Spring 2012 Midterm

CS184 - Foundations of Computer Graphics

University of California at Berkeley

- **Write your name HERE:___________________________**
- **Write your login HERE:___________________________**
- **Closed book.**
- **You may not use any notes or printed/electronic materials.**
- **No calculators.**
- **In class, 1 hour and 15 minutes.**
- **14 pages: 1 cover, 13 question pages.**

Question	Points	Score
1. Transformations	20	
2. Color and Gamma Correction	20	
3. OpenGL and Shading	20	
4. B-Spline and Bezier Curves	20	

1. Transformations [20]

Note: sin(45°) = cos(45°) = $1/\sqrt{2}$. You can leave your answers in terms of $\sqrt{2}$. There is no need to compute numerical values. Note that many of the questions below build on previous answers. Please show your reasoning, so partial credit can be given even if the earlier answer is not correct. This last advice applies to all of the questions on this test.

Consider the following transformations:

(1) A translation along the Y axis by +3 units

(2) A rotation along the Z axis by 45 degrees

a) Write down the 4x4 homogeneous transformation matrix for both operations

(i) Translation Matrix			

(ii) Rotation Matrix			

b) Write down the combined transformation matrix when (i) you first apply the translation (1) and then the rotation (2), and (ii) you do the opposite, first applying the rotation (2) and translation (1)

Hint: You may either use matrix multiplication or remember the discussion in class on combining rotations and translations.

(i) Translation then rotation			

(ii) Rotation then translation			

c) Now derive the transformation matrix for rotating by 45 degrees about the Z-axis, with the center of rotation being not the origin, but a point on the Y axis (0,+3,0). Hint: You will need to appropriately combine transformations (1) and (2) above.

d) How is the transformation of normals different from the transformation of positions (i.e., how are the two transformation matrices related)? What will be the normal transformation matrix corresponding to (c)?

Answer: (please be short)

e) Write down the inverse transformation matrix for (c).

Work sheet

2. Color and Gamma Correction [20]

Let us say your monitor has a gamma of 2.0 and you are trying to display a color from your computer graphics program (that operates on a linear scale) with RGB color [1.0, 0.5, 0.5].

a) What will be the color value actually displayed by the monitor? Is this the value you originally intended?

b) (i) Is the overall intensity of the color value displayed brighter or darker than the intended value? (ii) Is the displayed color more or less saturated than the intended value? *Saturation is a measure of how close a color is to a "pure" color, such as a primary color like red, as opposed to white. A fully saturated color will be a pure primary. A fully desaturated color will be white.*

c) How would you gamma correct the color to display the originally intended value? What is the gamma corrected RGB color? Verify that it would be displayed correctly.

d**) In general, does gamma correction (with a normal value of gamma greater than 1.0) increase or decrease intensity?** (consider the full range of intensities; the answer is subtly different for low, mid and high intensities). **Does gamma correction increase or decrease color saturation? Explain your answer.**

3. OpenGL and Shading [20]

Consider writing a fragment program to compute diffuse and specular lighting on a surface from a single point light. The inputs to the fragment program are the interpolated normal N, vertex position X, modelview matrix M, projection matrix P, and point light located at L in eye coordinates. The light color is C, diffuse reflection color is D, specular reflection color is S, and shininess is A. Use the Blinn-Phong half-angle form for the specular reflection, as in homework 2.

There are a number of steps in writing the fragment program to compute the shading, some of which are listed below.

a) Viewing Direction

b) Diffuse Shading Formula

c) Model View Matrix for position

d) Normal calculation

e) Lighting Direction

f) Dehomogenization

g) Projection Matrix for position

h) Final shading

i) Half angle calculation

j) Specular Shading Formula

Your goal is to put the steps in order, and for each provide a brief explanation (1-2 lines) of what the step is, and give a formula for what happens. (To be more precise, it is recommended you provide GLSL code or pseudocode, but exact syntax is not required). When reading your answer together, one should get a very good sense of all the steps involved in lighting (and if you provide GLSL code, the full pseudocode).

Question 3 answer sheet

1. (   )

2. (   )

3. (   )

4. (   )

5. (   )

6. (   )

7. (   )

8. (   )

9. (   )

10. (   )

4. B-Spline and Bezier Curves [20] (part (c) and (d) on page 12)

Consider a uniform quadratic B-spline curve with control points at (-2,0), (0,2), (2,0) in that order.

Note: the grids are provided for work sheet, not part of the answer.

a) What are the end-points of the curve?

b) What is the mid-point?

c) What are the control points for a Bezier curve that generates the same curve as the B-Spline above (this follows directly from the above)? Verify that the mid-point of the resulting Bezier curve matches the midpoint for the B-Spline curve in (b).

Work sheet

d) What are the control points for the left and right halves of the Bezier curve (per the deCasteljau subdivision scheme)?

e) What are the corresponding B-spline control points for the left and right halves of the uniform B-spline curve? (i.e., what B-spline control points would match left and right halves from (d))?

Work sheet

Work sheet