博士班流力資格考 A, 3/31/99

1. The velocity components of an incompressible, two-dimensional velocity field are given by the equations

$$u = 2xy$$
$$v = x^2 - y^2$$

Show that the flow is irrotational and satisfies conservation of mass. (10%)

2. Laminar Boundary Layer, Blasius Equation, $2f''' + ff'' = 0$,
$f \equiv \frac{\psi}{\sqrt{\nu x U}}$, $\eta \equiv y\sqrt{\frac{U}{\nu x}}$, $f' = \frac{u}{U}$
由其 solution (查表), 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 $\bar{C}_f$,
(其中 $\psi \equiv$ stream function, $\nu \equiv$ kinematic viscosity, U = free stream velocity, u = fluid velocity) (20%)

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

3. 平板之 momentum integral equation, $\tau_w = \rho U^2 \frac{d}{dx}\left[\int_0^\delta \frac{u}{U}\left(1 - \frac{u}{U}\right)dy\right]$
用 $u = a + by + cy^2$ (二次項), 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 (20%)

Fluid Mechanics Qualify Exam (part II) 2010/04

(1) What are "source and sink"? Please write down the expression of velocity potential and stream function for them. (15%)

(2) Please describe the mechanism to form the shear stress in laminar flow and turbulent flow, with figure to explain will be better. (15%)

(3) Please use finite control volume analysis to derive the energy equation. (20%)