

Homework 1  
CS 354  
Due Feb 7 at the beginning of class

**Name**

**UT EID**

1. (10 points) Consider the following two commands:

```
glutInitWindowSize(800, 600);  
gluOrtho2D(-100.0, 100.0, -100.0, 100.0);
```

Give the window coordinates for each of the following object coordinates. The origin in window coordinates will be at the top-left corner.

- (a) (0, 0)
  - (b) (-50, 50)
  - (c) (-75, -100)
  - (d) (90, 10)
  - (e) (0, -40)
2. (5 points) Let  $\alpha, \beta, \gamma$  be scalars,  $A, B, C$  be points, and  $u, v, w$  be vectors. Answer T/F/? for each operation. If the operation is defined, answer T. If it is undefined, answer F. If you don't know, answer ?. Each correct answer is worth 2 points. Each incorrect answer receives -1. 0 points are given for ?.
- (a)  $v - u$
  - (b)  $v - A$
  - (c)  $A - v$
  - (d)  $A + \alpha(B - A)$
  - (e)  $\alpha A + v$

3. (15 points) If we are interested in only two-dimensional graphics, we can use three-dimensional homogeneous coordinates by representing a point as  $\mathbf{p} = [x \ y \ 1]^T$  and a vector as  $\mathbf{v} = [a \ b \ 0]^T$ . Find the  $3 \times 3$  rotation, translation, scaling, and shear matrices  $\mathbf{R}$ ,  $\mathbf{T}$ ,  $\mathbf{S}$ , and  $\mathbf{H}$ , respectively. How many degrees of freedom are there in an affine transformation for transforming two-dimensional points?

4. (15 points) Derive a rotation matrix where we rotate first about the x-axis  $\mathbf{R}_x(\theta_x)$ , then about the y-axis  $\mathbf{R}_y(\theta_y)$ , and then about the z-axis  $\mathbf{R}_z(\theta_z)$ . Assume that the fixed point is the origin.