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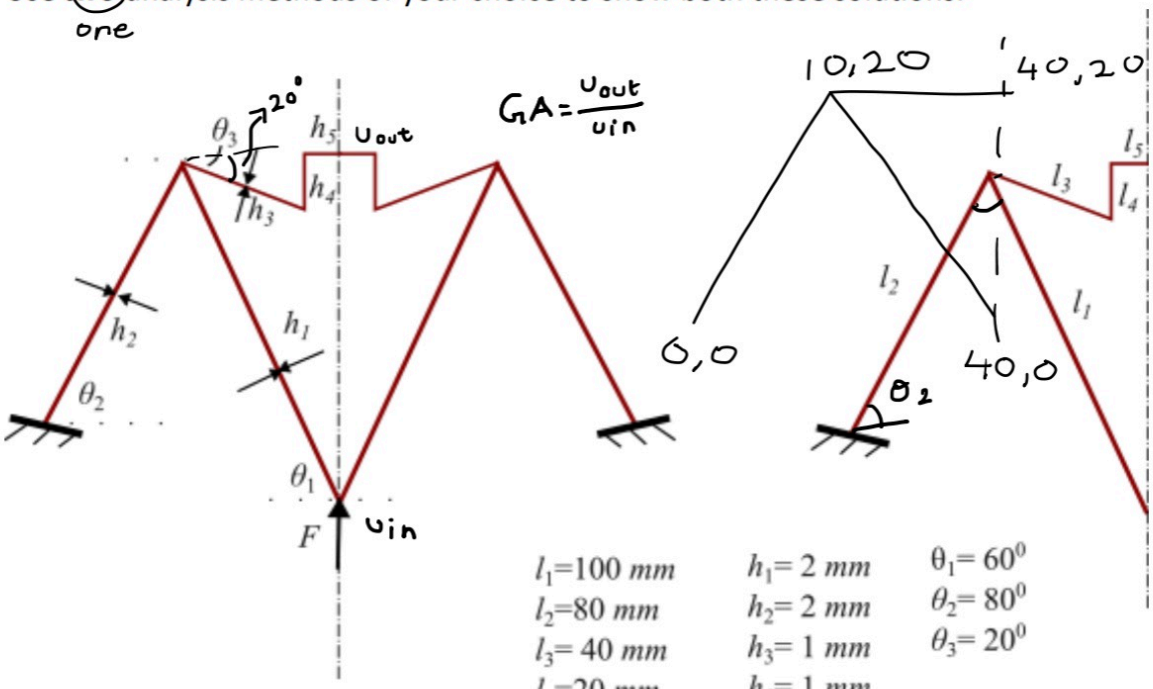
SE598 Design of Soft Mechanisms - Mini Project 1

1. Consider the compliant motion amplifier in the figure below. The right subfigure shows a symmetric half of the mechanism. Without changing any other dimensions, find the angle θ_2 that
   a. Maximizes the output displacement.
   b. Maximizes the geometric advantage. GA

   Use two analysis methods of your choice to show both these solutions.

Large Deflections

one



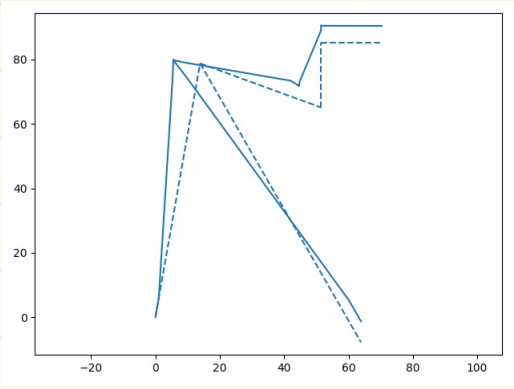
l_1=100 mm	h_1= 2 mm	θ_1= 60°
l_2=80 mm	h_2= 2 mm	θ_2= 80°
l_3= 40 mm	h_3= 1 mm	θ_3= 20°
l_4=20 mm	h_4= 1 mm	
l_5 = 18.8 mm	h_5= 5 mm	

