

1002 機械系博士班資格考試題目

考試科目	方式	
流體力學	Closed Book, 可使用計算機	Part I

1. The velocity distribution for laminar flow between parallel plates is given by

$$\frac{u}{u_{\max}} = 1 - \left(\frac{2y}{h}\right)^2$$

(10%)

where h is the distance separating the plates and the origin is placed midway between the plates. Consider flow of water at 15°C with maximum speed of 0.05 m/s and $h = 5\text{ mm}$. Calculate the force on a 0.3 m^2 section of the lower plate and give its direction.

$$\mu = 1.2 \cdot 10^{-3} \text{ N}\cdot\text{sec}/\text{m}^2$$

2. Consider the flow field given by $\vec{V} = ax^2y\hat{i} - by\hat{j} + cz^2\hat{k}$, where $a = 1\text{ m}^{-2}\cdot\text{s}^{-1}$, $b = 3\text{ s}^{-1}$, and $c = 2\text{ m}^{-1}\cdot\text{s}^{-1}$. Determine (a) the number of dimensions of the flow, (b) if it is a possible incompressible flow, and (c) the acceleration of a fluid particle at point $(x, y, z) = (3, 1, 2)$.

(10%)

3. Explain the Physical meaning of "Moody Chart".

(5%)

4. **GIVEN** Air at a temperature of 38°C and standard pressure flows from a clothes dryer. According to the appliance manufacturer, the 10-cm-diameter galvanized iron vent on the clothes dryer is not to contain more than 6 m of pipe and four 90° elbows.

$$\gamma = 11.05 \text{ N}/\text{m}^3, \quad \nu = 1.66 \cdot 10^{-5} \text{ m}^2/\text{s}$$

FIND Under these conditions determine the air flowrate if the pressure at the start of the vent pipe, directly downstream of the dryer fan, is 0.5 cm of water. $\epsilon = 1.5 \cdot 10^{-4} \text{ m}$

$$\frac{1}{\sqrt{f}} = -2.0 \log\left(\frac{\epsilon/D}{3.7} + \frac{2.51}{\text{Re}\sqrt{f}}\right)$$

(25%)

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Part II

- (1) What is the “vortex”? Please write down the expression of velocity potential and stream function for the vortex motion. Also explain the difference between free vortex and forced vortex. (15%)
- (1) Please use Navier-Stokes equations (cylindrical coordinates) to derive the expression for the axial velocity for the flow through a horizontal circular tube with radius R . (assume the flow is parallel to the walls so that $v_r = v_\theta = 0$) (15%)
- (2) The pressure drop needed to force water through a horizontal 1-in. diameter pipe is 0.6 psi for every 12-ft length of pipe. Determine the shear stress on the pipe wall. Determine the shear stress at distance 0.3 and 0.5 in. away from the pipe wall. (20%)