

# Exam 1. Cmps 160. Fall 2001

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NAME: \_\_\_\_\_ LOGIN: \_\_\_\_\_

## Useful Information – Read This First

### READ THIS FIRST.

The exam is closed book, closed note, no calculators. I will provide scrap paper if needed.

Write on the exam any information that explains your reasoning toward the answer, if you think it may help toward part credit. Always show your work. If you just give the final answer with no indication of how you got it, you may not get credit.

Think about the problem rather than blindly throwing mathematics at it. There might be an obvious solution.

## 1 Linear Algebra (? points)

1. Find a vector of length 1 that is perpendicular (normal) to these two vectors:  $(.707, 0, .707)$  and  $(-.707, 0, .707)$ .
2. Find the angle in degrees between these two vectors:  $(0.707, 0.0, 0.707)$  and  $(-0.707, 0.0, 0.707)$ .
3. What is the length of this vector?  $(1, 2, 3)$ .

4. What is the result of multiplying the vector  $(1,2,1)$  times the matrix

$$\begin{pmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

5. What is the result of multiplying these two matrices (the top times the bottom): the matrix

$$\begin{pmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \\ 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

## 2 Line Drawing (? points)

1. Why is Bresenham's algorithm considered such a good way to draw lines?
2. You are using Bresenham's algorithm to draw a line whose end points are (0,1) and (5,2). You have just decided that for pixel column  $x + 1$ , you set pixel (1,1). The present value of  $F(x,y)$  is -3. What is the next value of  $F(x,y)$ ?

## 3 3D Clipping (15 points)

A line runs from  $V0 = (-1,-1,0)$  to  $V1 = (1,1,1)$ .

A 3D window for parallel orthographic projection is defined by

$xwmin = 0; xwmax = 2;$

$ywmin = -1; ywmax = 1;$

$zwmin = 0; zwmax = 1;$

A. What are the Cohen-Sutherland clipping codes for the vertices, using this order: (4 points)

.....Top.....Bottom...Right....Left.....Front....Back

V0

V1

B. What is the parametric equation of the line? (6 points)

C. What are the line endpoints after it is clipped against the window boundaries in 3D? (5 points)

## 4 Fill Algorithms (? points)

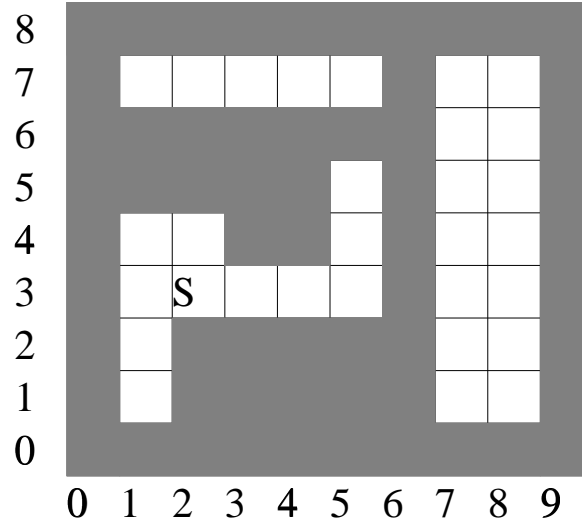
Using a recursive boundary fill algorithm and a seed of (2,3) for the following picture, how many times will pixel (3,3) be examined to check its color. (The traversal is 4-connected.) Assume the boundary color is dark grey.

## 5 ScanLine Algorithms (? points)

You are scan-converting a triangle with vertices  $V0=(3,6)$ ,  $V1=(5,4)$ ,  $V2=(3,2)$ . Edge A goes from  $V0$  to  $V1$ . Edge B goes from  $V1$  to  $V2$ . Edge C goes from  $V2$  to  $V3$ .

a. Show the data structures at the beginning of the scan. Also what y-bucket is each edge associated with? (? points)

Ybucket?                  Ymax                  X                  Delta X



b. What is the active edge list at scan line 5? That is, at the time when that scanline is about to be displayed. (? points)

Ybucket?                  Ymax                  X                  Delta X

## 6 Window to Viewport Transformations (10 points)

A line is from  $V_0 = (50,0)$  to  $V_1 = (200,400)$ .

The window is defined by

$x_{wmin} = -100$ ;  $x_{wmax} = 200$ ;  $y_{wmin} = -200$ ;  $y_{wmax} = 400$ ;

The viewport is defined on a 1000 x 1000 screen by

$u_{min} = 500$ ;  $u_{max} = 1000$ ;  $v_{min} = 0$ ;  $v_{max} = 1000$ ;

Give me the location of the line endpoints in viewport coordinates. Show your reasoning.