ME3700 Exam 1 - Equations Sheet

Fluid Statics:

$$\frac{dp}{dz} = -\rho g$$

$$\vec{F}_R = \int_A -p(\hat{n})dA$$

$$y'\vec{F}_R = \int_A yp(\hat{n})dA$$

Euler's Equation:

$$\rho\frac{D\vec{V}}{Dt} = -\vec{\nabla}P + \rho\vec{g}$$

Continuity Equation:

$$\vec{\nabla}\bullet\vec{V} = 0$$

Euler-n Equation:

$$\frac{dP}{dn} = \rho\frac{V^2}{R}$$

Bernoulli's Equation:

$$\frac{P}{\rho} + \frac{V^2}{2} + gz = Const.$$

Integral form of Conservation of Mass (Non-deformable Control Volume):

$$\frac{DM_{sys}}{Dt} = 0 = \frac{\partial}{\partial t}\int_{C\forall}\rho d\forall + \int_{CS}\rho(\vec{V}\cdot\hat{n})dA$$

Integral form of Conservation of Momentum (Non-deformable Control Volume):

$$\sum\vec{F} = \frac{D\overrightarrow{Mom}_{sys}}{Dt} = \frac{\partial}{\partial t}\int_{C\forall}\rho\vec{V}d\forall + \int_{CS}\rho\vec{V}(\vec{V}\cdot\hat{n})dA$$

Integral form of Conservation of Energy (Non-deformable Control Volume):

$$\frac{DE_{sys}}{Dt} = \dot{Q} - \dot{W} = \frac{\partial}{\partial t}\int_{C\forall}\rho ed\forall + \int_{CS}\rho e(\vec{V}\cdot\hat{n})dA$$

Specific Energy:

$$e = \tilde{u} + \frac{V^2}{2} + gz$$

Simplified Energy Equation:

$$-\frac{\dot{W}_{shaft}}{\dot{m}g} = -\left(\frac{P}{\rho g} + \frac{V^2}{2g} + z\right)_1 + \left(\frac{P}{\rho g} + \frac{V^2}{2g} + z\right)_2 + H_L$$

$$H_L = K\frac{V^2}{2g}$$

Equation of state:

$$P = \rho RT$$