MIN-557: Finite Element Methods
Assignment 4

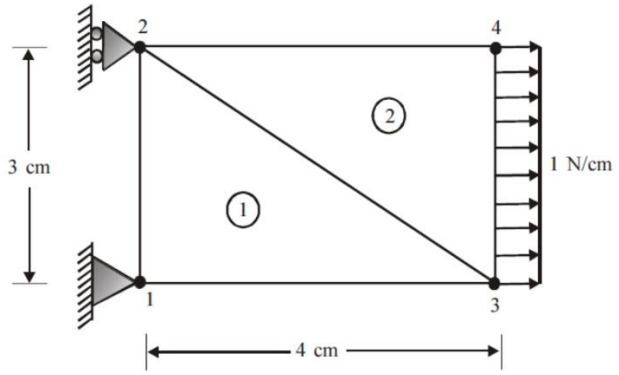
(Due Date: Tuesday, 15th December 2020)

Note: Both groups will solve all the problems.

1. Write a computer program for 2D elasticity. Your program
- (a) should be capable of taking total number of elements from the user
- (b) should be capable of taking type of element from the user. Consider following element: 3-noded triangular element, 6-noded triangular element, 4-noded rectangular element, 4-noded quadrilateral element, 8-noded quadrilateral element
- (c) should accommodate geometric and material parameters (i.e., length, area, Young's modulus) of the bar from the user
- (d) should accommodate loading and boundary condition at desired locations from the user
- (e) should accommodate proper element assembly
- (f) should be able to compute displacement, strain, and stress
- (g) should be able to interpolate at desired point within an element
- (h) should be self explanatory (i.e., any other person from similar background should be able to easily understand your code and should be able to run it seamlessly for problem of his/her interest). To facilitate above add proper comments throughout the code.

Please attach a source code (e.g., *.m file) along with a pdf copy of a code during the submission. Also attach concise but complete documentation (in pdf format) of your code so that anyone who wish to use your code should benefit from this documentation.

2. Test your code for the following example:

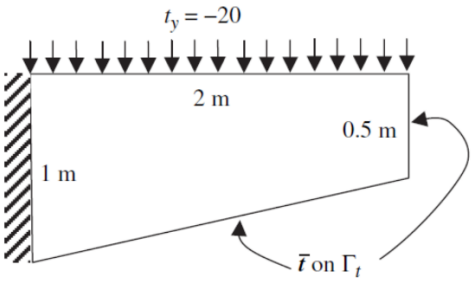


Thin plate under uniform tension

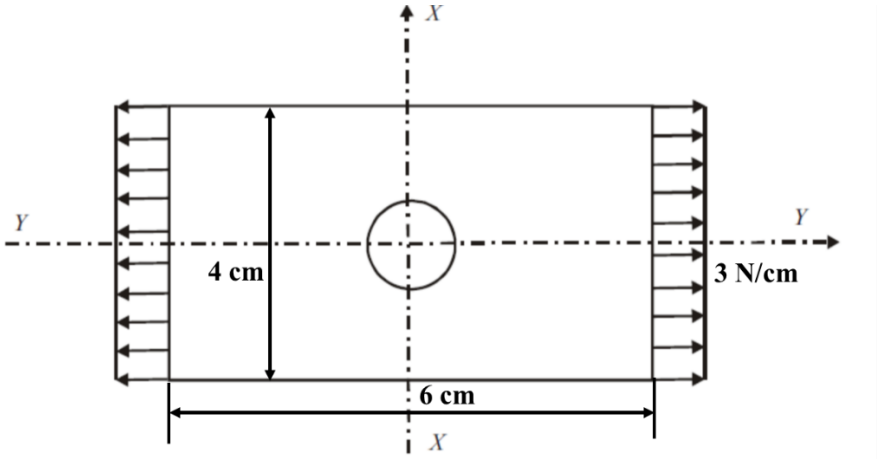
Study the sensitivity of results to type and number of elements. Compare your results against exact solution. Comment on the obtained results. Also, check for convergence and comment on the rate of convergence. Material properties are Young's modulus E = 210 GPa and Poisson's ratio $\nu = 0.3$.

3. Consider a linear elasticity problem as shown in Figure below. The vertical left edge is fixed. The bottom and the right vertical edges are traction free (i.e., $\bar{\boldsymbol{t}} = 0$). Traction $\bar{t}_y = -20\frac{N}{m}$ is applied on the top horizontal edge. Material properties are Young's modulus E = 30 MPa and Poisson's ratio $\nu = 0.3$. Plane stress conditions are considered. Using code developed

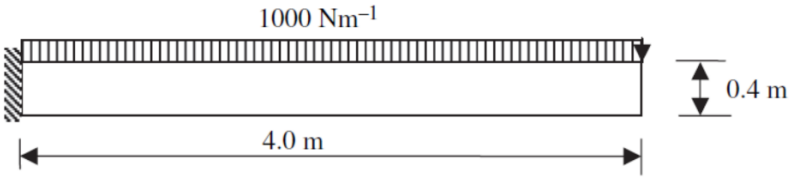
in # 1 compute the displacements and stresses in the plate. Study the sensitivity of results to type and number of elements.



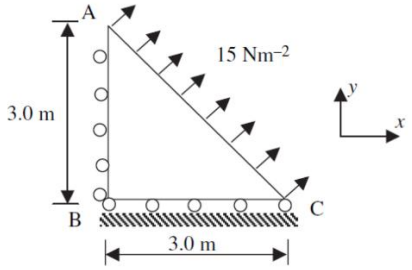
4. Thin plate with a circular hole is subjected to uniform tension as shown in figure below. Compute a stress concentration around a hole using code developed in # 1. (Hint: Plate is symmetric about x and y axes). Diameter of the hole is 1.5 cm. Material properties are Young's modulus E = 210 GPa and Poisson's ratio $\nu = 0.3$.



5. Using a code developed in # 1, analyze the cantilever beam shown in figure below. Material properties are Young's modulus E = 1.5 GPa and Poisson's ratio $\nu = 0.25$.



6. For the following figure, calculate displacement and stress at (1.5, 1.5) using a code developed in # 1. Assume E = 210 GPa and Poisson's ratio $\nu = 0.3$.



7. Write down the shape functions for the following element