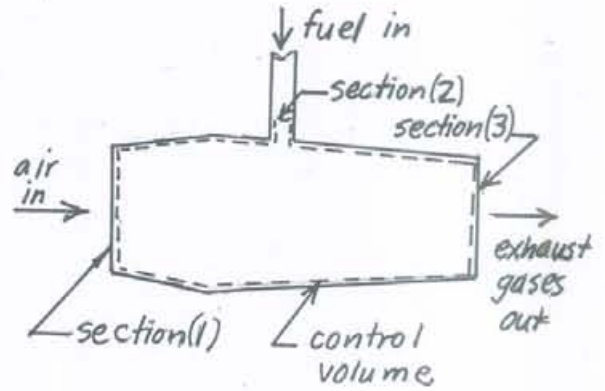5.14 At cruise conditions, air flows into a jet engine at a steady rate of 65 lbm/s. Fuel enters the engine at a steady rate of 0.60 lbm/s. The average velocity of the exhaust gases is 1500 ft/s relative to the engine. If the engine exhaust effective cross-sectional area is 3.5 ft², estimate the density of the exhaust gases in lbm/ft³.

For steady flow

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

or

$$\rho_3 A_3 \bar{V}_3 = \dot{m}_1 + \dot{m}_2$$

Thus

$$\rho_3 = \frac{\dot{m}_1 + \dot{m}_2}{A_3 \bar{V}_3} = \frac{65 \frac{lbm}{s} + 0.60 \frac{lbm}{s}}{(3.5 \ ft^2)(1500 \frac{ft}{s})}$$

$$\rho_3 = \underline{\underline{0.0125 \ \frac{lbm}{ft^3}}}$$