NAME:

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Computer Science 426 Exam 1
25 Oct 2001

This test is 8 questions, of equal weight. Do all of your work on these pages (use the back for scratch space), giving the answer in the space provided. This is a closed-book exam -- you may use one-page of notes with writing on both sides during the exam. **Put your name on every page, and write out and sign the Honor Code pledge before turning in the test.**

``I pledge my honor that I have not violated the Honor Code during this examination."

Question	Score
1	
2	
3	
4	
5	
6	
7	
8	
Total:	

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Q1: Colors

(a) Draw the RGB color cube, labeling the corners of the cube and the color axes. Also show where gray colors appear in the cube.

(b) Draw the CMY color cube, labeling the corners of the cube and the color axes. Also show where gray colors appear in the cube.

(c) What is the meaning of the pre-multiplied (R, G, B, A) tuple (0.0, 0.25, 0.25, 0.5)?

(d) Representing colors as pre-multiplied (R, G, B, A) tuples, what color do we get if we composite (0.0, 0.25, 0.25, 0.5) OVER (1.0, 0.0, 1.0, 1.0)?

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Q2: Modeling Transformations

For each of the following cases, write a single 4x4 matrix that applies the given transformation to any arbitrary 3D point (x, y, z, 1). Assume that points to be transformed are represented as a column vectors and they are left-multiplied by the matrix. If it is impossible to define a matrix for the given transformation, say so and explain why.

(a) Transform (x, y, z, 1) to (x+3, -2y, 2z - 4, 1).

(b) Transform (x, y, z, 1) to (x+y/2, y, z, 1).
Also, what is the name for this kind of transformation?

(c) Rotate (x, y, z, 1) by Θ degrees around the Z axis (clockwise when viewed in the Z direction).

(d) Transform (x, y, z, 1) to (x, yz, 0, 1).

(e) Scale (x, y, z, 1) by a factor S around the point C = (1, 2, -3, 1)
(you may leave your answer as a product of matrices):

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Q3: Lighting

(a) With the Lambertian model for ideal diffuse reflection, how does the intensity of reflected light vary as the angle to the **light** changes with respect to the surface normal?

(b) With the Lambertian model for ideal diffuse reflection, how does the intensity of reflected light vary as the angle to the **viewer** changes with respect to the surface normal?

In the Phong reflectance model, the equation for intensity of light emanating from a surface is:

$$I = I_E + K_A I_{AL} + \sum_i (K_D (N \bullet L_i) I_i + K_S (V \bullet R_i)^n I_i)$$

(c) What does the exponent 'n' describe? (*one short sentence*)

(d) What is a physical explanation for the term $K_A I_{AL}$? (*one short sentence*)

(e) Describe a (non-transmissive) surface material whose reflectance properties are **not** well characterized by the Phong model.

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Q4: Projection

(a) Draw four pictures of a rectangular box. From left to right, the drawings should be in (1) one-point, (2) two-point, and (3) three-point perspective, and (4) orthographic projection.

(b) Write out the 4x4 perspective projection matrix that projects from 3D camera coordinates into screen coordinates:

$$\begin{bmatrix} x_s \\ y_s \\ z_s \\ w_s \end{bmatrix} = \begin{bmatrix} ? & ? & ? & ? \\ ? & ? & ? & ? \\ ? & ? & ? & ? \\ ? & ? & ? & ? \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix}$$

(c) In a typical hardware implementation of the 3D polygon-rendering pipeline, when we perform the perspective projection (above in b) why do we compute z_s even though the screen is 2D? (*one short sentence*)

(d) What is the difference between orthographic and oblique projection? (*one short sentence*)

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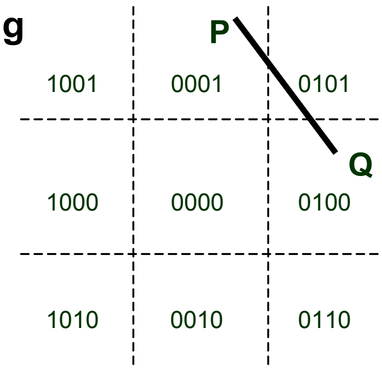
Q5: Cohen-Sutherland Line Clipping



(a) How are bit codes assigned to the regions? *(one or two short sentences)*

(b) What rule is applied to the bit codes of the endpoints of a line segment to trivially **accept** it? *(one short sentence)*

(c) What rule is applied to the bit codes of the endpoints of a line segment to trivially **reject** it? **Why?** *(one or two short sentences)*

(d) For the given segment PQ, concisely trace the steps followed by the Cohen-Sutherland clipping algorithm to clip the segment, assuming endpoint P is initially chosen.

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Q6: Visibility

Specify whether the following visibility algorithms operate with object-space precision or image-space (pixel) precision by writing the letter ‘O’ or ‘I’ next to each.

(a) back-face culling:

(b) depth-sort:

(c) z-buffer:

(d) ray casting:

(e) Warnock's area subdivision:

(f) scan-line:

(g) Briefly describe Warnock's area subdivision algorithm. Support your answer with a picture.

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Q7: Image Processing

(a) What is aliasing? (*one sentence*)

(b) Why is the sinc filter useful for avoiding aliasing in image processing applications? (*one sentence*)

(c) Why don't we use the sinc filter in practice in image processing applications? (*one sentence*)

(d) When warping an image, we use either forward mapping or reverse mapping. Describe two problems with forward mapping (*two sentences*).

(e) In the Beier & Neely feature-based image warp, why is it important not to cross the feature lines (*one or two sentences*)?

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Q8: Scan conversion

(a) Describe a way to test whether a point is inside a triangle. (*one or two sentences*)

(b) Can this "inside triangle test" be applied to arbitrary polygons? (*Explain in one short sentence*.)

(c) What modifications must be made to the **sweep-line** algorithm for scan converting triangles in order to apply it to arbitrary polygons?

(d) What approach is normally implemented in modern graphics systems for scan-converting arbitrary polygons? (*one sentence*)