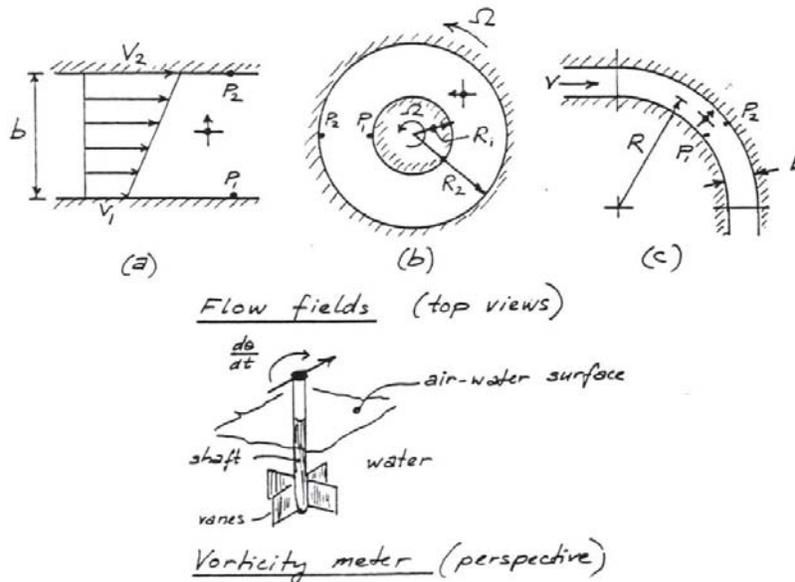


MIT Department of Mechanical Engineering  
2.25 Advanced Fluid Mechanics

**Problem 10.03**

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



Consider the three different, steady, two dimensional incompressible flow fields illustrated in Figures (a), (b), and (c) above. The flows represent

- (a) a parallel flow in a channel, with a linear velocity profile,
- (b) a flow in an annulus, with the liquid rotating like a solid body in unison with its bounding walls at an angular speed  $\Omega$ , and
- (c) an inviscid flow in a bend of width  $b$  small compared with the mean radius of curvature  $R$ . the flow being uniform at a speed  $V$  prior to entering the bend.

A primitive ‘vorticity meter’ made of two perpendicular vanes mounted on a shaft, as sketched, is inserted into each of these flows, oriented so that its shaft with the arrow on top is pointing upwards from the paper. The ‘vorticity meter’ is neutrally buoyant and its axis moves with the bulk motion of the fluid in which it is immersed.

You are to estimate, for each of the cases (a) to (c),

- (i) the clockwise angular rate of rotation  $\frac{d\theta}{dt}$  of the ‘vorticity meter’ and
- (ii) the pressure difference  $p_2 - p_1$

In case (c) do this for a point in the middle of the bend.

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