

Simulation Lab 4: Matlab Design of a Bistable Mechanism

1 Introduction

In the last lab, you wrote a Matlab function to describe the force and deflection behavior of a bistable mechanism. In this lab, you will use that function, together with the optimization capabilities of Matlab, to design two new bistable mechanisms with desirable properties.

2 Optimization in Matlab

In this lab, we will use a genetic algorithm function. This will allow minimization of any bistable mechanism parameter you choose, subject to any constraints you impose.

The SU-8 mechanism you analyzed last week has a deflection of approximately $63 \mu\text{m}$ between its first and second stable positions. For your first optimal design, find mechanism parameters which will give a displacement of $40 \mu\text{m}$ between stable positions. Table 1 gives a list of which parameters you can vary, and the limits they can take. For Young's modulus, use 4.4 GPa. For this problem, the TA can help you to apply the constraint that the mechanism remain bistable. You will need to figure out how to find the distance the mechanism moves between stable positions. You will want to minimize the square of the difference between that distance and $40 \mu\text{m}$. Add the objective to minimize (more negative) the force required to switch from the second back to the first positions while having a second stable position located at about $40 \mu\text{m}$ away.

Table 1: Parameters to vary and their limits

Variable	Lower Limit	Upper Limit	Units
w	5	30	μm
t	20	40	μm
l	10	200	μm
r_{10}	100	500	μm
θ_0	0.001	0.25	rad

Now, in a separate optimization use a fitness value to minimize the distance to the second stable position and optimize.

3 Deliverables

Turn in a professional memo (approximately one page) that describes the two new designs you found. Report variable values, as well as the distance between stable positions for the first design and the switching force. Include a plot with both designs plotted on it. In your memo, discuss any important characteristics of your two designs. Did the optimizer return designs with behavior similar to what you expected (Do the variables minimized and maximized make sense?), or were you surprised at some things?