Young's Modulus =2 GPa= 2000 N/mm^2

Force F=10 N

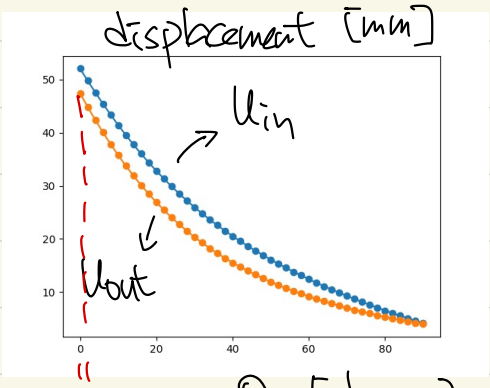
Out of plane thickness is 5 mm

(i) Default Design



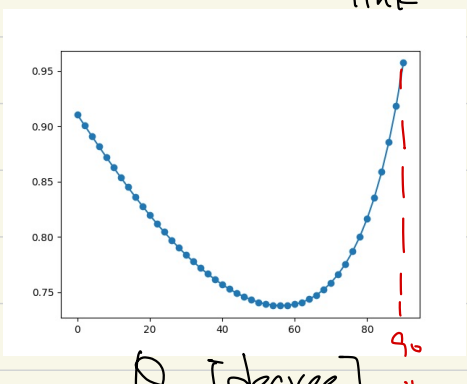
$\theta_2 \in [0°, 90°]$

(ii) (a) Max U_{out} at $\theta_2 = 0°$ (Horizontal link)



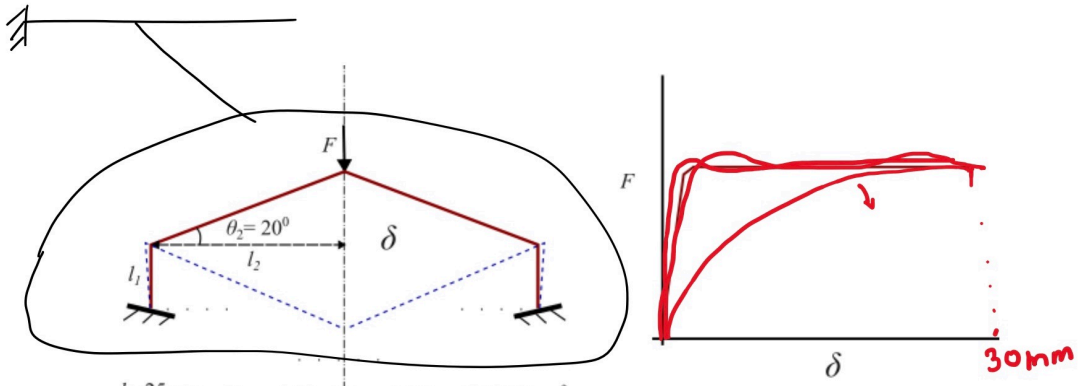
angle at max U_{out}

(b) Max $\frac{U_{out}}{U_{in}}$ at $\theta_2 = 90°$ (Vertical link)



