MAE 4291/5230 Design Project

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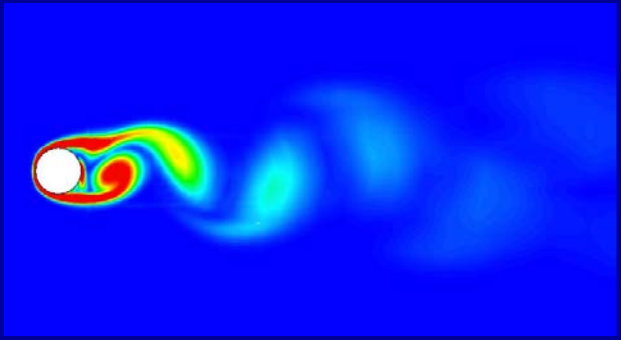

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Section Instructor

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- Office hours in Swanson Lab (163 Rhodes):
  - TBA

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Design Project

- Will use Computational Fluid Dynamics (CFD)
- CFD software to be used is ANSYS FLUENT
- Section will involve hands-on experience with FLUENT
- Reliable use of CFD software involves:
  - Strong understanding of *concepts*
  - Software *skills*
- Concepts:
  - Mathematical models, solution procedures, physical interpretation etc.

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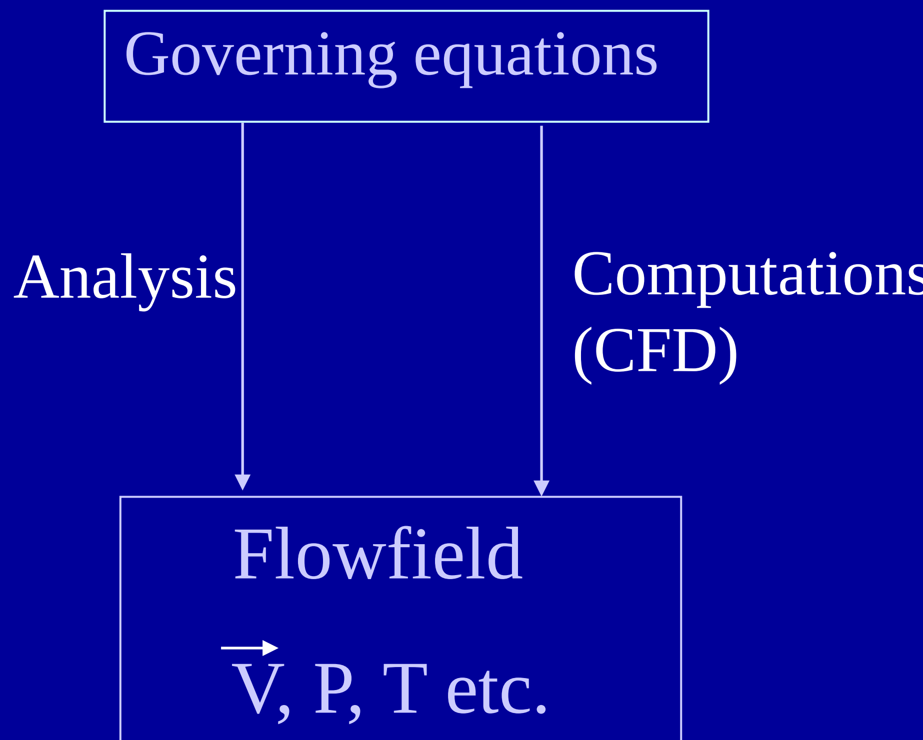
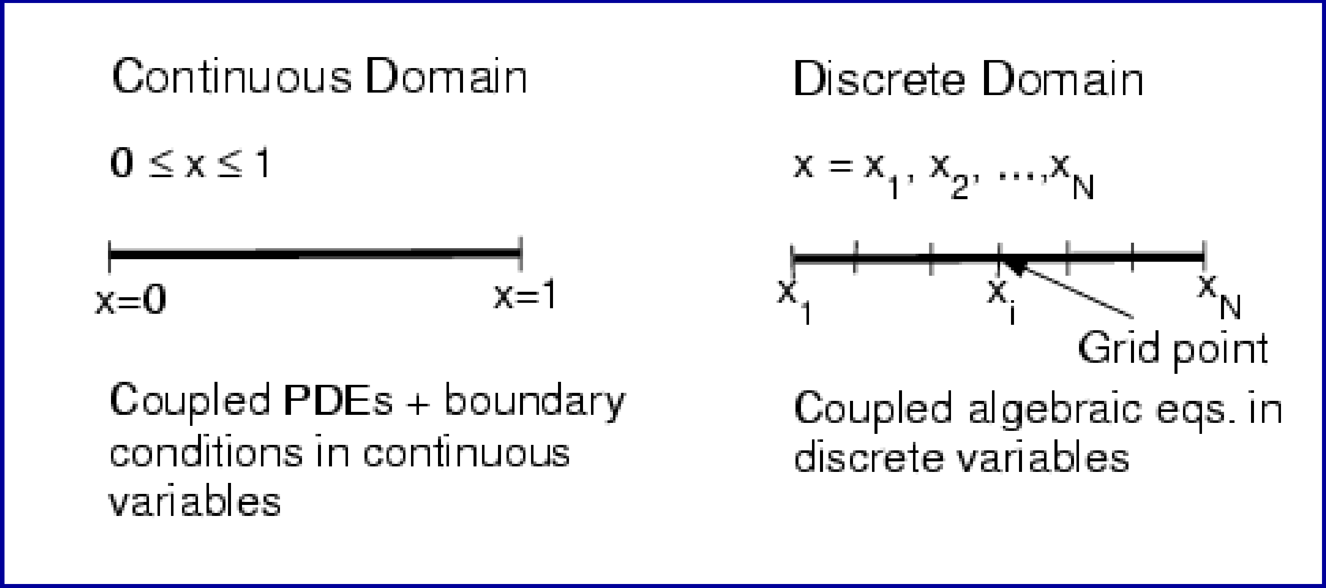
CFD vs. Analysis

