國立成功大學

110學年度碩士班招生考試試題

編　　號：142

系　　所：環境工程學系

科　　目：流體力學

日　　期：0202

節　　次：第 2 節

備　　註：不可使用計算機

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Please derive Darcy-Weisbach equation ($\Delta h_f = f\dfrac{L}{D}\dfrac{V^2}{2g}$) by using dimensional analysis following physical quantities (h_f: head loss, L: pipe length, D: inside diameter of pipe, V: average velocity, g: gravity, ε: roughness height, ε': roughness distance, m: shape factor of roughness). (20%)

2. Navier-Stokes equation can be shown below.

$$\rho\frac{D\mathbf{v}}{Dt} = \rho\mathbf{g} - \nabla P + \mu\nabla^2\mathbf{v}$$

(a) Please describe physical meaning of each term in the equation. (10%)

(b) As sown in the right figure, an incompressible fluid confined between two parallel, vertical surfaces. The left surface is stationary, whereas the other is moving upward at a constant velocity (v_0). If we consider the fluid Newtonian and the flow laminar, the governing equation of motion is the Navier-Stokes equation. Please illustrate the velocity profile. (10%)
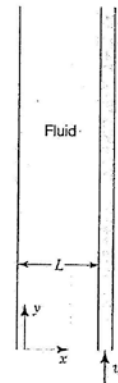
3. A pressurized tank contains oil (Specific gravity = 0.8) and has a square, 0.6 m by 0.6 m plate bolted to its side, as it is shown below. The pressure gage on the top of the tank is at atmospheric pressure. Please calculate the magnitude and location of the resultant force on the attached plate. (20%)
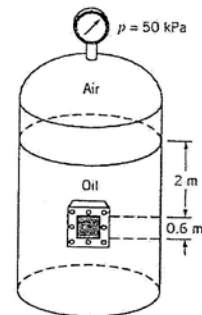
4. A large tank of unknown total volume is initially filled with 6000 g of a 10% by mass sodium sulfate solution. Into this tank a 50% sodium sulfate solution is added at a rate of 40 g/min. At the single outlet to the tank flows a 20 g/L solution at a rate of 0.01667 L/sec. Please calculate

(a) the total mass in the tank after 2 h. (10%)

(b) the amount of sodium sulfate in the tank after 2 h. (10%)

5. Calculate the **inlet pressure** to a pump 3 m above the level of a sump. The pipe is 8.9 cm in diameter, 0.89 m long and made of cast iron. The flow rate through the pump is 2.04 m^3/min. The kinematic viscosity of water is 1.22×10^{-5} m^2/s. The assumption of the flow is fully developed. Please use the following diagrams to find the e/D and f_f. Note that 1 in = 2.54 cm. (20%)