Outline for basic paper

1. Approximating the Beam (Domain = Union of elements)
   1. Each element:
      1. Has a local coordinate system
         1. For a beam it is the same as a global coordinate system
      2. It has a length in the x3 direction
      3. It has a cross sectional area over x1 and x2 directions
   2. I also need to explain how the centroid is where the 1D shape is approximated
      1. This is shown by two equations that are different in Dr. Shepherds and Hughes
2. Stress tensor
   1. Sigmaalphabeta = 0
      1. Show what that stress tensor looks like
   2. Transform it into principal stresses
      1. Talk about how this is now plane stress
         1. Is it actually plane stress?
         2. Can I transform it to the form [[t11 t12 0],[t21,t22,0],[0,0,0]]
         3. It works according to ChatGPT. I also think it works, but I don’t know how to actually to it
      2. Show the plane of principal stresses
         1. Try to explain or come up with a good reason why this works
3. Displacement equations
   1. Explain why u1 is -x2theta3
   2. Explain why u2 is +x1theta3
   3. Explain why u3 is -x1theta2 and +x2theta1
4. Add in other assumptions

I think I should also cover how this ties into classical linear elastic theory (Continuum Mechanics)

1. Sigma ij,j
2. Sigma ij
   1. Isotropic behavior
   2. From this we also get the equations for strain that I was confused about
   3. Explain those using math (reference picture taken on April 1, 2025)
3. Epsilonij
4. Ui=gi
   1. These are known displacements
5. Sigmaijnj=hi
   1. These are known forces
   2. We use the comibination of known forces, displacements, and equation of stress and strain to solve for the unknown forces and displacements

Next state the equations in continuum mechanics form

State the equations using just before Finite Element From (explain that it is just a substitution of variables, but all the information is the same)

It would be really great to also state the equation with basis functions included

TODO:

1. Include the justification for \sigma\_{\alpha\beta} = 0
   1. Derive the stress equations that are needed for approach 1
2. Make pictures
   1. Particularly make a picture for the +/- theta x thing
      1. To do that I am thinking use rhino to make a cross-section in 3D
      2. Put it into power point to add lines, axes, and +/- signs
3. Fix introduction
4. Include the stuff at the very end of outline (state equaitons of continuum mechanics and also the just before Finite Element Mehtod form)