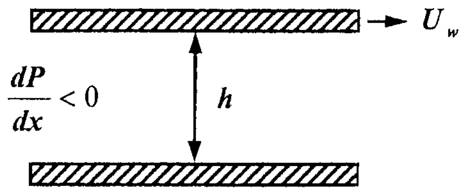
編號： 209　系所：奈米科技暨微系統工程研究所　　科目：流體力學

本試題是否可以使用計算機： □可使用 ， ☑不可使用 （請命題老師勾選）

1. Consider a general Couette flow (density $\rho$ and viscosity $\mu$) with a moving wall and a constant pressure gradient $dP/dx$ ($P$ is pressure) (Fig. 1). Determine the velocity distribution for the final steady state. (10%)

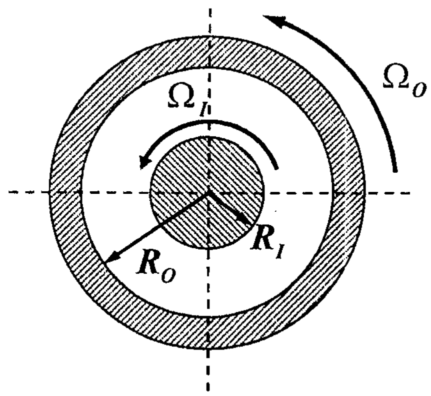



(Fig. 1)

2. Incompressible Newtonian fluid (with density $\rho$) flows steadily within the annular gap of two infinitely long cylinders ($R_O, R_I$). The outer cylinder rotates with $\Omega_O$, the inner one with $\Omega_I$ (Fig. 2). For the case that the axial component of the velocity is equal to zero,

(a) Determine the velocity field. (10%)

(b) Determine the pressure field. (10%)




(Fig. 2)

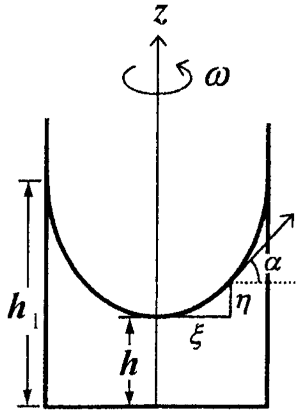
3. A cylindrical container of circular cross section, radius $R$, is so supported that it can rotate about its vertical axis (Fig. 3). It is first filled with a liquid (assumed to be incompressible) of density $\rho$ to a level $h$ above its flat bottom. The cylinder is then set in rotation with angular velocity $\omega$ about its axis. The angular velocity is kept constant, and we wait for a while until a steady state is achieved. It is assumed that the liquid does not overflow, and it is also assumed that no portion of the bottom is "dry". The liquid is, of course, subject to the influence of gravity, and we assume that the normal atmospheric pressure $p_a$ prevails in the environment.

(a) Find the equation for the upper surface of the liquid. (10%)

(b) Find an expression for the pressure $p(z)$ on the cylindrical surface at a height $z$ above the bottom. (10%)

(c) Find an expression for the pressure $p_0(z)$ along the axis at a height $z$ above the bottom. (10%)

(d) Is the fluid flow as viewed by a stationary observer irrotational? (10%)




(Fig. 3)

（背面仍有題目,請繼續作答）

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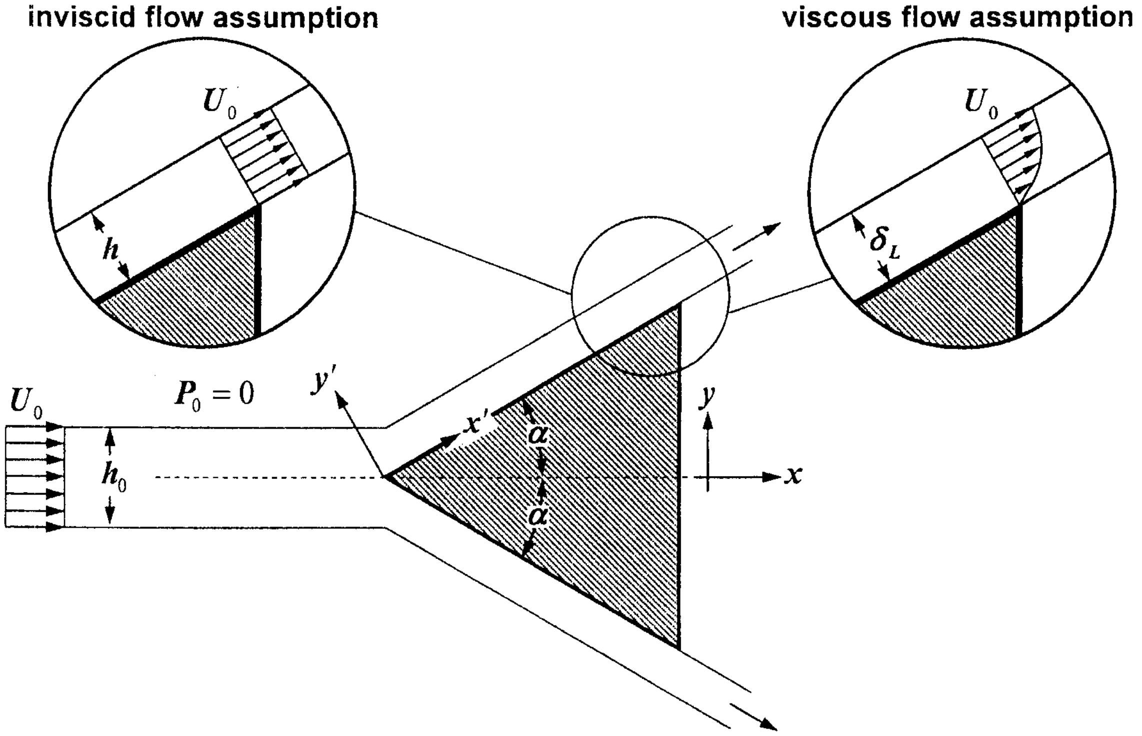
4. A two-dimensional water (with density $\rho$) jet symmetrically impinges on a wedge with included angle $2\alpha$ (Fig. 4). Far upstream, the jet has the velocity $U_0$ and a thickness of $h_0$. For the inviscid flow, the velocity distribution is $u(y') = U_0$. On the other hand, for the viscous flow, as a result of wall friction, at the end of the wedge, boundary layers with the following velocity distribution are developed

$$u(y') = U_0 \sin\left(\frac{\pi y'}{2\delta_L}\right)$$




(Fig. 4)

(a) Calculate the thicknesses

(1) $h$ for the inviscid flow. (5%)

(2) $\delta_L$ for the viscous flow. (5%)

(b) Determine the force per unit depth exerted on the wedge for the case that

(1) the flow is inviscid. (5%)

(2) the flow is viscous. (5%)

(c) Calculate the difference of the calculated forces for

(1) $\alpha = \frac{\pi}{4}$ (5%)

(2) $\alpha = \frac{\pi}{2}$ (5%)