SCHOOL OF COMPUTER SCIENCE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
DEHRADUN, UTTARAKHAND

COMPUTER GRAPHICS
LABORATORY FILE
(2024-2025)

For
Vth Semester

Submitted To:
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[Vth Semester]
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LAB EXPERIMENT – 5

Viewing and Clipping

[Geographical Animation for demonstration]

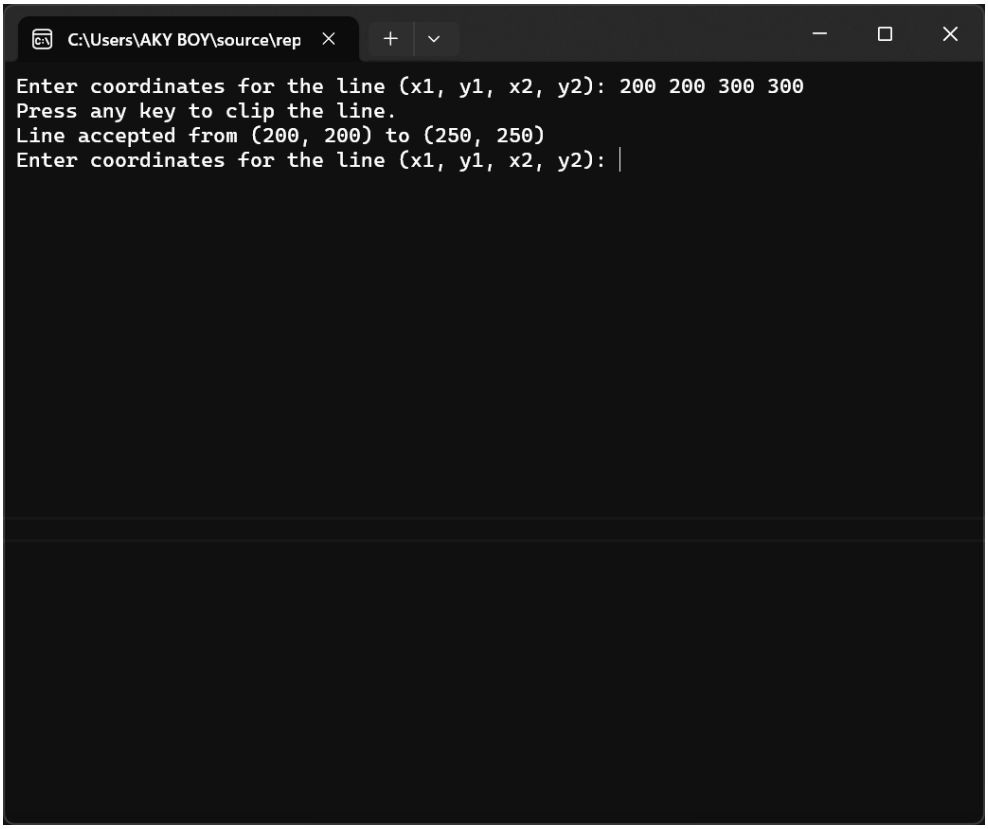
 # Take the window coordinates as input from the user, also take polygon coordinates as input.

