1(a) The fluid velocity along the x axis shown in Fig. 1(a) changes from the 12 m/s at point A to 36 m/s at point B. It is also known that the velocity is a linear function of distance along the streamline. Determine the acceleration at points A, B, and C. Assume steady flow. (5%)

1(b) A fluid flows steadily along the stream-line as shown in Fig.1(b). Determine the acceleration at point A. At point A what is the angle between the acceleration and the x axis? At point A what is the angle between the acceleration and the streamline? (5%)

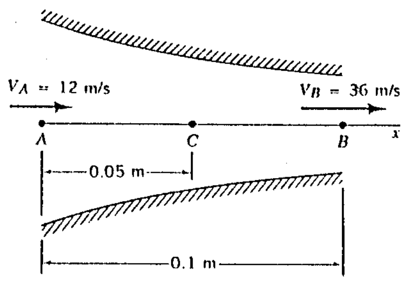

Fig.1(a)

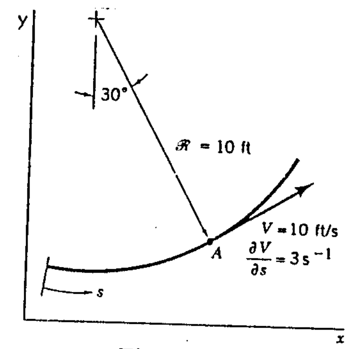

Fig.1(b)

2. A long porous pipe runs parallel to a horizontal plane surface as shown in Fig.2. The longitudinal axis of the pipe is perpendicular to the plane of the paper. Water flows radially from the pipe at a rate of 0.5π ft^3/s per foot of pipe.(1) Determine the difference in pressure (in lb/ft^2) between point B and point A. The flow from the pipe may be approximated by a two-dimensional source. (2) Determine the pressure force acting on the length AB. (20%)

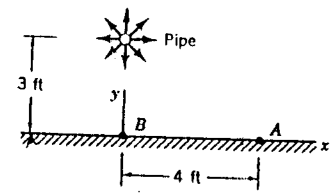

Fig. 2

3. A liquid flows with a velocity V through a hole in the side of a large tank. Assume that

$$V = f(h, g, \rho, \sigma)$$

where h is the depth of fluid above the hole, g is the acceleration of gravity, ρ is the fluid density, and σ is the surface tension. The following data were obtained by changing h and measuring V, with a fluid having a density = 10^3 kg/m^3 and surface tension = 0.074 N/m. Plot these data by using appropriate dimensionless variables. Could any of the original variables have been omitted? (20%)

V (m/s)	3.13	4.43	5.42	6.25	7.00
h (m)	0.50	1.00	1.50	2.00	2.50

(背面仍有題目,請繼續作答)

4. (a) What is the drag coefficient C_D? Give a brief discussion of the fluid flow mechanisms contributing to the magnitude of C_D. (10%)

   (b) At the separation point of a two-dimensional viscous boundary layer around a blunt body, the vorticity is equal to zero. True or False. Explain. (5%).

5. For ordinary Newtonian fluids, the universal turbulent velocity profile in a pipe of diameter D can be approximated by the relationship of

$$\frac{\bar{u}}{u^*} = 8.7\left(\frac{yu^*}{\nu}\right)^{1/7}$$

where $u^* = (\tau_w / \rho)^{1/2}$ is the frictional velocity and y is the distance from the pipe wall. A fluid containing a small amount of certain additives behaves somewhat differently and its universal velocity profile can be expressed as

$$\frac{\bar{u}}{u^*} = 8.7\left(\frac{yu^*}{\nu}\right)^{1/7} + A$$

where A is a constant. For such a fluid derive an equation involving Re and A that can be used to determine the pipe friction factor f, where $Re = VD/\nu$ and V is the mean flow velocity in the pipe. (15%)

6. Starting with the momentum boundary layer equation for a uniform flow stream over a flat plate and using the free stream velocity U_∞ and the boundary layer thickness δ as the reference velocity and the characteristic length, respectively, derive by means of the order-of-magnitude analysis the following relationship between the local skin friction coefficient, $C_f (= \tau_w / (\rho U_\infty^2 / 2))$ and the Reynolds number based on the downstream distance x, $Re = (U_\infty x / \nu)$

$$C_f \sim Re_x^{-1/2}$$

(20%)