

## Homework 10: Finite-Element Analysis using ANSYS

MAE 4770/5770

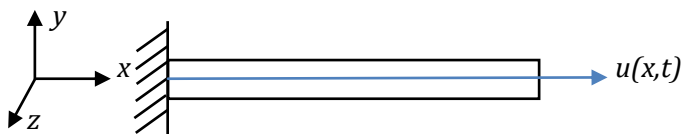
April 20, 2011

This assignment involves extending the course principles through finite-element analysis using the ANSYS software platform. ANSYS can be accessed in the CIT Lab in B7 Upson Hall and in the ACCEL Lab in Carpenter Hall. For this assignment it is very important (and helpful) to begin with the cantilever beam tutorial located at <https://confluence.cornell.edu/x/9L9-Bw> and <https://confluence.cornell.edu/x/MxOwC>

**Problem One:** Given the following beam properties for an aluminum beam:

$$\begin{aligned}l &= 4 \text{ m} & E &= 70 \text{ GPa} \\h &= 0.346 \text{ m} & \mu &= 0.35 \\w &= 0.346 \text{ m} & \rho &= 2.7 \times 10^3 \text{ kg/m}^3\end{aligned}$$

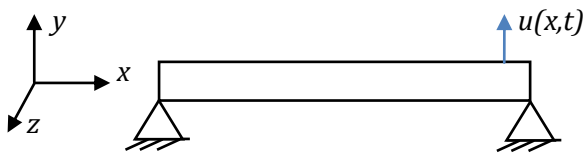
- 1a) Use ANSYS to determine the first six frequencies of vibration in the  $xy$ -plane for the beam if it is cantilevered (fixed-free). Calculate the first three natural frequencies using theoretical methods and compare to the frequencies found with ANSYS, account for any discrepancies or differences between theoretically calculated natural frequencies and the ANSYS results (hints: natural frequency equation must account for cross-sectional area of beam, experiment with ways to limit the orientation of the response). Describe the behavior of the beam at each frequency and print a graph of the beam displacement for at least two modes.



- 1b) Repeat the analysis for the beam vibrating in the  $xy$ -plane if it is fixed at both ends (fixed-fixed).



- 1c) Repeat the analysis for a simply supported (pinned-pinned) beam in vibrating in the  $xy$ -plane.



- 1d) Discuss observations in differences of beam deflection behavior as a function of the mode and as a function of the end conditions of the beam.
- 1e) Allow the cantilever beam to vibrate freely (not limited to any specific plane) and discuss how (if at all) this changes the beam behavior as a function of mode shape.

**Problem Two:** Perform modal analysis of a straight wing with a NACA 0012 Airfoil cross-section for 6 modes of free vibration as shown in <https://confluence.cornell.edu/x/1x6wC>. Explain and describe the behavior at each mode and produce graphs of the displacement of the airfoil for each mode with the frequencies clearly labeled.