angle at max $\frac{U_{out}}{U_{in}}$

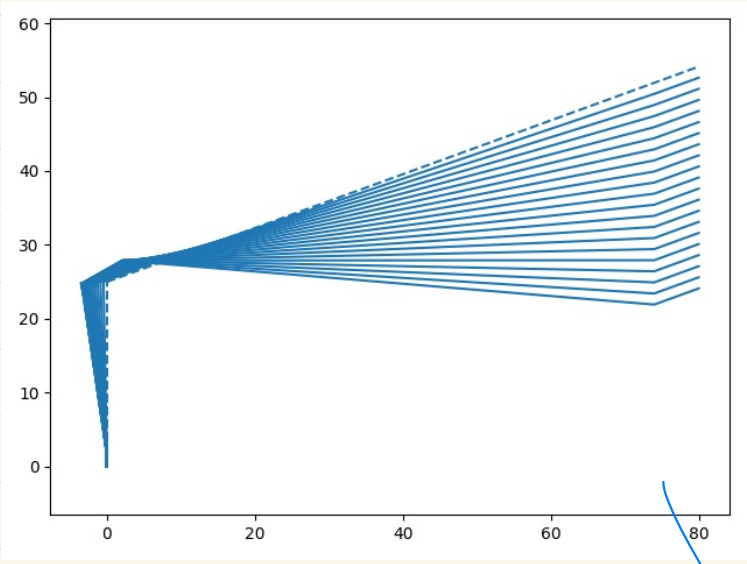
2. Consider a compliant mechanism shown in the left part of the figure below. Without changing l_2, and changing everything else ensure that the force-displacement profile is constant for a large fraction of the displacement range δ.
Use ***two*** analysis methods of your choice to show both these solutions.



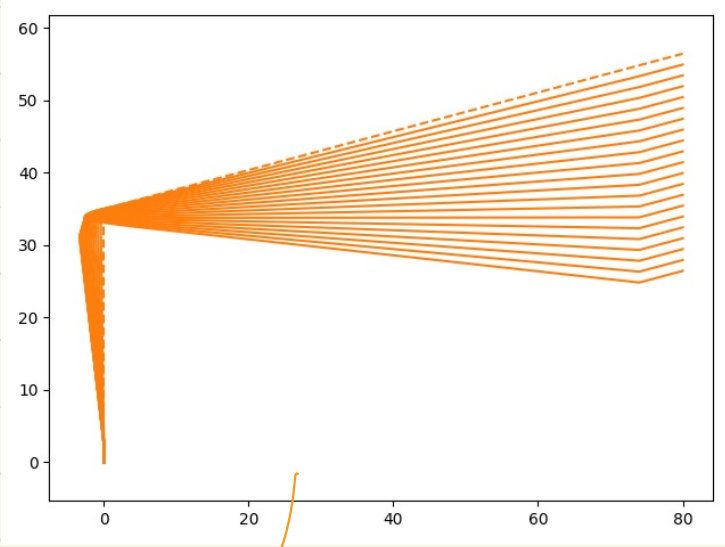
l_1=25 *mm*
l_2=80 *mm*
h_1= 5 *mm*
h_2= 2 *mm*

Young's Modulus =2 GPa= 2000 N/*mm*^{2}
Out of plane thickness is 5 *mm*
Max Displacement δ is 30 *mm*

