Name: ID#: Grade:

CSE 332 - Midterm 2 Exam
Fall 2004

This exam is closed book and notes, no cheat sheet is allowed. Please do all the problems, at least in part. This way you can gather partial credit. If you have to calculate a result, don't just write down a number. Show your path of thought and show both symbolic and numerical results where applicable. This way, in case you miscalculate, I can at least give you points for the correct approach. Good luck!!

1. Warm-Up

a) In what cases may you get aliasing (mark all that apply)?
___ When you reduce the size of (subsample) an image that is uniformly red.
___ When you reduce the size of (subsample) an image that shows vertical red stripes.
___ When you enlarge an image that shows vertical red stripes.
___ When you smooth an image that shows vertical red stripes.
___ When you reduce the size of (subsample) an image that shows horizontal blue stripes.
___ When you run an edge filter mask over an image that shows horizontal blue stripes.

b) How can you prevent aliasing in these cases?
___ Blur before you perform the operation.
___ Blur after you performed the operation.
___ Avoid the operation altogether.

c) What is the better interpolation method?
___ Nearest neighbor interpolation
___ Closest color interpolation
___ Trilinear interpolation.
___ Parallel coordinate interpolation
___ Tristimulus interpolation

d) What is a normal vector (mark all that apply)?
___ A vector that according to a Gallup poll is the vector most widely known.
___ A vector with 3 components (x,y,z).
___ A vector of unit length.
___ A vector that is perpendicular to a surface.
___ A vector that can be found using methods that are similar to smoothing in images.
___ A vector that can be found using methods that are similar to edge detection in images.

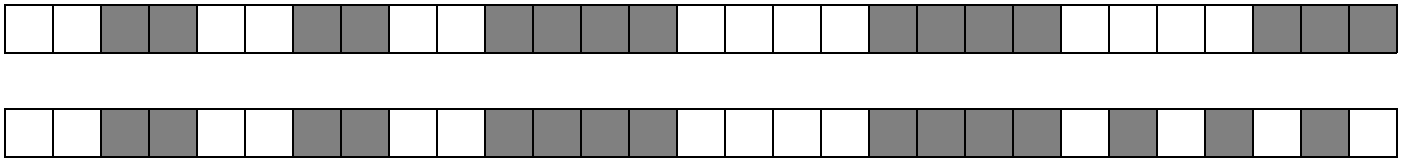
e) Where does the positive y-axis point in the following figure?
Draw it into the figure.
What is the direction of positive rotation around the x-axis.
Draw this into the figure as well.

z-axis, pointing towards you

f) If the opacity of an object is 0.3, what is its transparency ?

2. Anti-aliasing

Consider the following two 1D images:



Fill in this table (recall frequency = 1 / period length):

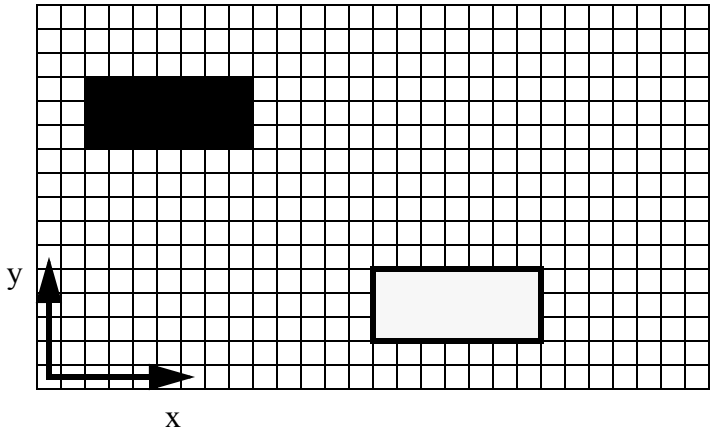
	highest spatial frequency	lowest spatial frequency	highest subsampling rate without aliasing	will blurring reduce aliasing when subsampling rate is 2 (yes/no)?
upper image				
lower image				

