Homework 1
CS 354, BME 345
Due Sept 25 at the beginning of class

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)

   Solution:

2. (5 points) Let α, β, γ 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. (5 points) Find a homogeneous-coordinate representation of a plane. *Hint:* the answer will be a dot product.

4. (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 3×3 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?

5. (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.