CS 638 - Fall 1999 - Computer Graphics

Final Exam

Please be sure to write your CS login on every page!

This exam is closed book and closed notes.

You will have the full exam period to complete the test.

If you need additional space for your answers, please use the back of the page. If you do use the back of a page please indicate this on the front.

It is acceptable to leave results in fractional form, or as irrational numbers.

NOTES:

All angle measurements are in degrees, measured counter clockwise.
Unless otherwise stated, rotation and scale transforms rotate about the origin.
Unless otherwise stated, assume the "post-multiply" convention for matrix transforms.

Useful Facts:

$\sin(30) = 1/2$ $\quad\quad$ $\cos(45) = 1/\sqrt{2}$

$\cos(30) = \sqrt{3}/2$ $\quad\quad$ $\sin(45) = 1/\sqrt{2}$

$\tan(30) = 1/\sqrt{3}$ $\quad\quad$ $\tan(45) = 1$

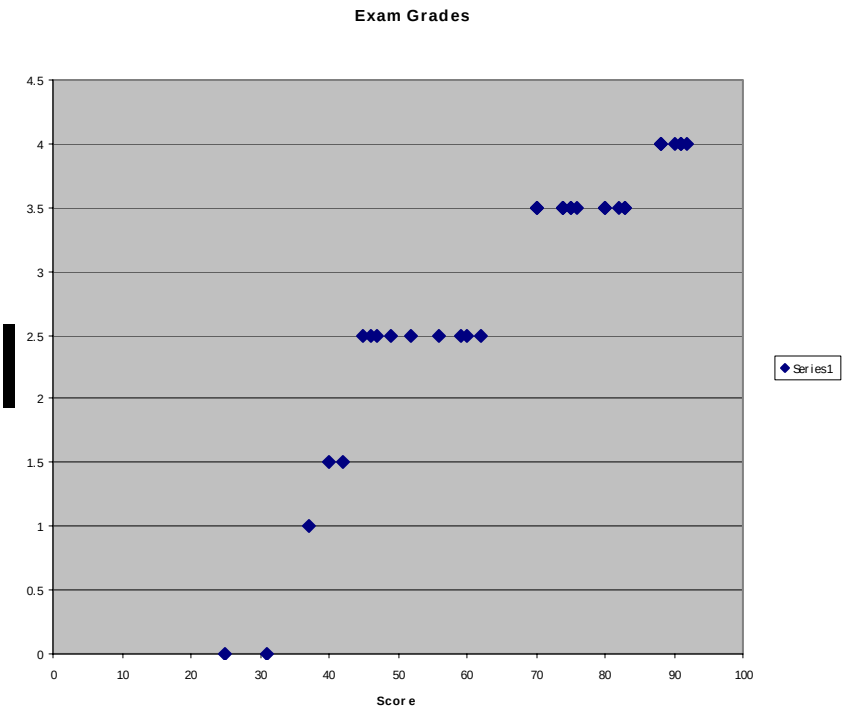
Scoring

Question 1	___ / 14 pts	**mean was 10**
Question 2	___ / 16 pts	**mean was 8**
Question 3	___ / 20 pts	**mean was 14**
Question 4	___ / 14 pts	**mean was 11**
Question 5	___ / 12 pts	**mean was 10**
Question 6	___ / 24 pts	**mean was 13**

Total: **Mean was 66/100, Median was 74/100**

A 70 earned an AB. 60% of the class earned that score or better

To compute your final grade, we added .2 to the average of the 5 course parts (projects, exam, quiz & homeworks) before rounding.


Exam Grades
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
100
Score
Series1

Question 1: Lighting and Shading

Note: in this problem, all objects are in the XY plane (e.g. have Z=0)
A camera is placed along the X axis with its focal point at the point (10,0,0).
An object is at the origin (0,0,0). The object's surface normal at the origin is (1,1,0) (45 degrees between the X and Y axis).

For the following questions, use the "standard" Phong lighting model (such as used in OpenGL or discussed in class).

A point light source is to be placed in the ceiling, 10 units above the origin. Thus, its Y component will be 10 and its X and Z components may vary.

1.A: Where would you place the light source such that the diffuse component of the illumination of the point at the origin is as bright as possible?

10,10,0 (along the normal, in the ceiling)

1.B: Where would you place the light source such that the specular component of the illumination of the point at the origin is as bright as possible?