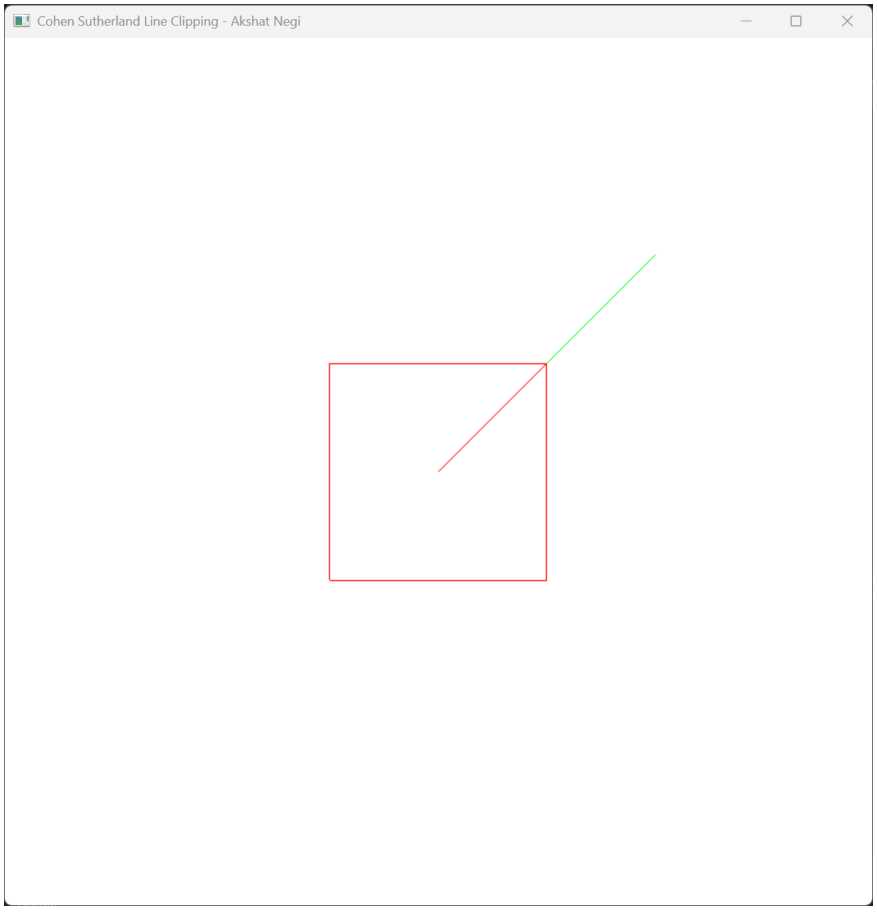
a. Write an interactive program for line clipping using Cohen Sutherland line clipping algorithm.

```
#include <GL/freeglut.h>
#include <iostream>
using namespace std;

// Defining region codes
const int INSIDE = 0;  // 0000
const int LEFT = 1;    // 0001
const int RIGHT = 2;   // 0010
const int BOTTOM = 4;  // 0100
const int TOP = 8;     // 1000

// Defining x_max, y_max, x_min, y_min for clipping rectangle
const int x_max = 250;
const int y_max = 250;
const int x_min = 150;
const int y_min = 150;

// Function to compute region code for a point (x, y)
int computeCode(double x, double y) {
    int code = INSIDE;

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

    return code;
}

// Function to draw the clipping boundary
void drawBoundary() {
    glColor3f(1.0, 0.0, 0.0); // Red color for the boundary
    glBegin(GL_LINE_LOOP);
    glVertex2f(x_min, y_min);
    glVertex2f(x_max, y_min);
    glVertex2f(x_max, y_max);
    glVertex2f(x_min, y_max);
    glEnd();
}

// Function to draw a line with specific color
void drawLine(float x1, float y1, float x2, float y2, float r, float g, float b)
{
    glColor3f(r, g, b); // Set the color for the line
    glBegin(GL_LINES);
    glVertex2f(x1, y1);
```

```
    glVertex2f(x2, y2);
    glEnd();
}

// Cohen-Sutherland Line Clipping Algorithm
void cohenSutherlandClip(double x1, double y1, double x2, double y2) {
    int code1 = computeCode(x1, y1);
    int code2 = computeCode(x2, y2);

    bool accept = false;

    while (true) {
        if ((code1 == 0) && (code2 == 0)) {
            // If both endpoints lie within the rectangle
            accept = true;
            break;
        }
        else if (code1 & code2) {
            // If both endpoints are outside the rectangle in the same region
            break;
        }
        else {
            // Some segment of the line lies within the rectangle
            int code_out;
            double x, y;

            if (code1 != 0) code_out = code1;
            else code_out = code2;

            // Find intersection point
            if (code_out & TOP) {
                x = x1 + (x2 - x1) * (y_max - y1) / (y2 - y1);
                y = y_max;
            }
            else if (code_out & BOTTOM) {
                x = x1 + (x2 - x1) * (y_min - y1) / (y2 - y1);
                y = y_min;
            }
            else if (code_out & RIGHT) {
                y = y1 + (y2 - y1) * (x_max - x1) / (x2 - x1);
                x = x_max;
            }
            else if (code_out & LEFT) {
                y = y1 + (y2 - y1) * (x_min - x1) / (x2 - x1);
                x = x_min;
            }

            // Replace the point outside the rectangle with the intersection
point
            if (code_out == code1) {
                x1 = x;
                y1 = y;
                code1 = computeCode(x1, y1);
            }
            else {
                x2 = x;
                y2 = y;
                code2 = computeCode(x2, y2);
            }
        }
    }

    if (accept) {
```

```
        cout << "Line accepted from (" << x1 << ", " << y1 << ") to (" << x2 <<
", " << y2 << ")\n";
        drawLine(x1, y1, x2, y2, 1.0, 0.0, 0.0); // Draw the clipped line in red
    }
    else {
        cout << "Line rejected\n";
    }
}

// Function to display the content
void display() {
    glClear(GL_COLOR_BUFFER_BIT);  // Clear the screen

    drawBoundary();  // Draw the clipping boundary

    // Prompt the user for input coordinates
    double x1, y1, x2, y2;
    cout << "Enter coordinates for the line (x1, y1, x2, y2): ";
    cin >> x1 >> y1 >> x2 >> y2;

    drawLine(x1, y1, x2, y2, 0.0, 1.0, 0.0);  // Draw the original line in green

    cout << "Press any key to clip the line.\n";
    cohenSutherlandClip(x1, y1, x2, y2);  // Clip the line

    glFlush();  // Render now
}

// Function to set up OpenGL projection and modelview matrices
void init() {
    glClearColor(1.0, 1.0, 1.0, 1.0); // Set background color to white
    glMatrixMode(GL_PROJECTION);
    gluOrtho2D(0, 400, 0, 400);  // Define the 2D orthographic projection
}

int main(int argc, char** argv) {
    // Initialize GLUT
    glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(800, 800);  // Set the window size
    glutCreateWindow("Cohen Sutherland Line Clipping - Akshat Negi");  // Create
the window
    init();  // Initialize OpenGL state

    // Register display callback function
    glutDisplayFunc(display);

    // Enter the GLUT event processing loop
    glutMainLoop();

    return 0;
   }
```


