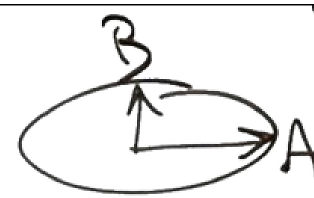
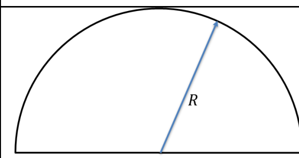
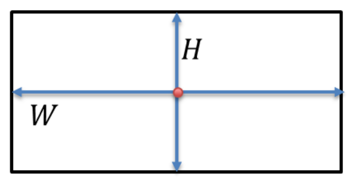
CS/RBE 549 Computer Vision (Online) Name:______________________________

Fall 2022

HW #7

1. **Object Signatures (30%):** Please draw and describe the function to represent $r(\theta)$ for the following objects

a. **Ellipse (10%)**	
b. **Dome (10%)**	
c. **Rectangle (10%)**	

2. **Classification(30%):** Suppose we have a 2-class classification problem with class means μA and μB. Assuming that both classes are equally likely, show that the Nearest Mean classifier decision boundary is the hyper-plane perpendicular to, and midway along, the line segment connecting μA to μB. No need to assume any particular distribution for classes A and B.

3. **Object Representation (40%):** We can represent an object by its boundary $(x(s), y(s)), 0 \leq s \leq S$ where S is the length of the object's boundary and s is distance along that boundary from some arbitrary starting point. Combine x and y into a single complex function $z(s) = x(s) + jy(s)$. The Discrete Fourier Transform (DFT) of z is

$$Z(k) = \sum_{s=0}^{S-1} e^{-2\pi j\frac{ks}{S}} z(s), 0 \leq k \leq S-1$$

We can use the coefficients $Z(k)$ to represent the object boundary. The limit on s is S-1 because for a closed contour $z(S) = z(0)$. The Inverse Discrete Fourier Transform is

$$z(s) = \frac{1}{S} \sum_{k=0}^{S-1} e^{+2\pi j \frac{ks}{S}} Z(k), 0 \leq s \leq S - 1$$

a. **(15%)** Suppose that the object is translated by $(\Delta x, \Delta y)$, that is, $z'(s) = z(s) + \Delta x + j\Delta y$. How is z''s DFT $Z'(k)$ related to $Z(k)$?

b. **(10%)** What object has $z(s) = R \cos \frac{2\pi s}{S} + jR \sin \frac{4\pi s}{S}$? Sketch it. Hint: This is infinitely easy!

c. **(15%)** What is $Z(k)$ corresponding to $z(s)$ from Part b? Hint: Most coefficients are 0.