Control Volume Forms of the General Conservation Equations

Continuity Equation

$$\frac{\partial}{\partial t}\left(\int_{CV}\rho\,dV\right) = \sum_{\text{in}}\dot{m} - \sum_{\text{out}}\dot{m}$$

First Law of Thermodynamics

$$\frac{\partial}{\partial t}\left(\int_{CV} e\rho\,dV\right) = \sum_{\text{in}}\int_{A_{\text{in}}}(e+Pv)\,d\dot{m} - \sum_{\text{out}}\int_{A_{\text{out}}}(e+Pv)\,d\dot{m} + \dot{Q}_{CV} + \dot{W}_{CV}$$

Second Law of Thermodynamics

$$\frac{\partial}{\partial t}\left(\int_{CV} s\rho\,dV\right) - \sum_{\text{in}}\int_{A_{\text{in}}} s\,d\dot{m} + \sum_{\text{out}}\int_{A_{\text{out}}} s\,d\dot{m} - \sum_{i}\left(\frac{\dot{Q}_i}{T_i}\right)_{CV} = \mathcal{P}_{\text{s}} \geq 0$$