國立清華大學 106 學年度碩士班考試入學試題

系所班組別：工程與系統科學系碩士班 乙組(0527)

考試科目（代碼）：流體力學 (2703)

 *請在【答案卷】作答

1. 解釋名詞 (30%)

- 解釋 Largrangian Method 與 Eulerian Method
- 寫出 the Bernoulli equation 與應用 Bernoulli equation 的假設為何?
- 用圖形解釋 Developing flow, Entrance region 以及 Fully developed flow
- 繪出 Shear stress 與 Pressure drop 沿著軸向分布的特性以解釋 Developing flow 與 Fully-developed flow 的不同
- 解釋 Major loss and Minor loss

2. (20%)

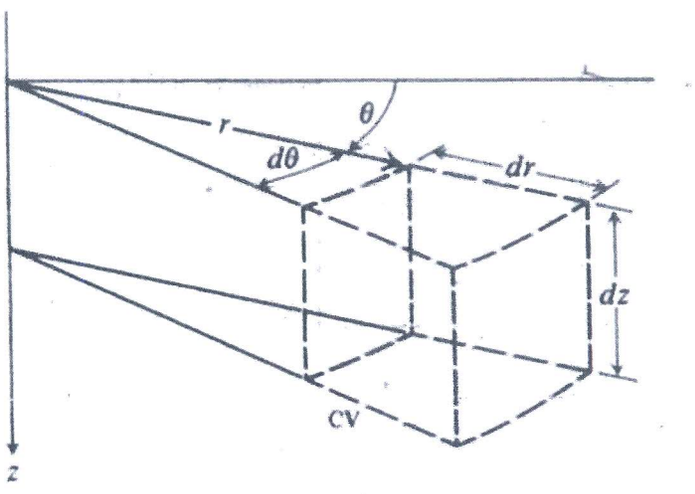
(1)描繪 Moody Diagram

(2)說明摩擦係數與壓降的關係

(3)說明層流與紊流的流動阻力與牆壁粗糙度的關係

3. (30 %)

Develop the differential equation for conservation of linear momentum (i.e. Navier-Stokes equation) in cylindrical coordinates by applying the control volume method to an infinitesimal control volume of dimensions $rd\theta, dr, dz$. (σ is the normal stress and τ is the shear stress)



[Hint]

$$\sigma_{rr} = -p + 2\mu\frac{\partial v_r}{\partial r}$$

$$\sigma_{\theta\theta} = -p + 2\mu\left(\frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r}{r}\right)$$

$$\sigma_{zz} = -p + 2\mu\frac{\partial v_z}{\partial z}$$

$$\tau_{r\theta} = \tau_{\theta r} = \mu\left(r\frac{\partial}{\partial r}\left(\frac{v_\theta}{r}\right) + \frac{1}{r}\frac{\partial v_r}{\partial \theta}\right)$$

$$\tau_{\theta z} = \tau_{z\theta} = \mu\left(\frac{\partial v_\theta}{\partial z} + \frac{1}{r}\frac{\partial v_z}{\partial \theta}\right)$$

$$\tau_{rz} = \tau_{zr} = \mu\left(\frac{\partial v_r}{\partial z} + \frac{\partial v_z}{\partial r}\right)$$

4. (20 %)

(a) A stirrer is used to mix chemicals in a large tank, as shown in the following figure. The shaft power $\dot{W}$ supplied to the stirrer blades is a function of stirrer diameter D, liquid density ρ, liquid viscosity μ, and the angular velocity ω of the spinning blades. Use the method of repeating variables to generate a dimensionless relationship between these parameters. Show all your work and be sure to identify your Π groups, modifying them as necessary.

(b) Repeat above problem except do not assume that the tank is large. Instead, let tank diameter D_{tank} and average liquid depth h_{tank} be additional relevant parameters.