

MIT Department of Mechanical Engineering
2.25 Advanced Fluid Mechanics

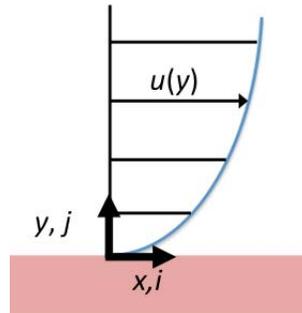
Problem 10.2

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,

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

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,

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

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

$$P_2 + \rho g y_2 = P_1 + \rho g y_1 \quad (10.2-3)$$

- (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)

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Fall 2013

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