C:\Users\AKY BOY\source\rep
Enter coordinates for the line (x1, y1, x2, y2): 200 200 300 300
Press any key to clip the line.
Line accepted from (200, 200) to (250, 250)
Enter coordinates for the line (x1, y1, x2, y2):

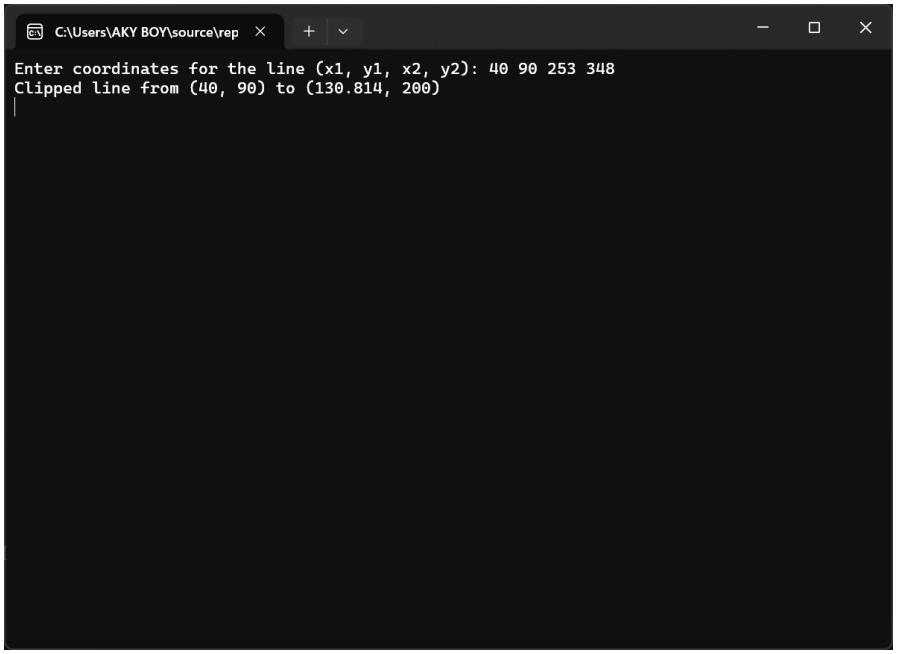

Cohen Sutherland Line Clipping - Akshat Negi

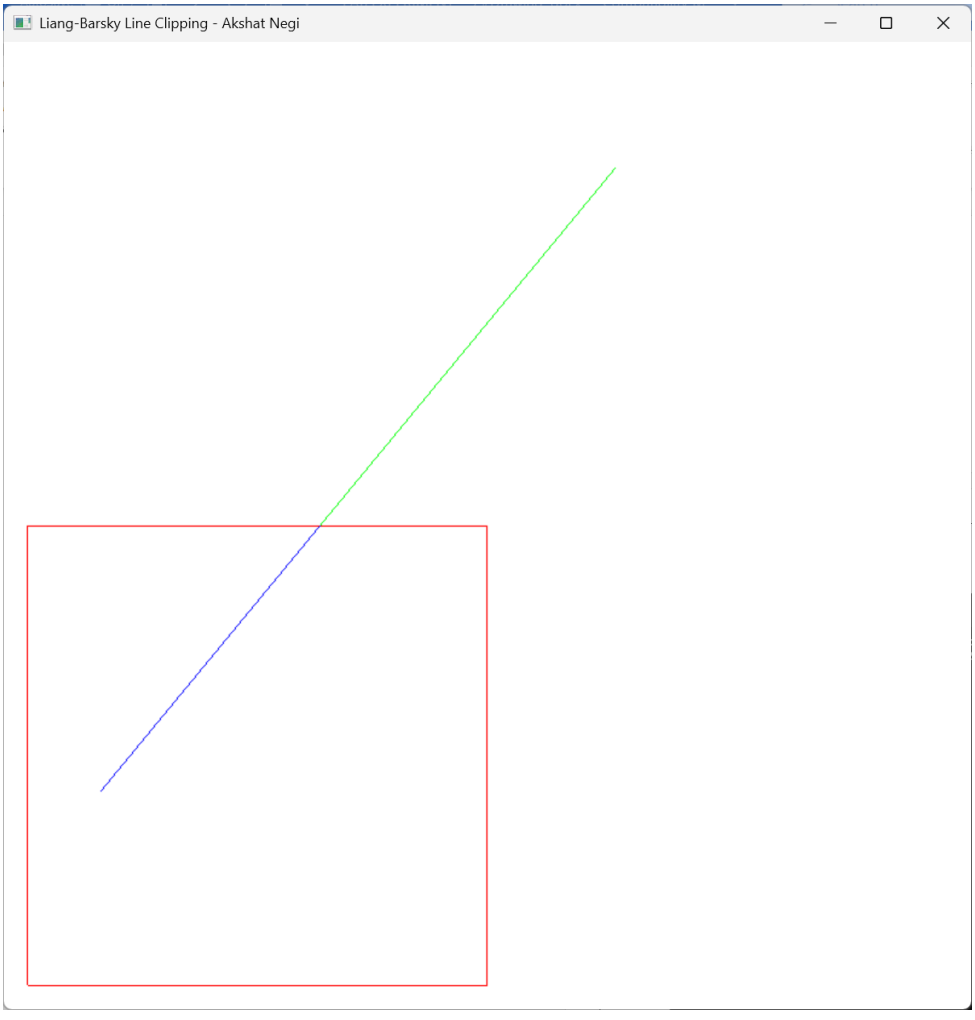
b. Write an interactive program for line clipping using Liang-Barsky line clipping algorithm.

```
#include <GL/freeglut.h>
#include <iostream>
using namespace std;

// Defining the clipping window boundaries
const int x_min = 10;
const int x_max = 200;
const int y_min = 10;
const int y_max = 200;

// Function to draw a line with specified color
void drawLine(float x1, float y1, float x2, float y2, float r, float g, float b)
{
    glColor3f(r, g, b); // Set color for the line
    glBegin(GL_LINES);
    glVertex2f(x1, y1);
    glVertex2f(x2, y2);
    glEnd();
}

// Liang-Barsky Line Clipping Algorithm
bool liangBarskyClip(double& x1, double& y1, double& x2, double& y2) {
    double t0 = 0.0, t1 = 1.0;
    double dx = x2 - x1;
    double dy = y2 - y1;

    auto clipTest = [&](double p, double q) {
        if (p == 0) {
            if (q < 0) return false;
        }
        else {
            double t = q / p;
            if (p < 0) {
                if (t > t1) return false;
                if (t > t0) t0 = t;
            }
            else {
                if (t < t0) return false;
                if (t < t1) t1 = t;
            }
        }
        return true;
        };

    // Clip against each boundary
    if (!clipTest(-dx, x1 - x_min) || !clipTest(dx, x_max - x1) ||
        !clipTest(-dy, y1 - y_min) || !clipTest(dy, y_max - y1)) {
        return false;
    }

    // Update the points based on t0 and t1
    if (t1 < 1.0) {
        x2 = x1 + t1 * dx;
        y2 = y1 + t1 * dy;
    }
    if (t0 > 0.0) {
        x1 = x1 + t0 * dx;
