersection_point(GLint x1, GLint y1, GLint x2, GLint y2)
{
	float M, x;
	int t, y;
	if (y1 > y2)
	{
		t = x1;
		x1 = x2;
		x2 = t;
		t = y1;
		y1 = y2;
		y2 = t;
	}
	if ((y2 - y1) == 0)
```

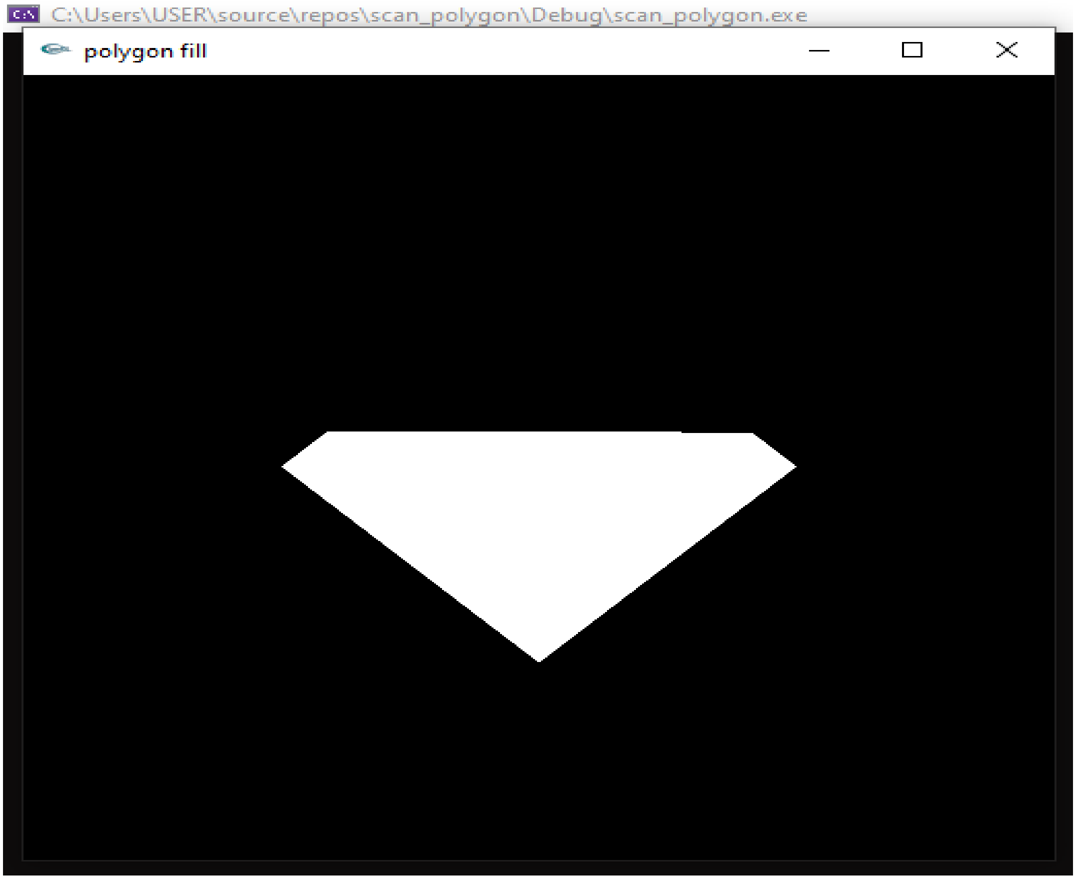
```
                M = (x2 - x1);
        else
                M = (x2 - x1) / (y2 - y1);
        x = x1;
        for (y = y1; y <= y2; y++)
        {
                if (x < LE[y])
                        LE[y] = x;
                if (x > RE[y])
                        RE[y] = x;
        x = x + M;
        }
}
void Draw()
{
        GLint P1[2] = { 125,250 }, P2[2] = { 250,125 }, P3[2] = { 375,250 }, P4[2] = {
250,375 };
        glClear(GL_COLOR_BUFFER_BIT);
        for (int i = 0; i < 500; i++)
        {
                LE[i] = 500;
                RE[i] = 0;
        }
        if (Edgeflag == 1)
        {
                glBegin(GL_LINE_LOOP);
                glVertex2iv(P1);
                glVertex2iv(P2);
                glVertex2iv(P3);
                glVertex2iv(P4);
                glEnd();
        }
        intersection_point(P1[0], P1[1], P2[0], P2[1]);
        intersection_point(P2[0], P2[1], P3[0], P3[1]);
        intersection_point(P3[0], P3[1], P4[0], P4[1]);
        intersection_point(P4[0], P4[1], P1[0], P1[1]);
        if (FillFlag == 1)
        {
                for (int y = 0; y < 500; y++)
                {
                        for (int x = LE[y]; x < RE[y]; x++)
                        {
                                glBegin(GL_POINTS);
```

```
                                        glVertex2i(x, y);
                                        glEnd();
                                        glFlush();
                              }
                    }
          }
          glFlush();
}
int main(int argc, char** argv)
{
          glutInit(&argc, argv);
          glutInitDisplayMode(GLUT_RGB | GLUT_SINGLE);
          glutInitWindowSize(500, 500);
          glutInitWindowPosition(10, 50);
          glutCreateWindow("polygon fill");
          MyInit();
          glutDisplayFunc(Draw);
          glutMainLoop();
          return 0;
}
```

OUTPUT:




polygon fill


C:\Users\USER\source\repos\scan_polygon\Debug\scan_polygon.exe
polygon fill