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） 考試日期：0301，節次：2

1. Compressibility E of a fluid is defined as $E = \dfrac{-\Delta P}{(\Delta V)/V}$, the change in volume ($V$) of a fluid that is subjected to a change in pressure. Figure 1 shows a hydraulic linear actuator with inside diameter D and length L. A measure of **stiffness** of a linear actuator is the amount of the force required to cause a certain linear deflection. For two actuators that have inside diameters of $D=D_1$ and $D=D_2$ and lengths of $L=L_1$ and $L=L_2$ and that are filled with water.

(a) Computer the stiffness ratio if $D_1/D_2=2$ and $L_1/L_2=2$. (10 %)

(c) Describe how to design the stiffness of hydraulic linear actuator by varying diameter D and length L? (10 %)

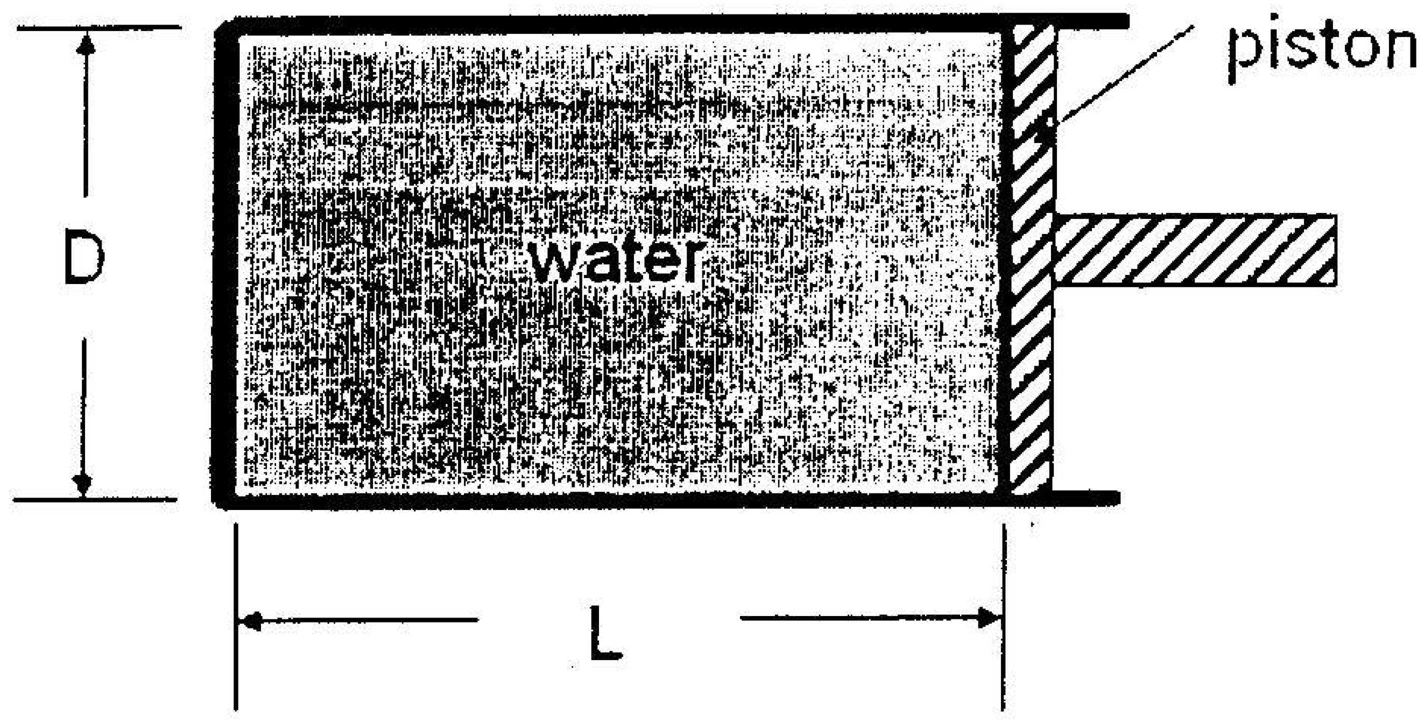

Figure 1

2. Figure 2 shows a tank (diameter D) with a smooth, well-rounded nozzle (diameter d) in the bottom through which fluid is discharging. Derive the equation for the time required to empty a tank, considering the variation of velocity as the depth decreases. (10%)