        y1 = y1 + t0 * dy;
    }
```

```
    return true;
}

// Function to display the content
void display() {
    glClear(GL_COLOR_BUFFER_BIT);  // Clear the screen

    // Draw the clipping boundary (rectangle)
    glColor3f(1.0, 0.0, 0.0); // Red color for the boundary
    glBegin(GL_LINE_LOOP);
    glVertex2f(x_min, y_min);
    glVertex2f(x_max, y_min);
    glVertex2f(x_max, y_max);
    glVertex2f(x_min, y_max);
    glEnd();

    // Prompt the user for input coordinates
    double x1, y1, x2, y2;
    cout << "Enter coordinates for the line (x1, y1, x2, y2): ";
    cin >> x1 >> y1 >> x2 >> y2;

    // Draw the original line in green
    drawLine(x1, y1, x2, y2, 0.0, 1.0, 0.0);

    // Apply Liang-Barsky clipping
    bool isClipped = liangBarskyClip(x1, y1, x2, y2);

    if (isClipped) {
        // Draw the clipped line in blue and print clipped coordinates
        cout << "Clipped line from (" << x1 << ", " << y1 << ") to (" << x2 << ",
" << y2 << ")\n";
        drawLine(x1, y1, x2, y2, 0.0, 0.0, 1.0);  // Draw the clipped line in
blue
    }
    else {
        // Line is outside the window
        cout << "Line is outside the clipping window.\n";
    }

    glFlush();  // Render now
}

// Function to set up OpenGL projection and modelview matrices
void init() {
    glClearColor(1.0, 1.0, 1.0, 1.0); // Set background color to white
    glMatrixMode(GL_PROJECTION);
    gluOrtho2D(0, 400, 0, 400);  // Define the 2D orthographic projection
}

int main(int argc, char** argv) {
    // Initialize GLUT
    glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(800, 800);  // Set the window size
    glutCreateWindow("Liang-Barsky Line Clipping - Akshat Negi");  // Create the
window
    init();  // Initialize OpenGL state

    // Register display callback function
    glutDisplayFunc(display);

    // Enter the GLUT event processing loop
    glutMainLoop();
```

```
    return 0;
}
```


