Derivation process

1. \[ \sum \mathbf{F} = m \mathbf{a} \]
   - Newton's 2nd Law.
   - Apply to a volume element
   - Shrink the volume to a point

2. \[ f_1 (\mathbf{V}, \mathbf{\Xi}) \]
   - Cauchy's equation of motion.
   - (12 unknowns)

3. \[ f_2 (\mathbf{\Xi}, \mathbf{\varepsilon}) \]
   - Fluid constitutive equation.

4. \[ f_3 (\mathbf{V}, \mathbf{\varepsilon}) \]
   - (Still 12 unknowns)

5. \[ f_4 (\mathbf{\varepsilon}, \mathbf{V}) \]
   - Deformation analysis

6. \[ f_5 (\mathbf{V}, p) \]
   - Navier-Stokes equations
   - (4 unknowns: \( u, v, w, p \))

\[ \rho \frac{D\mathbf{V}}{Dt} = - \nabla p + \mu \nabla^2 \mathbf{V} + \rho \mathbf{q} \]

NS equation for incompressible fluid

+ \[ \nabla \cdot \mathbf{V} = 0 \]
continuity equation for incompressible fluid.

System of 4 equations (3 NS equations + 1 continuity equation), with 4 unknowns.