國立成功大學
110學年度碩士班招生考試試題

編　號：135

系　所：航空太空工程學系

科　目：流體力學

日　期：0202

節　次：第 2 節

備　註：不可使用計算機

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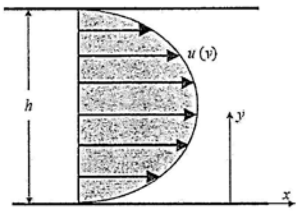
※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. For the two-dimensional laminar flow between two fixed parallel flat plates shown in the picture below, the governing equation is:

$$\frac{dp}{dx}=\mu\left(\frac{d^2u}{dy^2}\right),$$

and boundary conditions are $u=0$ at $y=0$ and $y=h$. (1) Derive the velocity profile $u(y)$, and (2) show the flow is rotational or irrotational and why? (10%)



2. Assum the streamwise boundary-layer velocity profile of the flow over a flat-plate is linear:

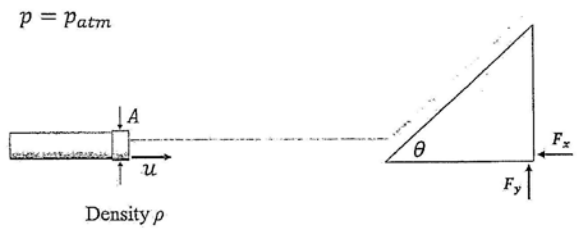
$u=\frac{y}{\delta}u_0$, and $\delta=c\sqrt{x}$;

where u_0 and c are the free-stream velocity and a constant, respectively. Derive expressions for (1) displacement thickness $\delta^*(x)$, (2) the transverse velocity component at the edge of the boundary layer $v_e(x)$, (3) shear stress at wall $\tau(x)$, and (4) skin-friction coefficient $C_f(x)$. (20%)

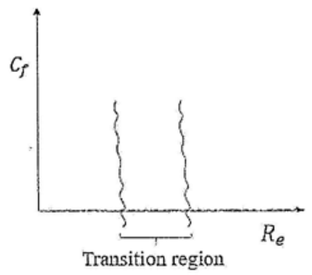
3. The Navier-Stokes equation for incompressible Newtonian fluid reads:

$$\rho\frac{D\bar{V}}{Dt}=-\nabla p+\rho\bar{g}+\mu\nabla\left(\nabla\bar{V}+\nabla\bar{V}^{T}\right).$$

Integrate the above equation over a fixed region in space, one can obtain the integral form of the Navier-Stokes equation over a control volume. Perform the volume integral and derive the integral form of the Navier-Stokes equation. Use the equation you derived to find the forces F_x and F_y in the following picture. (20%)



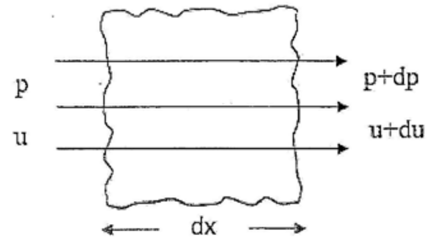
4.



(1) Derive the expression for the Reynolds number.

(2) The graph shwos skin friction against Reynolds number for a boundary layer on a flat plate. Complete the graph and interpret it. (15%)

5.

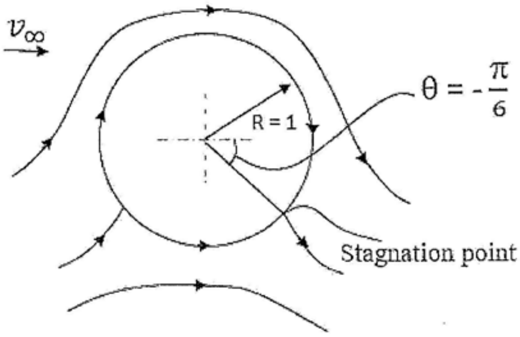


(Steady, inviscid, incompressible)

(1) Do the equilibrium of the forces in the x-direction for this infinitesimally small control volume.

(2) Based on this prove that: $c_p = 1 - \left(\frac{u}{u_\infty}\right)^2$. (15%)

6.



$$\varphi = (v_\infty r sin\theta)\left(1 - \frac{R^2}{r^2}\right) + \frac{\Gamma}{2\pi} ln \frac{r}{R}$$

Find the lift coefficient for the cylinder assuming an inviscid flow. (20%)

[N.B. $\sin\left(\frac{\pi}{6}\right) = 1/2$]