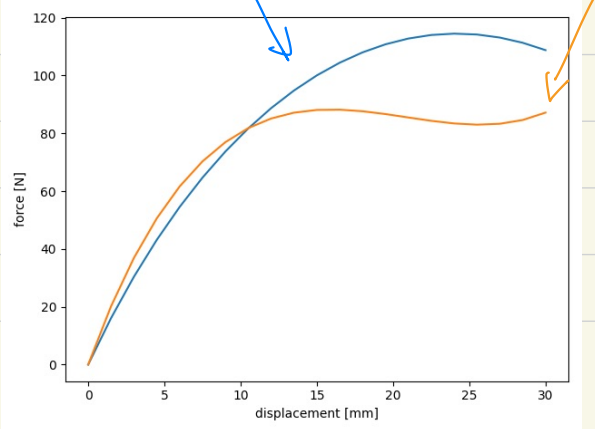
(i) Default Design



(ii) Optimized Design



(iii) Displacement Force Curve

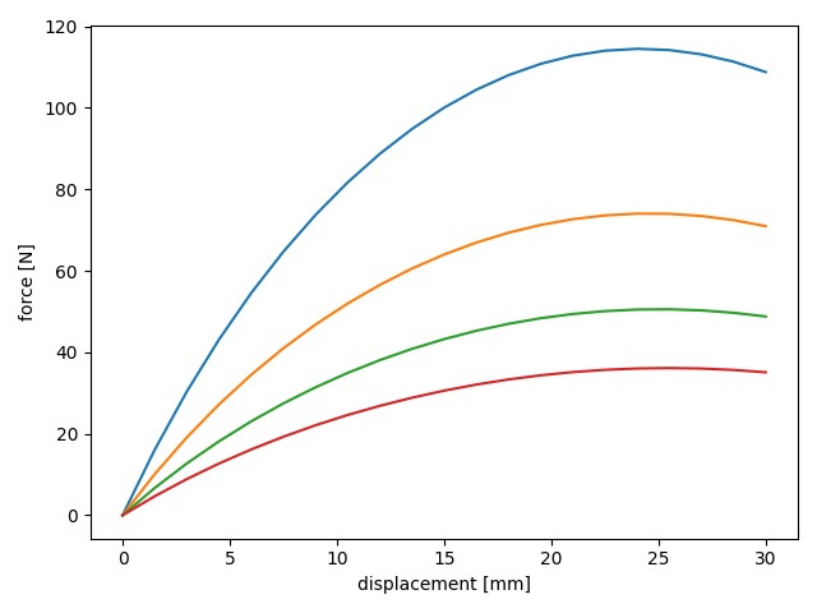


Optimized Parameters

$l_1 = 35$ mm
$\theta_2 = 15^\circ$
$E_z = 2 \times 10^6$ N/mm^2
(Carbon Nano Tube)

