Instructions:

This is a closed book exam. One 8.5 x 11 page of notes are allowed. Calculators can be used for numerical calculations only (not as electronic notebooks). Please write neatly and sign your name to your exam. Raise your hand if you have any questions.

Name: ____________________

Line Clipping (20 points)

Assume that you have a 2D line segment with endpoints (x1,y1) and (x2,y2). Describe how the Cohen-Sutherland algorithm can be used to clip this line segment against the window defined by the lines x=x_min, y=y_min, x=x_max, and y=y_max.

- Draw a diagram to illustrate outcodes and explain how they are used in the clipping process.
- What happens if both (x1,y1) and (x2,y2) are inside the clipping window?
- What happens if both (x1,y1) and (x2,y2) are above the line y=y_max?
- What happens when x1<x_min and x2>x_min?

Line Drawing (20 points)

Consider the following line drawing code:

```plaintext
int Image[10][10];
void draw_line1(int x1, int y1, int x2, int y2, int value)
{
    // Calculate step size
    int dx = x2 - x1;
    int dy = y2 - y1;
    double step = (double)dy / (double)dx;

    // Draw line
    double y = y1 + 0.5;
    for (int x=x1; x<=x2; x++, y += step)
        Image[(int)y][x] = value;
}
```

- Draw a picture to show which pixels are modified when we draw a line from (3,3) to (7,9).
- How many floating point operations (+, -, *, /) are needed to draw this line?
- What would happen if the line we draw has dy>dx?
- What would happen if the line we draw has dx<0?
Hidden Surface Removal (20 points)

Assume that you are given N convex polygons with (x,y,z) coordinates for each vertex.

- Describe the basic idea behind the painters algorithm for hidden surface removal.
- Describe the basic idea behind the Z-buffer algorithm for hidden surface removal.
- Give one advantage of the painters algorithm over the Z-buffer algorithm.
- Give one advantage of the Z-buffer algorithm over the painters algorithm.

Texture Mapping (20 points)

Assume that you are given the following image of the earth without clouds. Describe how you could use texture mapping to create a sphere that looks like the earth.

- How you would break the sphere into 100 polygons?
- How you would map the texture onto these polygons?
- What are the steps in using texture mapping using OpenGL?
- Describe how bump mapping could be used to make your model more realistic.