- Print your name on the cover of the exam booklet. If you need extra space, write "on the second booklet" on the last page of the first booklet and staple them together when you hand it in.
- Clearly label the problem number on the booklet(s)
- Carefully read each question before answering it
- **There are 2 pages 12 questions 100 points total in this exam.**
- **There are 15 point extra credit question.**

Strategy: Read through the entire question before you begin it. If you get bogged down on a question, go on and come back later. Even if you don't think you know the entire answer to a question, do what you can in order to get partial credit. If something isn't clear to you, ask.

Part 1: Odds, Ends, and Concepts (20 points)

1. (1 point) What is the most amusing bug you've written in this class?
2. (1 point) What is a pixel?
3. (2 points) Who was Ivan Sutherland in computer graphics? What did he do?
4. (2 points) What is the difference between interlaced and non-interlaced display? Why might you choose one over the other?
5. (3 points) Where is the default (0, 0) on the screen defined by OpenGL? Where is the point (100, 100) going to appear on a screen with a resolution of (640, 480)? You can answer these questions by drawing the screen coordinates.
6. (3 points) Two vectors can define a plane. Given two vectors, v1 (x1, y1, z1) and v2 (x2, y2, z2), what is the normal direction of the plane defined by these two vectors?
7. (3 points) Write a parametric equation for a sphere at the origin with radius R.
8. (5 points) What is the split triangles and index triangles representations? Which one is better and why?

Part 2: Problem Solving (80 points)

9. (20 points)

(1) Express the homogeneous 3D transformation defined by the matrix

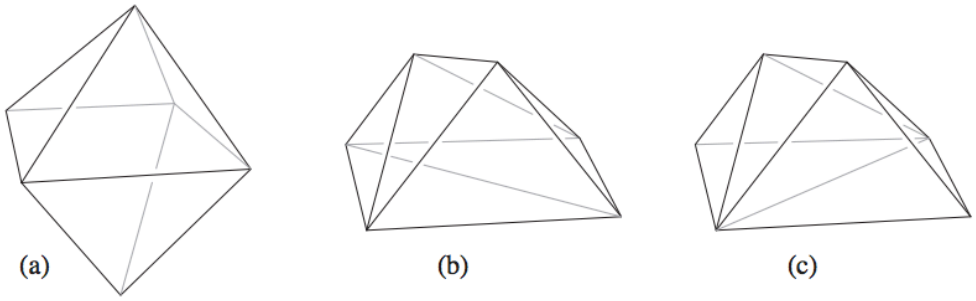
$$\begin{bmatrix} 0 & -1 & 0 & 2 \\ 1 & 0 & 0 & 3 \\ 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

as a sequence of transformations in the following ways:

- A rotation followed by a translation.
- A translation followed by a rotation.

(2) Write the OpenGL code for performing the transformation in (1) using glRotatef and glTranslatef.

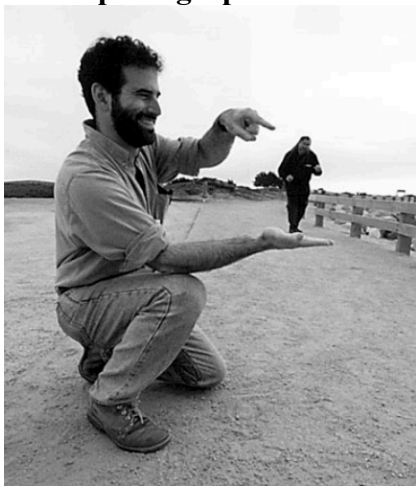
10. (20 points) Look at these three meshes:



(1) Which of these share the same geometry and why?
(2) The following incomplete triangle neighbor structure describes one of these meshes. Indicate which one it is, and complete the table so that it describes the whole mesh.

	tris[]			tNbr[]		
0	0	5	1	1		4
1	0	4	5	2		0
2	0	3	4	3		1
3	0	2	3	4		2
4	0	1	2	0		3
5						
6						
7						

11. (20 points) Here is an unedited photograph of two normal-sized people:



The image above is 450 pixels high, and the two heads measure 90 and 15 pixels high. Assume all heads are 30 cm high. The image on the camera's film plane is 24 mm high.

(1) If I know that the person in the foreground is 2 meters from the camera, what is the camera's image plane distance (the focal length) and how far away is the other person?
(2) If I know that the two people are standing 20 meters apart, what is the image plane distance and how far from the camera is the closer person?
(Photo courtesy of Seth Teller, who says, "no computers were used to make this picture.")

12. **(20 points)**

(1) You start by considering the kinds of splines you know about. Write out a matrix that looks like this and fill in yes or no in each space to indicate which type of spline has which properties.

	C^1 continuity	C^2 continuity	Stays in convex hull of control points	Interpolates control points	Can intersect with itself
Hermite					
Cubic Bezier					

(2) Write the OpenGL code that will plot the cubic Bezier curve formed by four control points: (0, 0), (0, 1), (1, 1), (1, 0). You only need to write the drawing routine.