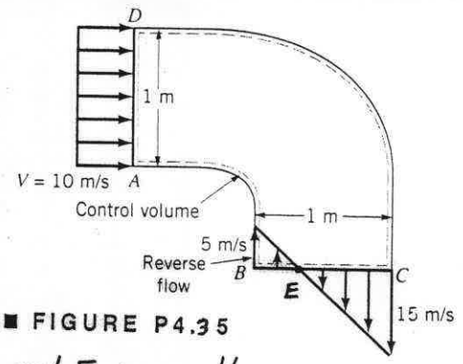
4.35

4.35 Air enters an elbow with a uniform speed of 10 m/s as shown in Fig. P4.35. At the exit of the elbow the velocity profile is not uniform. In fact, there is a region of separation or reverse flow. The fixed control volume *ABCD* coincides with the system at time $t = 0$. Make a sketch to indicate (**a**) the system at time $t = 0.01$ s and (**b**) the fluid that has entered and exited the control volume in that time period.



■ FIGURE P4.35

From $t=0$ to $t=0.01s$ particles A, B, C, D, and E move the following distances:

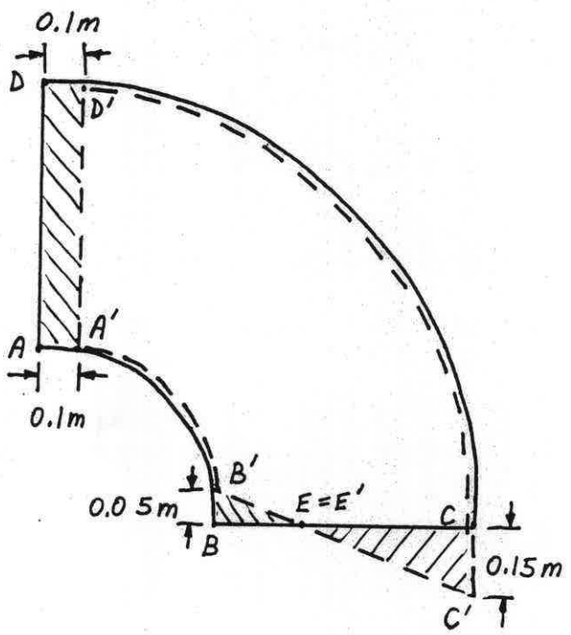
$\delta_A = V_A \delta t = (10 \frac{m}{s})(0.01s) = 0.1m = \delta_D$

$\delta_B = V_B \delta t = (5 \frac{m}{s})(0.01s) = 0.05m$

$\delta_C = V_C \delta t = (15 \frac{m}{s})(0.01s) = 0.15m$, and

$\delta_E = 0$

Thus, fluid along lines AD and BEC originally moves to lines A'D' and B'E'C' shown below.



——— system at $t=0$

– – – – system at $t=0.01s$

//// fluid that exited control volume

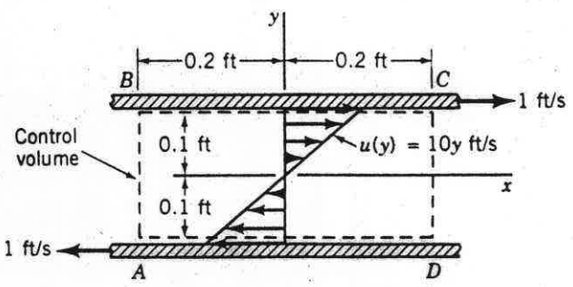
\\\\ fluid that entered control volume

35 br

27

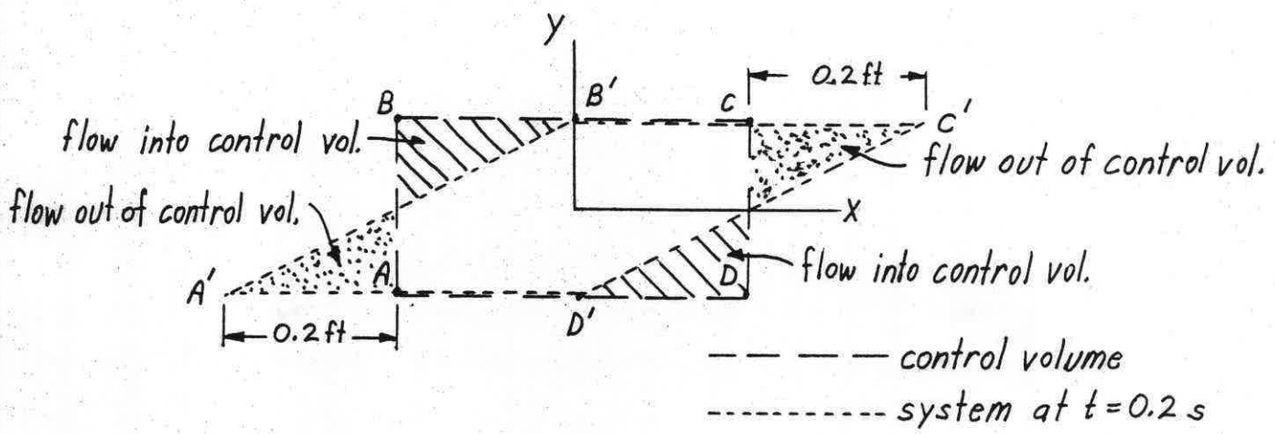
4.37

4.37 Two plates are pulled in opposite directions with speeds of 1.0 ft/s as shown in Fig. P4.37. The oil between the plates moves with a velocity given by $\mathbf{V} = 10y\hat{\mathbf{i}}$ ft/s, where y is in feet. The fixed control volume $ABCD$ coincides with the system at time $t = 0$. Make a sketch to indicate **(a)** the system at time $t = 0.2$ s and **(b)** the fluid that has entered and exited the control volume in that time period.



