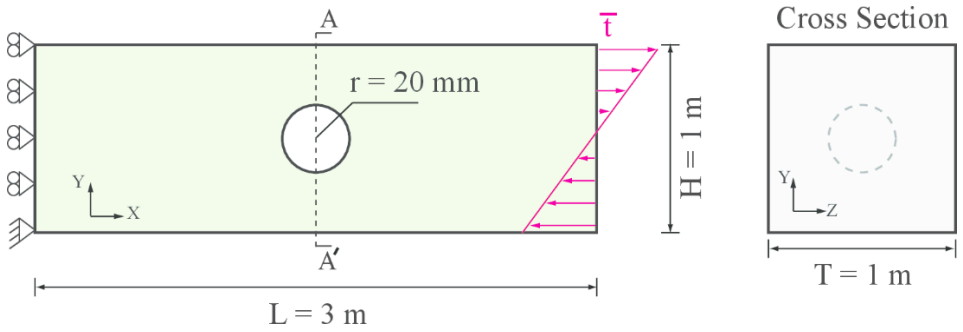
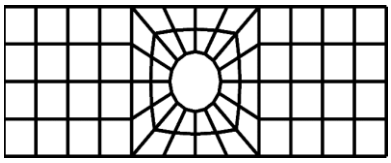
MAE 404/598 Finite Elements in Engineering
Project #3: **Due: May 7, 2015**

Analyze the following stress problem in a 2D beam with a center hole, shown below. The beam has a cantilever support on the left end. Moment is applied via an applied traction as shown in following figure. The maximum traction is 100 MPa. Beam thickness is 1m.



The function, **beam_mesh.m** is provided to generate a 2D mesh. The **beam_mesh(ey, L, r)** function takes 3 input arguments: ey gives the number of elements along height (The mesh pictured was generated with ey = 4), L gives the length of the beam (L=3 m for this problem), and r gives the radius of the central hole.
beam_mesh returns a structure containing two fields: (mesh.x stores the nodal coordinates in a [2, nn] matrix, and mesh.conn stores the connectivity matrix in a [4, ne] matrix.



2D mesh

Parameter		Value
Young's modulus	E	69 GPa
Poisson's ratio	ν	0.34

Material properties

Report format
Report must be typed and submitted by hard copy to ECG 205 (TA office) before the due date.
Each report should have the following sections:
1. 2D MATLAB solution
2. 3D ABAQUS solution
3. Appendix: MATLAB code(s)

Grading scale:
Points will be awarded for correct completion of each of the tasks listed below with partial credit awarded for incomplete or incorrect attempts. Plots must contain axis labels and units as appropriate for full credit.

General points (20 possible)
- [20] Report is clearly written.

MATLAB solution points (110 possible)
- [10] Code follows clean and consistent style with comments included as appropriate.
- [10] Contour plot of approximated displacement field under fine mesh using both plane strain and plane stress model.
- [10] Plot the maximum $|u_y|$ versus the number of elements using both plane strain and plane stress model in the same figure (two curves for plane strain and plane stress, respectively).

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- [20] Contour plot of σ_{xx} using plane stress and plane strain model. Are your results reasonable? Explain the reason (hint: compare numerical stress fields with analytical solution for beam).
- [20] Plot σ_{xx} along line AA' using plane stress and plane strain model.
- [40] Where is the mostly likely location for failure if the material is ductile? Does the predicted failure depend on the assumption of plane stress or plane strain? (Hint: locations with higher Von Mises stress are more likely to fail.)

ABAQUS 3D solution points (50 possible)

- [20] Show *publication-quality* plots of the displacement and stress fields for a two different element sizes. Contour plots must have a clear legend, clear font and show the extreme values.
- [20] Compare between solutions using linear and quadratic elements, given the limitation of number of elements, what is the best solution that you can achieve?
- [10] Justify that your Abaqus solution is reasonable.