OPTI 421/521 – Introductory Opto-Mechanical Engineering

Homework 8 – Kinematics, Finite element modeling in Solid Works

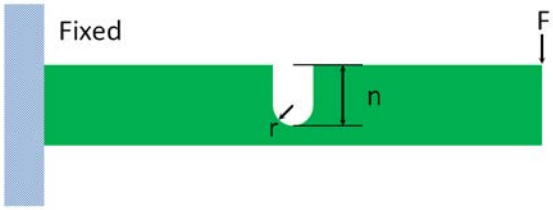
1) Kinematics

a) Find an optomechanical product or design that uses a kinematic interface. Provide a drawing of this and a brief description. Discuss the features that make this kinematic. Provide the benefits and limitations of using this particular kinematic constraint. Any place that sells optomechanical hardware will have numerous kinematic mounts and stages to choose from. You only need one.

b) Go to the Baltec website http://www.precisionballs.com/tech_papers.php and browse their library of technical reports and look at the range of products they sell. Choose one report and read it carefully. Write a brief summary of the report. What did you learn?

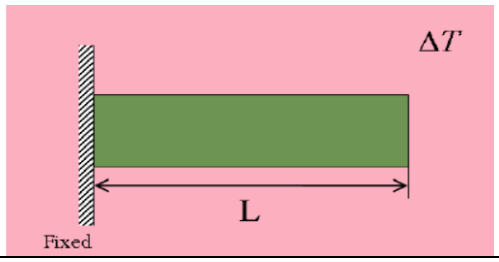
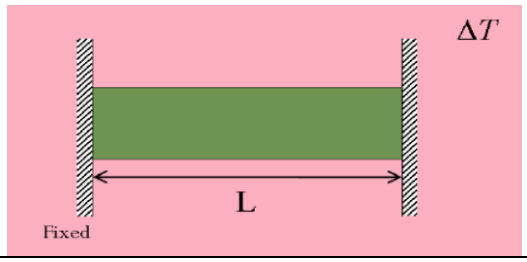
2. Finite element modeling, meshing optimization

Model a cantilevered aluminum beam, 15 cm long, 2 cm x 1 cm cross section with appropriate boundary conditions. Make a cut that goes 15 mm through the beam (n=15 mm, r=1 mm). Refine the mesh of your model and determine stress and deflection for a 1 N load. Show that the mesh is adequate to provide 1% accuracy for the stress calculation. Repeat this with r = 0.01 mm. Explain the difference.



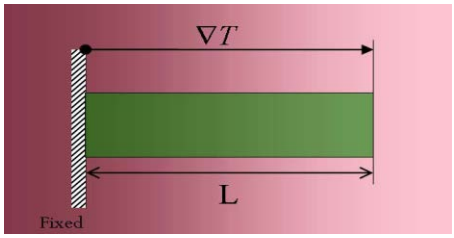
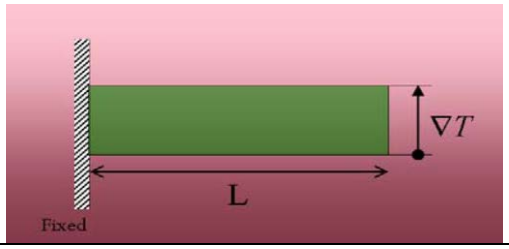
3. Finite element modeling:Thermal expansions and stresses

Use Solid Works Simulation to calculate thermal expansions and stresses for a 15 cm long, 2 cm x 1 cm aluminum bar. For the two cases below, apply the effect of a 1° C ambient temperature change to your models. Show the maximum deflection and maximum stress. Compare with a hand calculation

Case 4A. Cantilever expansion	Case 4B. Fully constrained – thermal stress
	

4. Finite element modeling: Thermal gradient

Use Solid Works simulation to model a thermal gradient and thermal distortion induced in a 15 cm long, 2 cm x 1 cm aluminum bar. For the two cases below, model the effect of a 0.1° C/cm thermal gradient. Show the maximum deflection and maximum stress. Compare each case with a hand calculation.

Case 3A. 0.1°C/cm Axial gradient	Case 3B. 0.1°C/cm Lateral gradient
	

5. Creative design and analysis

Make a Solid Works design of a part or assembly that you think is interesting. Choose real materials. Apply boundary conditions and evaluate the following:

a) Apply some loading, look at deformations and stresses
b) Apply some thermal condition, look at deformations and stresses
c) Look at the fundamental vibration modes, both frequency and shape.

For each case, provide a graphical output and comment on the analysis. Do the results make sense? Do you see anything interesting?

Be creative!

7 Rules of Thumb

Provide three rules of thumb using the standard format.