# CMSC 435 / 634 Introduction to Computer Graphics

## Homework Assignment 1
## (Released: Feb 29; Due: Mar 9)

**Viewing:**

**Question-1 (10).** To transform a point p from world-space to screen space we use a series of transformation. The transformation for *perspective viewing* is composed of five matrices, as shown here:

$$p' = A \cdot B \cdot C \cdot D \cdot E \cdot p$$

A, B, C, D, and E are matrices and correspond to the steps described in our lecture. p is a point in world-space, and we would like to construct a p′ relative to the camera's coordinate system, so that p′ is its resulting position on the screen (with its z-coordinate holding the depth buffer information).

(1) BRIEFLY write out what the matrices A, B, C, D, and E are responsible for doing. Then write what values they have. Make sure to get the order correct (that is, matrix E only corresponds to one of the steps described in the viewing lecture).

(2) Write down what A, B, C, D, and E are, assume the following about the camera,

- it has position (x,y,z,1)
- it has look vector *look* and up vector *up*
- it has height angle $\theta_h$ and width angle $\theta_w$.
- it has near and far clip planes *near* and *far*, respectively.

**Question-2 (10).** You need to perform rotation operations on the camera in its own virtual ***u, v, w*** coordinate system, e.g., spinning the camera about its ***v***-axis. Additionally, you will need to perform translation operations on the camera in world space.

**Translation**: How (mathematically) will you translate the camera's eye point...

- one unit right?
- one unit down?

- one unit forwards?

**Rotation**: How (mathematically) will you use the u, v, and w vectors, in conjunction with a rotation angle $\theta$, to get new u, v, and w vectors when:

- adjusting the "spin" in a clockwise direction by $\theta$ radians?
- adjusting (rotating) the "pitch" to face upwards by $\theta$ radians?
- adjusting the "yaw" to face right by $\theta$ radians?

***Question-3 (25)***. You have been asked to model a view from a character on a unicycle. The world coordinates are defined so x and y span the map horizontally and z points up. The unicycle coordinates are centered at the center of the axle, with x pointing right, y pointing forward, and z pointing up.

It may be useful for this problem to know the standard math library function atan2(y, x). This function computes the arctangent of y/x over the full circle, without singularities when x=0, and using the signs of both arguments to correctly determine the quadrant of the resulting angle.

a) If you have a translation function Translate(x,y,z), and three functions to rotate around the coordinate axes, RotateX(θ), RotateY(θ), and RotateZ(θ) (but NO lookAt transform), what sequence of calls transform from world-space to unicycle-space, leaving the unicycle at a world-space location of (ux, uy, uz), pointing in the direction (dx, dy)?

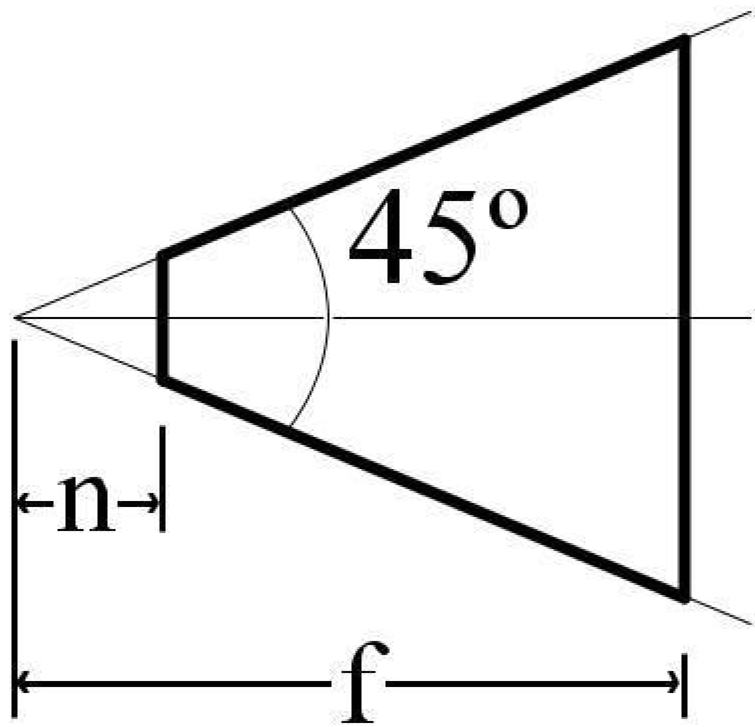
b) If the character's head is at (hx, hy, hz) in unicycle-coordinates with horizontal pan angle of q and vertical tilt angle of f, what sequence of calls will transform view space to world space? In view space, the camera should be at the origin, looking down the –z axis, with x pointing right and y pointing up.

c) What are the 4x4 transformation matrices for Translate, RotateX, RotateY, and RotateZ?

**Question – 4 (20)**. This is a side-view of a viewing frustum, with the eye at (0,0,0), x axis pointing out of the page, y axis pointing down, and z axis pointing to the right. This frustum has a 45º field of view and near and far planes at n and f:

a) What are the eight corners of the frustum?

b) What are the clipping cases? Give an example of each.

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