Steady Mass Flow

- The rate at which mass enters a given volume equals the rate at which mass leaves the same volume.

\[ P_1 A_1 V_1 = P_2 A_2 V_2 = m' \]

Where:
- \( P_1, P_2 \) = densities of the two streams.
- \( A_1 \) = area of entrance
- \( A_2 \) = area of exit
- \( V_1 \) = velocity of entering stream
- \( V_2 \) = velocity of leaving stream

The resultant forces of all external forces:

\[ \Sigma F = \dot{G} \]

Since \( \Delta G = (\Delta m)V_1 - (\Delta m)V_1 = \Delta m (V_2 - V_1) = \Delta m (\frac{dV}{dt}) \)

\[ m' = \lim_{\Delta t \to 0} \frac{\Delta m}{\Delta t} = \frac{dm}{dt} \]
Therefore, \[ \Sigma F = \dot{G} = \lim_{\Delta t \to 0} \frac{\Delta G}{\Delta t} = m' \Delta V \]

**Moment & Momentum**

\[ \Sigma M_0 = m' (d_2 \times V_2 - d_1 \times V_1) \]

where \( d_1 \) = position vector to the center of \( A_1 \)
\( d_2 \) = position vector to the center of \( A_2 \)

\[ \Sigma M_0 = \dot{H}_0 \quad \text{or} \quad \Sigma M_q = \dot{H}_q \]