## 305-577A Optimum Design

## Project # 1: Single-Variable Optimization The Optimum Design of a Terrestrial Vehicle

Assigned: September 5, 2006

Due: September 26, 2006

Shown in Fig. 1 is an experimental terrestrial vehicle under vertical vibration due to a wavy road. The model, which assumes geometric and mechanical symmetry, consists of:

- a plate of mass *m* that undergoes vertical translations and small-amplitude rotations in the plane of the figure, and hence, can be modelled as a slender, uniform bar of length *l*;
- two identical springs of stiffness k, whose axes are assumed to remain vertical, and symmetrically located with respect to the vertical of the mass centre C of the plate, a distance a/2 from C.



Figure 1: An experimental terrestrial vehicle

For maximum passenger comfort, the fundamental frequency of the two-degree-of-freedom model should be as large as possible, for given values of k, l, and m. The desired behaviour can be achieved by properly choosing the location of the springs on the chassis, i.e., by properly choosing a. For practical reasons, the springs should neither be too close nor too separate, which means that a is to be bounded by

$$0.5l \le a \le l$$

Find the optimum value of a within the above bounds by means of the a) Fibonacci and b) golden-section search methods, so that the optimum lie within an interval of length 2% of the original length. Comment on the performance of each of the above methods and on the feasibility of meeting all design specifications.