(iv) Some other results of parameters variation

(a) Varying l_1



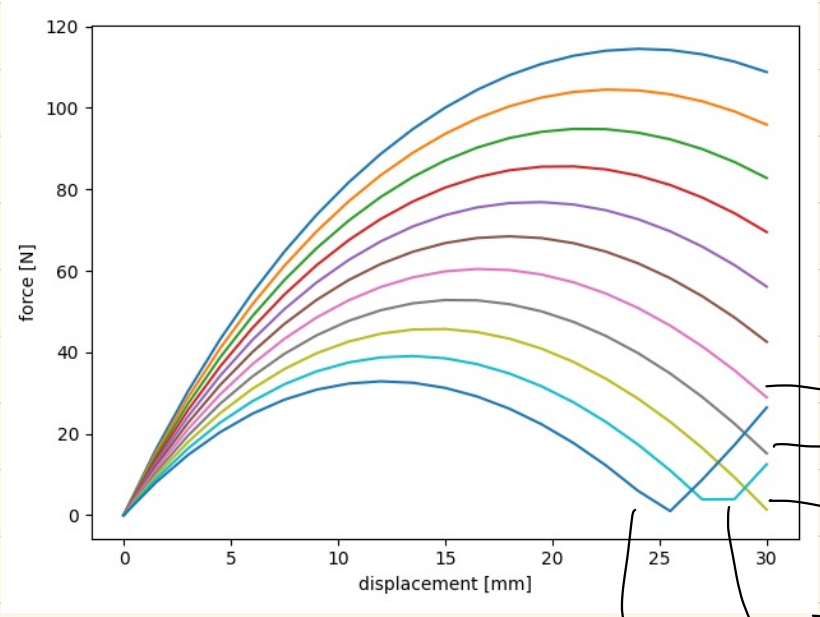
$l_1 = 25$mm

30 mm

35 mm

40 mm

(b) Varying θ_2



$\theta_2 = 20^\circ$

19°

18°

17°

16°

15°

14°

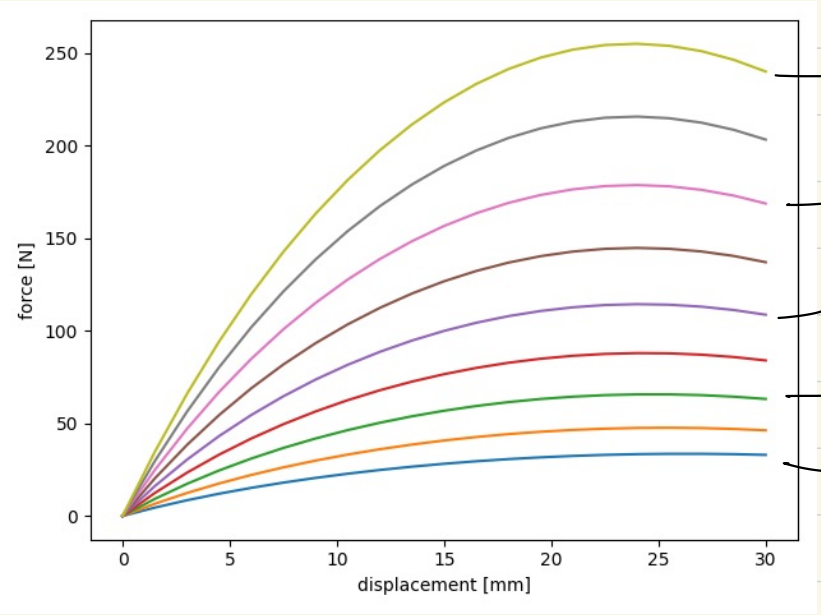
13°

12°

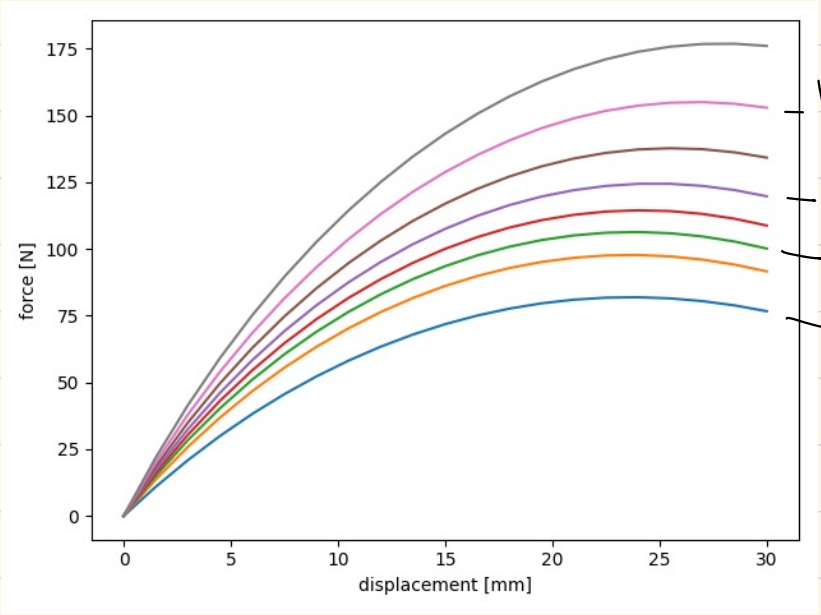
11°

10°

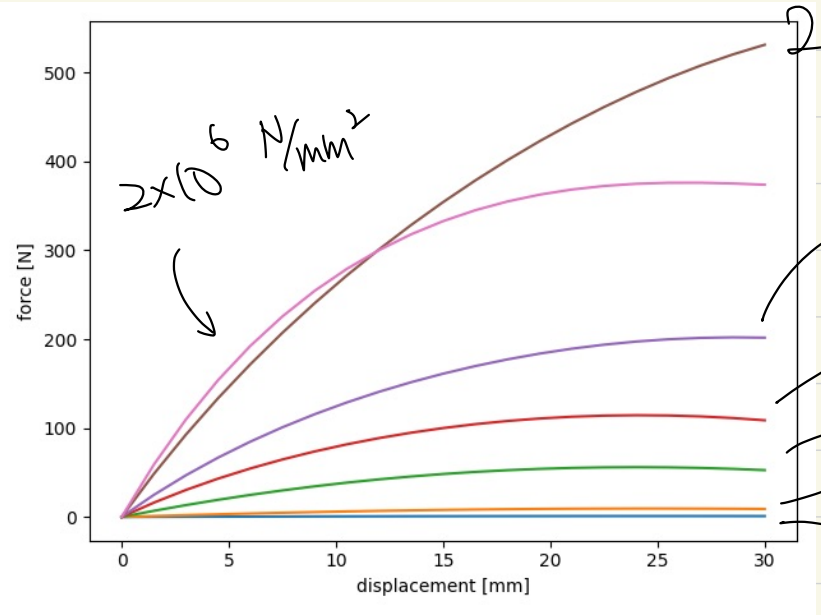
(c) Varying h_1



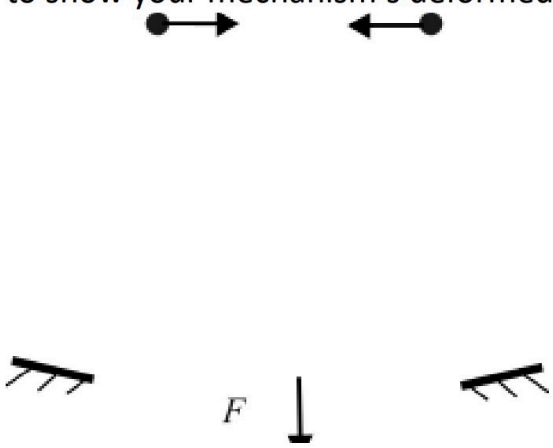
(d) Varying h_2



