**ME300 Applied Elasticity** David Wootton Cooper Union

**In Class Workshop: Contour Plots for Stress Field Visualization.** Thursday Oct 5, 2023

*(Problem 1 of HW 4) Use MATLAB (or Python) to create filled contour plots of the stress field in a plate with a circular hole in the center, loaded with uniform stress, sx(y) = s0 = 100 MPa at the ends (x = ±L). Make the hole radius 1/5 of the plate half-width, and the half-length twice the half-width. Things to think about: What is the stress field? How do you make a filled contour plot? What stress(es) do you want to show? How can you make a hole in a surface plot?*

Workshop goals: Create and display a grid of calculation points representing a plate with a hole, based on provided code (transfinite interpolation). Create and visualize simple test field functions (radial and angular position) on the plate using a filled contour plot. As time permits, calculate and visualize stress fields.

Suggestions (MATLAB):

1. Make a mesh file for a quarter plate with hole. MATLAB or Python script MeshPlateWithHole.m/py will get you started. Download the script from Teams. The script creates a mesh with node point x and y positions given in matrices X and Y, and displays the quarter plate mesh. (It also uses symmetry to display the full plate.)

A grid of blue lines

Description automatically generatedA blue grid with a white circle

Description automatically generated

1. Add equations to compute a radial position array, Rarray, from X and Y.
   1. Note your equation here:
   2. Use two nested loops to compute radius at each grid location.
   3. Or you can use vectorized calculations for more compact (and faster) code.

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| The vectorized calculations using MATLAB cart2pol:  [r, theta] = cart2pol(X,Y);  Rarray = theta; |

1. Use the command **surf** to make a colormap of the radial position field. Test the colormap by displaying the radius, using the following command:

surf(X,Y,Rarray); shading interp, axis equal tight, colorbar, view(2)

For Python: set Z = Rarray and make sure PLOT\_CONTOUR is set to “True”

Note that the axis equal setting is important to avoid distorting the geometry. Read the contour plot carefully to make sure that it looks right, and show your plot to the instructor.

A chart of a gradient

Description automatically generated with medium confidence

1. Once your sample plot looks right, compute angular position and plot it the same way (make a matrix Theta, and use in place of Rarray in the command above).

A rainbow colored graph with numbers

Description automatically generated with medium confidence

1. If you finish this, you should explore some different stress fields using your plotting routine. See for example the solution to the stresses for a plate with a small hole.
2. If time permits, you can also take advantage of symmetry to compute the stress fields in the other 3 quarters of the plate. Think carefully about the symmetry that you would expect for

**What to submit at the end of class:** a copy of your MATLAB script (m-file) or python script, and a sample contour plot of axial stress, sxx = s0, showing the stresses in polar coordinates (if time permits), or sample contour plots of radial and angular position.