Assignment 4
Math 503 - Fall 2006
Prof. J. A. Pelesko
Due October 6, 2006

In this assignment you will work with a team of your classmates to perform an experiment, construct a mathematical model of the experiment using the calculus of variations, compare your model to your experiment, and write a report on your results. This assignment is worth one and one-half times a normal homework assignment. That is, it is worth **150 points**. You will have two weeks to complete this assignment. Your team must hand in a typewritten report and send a PDF file containing your report to me via email on October 6th. Only one copy is required per team. All members of the team should clearly be identified on a cover page. All reports will be placed on the course web page. You will be responsible for understanding your own work as well as that of all other teams.

At a minimum, your report should contain the following sections:

- Introduction
- Experimental setup and results
- Derivation of the mathematical model
- Analysis of the model and comparison with experiment
- Conclusion

The key item that I will be looking for is how well you compare your model with your experiment. For example, one group will study the shape of a hanging chain. A convincing demonstration of your mastery of this project would consist of a 1:1 scale plot of the function that describes the shape of the chain with the actual chain superimposed on top of the plot.

There are four teams. Each team will work on a different project. A brief description of each project follows. I will elaborate on the projects in the MEC Lab when we meet.

Team One

This team will study the shape of a rope hung from a straight wire and dipped in a soap film. When the soap film is not present, this system reduces to the hanging chain problem. The presence of the soap film introduces a second energy into the problem which competes with the gravitational energy and changes the equilibrium shape of the rope. Your job is to derive the equation describing the shape of the rope and compare it with your experiment.

Team Two

This team will study the shape of a hanging chain. As you know, we have discussed this problem in class. In your first experiment, the chain will be hung from two points that do not lay on the same horizontal line. In your second experiment, the chain will be hung from two points that do lay on the same horizontal line, but an obstacle will be placed in the way of the chain. Your job is to derive the equation describing the shape of the chain and compare it with your experiment.

Team Three

This team will study the catenoid. As you know, we have discussed this problem in class. You will experimentally measure the maximum distance between the two circular rings that still allow the presence of a catenoid. Your job is to derive the equation that describes the shape of this catenoid and predicts the distance at which the rupture occurs.

Team Four

This team will study descent of a ball down a curved track. You'll be given a ball, a track, and a stopwatch. As you know, in class we discussed the brachistochrone problem. The solution to the brachistochrone problem gives the curve that minimizes the descent time. Your job is to experimentally study descent times for different curves, compare these times to the time predicted by your theory, and construct a brachistochrone as accurately as possible.