- CFD can handle
  - Complex geometries
  - Complex physics
- Caveat: Garbage in, garbage out



Key Idea of CFD: Discretization



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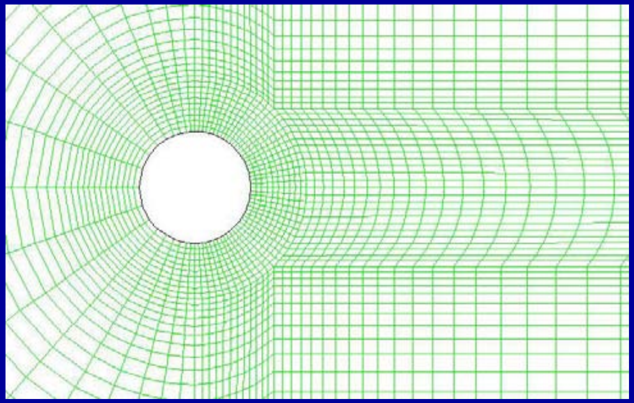
Software to be used

- ANSYS FLUENT
  - Solves the governing equations *approximately*
  - Can be used to simulate various kinds of flow physics from low-speed incompressible to high-speed compressible
  - One of the leading commercial CFD packages but no endorsement is implied
- ANSYS Workbench
  - Environment for pre- and post-processing
  - Pre-processing: Create geometry and mesh
  - Post-processing: Visualize and analyze results
- Software is evolving and is imperfect (so is the user)

Upcoming

- CFD solution process:
  - Geometry
  - Mesh
  - Setup (physics)
  - Solve
  - Results
- Fundamental CFD concepts will be discussed in the MW lectures in the next few weeks
- Will focus on geometry and mesh creation in the meantime

Cylinder Mesh



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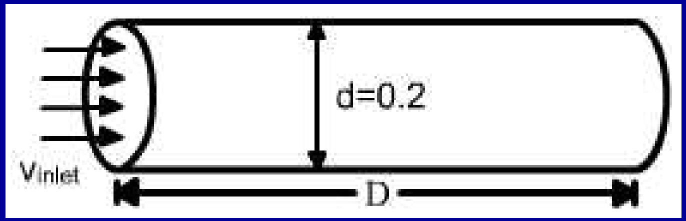
Example: Laminar Flow in a Pipe

