Computer Graphics Intro March 7, 2006

G. Farin **Name:**

ASU ID:

Midterm

1. Let a 4×4 matrix be given by

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

When interpreted as an affine map, what is the action of this matrix?

2. Let a 3D triangle be given by one of its vertices:

$$\mathbf{p} = \begin{bmatrix} 1 \\ -2 \\ 0 \end{bmatrix}$$

and two vectors

$$\mathbf{v}_1 = \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix}, \quad \mathbf{v}_2 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}.$$

Find the normalized normal to this triangle.

3. When you apply an affine map to a circle, will the resulting object be
A) an ellipse,
B) a square,
C) a point?
D) none of the above
(more than one answer may apply)

4. What is a viewing frustum? Draw a 2D sketch and describe its components.

5. Let a 2D cubic Bézier curve be given by the control polygon

$$\mathbf{b}_0, \mathbf{b}_1, \mathbf{b}_2, \mathbf{b}_3 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 \\ 4 \end{bmatrix}, \begin{bmatrix} 0 \\ 4 \end{bmatrix}.$$

Sketch control polygon and curve. Then sketch how to construct (e.g., using the de Casteljau algorithm) the point on the curve corresponding to $t = 0.25$.

6. Suppose we have a viewport defined by the lower-left point $\mathbf{l} = [0, 10]^{\mathrm{T}}$, width 10 and height 40. Given the point $[1, 1]^{\mathrm{T}}$ in 2D NDC coordinates, what is the corresponding point in the viewport? Recall that NDC coordinates live in the range [-1,1] in each coordinate.

7. Suppose you want to use the function

```
gluPerspective(fieldofview,aspect,znear,zfar)
```

to make an object appear smaller. Which parameter do you need to change and how?

8. Sketch an arbitrary 2D triangle and mark its vertices as $\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3$. Any point in the triangle has barycentric coordinates (u, v, w). Mark all points with $u = 0.5$.

9.Suppose you call `gluLookAt(eye,center,up)` with $eye = [0, 0, 10]$, $center = [0, 0, 0]$, $up = [0, 1, 0]$. Let your object be a cube of edge length 1, centered at the origin. Assuming you use wire frame mode , sketch what you will see for both orthographic and perspective projections.

10. Which kind of normals is used for
A) flat shading
B) smooth shading
of triangles in a triangle mesh?