

# 1011 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. **GIVEN** Air at a temperature of 38 °C and standard pressure flows from a clothes dryer. According to the appliance manufacturer, the 12-cm-diameter galvanized iron vent on the clothes dryer is not to contain more than 6 m of pipe and four 90° elbows.

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

**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.  $\epsilon = 1.5 \cdot 10^{-4} \text{ m}$

$\frac{1}{\sqrt{f}} = -2.0 \log \left( \frac{\epsilon/D}{3.7} + \frac{2.51}{\text{Re} \sqrt{f}} \right) \quad (10\%)$

2. Laminar Boundary Layer, Blasius

Equation,  $2f''' + ff'' = 0$ ,

$f \equiv \frac{\psi}{\sqrt{\nu x U}}, \eta \equiv y \sqrt{\frac{U}{\nu x}}, f' = \frac{u}{U}$

其 solution (右表), 求

- ① boundary layer thickness  $\equiv \delta$ ,
- ② wall shear stress  $\equiv \tau_w$ ,
- ③ skin friction coefficient  $\equiv C_f$ ,
- ④ drag  $\equiv D$ ,
- ⑤ 平均  $\bar{C}_f$ ,

Table The Function  $f(\eta)$  for the Laminar Boundary Layer along a Flat Plate at Zero Incidence

$\eta = y \sqrt{\frac{U}{\nu x}}$	$f$	$f' = \frac{u}{U}$	$f''$
0	0	0	0.3321
0.5	0.0415	0.1659	0.3309
1.0	0.1656	0.3298	0.3230
1.5	0.3701	0.4868	0.3026
2.0	0.6500	0.6298	0.2668
2.5	0.9963	0.7513	0.2174
3.0	1.3968	0.8460	0.1614
3.5	1.8377	0.9130	0.1078
4.0	2.3057	0.9555	0.0642
4.5	2.7901	0.9795	0.0340
5.0	3.2833	0.9915	0.0159
5.5	3.7806	0.9969	0.0066
6.0	4.2796	0.9990	0.0024
6.5	4.7793	0.9997	0.0008
7.0	5.2792	0.9999	0.0002
7.5	5.7792	1.0000	0.0001
8.0	6.2792	1.0000	0.0000

其中  $\psi \equiv$  stream function,  $\nu \equiv$  kinematic viscosity  $(10\%)$   
 $U =$  free stream velocity,  $u =$  fluid velocity

3. 平板之 momentum integral equation,  $\tau_w = \rho U^2 \frac{d}{dx} \left[ \int_0^\delta \frac{u}{U} (1 - \frac{u}{U}) dy \right]$

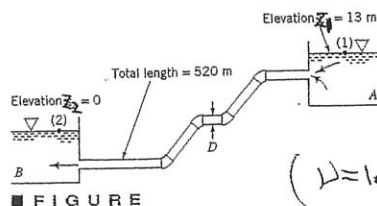
用  $u = a + by + cy^2$  (二次分布), B.C.s,  $\begin{cases} y=0, u=0 \\ y=\delta, u=U, \frac{\partial u}{\partial y}=0 \end{cases}$

求第2題以上5個變數, 並比較兩者  $(15\%)$

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

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

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



$(\nu = 1.12 \cdot 10^{-6} \text{ m}^2/\text{s})$

$(15\%)$

Use Colebrook eq.

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

### 1011 機械系博士班資格考試題目

考試科目	方式
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1. Please describe the boundary layer structure and the thickness on a flat plate. Also define the displacement thickness. (10%)
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? (20%)