Coding Assignment 3

In this coding assignment you will be extending your 1D code to be able to accommodate the 6 degree of freedom beam model described in class. You will then solve several beam deformation problems studied in detail in most introductory strength of materials courses (i.e., CE 203).

1. Extend your 1D code to accommodate multiple degrees of freedom per node and linear elastic beam constitutive behavior and kinematics. Please turn in your code.

2. Consider a prismatic cantilever beam of length L fixed at the left end with a distributed constant axial load N, Young's modulus E, and cross-sectional area A. Determine appropriate values of ν, I_1, I_2, G, and J for this type of problem.

   (a) Choose particular values for the L, N, E, and A.

   (b) Compute the maximum displacement at the right end of the beam using an analytical approach.

   (c) Plot the computed displacement $u^h(x)$ for the entire beam for $p = 1$ and $n = 1$ and 10.

   (d) Report the maximum computed displacement and compare it to the analytical result.

3. Consider a doubly symmetric cantilever beam of length L fixed at the left end with a constant transverse load N, Young's modulus E, bending moment of inertia I, and cross-sectional area A.

   (a) Choose particular values of L, N, E, I, and A.

   (b) For $p = 1, 2, 3$ and $n = 10$ and 100 plot $u^h(x)$ and $\theta^h(x)$ versus the exact solution $u(x)$ and $\theta^h(x)$.

   (c) Choose parameters for a very thin beam and a very thick beam and for each case compute the maximum displacement at the right end. Compare the converged (i.e., highly refined) computed maximum displacement to the predicted value for each case. To what can you attribute the discrepancies?

4. Consider a double symmetric simply supported beam (i.e., pin support at the left and roller support at the right) of length L with a linearly varying distributed load equal to zero at the left and a maximum value of N at the right, Young's modulus E, bending moment of inertia I, and cross-sectional area A.

   (a) Choose particular values of L, N, E, I, and A.

   (b) For $p = 1, 2, 3$ and $n = 10$ and 100 plot $u^h(x)$ and $\theta^h(x)$ versus the exact solution $u(x)$ and $\theta(x)$.