Soft Robotics **Assignment 2**

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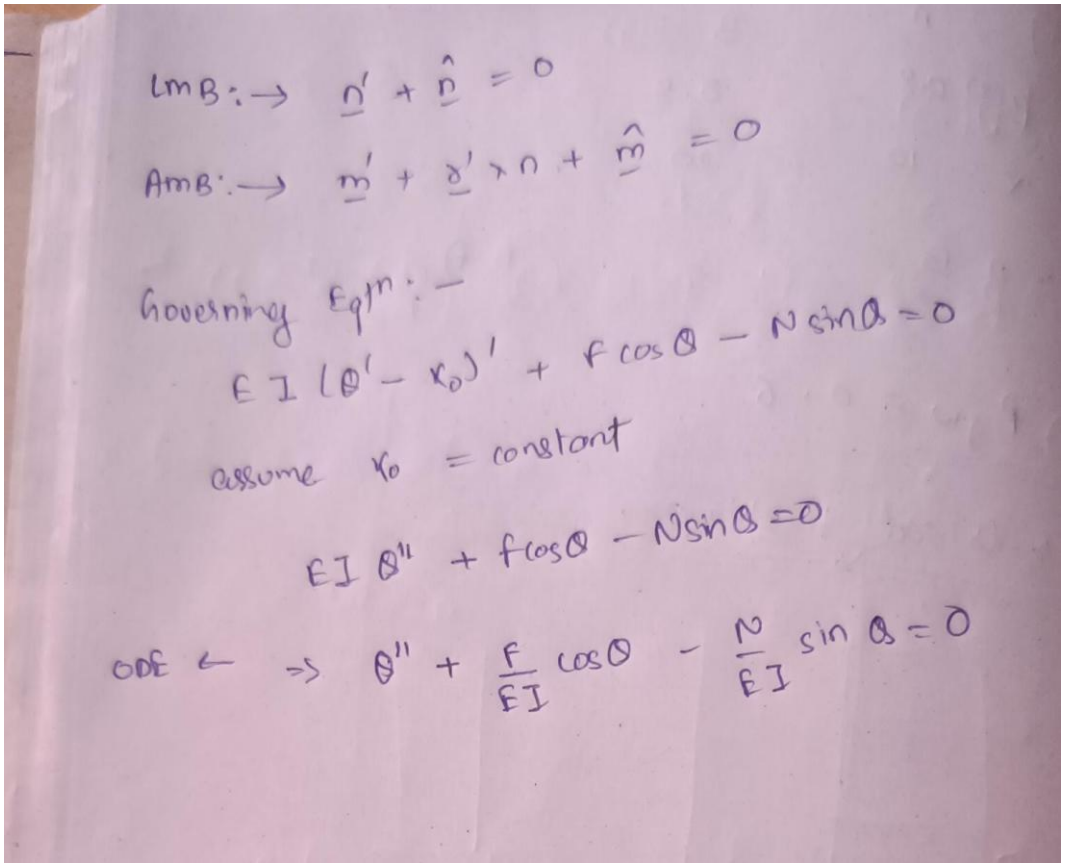
Question:

1. Plot the deformed gripper shape assuming values of F, N, EI, k_0, L
2. Find N, such that r3(L) = b/2 (b: length of the workpiece).
3. Calculate maximum frictional resistance \mu N.

Answer:

Note: .ipynb file containing the python code for the question is attached.

1)



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Required Normal Force (N) using Newton-Raphson: 36.7140 N
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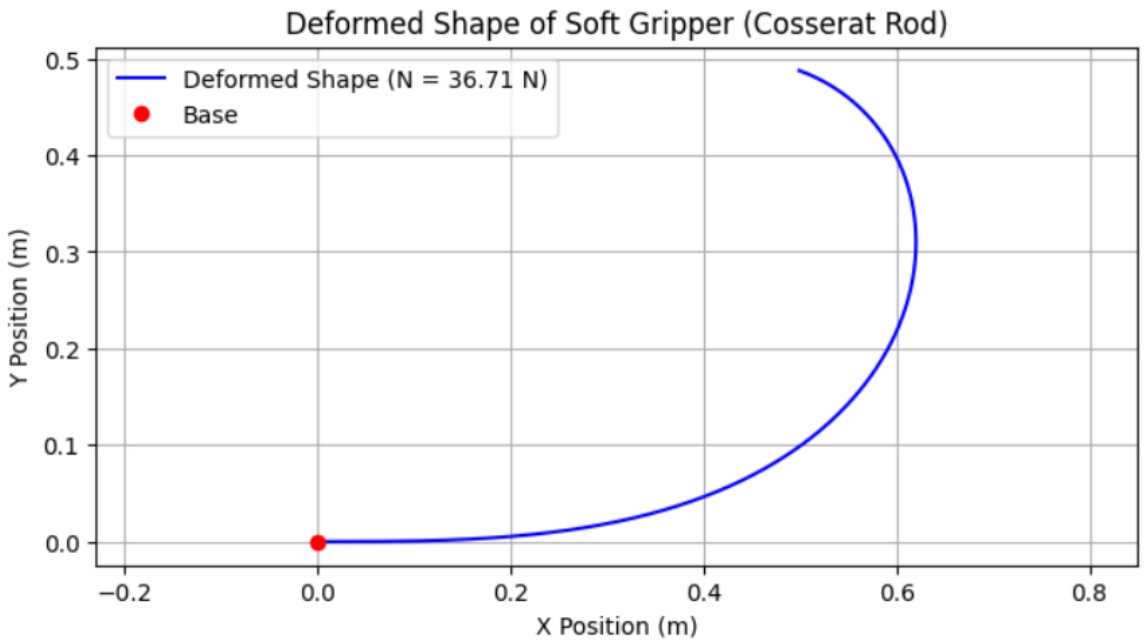