0,10,0 (along the origin, in the ceiling - the 45 degree normal bisects the light and eye ray)

The focal point of the camera is raised to the point $(10, \frac{10}{\sqrt{3}}, 0)$, but is still pointing at the origin. The angle of the camera's line of sight is 30 degrees above the X axis.

1.C: Does the answer to 1.A change? If so, what is the new position of the light?
NO
1.D: Does the answer to 1.B change? If so, what is the new position of the light?
YES, (10/sqrt(3),10,0)

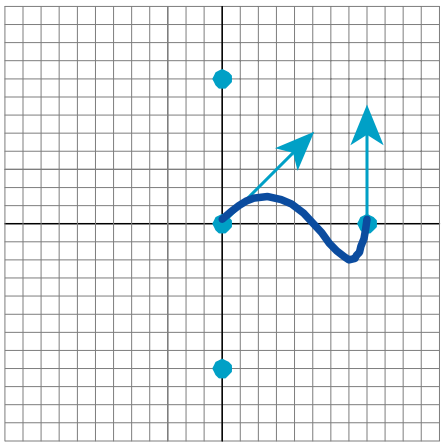
Question 2: Splines

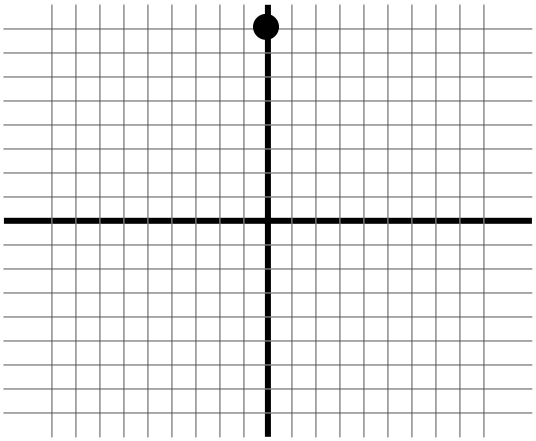
Recall that a Catmull-Rom Spline is a type of cardinal cubic spline (specifically one with tension = 0).

It's matrix is given by: $\begin{bmatrix} -1/2 & 3/2 & -3/2 & 1/2 \\ 1 & -5/2 & 2 & -1/2 \\ -1/2 & 0 & 1/2 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$

A segment of the curve in 2D (with u ranging from 0 to 1) has its 4 control points given by (0,-8), (0,0), (8,0), (0,8).

A. Sketch the curve segment: (hint: draw the tangents. Do not compute exact values)





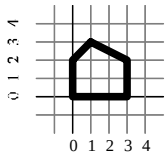
Points given for: knowing the curve connects points 1 and 2, drawing the tangents, having the approximate shape (curve crosses the X axis)

B. Where is the point that is halfway in parameter space (e.g. u=.5)? (compute its value)

(4.5, 0), compute $\begin{bmatrix} u^3 & u^2 & u & 1 \end{bmatrix}$ (for u=.5) times the matrix above times the two column vectors made from the Ps.

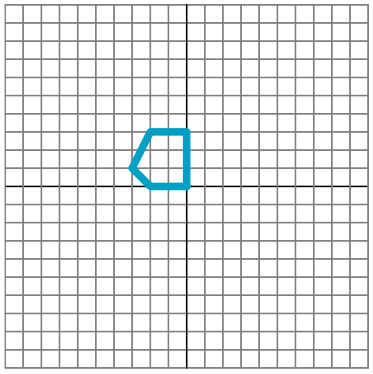
Question 3: Transformations

Given the following picture of a house: (note that it is NOT symmetric)

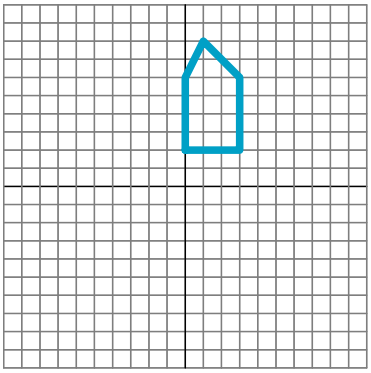


Sketch the house after applying the following transformations:

NOTE: there was an ambiguity in this problem as to whether the operations are applied in reverse order (as if it were GL code) or in "normal" order. We expected the normal order, but would have given credit for the other.



