12-355: Fluid Mechanics
Summary of Bernoulli Equation(s)

- **Along streamline:**
  - **differential form** (for steady, inviscid fluid):

$$-\frac{\partial p}{\partial s}-\gamma\frac{\partial z}{\partial s}=\rho V\frac{\partial V}{\partial s} \tag{1}$$

  - **integral form** (for steady, inviscid, incompressible fluid)

$$p+\gamma z+\frac{1}{2}\rho V^2=\text{constant along streamline} \tag{2}$$

- **Across streamline:**
  - **differential form** (for steady, inviscid fluid):

$$-\frac{\partial p}{\partial n}-\gamma\frac{\partial z}{\partial n}=\rho\frac{V^2}{\mathcal{R}} \tag{3}$$

  - **integral form** (for steady, inviscid, incompressible fluid):

$$p+\gamma z+\rho\int\frac{V^2}{\mathcal{R}}\,dn=\text{constant across streamline} \tag{4}$$

ρ is fluid density

γ is fluid unit weight

θ is angle streamline makes with horizontal

s is coordinate along streamline (in direction of flow)

n is coordinate normal to streamline (pointing inward)

V is fluid velocity (by definition along streamline)

z is vertical coordinate (opposite direction of gravity)

$\mathcal{R}$ is radius of curvature of streamline (at a point)

Typical usage:

- Equation 1: to find pressure gradient along streamline
- Equation 2: to find difference in pressure between two points along streamline
- Equation 3: to find pressure gradient across streamline
- Equation 4: to find difference in pressure between two points across streamline