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

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

Second Law of Thermodynamics

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