國立成功大學
114學年度碩士班招生考試試題

編　號：114

系　所：生物醫學工程學系

科　目：流體力學

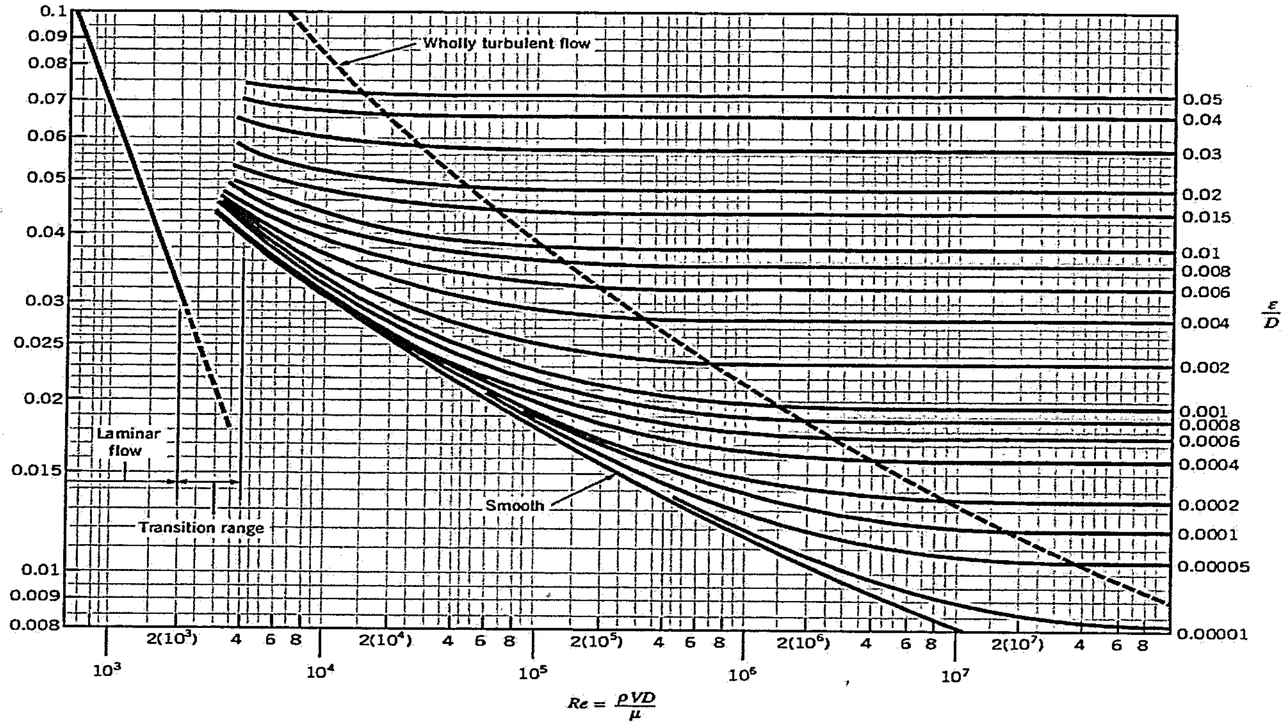
日　期：0210

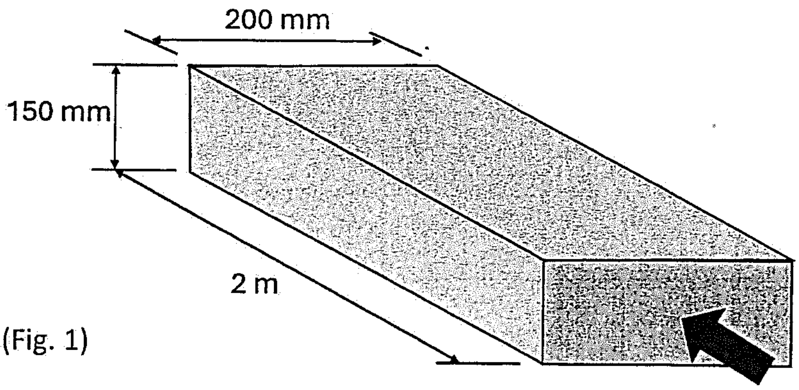
節　次：第 2 節

注　意：1.可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. Air flows through the galvanized steel duct with a velocity of 4 m/s (Fig.1).
(a) Determine the **hydraulic diameter** of the rectangular duct. (5%)
(b) Determine the flow regime (Hint: turbulent, transition, laminar, or creeping)? (5%)
(c) Determine the **pressure drop** along a 2-m length of the duct. Take $\rho_a = 1.202$ kg/m^3, $\nu_a = 15.1\times10^{-6}$ m^2/s. (15%)

	Smooth surface	Galvanized steel	Riveted steel	Cast iron	Drawn tubing	Concrete
Roughness (mm)	0	0.15	0.9	0.26	0.015	0.3

