ESO204A: Fluid Mechanics and Rate Processes
TUTORIAL 4 PROBLEMS

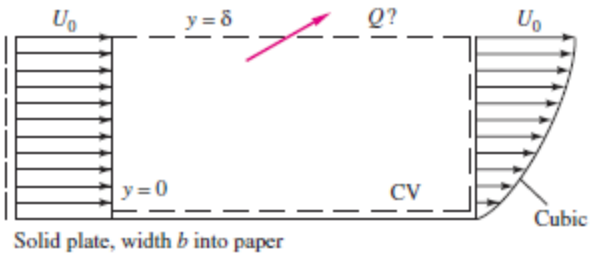
August-November 2017

1. Review of Tutorial 3

2. An incompressible fluid flows past an impermeable flat plate, as in Fig. P3.16, with a uniform inlet profile $u = U_0$ and a cubic polynomial exit profile

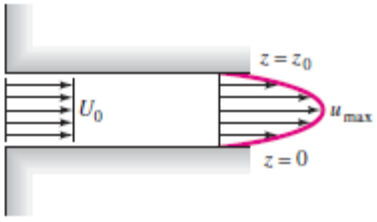
$$u \approx U_0\left(\frac{3\eta - \eta^3}{2}\right) \text{ where } \eta = \frac{y}{\delta}$$

Compute the volume flow Q across the top surface of the control volume.



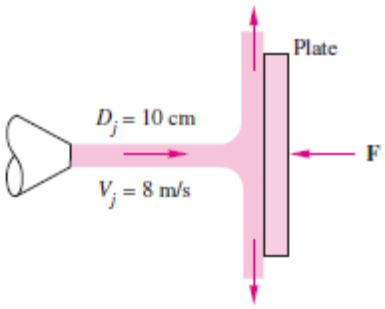
P3.16

3. Incompressible steady flow in the inlet between parallel plates in Fig. P3.17 is uniform, $u = U_0 = 8\,\text{cm/s}$, while downstream the flow develops into the parabolic laminar profile $u = az(z_0 - z)$, where a is a constant. If z_0 = 4 cm and the fluid is SAE 30 oil at 20°C, what is the value of u_{max} in cm/s?



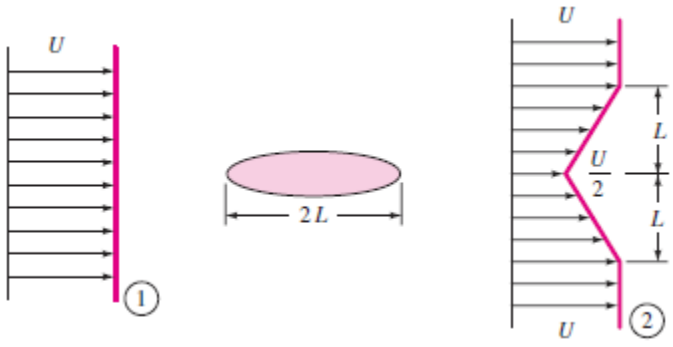
P3.17

4. The water jet in Fig. P3.40 strikes normal to a fixed plate. Neglect gravity and friction, and compute the force F in newtons required to hold the plate fixed.



P3.40

5. When a uniform stream flows past an immersed thick cylinder, a broad low-velocity wake is created downstream, idealized as a V shape in Fig. P3.44. Pressures p_1 and p_2 are approximately equal. If the flow is two-dimensional and incompressible, with width b into the paper, derive a formula for the drag force F on the cylinder. Rewrite your result in the form of a dimensionless *drag coefficient* based on the body length $C_D = F / \left(\rho U^2 bL\right)$.



P3.44