- We'll later be solving the laminar developing flow in a pipe



- See tutorial at
  - *http://confluence.cornell.edu/display/simulation*

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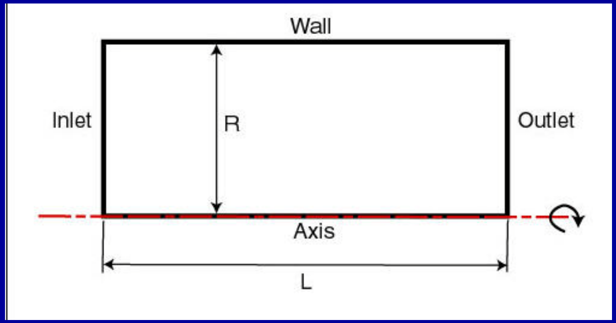
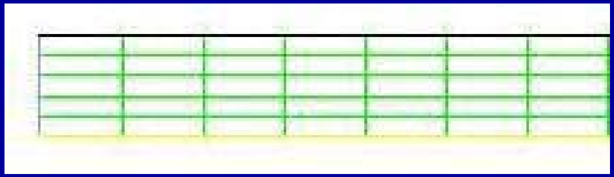
Laminar Flow in a Pipe

- Assume flow is axisymmetric. Hence, domain is rectangular.



- Sample grid for pipe



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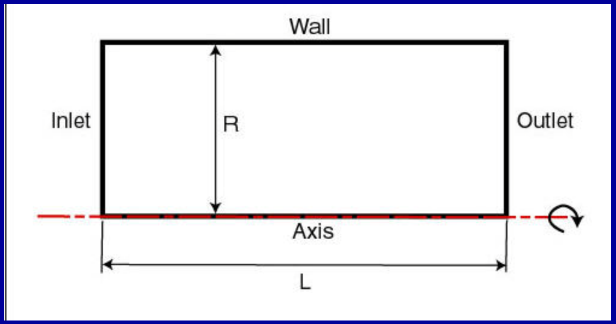
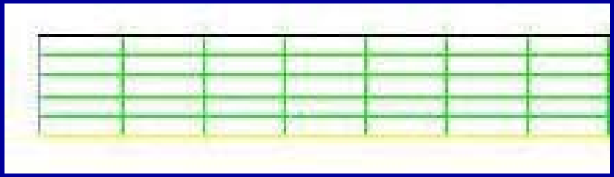
Laminar Flow in a Pipe: Tasks

- Create geometry
  - Rectangle
- Grid or mesh geometry
  - Uniform divisions
- Label boundaries
  - Inlet, Outlet etc.
  - Will later apply boundary conditions at the labeled boundaries





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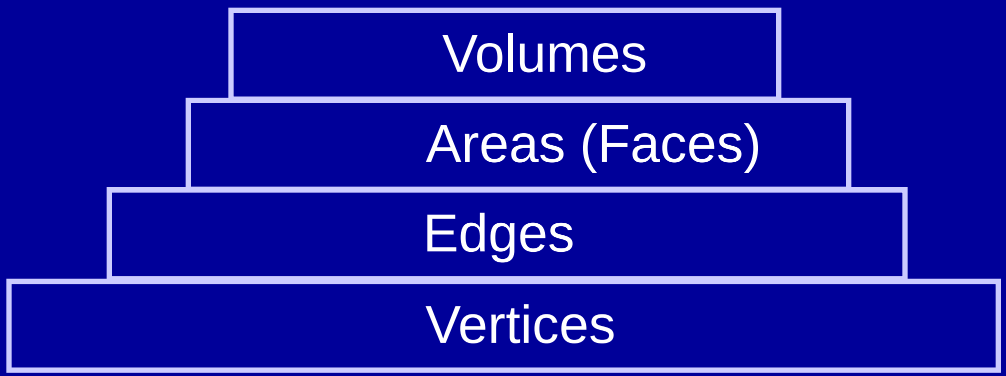
Pipe Flow: Inputs