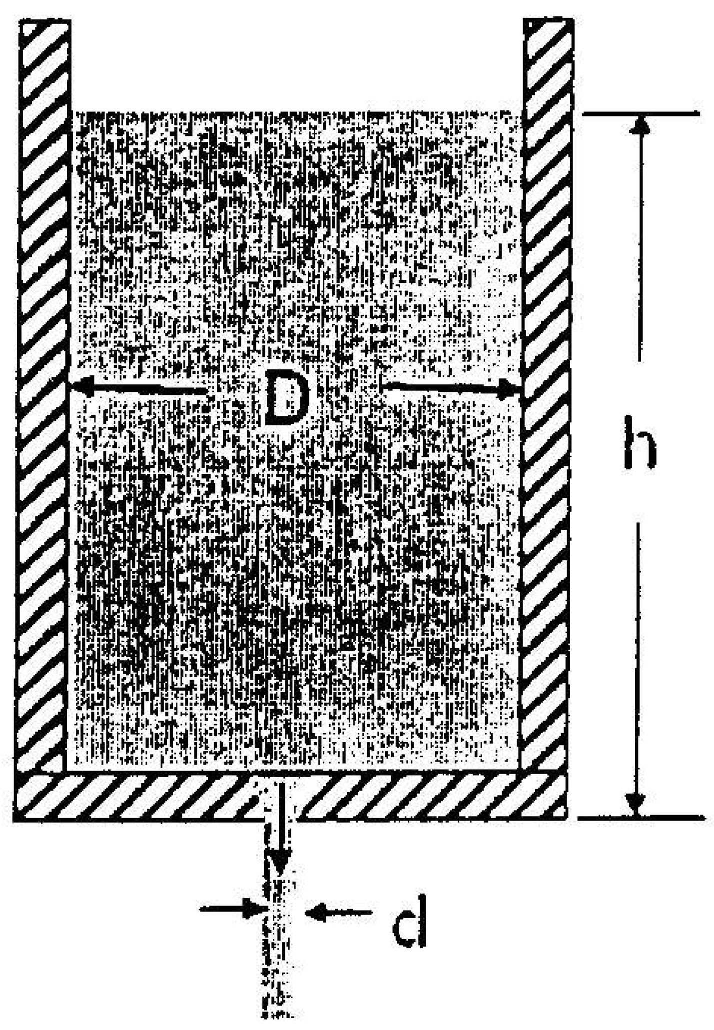

Figure 2

（背面仍有題目,請繼續作答）

3. Consider a two-dimensional flow field which is formed by a source of strength Λ located above a floor. The source is located at (0, 1), as shown in Figure 3.