3. Transformations

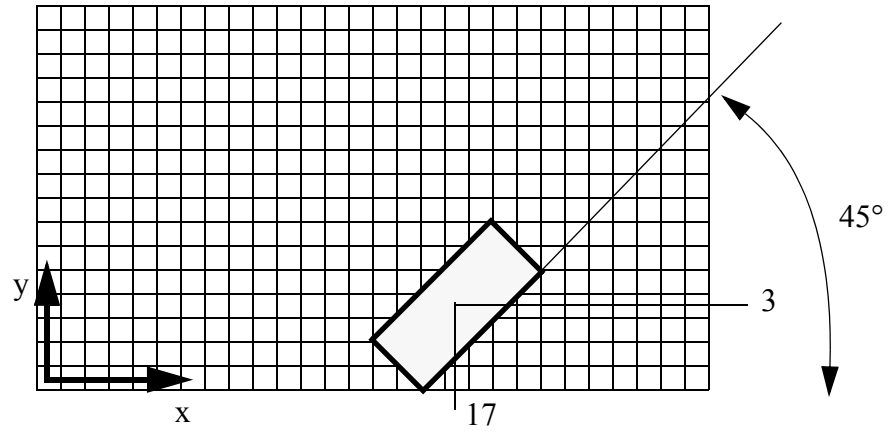
For all tasks below, write down the transformations (in matrix form) that are necessary and multiply the lower left vertex coordinates of the transformed body with it. You don't have to perform the actual calculations, multiplications, etc. Just write down what needs to be done, in matrix form. But be sure to fill in the numerical values.

For the following figures, note that the origin of the coordinate system is in the center of the (0,0) cell.

a) Draw the translation vector that moves the dark body into the new position (grey body). Write down the transformation matrix and multiply the lower left vertex of the dark body with it.



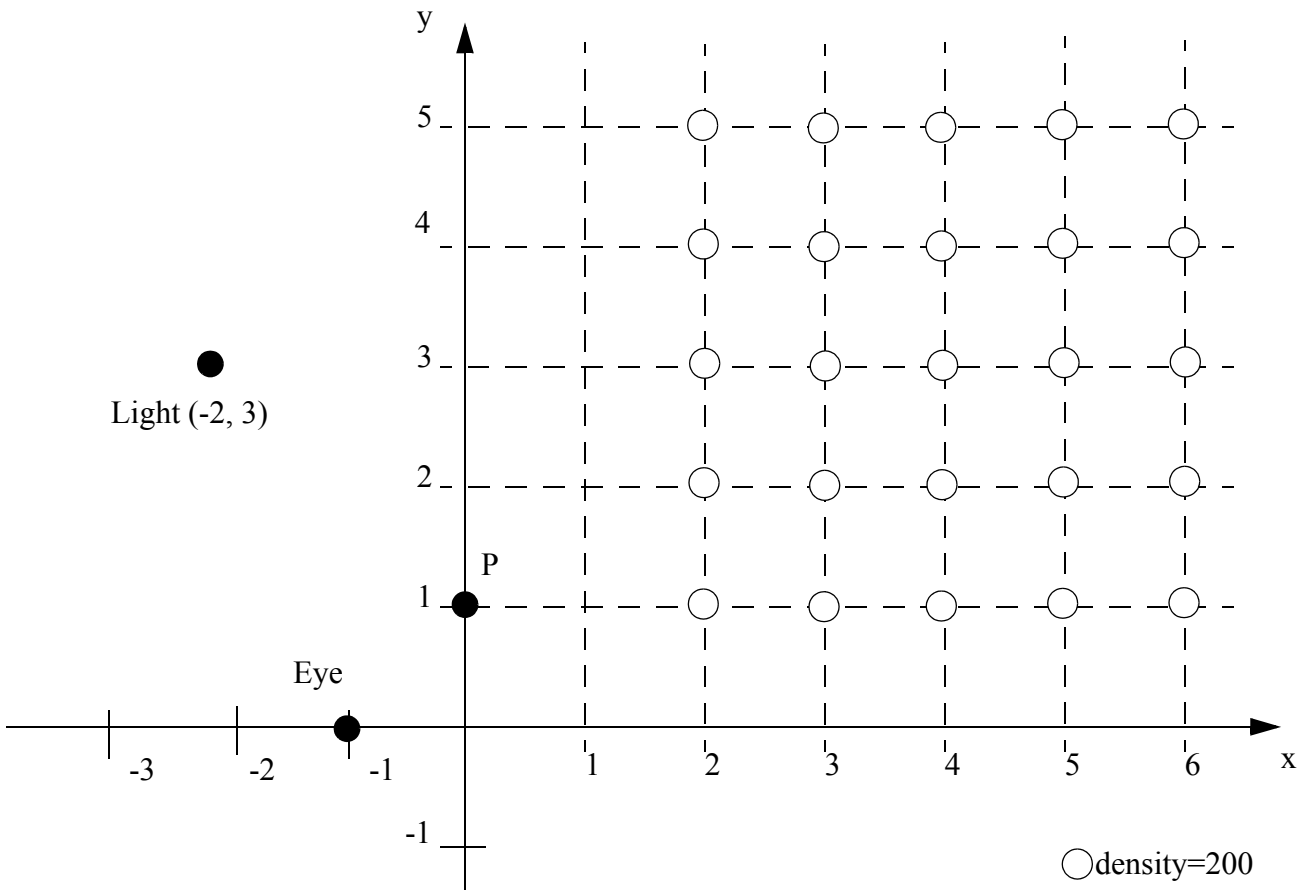
b) Now rotate the grey body from (a) into the shape indicated by the grey body in the figure below. Hint: You're rotating about the (imaginary) z-axis Where does the positive z-axis point to?



