1. Sketch the streamlines for the flow

$u = \alpha x$, $v = -\alpha y$, $w = 0$,

where α is a positive constant. Let the concentration (濃度) of some pollutant (污染物) in the fluid be

$c(x, y, t) = \beta x^2 y^2 e^{-\alpha t}$

for $y > 0$, where β is a constant. Does the pollutant concentration for any particular fluid element change with time? (16%)

2. Water flows through the pipe contraction shown in Fig. P2. For the given 0.1-m difference in the manometer level, determine the flowrate as a function of the diameter of the small pipe, D. (16%)

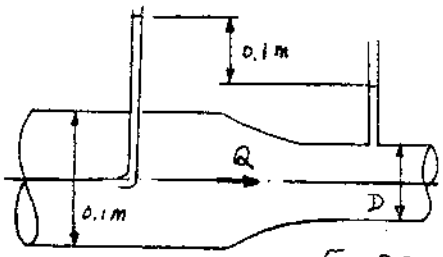


Fig. P2

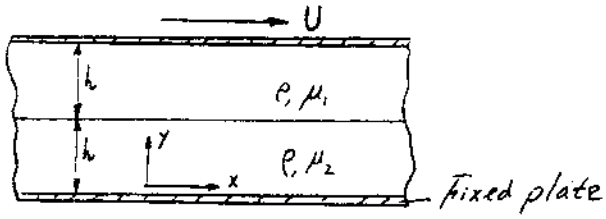


Fig. P3

3. Two immiscible, incompressible, viscous fluids having the same densities but different viscosities are contained between two infinite, horizontal, parallel plates (Fig. P3). The bottom plate is fixed and the upper plate moves with a constant velocity U. Determine the velocity at the interface. Express your answer in terms of U, μ_1, and μ_2. The motion of the fluid is caused entirely by the movement of the upper plate; that is, there is no pressure gradient in the x direction. The fluid velocity and shearing stress are continuous across the interface between the two fluids. Assume laminar flow. (18%)

4. A certain spillway for a dam is 20 m wide and is designed to carry 125 m^3/s at flood stage. A 1:15 model is constructed to study the flow characteristics through the spillway. Determine the required model width and flowrate. What operating time for the model corresponds to a 24-hr period in the prototype? The effects of surface tension and viscosity are to be neglected. (18%)

5. 在不考慮流體的可壓縮性及自由液面的情形下，流體通過物體所造成的阻力可分為形狀阻力（Pressure Drag, PD）及摩擦阻力（Friction Drag, FD）

(a)解釋這兩種阻力的差異。

(b)均勻流通過下列(A)、(B)、(C)及(D)物體中，分別指出每一流場中 PD 與 FD 大小關係。(16%)

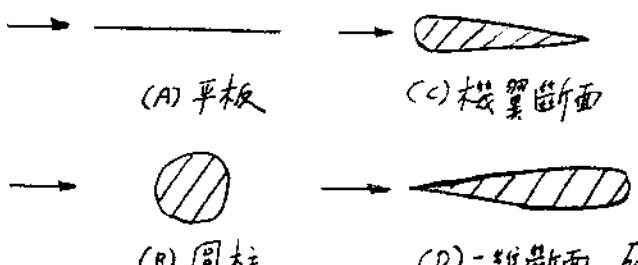


Fig. P5

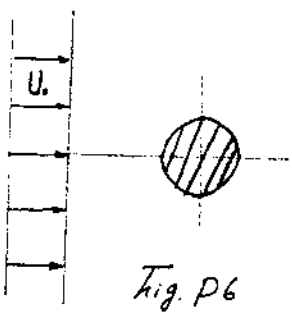
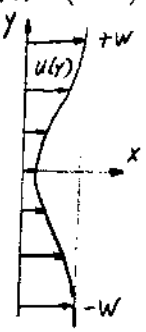


Fig. P6



6. 均勻流(uniform flow)流速為U_o(定值)，經過圓柱後，流場之速度分佈如圖(Fig. P6)所示，試証圓柱所受之阻力 D 可表示如下式

$$D = b\rho\int_{-w}^{w} u(U_o - u)dy$$

式中 ρ 為流体密度，b 為 z 方向圓柱長。(16%)