1001 機械系博士班資格考試題目

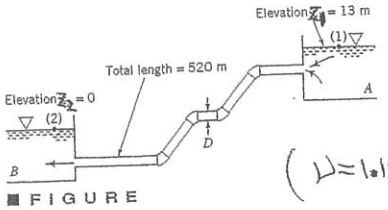
考試科目	方式	
流體力學	Closed Book,可使用計算機	Part I

1. An atmosphere on a planet has a temperature of 15°C at sea level and drops 1°C per 500 m of elevation. The gas constant R for this atmosphere is 220 N · m/(kg)(K). At what elevation is the pressure 30 percent that of sea level? Take $g = 9.00\ m/s^2$. (10%) (Please derive the eq. first)

2. **GIVEN** Water at 15 °C ($\nu = 1.12 \times 10^{-6}\ m^2/s$) is to flow from reservoir A to reservoir B through a pipe of length 520 m and roughness 1.5×10^{-4} m at a rate of $Q = 1\ m^3/s$ as shown in Fig. The system contains a sharp-edged entrance and four flanged 45° elbows.

FIND Determine the pipe diameter needed. (Use Colebrook eq.)

$K_{ent} = 0.5$, $K_{elbow} = 0.2$, $K_{exit} = 1$



■ FIGURE

($\nu = 1.12 \cdot 10^{-6}\ \frac{m^2}{s}$) (15%)

※ Colebrook eq.

$$\frac{1}{\sqrt{f}} = -2.0 \log\left[\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right]$$

3. The three components of velocity in a flow field are given by

$$u = x^2 + y^2 + z^2 + xy$$
$$v = xy + yz + z^2$$
$$w = -3xz - z^2/2 + 4yz$$

(a) Determine the volumetric dilatation rate and interpret the results. (b) Determine an expression for the rotation vector. Is this an irrotational flow field? (15%)

4. Oil ($\mu = 0.4\ N \cdot s/m^2$) flows between two fixed horizontal infinite parallel plates with a spacing of 4 mm. The flow is laminar and steady with a pressure gradient of $-900\ (N/m^2)$ per unit meter. Determine the volume flowrate per unit width and the shear stress on the upper plate. (10%)

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1. Please describe the boundary layer structure and the thickness on a flat plate. Also define the displacement thickness. (15%)

2. Please derive the boundary layer equations and its boundary conditions. (start from 2-D Navier-Stokes equations) (20%)

3. For laminar flow in a round pipe of diameter D, at what distance from the centerline is the actual velocity equal to the average velocity? (15%)