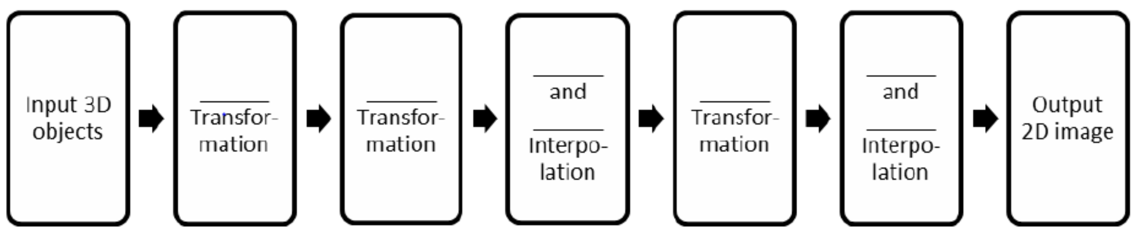
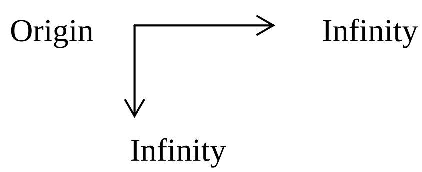
CS 112: Introduction to Computer Graphics (Winter 2016)
Written Assignment 1 (Total Points = 45)
Due: January 20, Wednesday, 1:30pm
(Turn in a hardcopy to instructor/TA in class)
Estimated Time: 2 hrs

Instructions: All answers must be typed other than small figures or matrices, which can be handwritten. Written assignment will be returned without grading if the work is not neat. Hard copies of written assignment must be submitted in class to Professor Majumder.

1. Fill the blanks to complete the graphics rendering pipeline. [7]



2. Many image files have linear structure. If the size of the image is 1000x1000 (WxH), then the element at position 3500 in the file would refer to the element in the fourth row and 500th column of the image. If the size of the image is infinite in both width and height, but has an origin (refer to the figure), then how would your organize your file into a linear structure? In other words, come up with a scheme of organizing the data in the file such that given the position of the element in the file, you can locate the corresponding position in the image. [4]



3. Choose the correct dimensions for each of the following: a *point* ___, *line*___, *and a triangle*___ in a 3D space. [1+1+1=3]
   a. 0
   b. 1
   c. 2
   d. 3
4. A plane defined by the equation $ax+by+cz = d$ is under ____ representation.
   a. Implicit
   b. Explicit
   c. Parametric
5. Define manifold and manifold with boundary. Draw one example for each of them. [2+2 = 4]
6. The Euler characteristic e is given by $e = V\text{-}E\text{+}F$ where V, E and F are the number of the vertices, edges and faces of the polygonal object. What is the Euler characteristic of a cube?

Euler characteristic is related to the genus by the formula *e=2-2g*. From the Euler characteristic of the cube, the genus of a sphere is ___. [2+2=4]

a. Not defined
b. 0
c. 1
d. 2

7. A cube is an approximation of a sphere using faces having four edges each (quadrilaterals). In such a cube, all vertices have degree three. My claim is that you can construct an approximation of a sphere using quadrilaterals such that the degree of every vertex is four. [2+2+3+3=10]

Find the relationship between *V, E,* and *F* in this claim. *V* =___ *E; E* = ___*F*.

a. 0.5x
b. 1x
c. 2x
d. Not a linear relationship

The Euler characteristics of the approximation of sphere formed by my construction is

a. 0
b. 1
c. 2
d. 3

Is my claim correct?

a. Yes
b. No

8. Consider a parallelepiped. A parallelepiped is a genus zero object with eight degree-three vertices and six parallelogram faces. (It is a sheared cuboid with no constraints on angle between the edges at a vertex.) Consider a 4x4 rigid model transformation matrix M. Naïve transformation of one vertex by M takes 16 multiplications and 12 additions/subtractions (4x4 matrix multiplied with a 4x1 vector). Hence for eight vertices, it would take 16x8 multiplications and 12x8 additions/subtractions. By utilizing characteristics of a rigid transformation, 16x___ multiplications and 12x___ additions/subtractions are enough to locate the transformed parallelepiped. [2+2=4]

a. 1
b. 2
c. 3
d. 8

9. One reason that homogeneous coordinates are attractive is that the 3D points at infinity in Cartesian coordinates can be explicitly represented by homogeneous coordinates. How can this be done? [3]