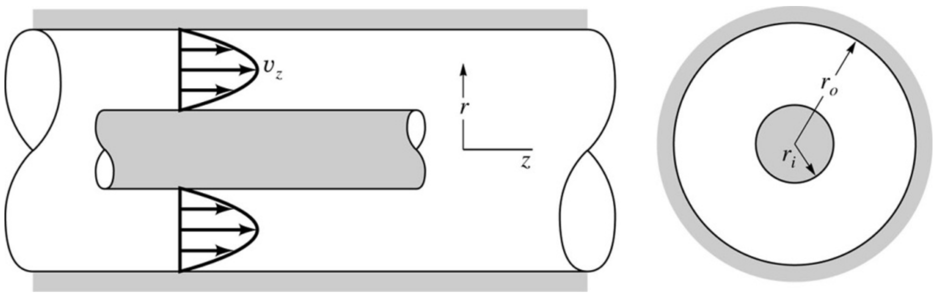
Simple solutions

Steady, axial, laminar flow in an annulus



$$v_z = \frac{f'(z)}{4\mu} r^2 + c_1 \ln r + c_2$$

but now with boundary conditions:

$$v_z = 0 \quad \text{at } r = r_i$$
$$v_z = 0 \quad \text{at } r = r_o$$

$$\rightarrow \quad v_z = \frac{f'(z)}{4\mu}\left[\left(r^2 - r_o^2\right) + \left(r_i^2 - r_o^2\right)\frac{\ln(r/r_o)}{\ln(r_o/r_i)}\right]$$

Eq (6.155)

Numerical Methods

Computational Fluid Dynamics (CFD)

Finite difference method:

- Flow field at discrete points that are arranged as grid or mesh
- The grid must represent the geometry correctly and accurately
- Finer mesh provides higher resolution to capture the relevant flow physics, such as in the boundary layer near a solid surface
- Only for structured grids that are used for geometry with some degree of symmetry
- For complex geometry, other methods, such as finite volume method, should be used

Numerical Methods

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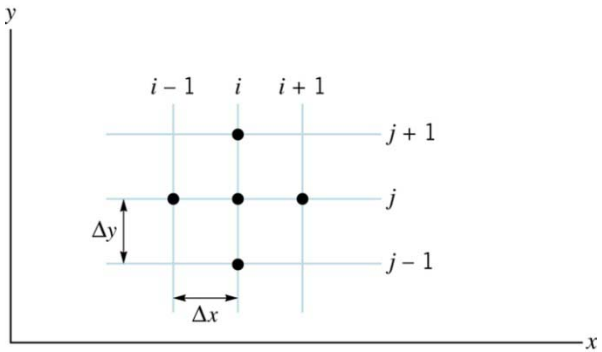
Finite difference method:



$$\left(\frac{\partial v}{\partial x}\right)_{i,j} = \frac{v_{i+1,j} - v_{i,j}}{\Delta x} + O(\Delta x)$$

$$\left(\frac{\partial v}{\partial x}\right)_{i,j} = \frac{v_{i+1,j} - v_{i-1,j}}{2\Delta x} + O(\Delta x^2)$$