ENGN 0310 **Mechanics of Solids** **Final Project**

Due Date: Thursday, Dec. 12 at 5pm via email to Ali only!

For your final project you will create a 3D Abaqus model of a cantilever beam. The goal of the project is to determine the optimal shape of the beam that minimizes the amount of total material used. Furthermore, the material is prohibited from yielding plastically.

The material is a linear elastic, homogenous, isotropic solid with the following parameters:

- Length of the beam, L = 1 m.
- Young's modulus of the beam material, E = 125 GPa.
- Yield point in tension = 1460 MPa, with a tensile yield strain of 1.35%.
- Yield point in compression = 3000 MPa with a compressive yield strain of 3%.

The loading profile across the TOP SURFACE of the beam is:

$$q(x) = P_0 \sin\left(\frac{2\pi x}{L}\right) N/m^2$$

First assume a solid rectangular beam of width b=10cm and height h=10cm. What is the maximum value of P_0 that you obtain before yield? You can do this analytically.

Now perform this simulation with the value of P_0 that you predicted. Analyze your results to see if you did indeed stay within the yield limit for stress and strain outlined above.

Next your task is to minimize the material used to design the beam by changing the cross-sectional area, and thus I(x). Choose a new design that uses less material than the original 10cm by 10cm cross-sectional area, yet supports the same load. Preform this simulation to confirm your savings. Compare it with the result above.

Your analysis needs to be quantitative, descriptive and concise providing representative contour plots of significant quantities.

Your report will be limited to 4 pages, consisting of a short introduction (5 pts), materials and methods section (10 pts), in which you describe your Abaqus meshes, element type, loading and boundary conditions, results and discussion (50 pts) and a short summary section (5 pts).

Your final report is to look professional and should be emailed to your TA as a single pdf file. DO NOT EMAIL THE INSTRUCTORS.

Any calculations, raw data tabulation, etc. should be attached as an appendix to the end of the document but should not be included as part of the main text. The appendix should be no longer than 6 pages.