■ FIGURE P4.37

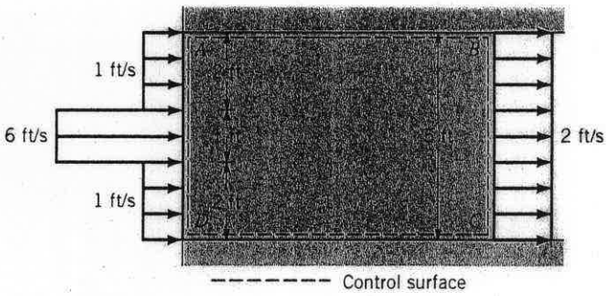
Since $\vec{V} = u(y)\hat{i} = 10y\,\hat{i}$ it follows that the fluid flows in the x-direction a distance of $\delta x = u\,\delta t = 10y\,(0.2)$ ft $= 2y$ ft from $t = 0$ to $t = 0.2$ s. The lines A-B and C-D (the ends of the original system location) deform into lines A'-B' and C'-D' as shown in the figure below. The portions of the system that have entered and exited the control volume during this time are indicated.



37 br

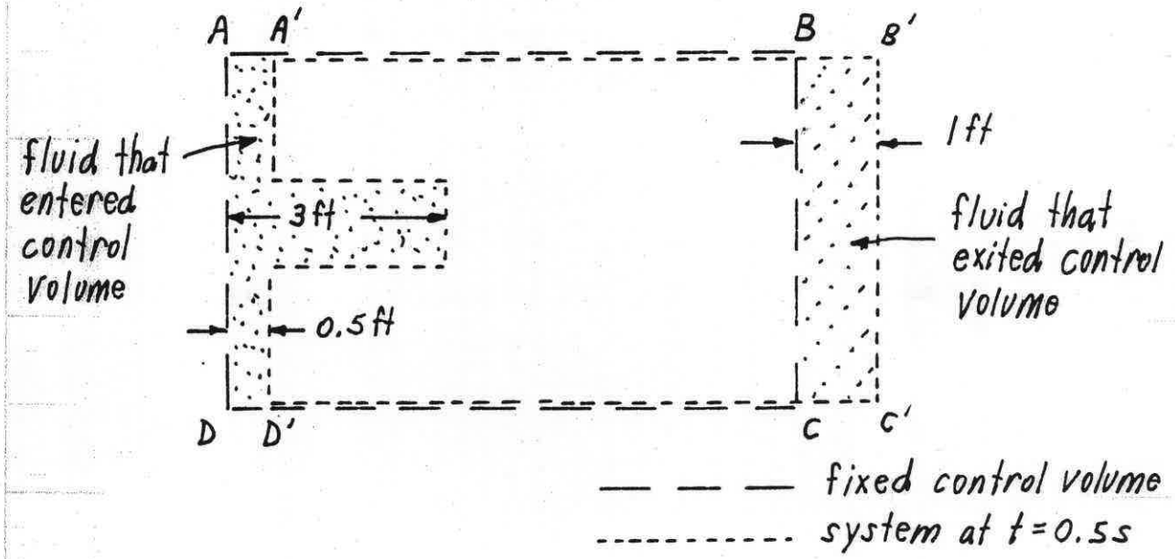
4.39

4.39 Water enters a 5-ft-wide, 1-ft-deep channel as shown in Fig. P4.39. Across the inlet the water velocity is 6 ft/s in the center portion of the channel and 1 ft/s in the remainder of it. Farther downstream the water flows at a uniform 2-ft/s velocity across the entire channel. The fixed control volume *ABCD* coincides with the system at time $t = 0$. Make a sketch to indicate **(a)** the system at time $t = 0.5$ s and **(b)** the fluid that has entered and exited the control volume in that time period.



■ FIGURE P4.39

During the $t = 0.5$ s time interval the fluid that was along line BC at time $t=0$ has moved to the right a distance $\ell = V\,t = 2\frac{ft}{s}(0.5s) = 1$ ft. Similarly, portions of the fluid along line AD have moved $\ell = 1\frac{ft}{s}(0.5s) = 0.5$ ft and $\ell = 6\frac{ft}{s}(0.5s) = 3$ ft. This assumes the $1\frac{ft}{s}$ and $6\frac{ft}{s}$ fluid streams do not mix or intermingle during the 0.5 s time interval. See figure below.



39 br