c) Finally, rotate and translate the dark body from (a) into the shape indicated by the grey body in the figure above. Hint, this is a combination of the operations you already did in a) and b).

4. Raycasting and 2D interpolation

For the following, if you did not bring a calculator, simplify the numerical expressions as much as you can. In the grid below, all unmarked grid points have density value=0, the marked ones have density value=200 (as shown). Assume the following values for the scene: k_a=0.2, k_d=0.5, k_s=0.3, ns=20, I_a=I_L=(1.0, 1.0, 1.0), C_{obj}=(0.1, 1.0, 0.2), and the illumination equation: $C_P = C_{obj} (k_a I_A + k_d I_L N \cdot L) + k_s I_L (H \cdot N)^{ns}$, where H=(L+E) / |L+E|



a) Suppose you want to trace a ray towards a pixel P. Draw the ray into the figure. What is the (normalized) ray direction vector *r*?

b) Starting at P, trace a ray with step size 1. What are the numerical coordinates of the first 5 ray sample points encountered (after P)?

c) Use bilinear interpolation to find the values of the ray sample points.

(Hint: if all 4 grid points around a ray sample point have identical values, then you know that the bilinear interpolation is very simple: It will be the same value than that of those 4 grid points, and then there's no need to go through all the calculations. Your probably only have to do a real calculations for one of the 5 ray sample points.)

d) Assume you're looking to display the surface with iso-value ≥ 200, where do you stop the ray?

d) Estimate the normal vector at that point. Let's call that point P1.

e) Calculate the reflected color C_a due to the ambient illumination at point P1.

f) Calculate the reflected color C_d due to the diffuse illumination at point P1.

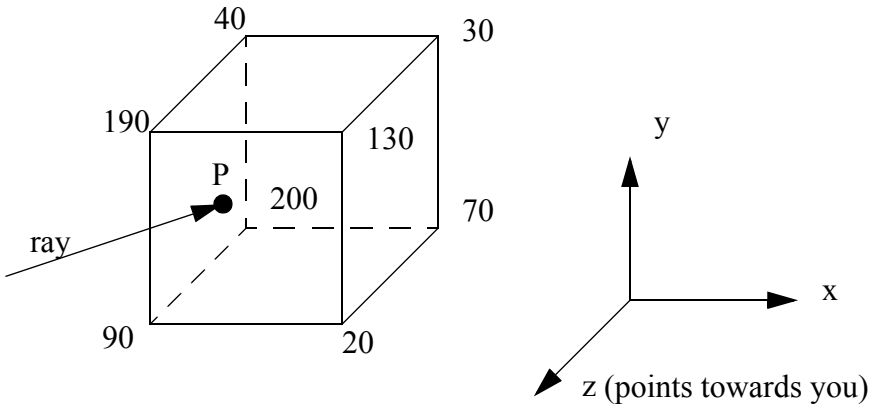
g) Calculate the reflected color C_s due to the specular illumination at P1.

h) Combine the ambient, diffuse, and specular colors to calculate the color C_P received at P and the eye (the color reflected at P1).

i) What color is this (is it a shade of red, blue, green, or white)?

5. Raycasting and 3D interpolation

Let's move to 3D. Assume that P has coordinates (10.2, 2.8, 12.4) and falls inside a cubic volume cell that has the following density values at the cell's grid points. Show all your steps. If you did not bring a calculator and you can't calculate all values numerically, do it symbolically but use lots of intermediate variables to save writing time if you need to.



a) What is the interpolated value using nearest neighbor interpolation?

b) Now perform trilinear interpolation. We will do this step by step. First, calculate the grid offsets u,v,w (we called them uu, vv, ww in the demo).

c) Calculate the linear interpolations along the x-axis.

d) Calculate the linear interpolations along the y-axis.

e) From this, calculate the value of P.