# CPSC 314, Written Homework 2

**Out: Wed 14 Feb 2007**
**Due: Fri 2 Mar 2007 3pm**
**Value: 3% of final grade**
**Total Points: 100**

1. (8 pts) Give the camera/viewing transformation matrix for an eye position (2,10,3), a lookat point (-2, 2, 0) and an up vector (-1,-1,0).

2. (8 pts) Give the perspective projection matrix with a near plane of 1, far plane of 100, a horizontal field of view of 30°, and an aspect ratio of 1:2.

3. (8 pts) Give the NDC-to-display transformation matrix for a viewport 200 pixels wide and 200 pixels high, with the origin in the upper left of the display.

4. (8 pts) An tetrahedron has vertices (3, 2, 1, 1), (0, 0, -3, 1), (-2, -1, 2, 1), and (1, 5, -1, 1) in world coordinates. Give its coordinates in the camera coordinate system, after the viewing transformation from problem 1 above has been applied to the points in world coordinates.

5. (8 pts) Then give the tetrahedron coordinates in the clipping coordinate system, after the perspective warp for the frustum specified in problem 2 has been applied to the tetrahedron points in camera coordinates (that is, the answer from problem 4).

6. (8 pts) Then give its coordinates in the normalized device coordinate system, after the perspective divide has been applied to the answer from problem 5.

7. (8 pts) Finally, give the point coordinates in the display coordinate system, after the viewport transformation of problem 3 has been applied to the answer from problem 6.

8. (8 pts) Suppose that you take a photograph with a digital camera that has a CCD imaging chip of size 4x3mm. Parallel light rays entering the camera lens will cross at a point X units behind it for a lens with focal length X. You are taking a picture of a small painting 75cm wide that you want to completely fill the horizontal field of view. The lookat point is lined up with the eye point, so that the painting is perpendicular to your gaze vector. If you have a lens with focal length 20mm, how far back should you stand?

9. (18 pts) **Extra Credit** You have a cube of size x=1, y=3, z=2. Its lower left front corner is at the origin and the front face of the cube is in the x/y plane. You are drawing the cube with an oblique projection. Two of the oblique projections are so common that they have specific names: the angle between the front face of the cube and its sides would be 45° for a cavalier projection or 63° for a cabinet projection.

   a) Sketch what the resulting image would look like with an oblique angle of 70° and a length of .7 for lines perpendicular to the image plane. Your sketch does not have to be geometrically perspective-perfect, but label the points in the image with the correct (x,y) locations.

   b) Construct the 4x4 matrix that would produce the above projection. Show your work. Confirm that points in the xy plane; that is, the vertices on the front face of the cube, are not changed by the projection.

10. (18 pts) We are designing a software module for computer-aided design in land surveying. The world-coordinate database contains objects in a two-dimensional world whose units are feet by feet. The display screen has size W inches wide by H inches high, and pixel resolution 800 x 600, and as usual, (0,0) is the upper-left corner. The user window on the world is specified by a 3-tuple (xc, yc, S) where (xc,yc) = the world coordinate point of the window center, and S = the display ”scale factor” in feet per inches, e.g. S = 50 means that one inch on the display represents 50 feet in the world. Write a function to map a world point to a device point, in your favorite programming language.

    (or pseudocode)