To: Professor Sargent and TA’s

From: Colin White

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Subject: Project 1, and bi-stability

Enclosures:

a) fig 1

b) fig 2

c) fig 3

Below please find figure 1, 2 and 3 that display the results I obtained from charting delta versus strain energy three times while changing the inner diameter (d) from 5, to 25, to 45 respectively.

As I ran this code I found that the ratio of inner diameter (d) to outer diameter (D) made a great difference in the strain energy curves. It became clear after running my code that the ratio between inner and outer diameter made a huge difference in how the strain energy manifested. One of the major objectives of this lab was to find “The number of stable positions (where the strain energy is equal to zero) is the major concern. If there is an additional point where the curve drops to zero (strain energy is always zero at δ=0 due to the assumptions, so one additional to the 0 @δ=0), the proposed dimensions of D, d, and n is considered bistable”. A stability point is when strain energy is equal to zero, according to the assignment. Strain energy is always zero when delta is equal to zero. Therefore, in order to achieve bi-stability, a strain energy curve needs to be equal to zero just one more time after the start. In order to determine the stability points, I made my program count how many times the derivative curve fell below zero. I found that when the inner diameter was 5 and 25 (shown in figure 1 and 2) that at least bi-stability was achieved. However, when the inner diameter was 45, bi-stability was not achieved. I also found that the step size of delta (the independent variable) made a huge difference in being able to find the stability points. When the step size of delta was 1\*10^-5, it appeared that only case 1 (figure 1) was bi-stable. However, when I changed the step size to 1\*10^-6, my program was able to see that case 2 (figure 2) also achieved bi-stability. I was very surprised to see that such a small change in the step size made such a crucial difference for the program to be able to find the stability points. That was part of the reason I chose 1\*10^-6 as the step size, there was another reason as well. When using doubles as the variable type, and having a step size of 1\*10^-6 optimizes the error between round off and approximate error.

One of the limitations of my program are that it only tells if a case bi-stable. it will not differentiate between having 2 bi-stability or any number of stability points greater than 2.

I chose to find the derivative of the strain energy curve by using the central because it minimizes error. Therefore, I took some of my code from the rocket altitude versus time assignment and repurposed it to get the derivative from strain energy. I did this because I was very familiar with the code and the algorithm.





