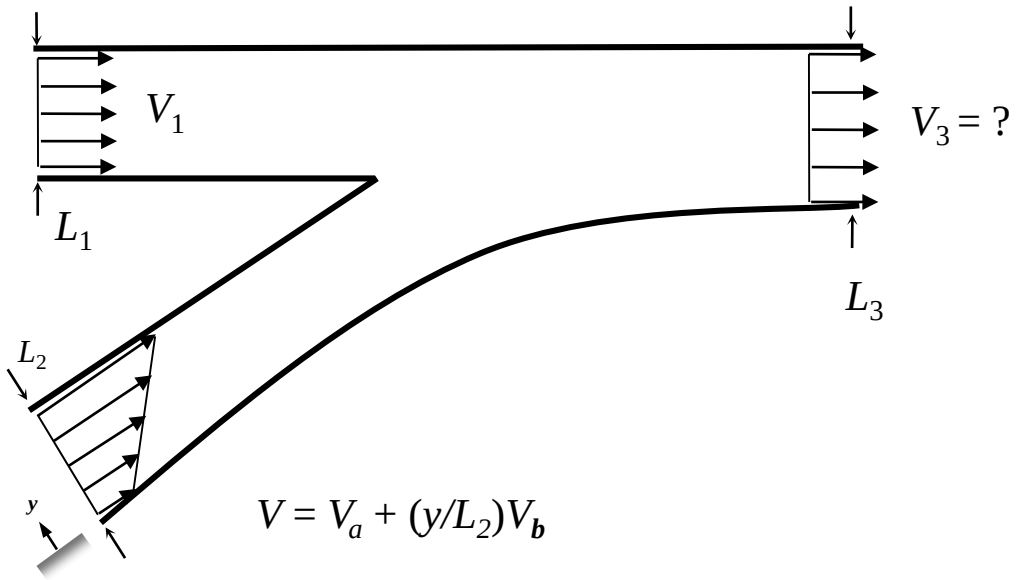
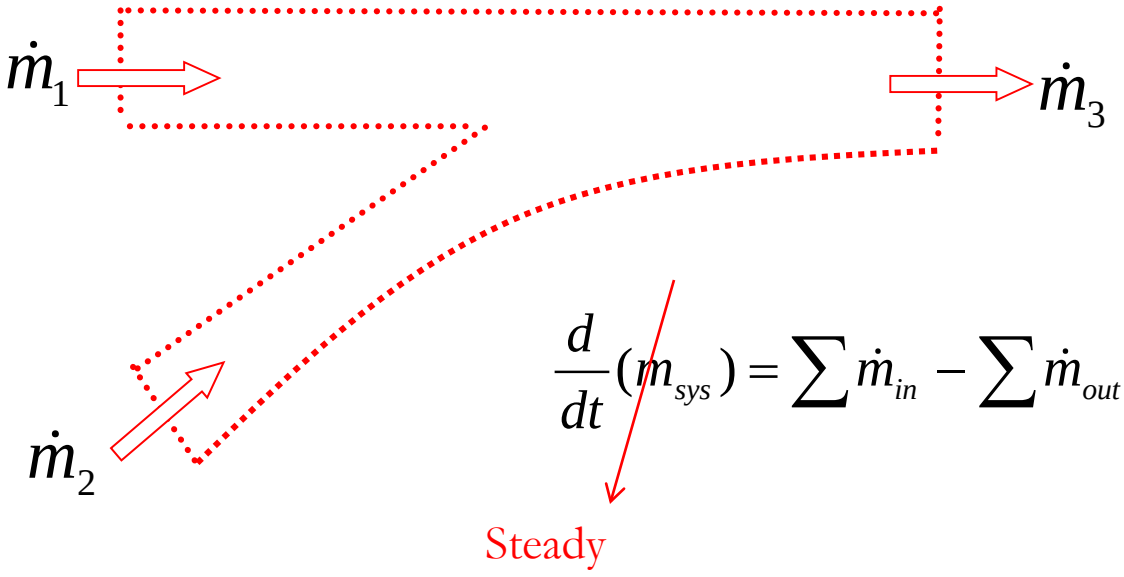
Example B

A steady-state ejector is shown in the figure below. The ejector has a constant length into the page of w. V_3 is an unknown quantity. All other lengths and velocities are known. The ejector fluid can be modeled as an incompressible fluid with density ρ.



Find an expression for the velocity at the outlet, V_3 in terms of the known quantities.



$$0 = \dot{m}_1 + \dot{m}_2 - \dot{m}_3$$

Mass flow rates:

$$\dot{m}_1 = \rho A_1 V_1 = \rho w L_1 V_1 \qquad \dot{m}_3 = \rho A_3 V_3 = \rho w L_3 V_3$$

$$\dot{m}_2 = \int_{A_2} \rho V(y) dA$$

$$= \rho \int_{A_2} (V_a + \frac{y}{L_2} V_b) dA \quad = \rho \int_{y=0}^{L_2} (V_a + \frac{y}{L_2} V_b) \overbrace{w dy}^{dA}$$

$$= \rho w L_2 (V_a + \frac{V_b}{2})$$

So:

$$V_3 = \frac{L_1 V_1 + L_2 (V_a + \frac{V_b}{2})}{L_3}$$