Physics 3345 **Professor Scalise**
Fall 2000 **Assignment #5**

Due: Monday 2 October 2000

1. Imagine that you are a lifeguard trying to reach a drowning swimmer. Choose the x axis along the linear water-land boundary. You are at position $(-5, -5)$ m and the swimmer is at $(+5, +5)$ m. Your speed on land is v_L; your speed in water is $v_W \leq v_L$. The ratio of speeds is $\frac{v_L}{v_W} \equiv n \geq 1$.

   (a) If you try to reach the swimmer in the least possible time, show that you reproduce Snel's Law.

   (b) If $n = 2$, at what point along the x axis should you enter the water?

2. Given the functional

$$f[y(x), y'(x), z(x), z'(x); x] = yy' \sin(z) + x^2 y^2$$

   what are the Euler equations? Don't try to solve them but carry through all the differentiations.

3. A steamroller cylinder of radius a is rolled along a flat horizontal road. At some point the cylinder rolls over and crushes an ant. The steamroller operator feels the bump and stops after a few seconds. The operator observes that the stain on the roller is one meter to the right of and one meter above the stain on the road.

   (a) What is the radius of the steamroller cylinder?

   (b) Through what angle has the cylinder rolled after crushing the ant?

   (c) Are the previous answers unique?

   (d) Is the stain on the roller on its way up toward the maximum possible height of $2a$, or on it way down from the maximum height?

4. Show that the curve which minimizes the distance between two points in the plane is a straight line.