國立臺北科技大學 102 學年度碩士班招生考試

系所組別：1432 能源與冷凍空調工程系碩士班丙組

第二節　流體力學　試題（選考）

注意事項：

1. 本試題共五題，每題 20 分，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、(20%)

An idealized velocity distribution is given by $\vec{V} = x(1+2t)\vec{i} + y\vec{j}$, please find the following equations which pass through the point (1, 1) at the time $t = 0$.

1. streamline (6%)
2. pathline (7%)
3. streakline (7%)

二、(20%)

As shown in Fig. 1, a liquid flows from a large tank (d=0.4 m) into a small tube (d=1.2 mm) in the center of the bottom of the large tank. There is 0.4 m of liquid in the large tank and the length of the small capillary tube is 0.5 m. Assume the flow is laminar. Both the inlet of the large tank and the discharge of small tube are open to the atmosphere. The volume flow rate of the small tube is 70 cm^3/min. The flow is supported by gravity alone, and the level of liquid in the large tank is maintained constant. You may neglect the friction effect of the large tank, but the friction effect of the small capillary tube cannot be neglected. The loss coefficient, k_m accounting for the total minor losses of the entrance and the exit of the small capillary tube is 1.41. Calculate the kinematic viscosity of the liquid. (20%)

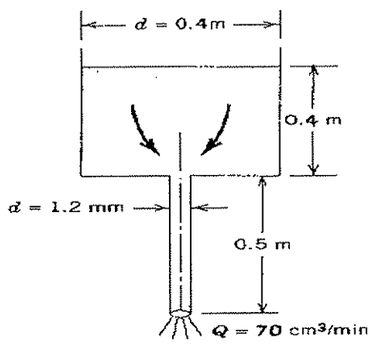

Fig. 1

三、(20%)

As shown in Fig. 2, a tank of fixed volume contains brine with initial density, ρ_i, greater than water. Pure water with the density, ρ_{H_2O}, enters the tank steadily and mixes thoroughly with the brine in the tank. The liquid level in the tank remains constant. Derive expressions for

1. the rate of change of density of the liquid mixture in the tank. (10%)
2. the time required for the density to reach the value ρ_f, where $\rho_i > \rho_f > \rho_{H_2O}$. (10%)

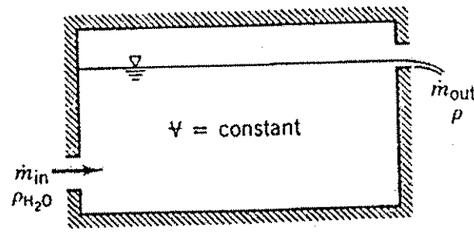

Fig. 2

四、(20%)

Consider a two-dimensional laminar boundary-layer flow over a flat plate. Assume that the velocity profile is given by

$$\frac{u}{U} = a + by + cy^2 + dy^3$$

where U is the free stream velocity and y is the coordinate vertical to the flat plate.

1. Determine the constants a, b, c and d. (8%)
2. Show that $\frac{\delta}{x} = \frac{4.64}{\mathrm{Re}_x^{0.5}}$, where δ is the boundary-layer thickness and $\mathrm{Re}_x = \frac{Ux}{\nu}$. ($x$ is the coordinate along the flat plate, and ν is the kinematic viscosity.) (12%)

五、(20%)

Use the Navier-Stokes equations to prove the Poiseuille's law for a fully-developed laminar flow in an inclined pipe, as displayed in Fig. 3 That is,

$$Q = \frac{\pi(\Delta p - \gamma \ell \sin\alpha)D^4}{128\mu\ell}$$

where Q is the volume flow rate, Δp is the pressure drop across the pipe length l, γ is the specific weight of flowing fluid, D is the pipe diameter, μ is the dynamic viscosity, and α is the angle between the pipe and the horizontal.

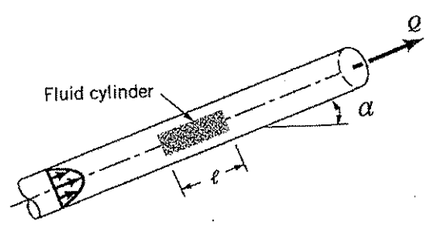

Fig.3.

注意：背面尚有參考資料

Moody's Chart: