MAE 101A Midterm 2
02-24-09

Formula sheet

Mass Conservation Law

$$\frac{d}{dt}\int_{CV}\rho\, dV + \int_{CS}\rho(\vec{v}_{rel}\cdot\vec{n})\, dA = 0$$

Linear Momentum Conservation Law

$$\sum\vec{F} = \frac{d}{dt}\int_{CV}\rho\vec{v}\, dV + \int_{CS}\rho\vec{v}(\vec{v}_{rel}\cdot\vec{n})\, dA$$

Angular Momentum Conservation Law

$$\frac{d\vec{H}_O}{dt} = \sum(\vec{r}\times\vec{F}) = \sum\vec{M}_O = \frac{d}{dt}\int_{CV}(\vec{r}\times\rho\vec{v})\, dV + \int_{CS}(\vec{r}\times\rho\vec{v})(\vec{v}_{rel}\cdot\vec{n})\, dA$$

Energy Conservation Law

$$\dot{Q} - \dot{W}_S - \dot{W}_v = \frac{\partial}{\partial t}\int_{CV}(\hat{u} + \frac{1}{2}v^2)\rho\, dV + \int_{CS}(\hat{h} + \frac{1}{2}v^2 + gz)\rho(\vec{v}\cdot\vec{n})\, dA$$

Incompressible (low speed), steady flow through a pipe

$$(\frac{p}{\rho g} + \frac{\alpha V^2}{2g} + z)_{in} = (\frac{p}{\rho g} + \frac{\alpha V^2}{2g} + z)_{out} + h_{turbine} - h_{pump} + h_{friction}$$

$\alpha =$ kinetic energy correction factor

Ideal Gas Law
$p = \rho RT$

Enthalpy
$\hat{h} = C_p T$

$$R = 287\frac{J}{kg\ K} = 1716\frac{ft - lbf}{slug^0 R}$$

Bernoulli Equation

Steady, frictionless incompressible flow along a streamline

$$\frac{p}{\rho} + \frac{1}{2}V^2 + gz = const$$