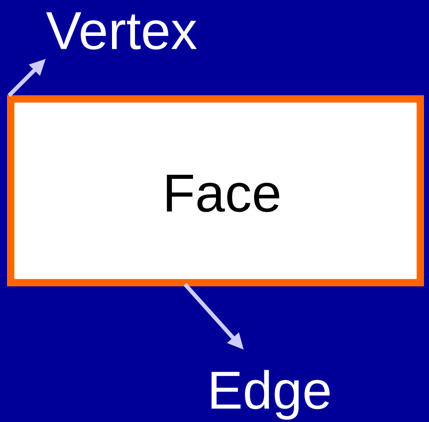
No. of divisions in axial direction NL=100

No. of divisions in radial direction NR=5

Geometry Components Hierarchy

- Geometry is usually referred to as "Solid Model"
- Hierarchy





- Can control face mesh through edge mesh etc.

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471 Rhodes Computer Classroom

- Request an account in 471 Rhodes from the following webpage:
  http://intranet.orie.cornell.edu
- An email will be sent to you providing you with your first use password. **Please bring this password to the section meeting.**

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471 Rhodes Temporary Account

- username: monday
  password: 0ri3Temp
  (zero - r - i - three - capital T - e - m - p)

471 Rhodes Temporary Account #2

- username: tuesday
  password: 0ri3Tues
  (zero - r - i - three - capital T - u - e - s)

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Mapped Meshing

- Valid in 2D and 3D
- Generates regular meshes that generally lead to increased accuracy
- Can be used only in “regular” regions
- For 2D, works on areas with
  - 3 or 4 sides
  - 4 sides: Opposite sides have equal number of divisions
  - 3 sides: All sides must have an equal, even number of divisions

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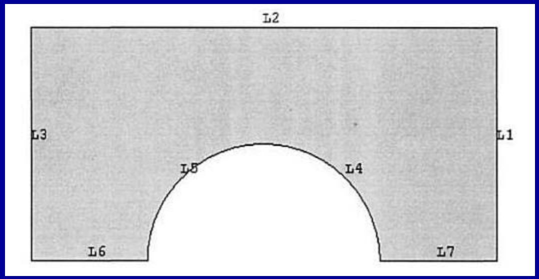
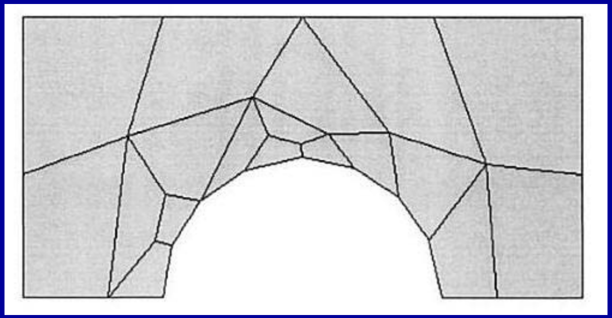
Mapped Meshing

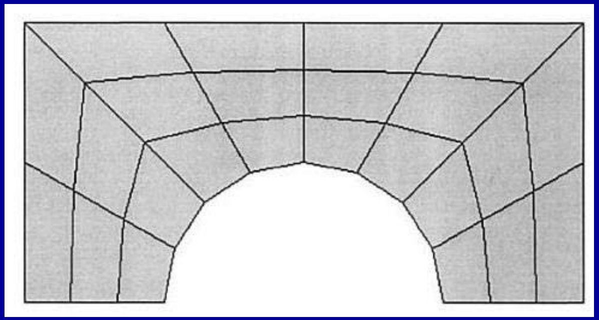
- Example from “The finite element method and applications in engineering using ANSYS” by Madenci & Guven



Free mesh



Mapped mesh



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Mapped Meshing

- Why the “mapped” in name?
  - A four-sided area with equal number of divisions on the opposite edges can be mapped to a regular mesh on a square