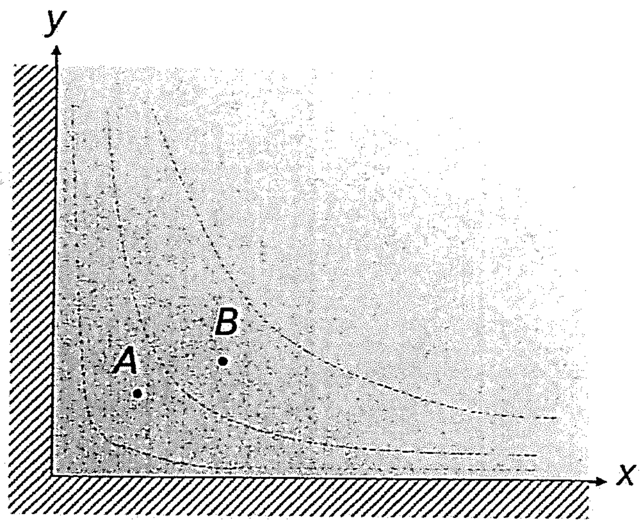




(Fig. 1)

2. The stream function for horizontal flow near the corner is defined by $\psi = (8xy)$ m^2/s, where x and y are in meters (Fig. 2).
(a) Show the flow **velocities u and v** in terms of x and y. (8%)
(b) Show whether the flow is **rotational or irrotational**? (5%)
(c) If the pressure at point A (1 m, 2 m) is 150 kPa, **determine the pressure at point B** (2 m, 3 m). Take ρ = 980 kg/m^3. (15%)

(d) **Explain why** there won't be vortices forming at the sharp corner O in this case even at very high speed flow? (4%)



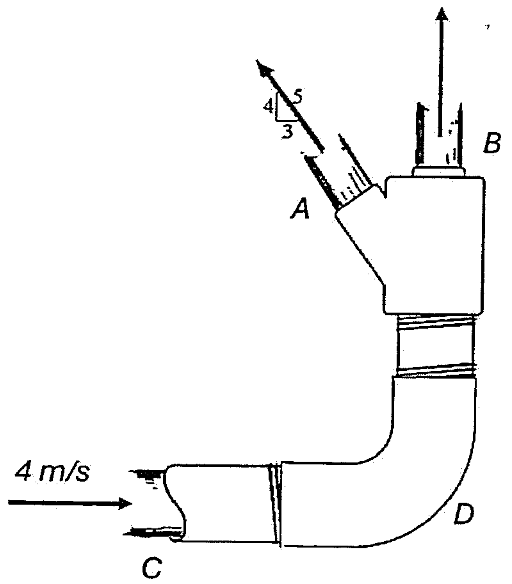
(Fig. 2)

3. Water flows through the pipe C at 4 m/s as shown in Fig. 3. Neglect the size and weight of the pipe and the water within it. The pipe has a diameter of 60 mm at C, and at A and B the diameters are 20 mm.

(a) **Draw a control volume (CV)** and **define the term CV** in fluid mechanics. (3%)

(b) Determine the **pressure at C** (Hint: Bernoulli Equation). (8%)

(c) Determine the **horizontal and vertical components of force** exerted by elbow D necessary to hold the pipe assembly in equilibrium. (Notice: a Free Body Diagram is required!) (12%)



(Fig. 3)

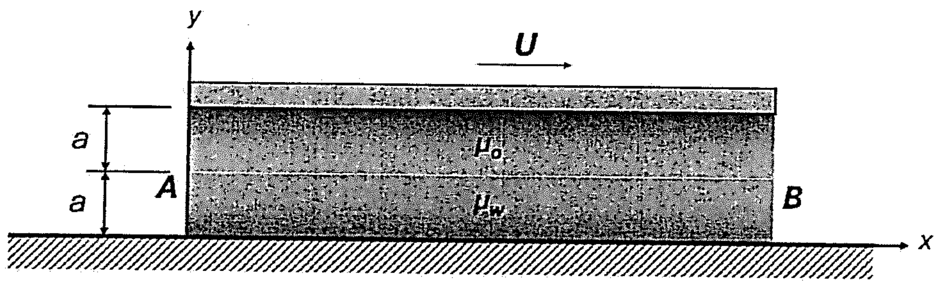
4. The water and oil films have the same thickness a and are subjected to the movement (U) of the top plate in the x-axis (Fig. 4). **Derive velocity profiles for both fluids** in steady state. Noted that there is no pressure gradient between A and B, and no gravity. The viscosities of water and oil are μ_w and μ_o, respectively. (20%)

Navier-Stokes equations for an incompressible Newtonian fluid with dynamic viscosity (μ) rectangular coordinates (x, y, z):

$$\rho\left(\frac{\partial u_x}{\partial t}+u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_x}{\partial y}+u_z\frac{\partial u_x}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left[\frac{\partial^2 u_x}{\partial x^2}+\frac{\partial^2 u_x}{\partial y^2}+\frac{\partial^2 u_x}{\partial z^2}\right]+\rho f_x$$

$$\rho\left(\frac{\partial u_y}{\partial t}+u_x\frac{\partial u_y}{\partial x}+u_y\frac{\partial u_y}{\partial y}+u_z\frac{\partial u_y}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left[\frac{\partial^2 u_y}{\partial x^2}+\frac{\partial^2 u_y}{\partial y^2}+\frac{\partial^2 u_y}{\partial z^2}\right]+\rho f_y$$

$$\rho\left(\frac{\partial u_z}{\partial t}+u_x\frac{\partial u_z}{\partial x}+u_y\frac{\partial u_z}{\partial y}+u_z\frac{\partial u_z}{\partial z}\right)=-\frac{\partial p}{\partial z}+\mu\left[\frac{\partial^2 u_z}{\partial x^2}+\frac{\partial^2 u_z}{\partial y^2}+\frac{\partial^2 u_z}{\partial z^2}\right]+\rho f_z$$



(Fig. 4)