C:\Users\AKY BOY\source\rep
Enter coordinates for the line (x1, y1, x2, y2): 40 90 253 348
Clipped line from (40, 90) to (130.814, 200)

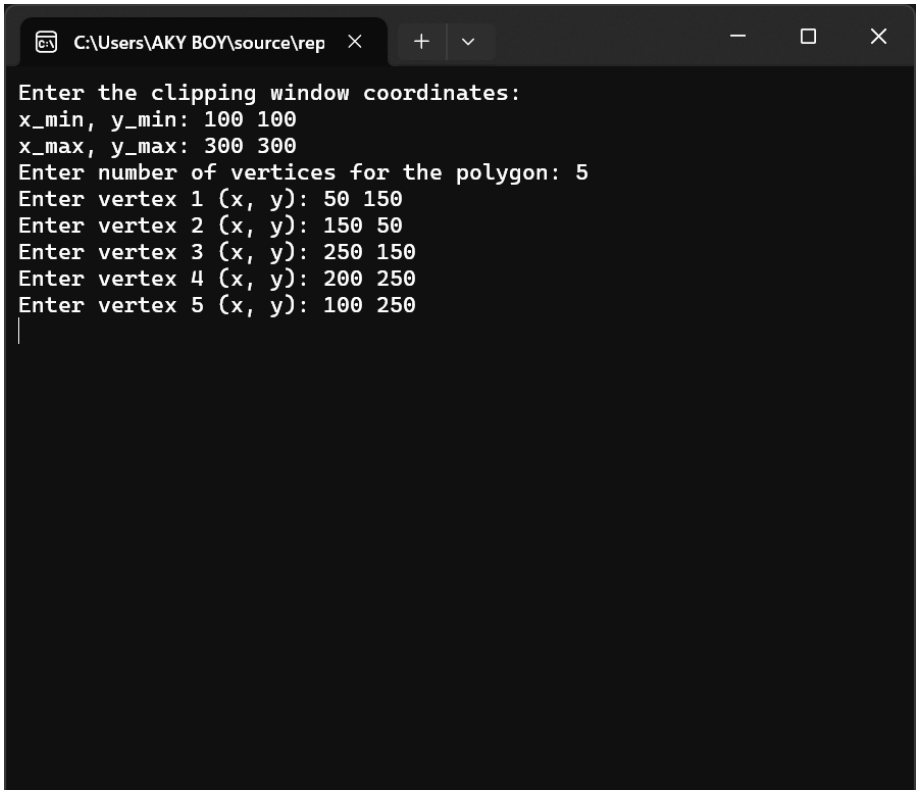

Liang-Barsky Line Clipping - Akshat Negi

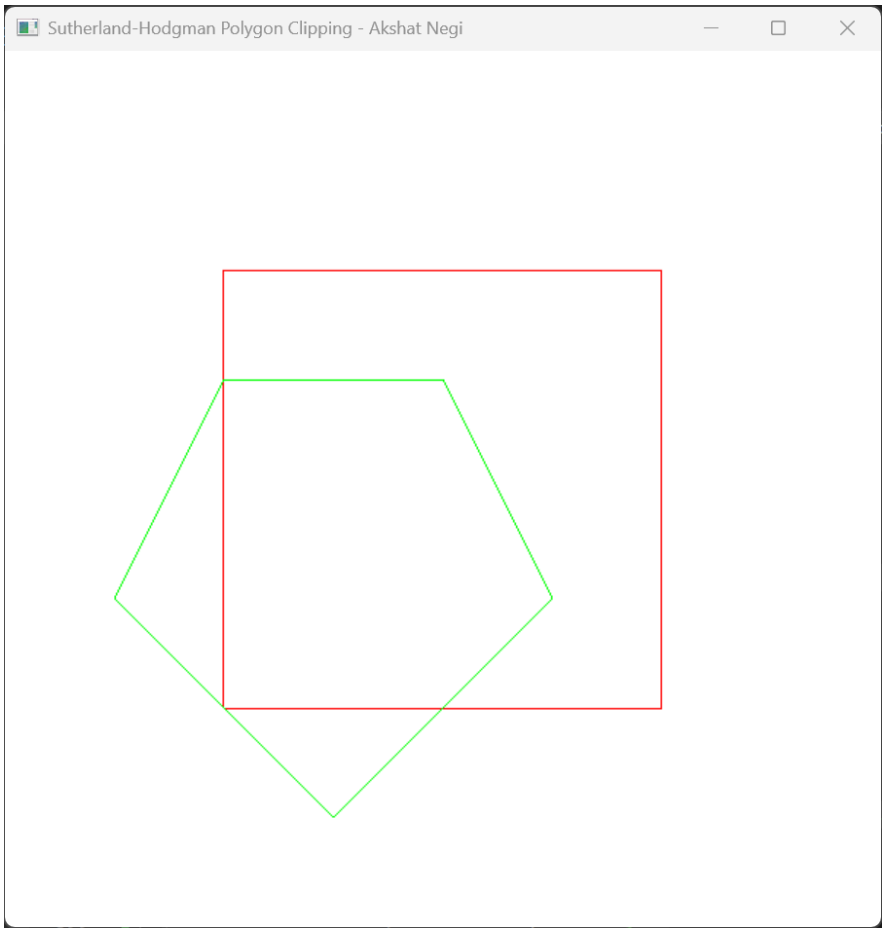
c. Write an interactive program for polygon clipping using Sutherland – Hodgeman polygon clipping algorithm.

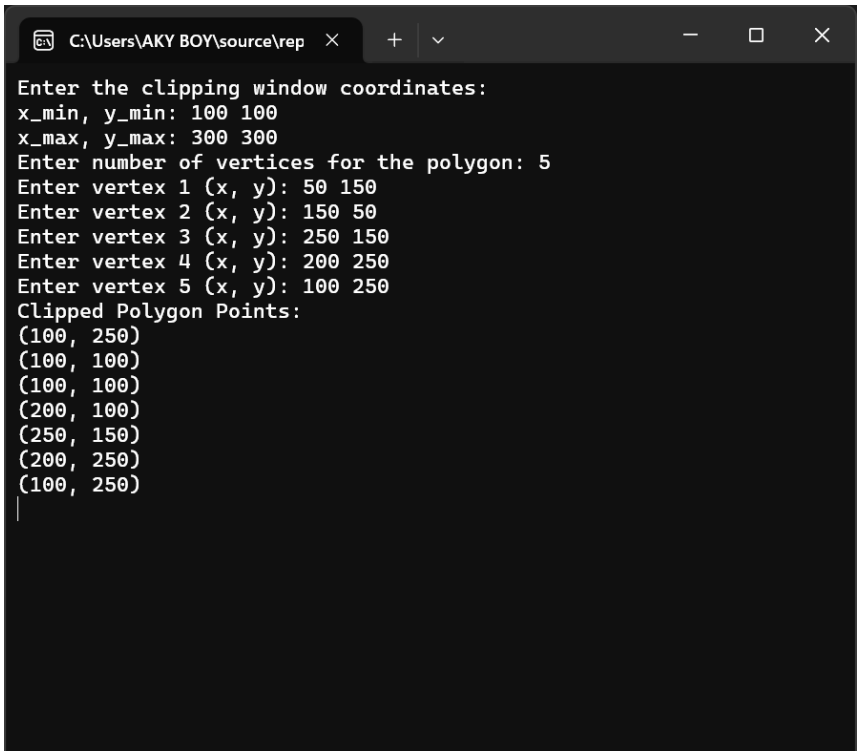
```
#include <GL/freeglut.h>
#include <iostream>
#include <vector>
using namespace std;

struct Point {
    float x, y;
};

// Global variables for the clipping window boundaries
int x_min, y_min, x_max, y_max;
vector<Point> polygon;
vector<Point> clippedPolygon;

// Function to draw a polygon
void drawPolygon(const vector<Point>& poly, float r, float g, float b) {
    glColor3f(r, g, b);
    glBegin(GL_LINE_LOOP);
    for (const auto& p : poly) {
        glVertex2f(p.x, p.y);
    }
    glEnd();
}

// Function to check if a point is inside the clipping boundary
bool inside(const Point& p, int edge) {
    switch (edge) {
    case 0: return p.x >= x_min;  // Left
    case 1: return p.x <= x_max;  // Right
    case 2: return p.y >= y_min;  // Bottom
    case 3: return p.y <= y_max;  // Top
    }
    return true;
}

// Function to compute the intersection point with a clipping edge
Point intersect(const Point& p1, const Point& p2, int edge) {
    Point intersection;
    float m;

    if (p2.x != p1.x)
        m = (p2.y - p1.y) / (p2.x - p1.x);  // Slope of the line

    switch (edge) {
    case 0: // Left edge
        intersection.x = x_min;
        intersection.y = p1.y + m * (x_min - p1.x);
        break;
    case 1: // Right edge
        intersection.x = x_max;
        intersection.y = p1.y + m * (x_max - p1.x);
        break;
    case 2: // Bottom edge
        intersection.y = y_min;
        if (p2.x != p1.x)
            intersection.x = p1.x + (y_min - p1.y) / m;
        else
            intersection.x = p1.x;
        break;
    case 3: // Top edge
```

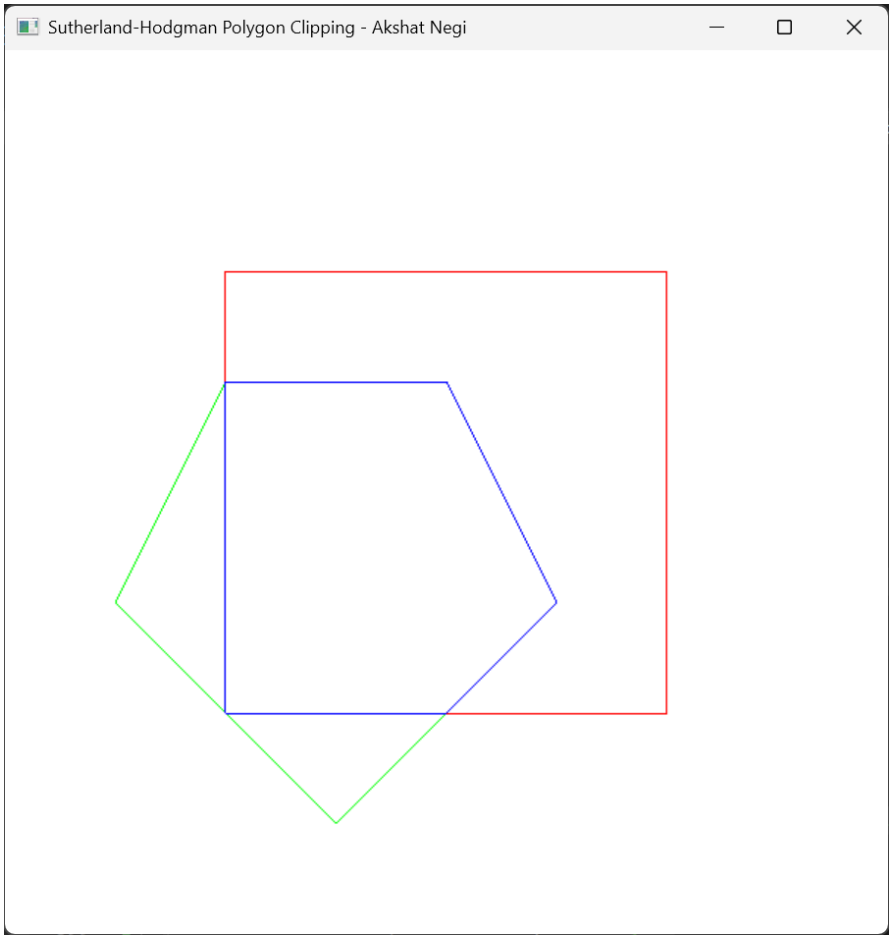
```
            intersection.y = y_max;
            if (p2.x != p1.x)
                intersection.x = p1.x + (y_max - p1.y) / m;
            else
                intersection.x = p1.x;
            break;
        }
        return intersection;
    }

    // Sutherland-Hodgman Polygon Clipping Algorithm
    vector<Point> sutherlandHodgmanClip(const vector<Point>& input, int edge) {
        vector<Point> output;
        Point s = input.back();  // Start with the last point

        for (const auto& e : input) {
            if (inside(e, edge)) { // Case 1: End point is inside
                if (!inside(s, edge)) // Case 1.1: Start point is outside
                    output.push_back(intersect(s, e, edge));  // Add intersection
    point
                output.push_back(e);  // Add end point
            }
            else if (inside(s, edge)) { // Case 2: End point is outside, start is
    inside
                output.push_back(intersect(s, e, edge));  // Add intersection point
            }
            s = e;
        }
        return output;
    }

    // Clipping function to clip the polygon against all four edges
    void clipPolygon() {
        clippedPolygon = polygon;
        for (int edge = 0; edge < 4; edge++) {
            clippedPolygon = sutherlandHodgmanClip(clippedPolygon, edge);
        }

        // Print the clipped polygon points to the console
        cout << "Clipped Polygon Points:\n";
        for (const auto& point : clippedPolygon) {
            cout << "(" << point.x << ", " << point.y << ")\n";
        }
    }

    // Display function to render the polygons
    void display() {
        glClear(GL_COLOR_BUFFER_BIT);

        // Draw clipping window (rectangle)
        glColor3f(1.0, 0.0, 0.0);  // Red color for the boundary
        glBegin(GL_LINE_LOOP);
        glVertex2f(x_min, y_min);
        glVertex2f(x_max, y_min);
        glVertex2f(x_max, y_max);
        glVertex2f(x_min, y_max);
        glEnd();

        // Draw original polygon
        drawPolygon(polygon, 0.0f, 1.0f, 0.0f);  // Green color

        // Draw clipped polygon
        drawPolygon(clippedPolygon, 0.0f, 0.0f, 1.0f);  // Blue color
```

```
    glFlush();
}

// Keyboard callback function