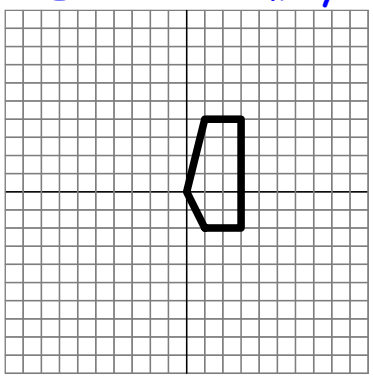
1. Translate(2,0)
2. Rotate(90)
3. Translate(0,-2)



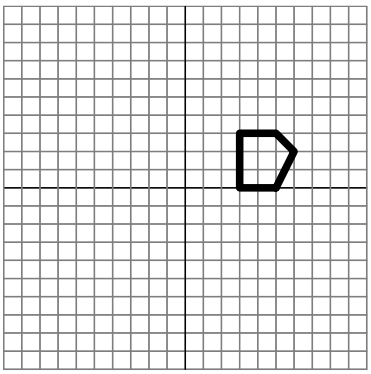
1. Rotate(-90)
2. Scale(2,1)
3. Translate(2,0)
4. Rotate(90)

Write a sequence of Rotate, Scale, and Translate transformations (such as what is given in parts A and B) to apply to the house to put it into this configuration. You should not need to use all of the lines given.

NOTE: there are many answers to these



trans -1, -3
rot 90
scale 1,2



rot -90
trans 3,3

Question 4: Short Answer

4A: Name two methods for drawing lines. Which is better for a hardware implementation, and why?

Bresenham's algorithm, DDA, Midpoint Method, Slope-Intercept Formula

Almost everyone got that Bresenham's algorithm is better since it is integer only and/or requires no division.

4B: Ordered dithering and Floyd-Steinberg error diffusion provide two methods for creating a bi-level image from a continuous tone one. Give two reasons why one might be better than the other.

Some people said the O.D. is better since it is cheaper to compute and didn't push the errors to the edge.

Other would say that FS is better since it better distributes the error, is less likely to alias thin lines away, is less likely to give visible patterns, or a few other things.

4C: Describe a situation where the order that objects are drawn matters when using a Z-Buffer hidden surface technique.

Order matters when either there are transparent objects or co-planar objects (or, more generally, objects with the same Z value).

Note: objects that overlap in depth are a problem for the Painter's algorithm, not for Z-buffering.

Question 5: Matching

Match the task in the left column to the most appropriate method on the right.

_**D**_ Reduce an image by a factor of 2
_**B**_ Enlarge an image by a factor of 2
_**E**_ Extract a Matte
_**F**_ Compute Global Illumination
_**A**_ Draw reflections on a shiny surface
_**C**_ Choose a color map for an image

A. Environment Maps
B. Point sampling followed by convolution
C. Median-Cut Algorithm
D. Convolution followed by point sampling
E. Blue Screening
F. Radiosity

Question 6: Multiple Multiple Choice

Choose ALL of the correct responses. There may be zero, one, or several correct answers.

6.A: Soft Shadows:
A. Are caused by using blurry shadow maps.
B. Are created by point light sources.
C. Are sometimes approximated by using many point light sources.
D. Use transparency or alpha-blending to give a less blocky look.

C - although, if you picked at most one of the others we gave you partial credit.

6.B A color printer prints using the 3 subtractive primary colors. If it is unable to print red, what color(s) of ink might it have run out of?
A. Red
B. Cyan
C. Magenta
D. Blue
E. Green
F. Yellow

C and F. Partial credit for getting 1 of the 2. Picking B is technically not wrong (since there is no way to no if it ran out of Cyan ink), so it would not have been marked wrong (providing you got C and F).

6.C The HLS color space is designed to:
A. Be easier for artists to use than RGB.
B. Directly apply to standard computer monitors.
C. Express all colors in terms of a small set of primary colors.
D. Model the human perceptual system for GAMUT comparisons.

A only.

6.D. Which of the following curves always interpolate their control points:
A. Cardinal cubic splines
B. Cubic B-Splines
C. Some types of C2 cubic splines with local control
D. Some types of C1 cubic splines with local control

A and D. Partial credit if you only picked one of the two.

6.E Which of the following are symptoms of aliasing:
A. A Zebra's black and white stripes appear gray when its picture is reduced in size.
B. A Ray-Tracer doesn't show a small object.
C. A Zebra's stripes become blurry when a picture is enlarged.

B Answer A is ambiguous, so we ignore whether you picked it or not.

6.F A 3D Rotation
A. Can represent a mirror reflection about any axis.
B. Cannot be represented by a set of numbers without a singularity.
C. Can always be represented by a rotation about the Z axis, followed by a rotation about the X axis, followed by another rotation about the Z axis.

C