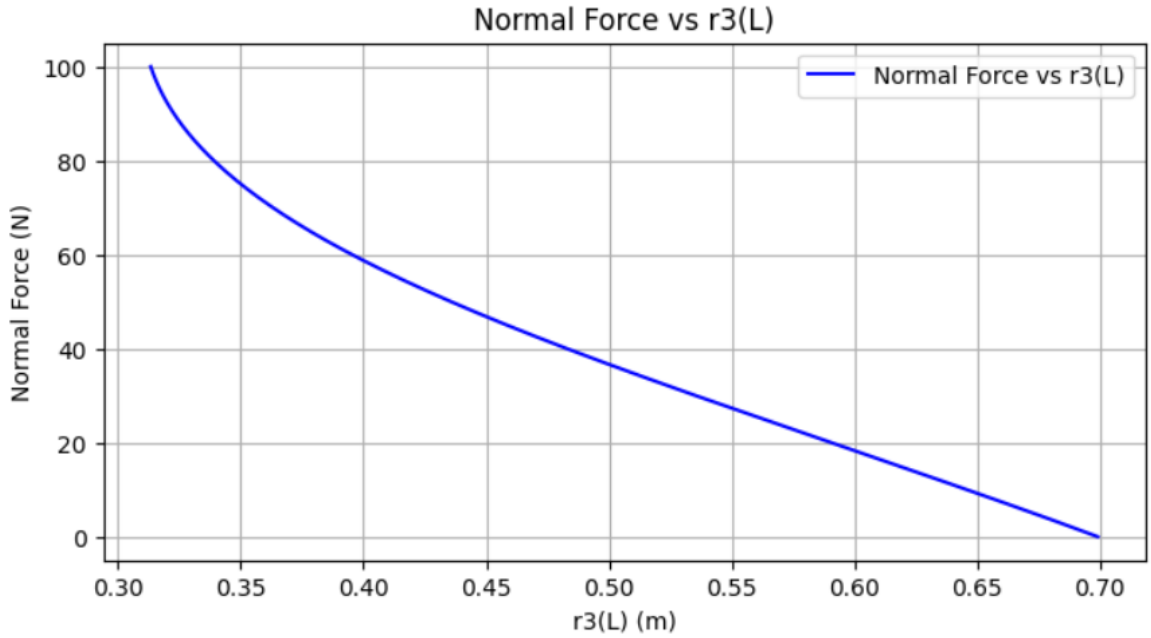


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Maximum Frictional Resistance: 18.3570 N
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The Cosserat rod equation for a soft robotic gripper

$EI(\theta' - k0)' + F\cos\theta - N\sin\theta = 0$

Where:

- E is the Young's modulus,
- I is the moment of area,
- θ is the bending angle,
- k is the initial curvature,
- F and N are force components along the rod.

Assuming the unknown values

2) Maximum Normal Force = 36.714 N.
   To determine the internal normal force N that ensures the gripper's end position r3(L) aligns with half the workpiece length b/2, we follow these steps:
   1. Define the Objective Function
      - Solve the governing differential equation for a given N.
      - Compute r3(L) using numerical integration.
      - Define an equation where the difference between r3(L)and b/2 is minimized.
   2. Use the Newton-Raphson Method to Find N
      - Iteratively adjust N using Newton-Raphson's formula.
      - Converge to a solution where the objective function approaches zero.

   This process ensures that the normal force N is accurately determined to match the specified boundary condition for the gripper's deformation.

3) Maximum Frictional Force = 18.35 N.
   The maximum frictional resistance is given by:
   $F_{max}=\mu N$.
   Where:
   - μ is the coefficient of friction.
   - N is the normal force calculated in Part (b).

   This frictional resistance determines the maximum force the gripper can apply without slipping.