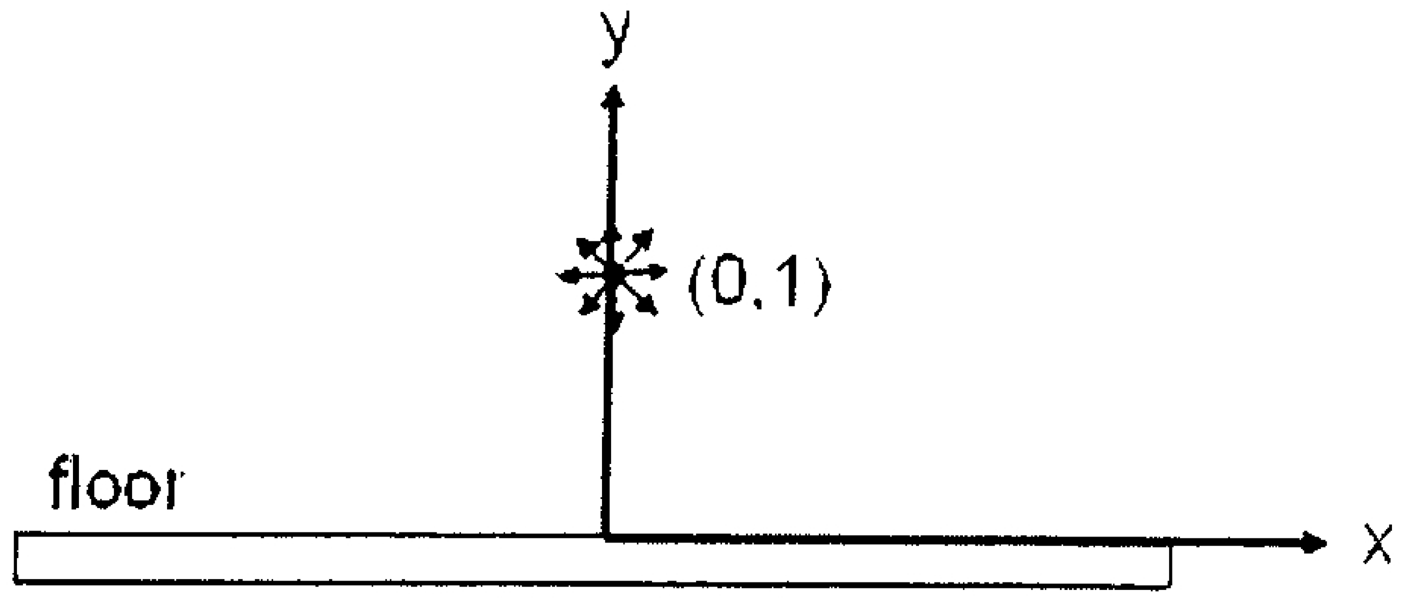

Figure 3

(i) Determine velocity potential ϕ for this flow field. (10%)
(ii) Locate the stagnation point in this flow field. (5%)
(iii) Determine the streamline equation passing through the stagnation point in the Cartesian coordinate. (5%)
(iv) Where does the maximum speed along the floor occur? (10%)
(v) Assume the total (or stagnation) pressure in the flow field is P_o and the density of the fluid is ρ, find the static pressure P at the point (1,0). (10%)

Hint: If a source flow located at the origin (0, 0), the velocities in (r,θ) direction of polar coordinate are

$$u_r = \frac{\Lambda}{2\pi r},\ u_\theta = 0 \text{ where } r = \sqrt{x^2 + y^2}$$

4. As shown in Figure 4, the wind stress exerts a stress τ_w at the free surface which induces a Couette type of flow to the right. However, in order to conserve mass within the <u>closed</u> region, a return flow is required. In this problem, we can assume the flow is nearly parallel far from the ends and the free surface remains flat. Please answer the following questions:

(a) Please simplify Navier Stokes equation and derive the governing equation for velocity flow field far from the ends. (10%)

(b) List the boundary conditions and find out solution of the velocity flow field far from ends. (10%)

(c) Find out the pressure gradient dp/dx in terms of τ_w and H . (10%)

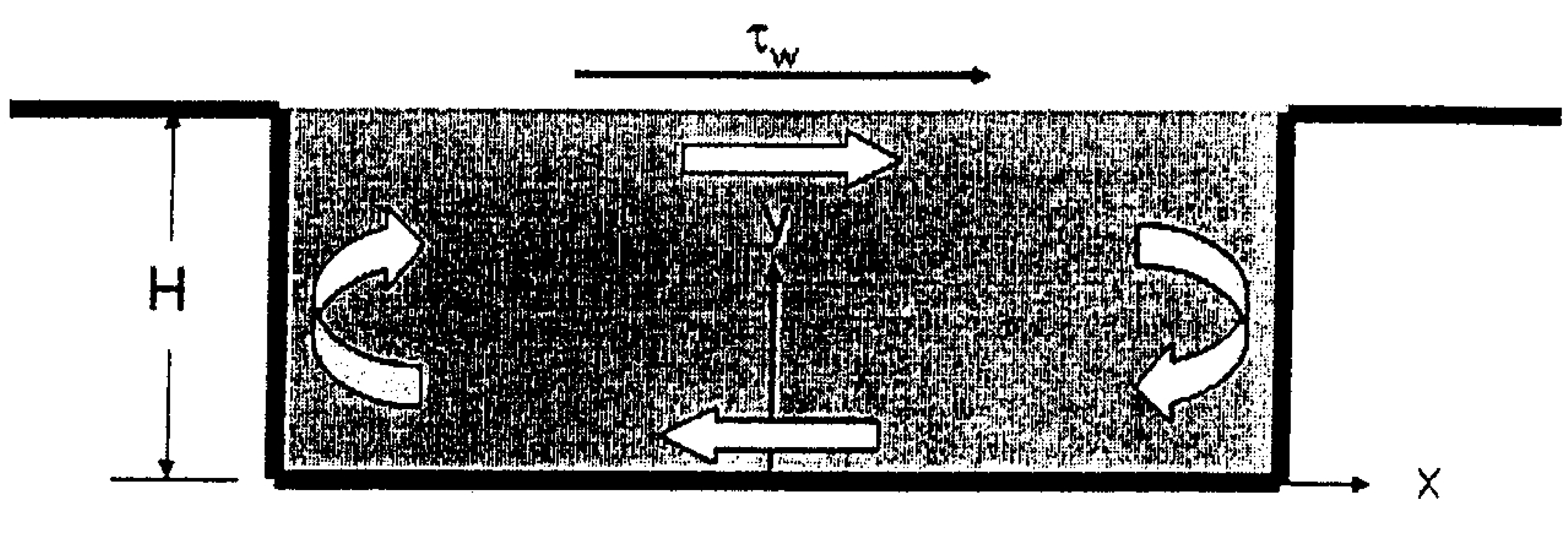

Figure 4