void handleKeypress(unsigned char key, int x, int y) {
    if (key == 'c') {
        clipPolygon();
        glutPostRedisplay();  // Request redisplay
    }
    else if (key == 27) {  // ESC key
        exit(0);
    }
}

// Setup OpenGL
void initGL() {
    glClearColor(1.0, 1.0, 1.0, 1.0); // Set background color to white
    glMatrixMode(GL_PROJECTION);
    gluOrtho2D(0, 400, 0, 400); // Define 2D orthographic projection
}

void inputPolygon() {
    int numVertices;
    cout << "Enter number of vertices for the polygon: ";
    cin >> numVertices;

    polygon.clear();
    for (int i = 0; i < numVertices; i++) {
        Point p;
        cout << "Enter vertex " << i + 1 << " (x, y): ";
        cin >> p.x >> p.y;
        polygon.push_back(p);
    }
}

void inputClippingWindow() {
    cout << "Enter the clipping window coordinates:\n";
    cout << "x_min, y_min: ";
    cin >> x_min >> y_min;
    cout << "x_max, y_max: ";
    cin >> x_max >> y_max;
}

int main(int argc, char** argv) {
    // User inputs
    inputClippingWindow();
    inputPolygon();

    // Initialize GLUT and display
    glutInit(&argc, argv);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
    glutInitWindowSize(600, 600);
    glutCreateWindow("Sutherland-Hodgman Polygon Clipping - Akshat Negi");

    initGL();
    glutDisplayFunc(display);
    glutKeyboardFunc(handleKeypress);
    glutMainLoop();

    return 0;
}
```


C:\Users\AKY BOY\source\rep
Enter the clipping window coordinates:
x_min, y_min: 100 100
x_max, y_max: 300 300
Enter number of vertices for the polygon: 5
Enter vertex 1 (x, y): 50 150
Enter vertex 2 (x, y): 150 50
Enter vertex 3 (x, y): 250 150
Enter vertex 4 (x, y): 200 250
Enter vertex 5 (x, y): 100 250


Sutherland-Hodgman Polygon Clipping - Akshat Negi


C:\Users\AKY BOY\source\rep
Enter the clipping window coordinates:
x_min, y_min: 100 100
x_max, y_max: 300 300
Enter number of vertices for the polygon: 5
Enter vertex 1 (x, y): 50 150
Enter vertex 2 (x, y): 150 50
Enter vertex 3 (x, y): 250 150
Enter vertex 4 (x, y): 200 250
Enter vertex 5 (x, y): 100 250
Clipped Polygon Points:
(100, 250)
(100, 100)
(100, 100)
(200, 100)
(250, 150)
(200, 250)
(100, 250)


Sutherland-Hodgman Polygon Clipping - Akshat Negi