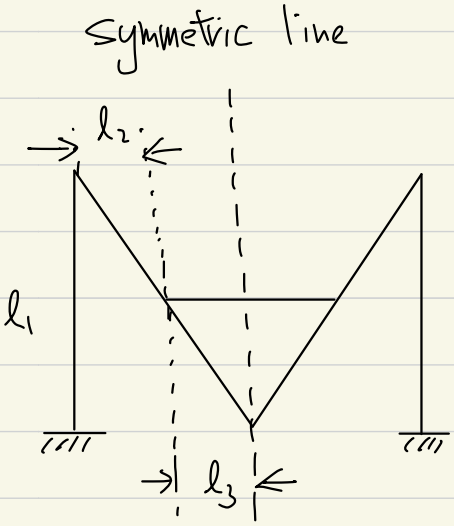
(e) Varying Young's Modulus of link 2

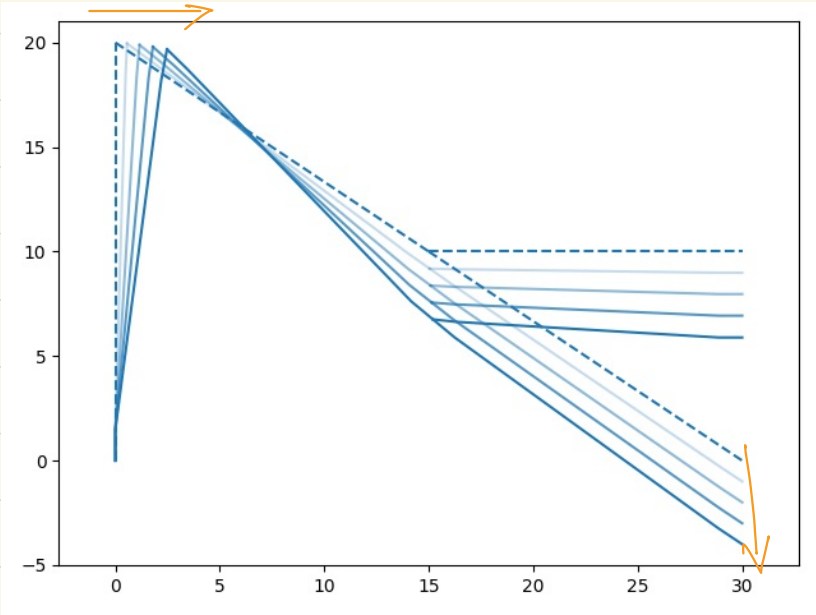


3. From intuition, design your own robotic gripper mechanism. With a downward force, the two ends at either side must displace towards each other. Use any one analysis method to show your mechanism's deformed behavior.



Horizontal Displacement





verfical force.

$l_1 = 20$ mm

$l_2 = l_3 = 15$ mm