

Basic Laws for Finite Systems - 1

3.1 A two dimensional flow has the velocity field $u=ax$ and $v=-ay$. Find the displaced system if it is a square ($1 \leq x \leq 2, 1 \leq y \leq 2$) at time $t=0$. Find the change in volume of the system between the displaced and original positions. (Hint: Use $dx/dt=u$ and $dy/dt=v$ to track the corners of the system.)

3.2 The velocity profile for fully developed turbulent flow in a pipe is $\bar{u} = \bar{u}_c (1 - r/R)^{1/7}$. Find the volume flow rate in the pipe and the centerline velocity \bar{u}_c in terms of the average velocity \bar{u}_{ave} .

3.3 Two pipes join to form a single pipe. If the mass flow rates in the first two pipes are $\dot{m}_1 = 0.2 \text{ kg/s}$ and $\dot{m}_2 = 0.15 \text{ kg/s}$, what is the flow rate in the joined pipe? If the cross-sectional area of the joined pipe is $A = 2 \text{ cm}^2$, what is the velocity of the water flow.