2.25 Advanced Fluid Mechanics

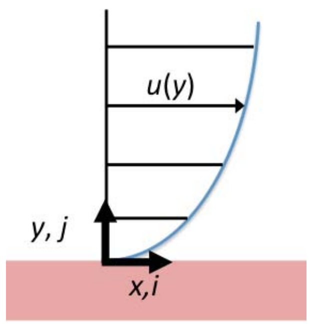
Problem 10.2

This problem is from "Advanced Fluid Mechanics Problems" by 2.25 Problem Set Solution — Problem

- (*a*) Show that if (1) and (2) are two arbitrary points in a steady, inviscid, incompressible flow in a uniform gravitational field,

$$\left(P_2 + \frac{v_2^2}{2} + \rho g y_2\right) = \left(P_1 + \frac{v_1^2}{2} + \rho g y_1\right) + \rho \int_1^2 (\underline{v} \times \underline{\omega}) \cdot d\underline{l} \tag{10.2-1}$$

  Here, y is measured up against the gravitational field, $\omega = \nabla \times \underline{v}$ is the vorticity vector and the last term represents a line integral along any path between (1) and (2) through the flow.



- (*b*) Show that if the flow in (a) is a parallel, horizontal flow, that is,

$$\underline{v} = u(y)\underline{i}, \tag{10.2-2}$$

  as shown in the sketch, it follows from the equation in (a) that the pressure distribution is the hydrostatic one,

$$P_2 + \rho g y_2 = P_1 + \rho g y_1 \tag{10.2-3}$$

- (*c*) Obtain the conclusion of (b) by using an argument based on Euler's equation in streamline form, rather than starting with the equation in part (a)

