1 Key Concepts

- Conservation of Mass and Momentum
- Bernoulli's Equation

2 Important Equations

$$\frac{dM}{dt} = \int_S \rho \overrightarrow{u} \cdot \overrightarrow{n} dS \qquad \text{(Conservation of Mass)}$$

$$\int_V \frac{d}{dt} \rho \overrightarrow{u} dV + \int_A \rho \overrightarrow{u} \left(\overrightarrow{u} \cdot \overrightarrow{n} \right) dA = \int_V \rho \overrightarrow{g} dV + \int_A \rho \overrightarrow{f} dA \qquad \text{(Integral Conservation of Momentum)}$$

$$\rho \left(\frac{d\overrightarrow{u}}{dt} + \overrightarrow{u} \cdot \nabla \overrightarrow{u} \right) = \rho \overrightarrow{g} - \nabla P \qquad \text{(Differential Conservation of Momentum)}$$

$$H = \frac{v^2}{2} + \overrightarrow{g} \cdot \overrightarrow{r} + \frac{p}{\rho} \qquad \text{(Bernoulli's Equation)}$$

3 Practice Problems

1. A Venturi device is commonly used to determine the mass flow rate of a fluid passing through a pipe. Assuming the entrance cross section of the Venturi has an area A_1, which narrows down to a cross sectional area A_2. If a differential pressure gauge reads a differential pressure of P_D, then what is the mass flow rate? You may assume an incompressible, ideal fluid of density ρ.

2. Write out the free-body diagram of Problem 1 of Homework 1, and label all forces. What is difference in pressure between the inlet and the spreading liquid?

3. Suppose the same Venturi setup is used in problem one, but in this case the flow has choked (moving at the speed of sound of the fluid). What is the mass flow rate leaving the Venturi device?