CAD Laboratory (CE4P001) — Assignment 2
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Report
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Question 1: Displaced Shape of a 2D Body
• Plots.jl was utilized to construct two-dimensional plots.
• Grids for $x_1$ and $x_2$ were generated using step-based ranges and combined through broadcasting to form a mesh.
• Displacement components $u_1$ and $u_2$ were evaluated using logarithmic and exponential functions.
• Deformed coordinates ($x_1 + u_1, x_2 + u_2$) were obtained and visualized.
• Boundary lines and internal mesh lines were plotted for the original configuration (blue) and the deformed configuration (red).

Question 2: Annular Body in Polar Coordinates
• Radial (r) and angular (θ) grids were sampled uniformly.
• Polar coordinates were transformed into Cartesian coordinates.
• Radial and tangential displacement fields ur and uθ were defined.
• The polar displacement fields were converted into Cartesian components (ux, uy).
• Deformed coordinates were computed and radial/circular lines were plotted before and after deformation.

Question 3: Polar Transformation-Based Deformation
• A rectangular grid ($x_1, x_2$) was generated.
• Each grid point was transformed into its polar radius r and angle θ.
• Displacement components ur and uθ were defined using exponential and logarithmic expressions.
• These were transformed into Cartesian displacement components ($u_1, u_2$).
• The deformed configuration was plotted by adding displacement to original coordinates.

Question 4: Plate with Circular Hole — Meshing
• Geometry was defined with given values of plate length, height, thickness, and hole radius.
• Corner points and arc points were specified in Gmsh.
• An outer rectangular loop and an inner circular loop were created.
• A plane surface containing a circular void was generated.

• The 2D surface was extruded to obtain a 3D plate model.
• Physical groups were assigned for boundaries and the volume.
• A 3D mesh was generated.
• Governing PDE: $\nabla \cdot \sigma = 0$, $\varepsilon = (\nabla u + \nabla u^T)/2$, $\sigma = 2\mu\, \varepsilon + \lambda\, \mathrm{tr}(\varepsilon) I$.
• Boundary conditions: left edge fixed; remaining edges traction-free except the loaded boundary.
• Julia and Abaqus meshing workflows were compared, including material assignment and application of pressure on the plate.

Question 5: Cantilever Beam with Point Load — Meshing
• Beam dimensions (length, width, depth) were specified.
• Rectangle defining cross-section was created in Gmsh.
• Lines and surface loops were generated and extruded into a 3D model.
• Mesh generation followed.
• PDE remained the same as in Question 4 (linear elasticity).
• One end was fully fixed; a concentrated point load was applied at the free end.
• Corresponding steps in Abaqus included defining 3D geometry, assigning material ($E = 25$ GPa, $\nu = 0.2$), creating a reference point, tying it to an edge, and generating mesh.

Question 6: Cantilever Beam with UDL — Meshing
• Same cantilever geometry as in Question 5, but subjected to uniformly distributed load.
• 3D mesh was generated using Gmsh extrusion.
• Appropriate boundary groups were defined.
• PDE: linear elastic solid subjected to distributed loading.
• Boundary: fixed support at one end and UDL acting on the top face.
• Abaqus modelling involved applying pressure load on the top surface and generating the mesh.