編號： 127

國立成功大學 109 學年度碩士班招生考試試題

系　　所：系統及船舶機電工程學系

考試科目：流體力學

考試日期：0210，節次：2

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

1. (20%)

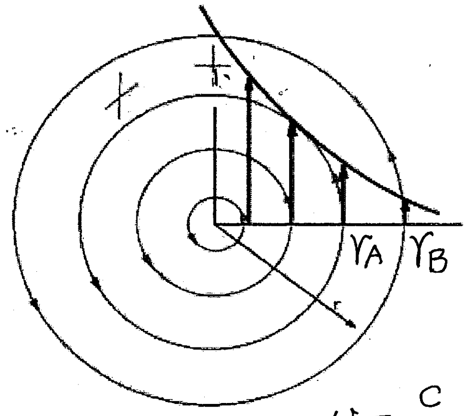
   (a)What is the Bernoulli equation, explain its physical significance.

   (b)Derive the Bernoulli equation in a steady, inviscid flow, any limitation?

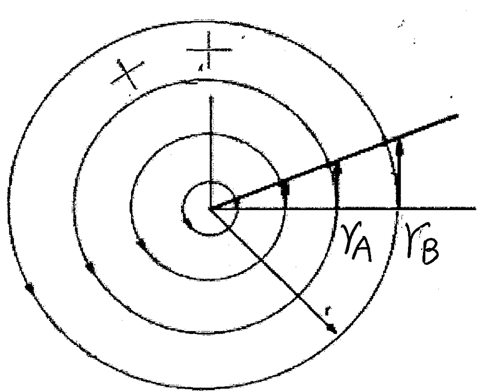
   (c)Derive the Bernoulli equation in an irrotational flow, any limitation?

   (d)Are there differences between the Bernoulli equation and the energy equation?

2. (20%)A free vortex flow is described by $v = \frac{c}{r}$, while a forced vortex is given by $v = r\omega$, where v = circumferential velocity, r=radius, c and ω=physical constants. Find the vorticity and circulation of the two flow fields. Also find the pressure difference between two points lie on the circles of the radii r_A and r_B respectively ($r_B > r_A$) in a horizental plane.



FREE VORTEX $v = \frac{c}{r}$



FORCED VORTEX $v = r\omega$

3. (20%)A uniform stream of incompressible fluid enters a channel of square cross section (side h). Boundary layers develop on four walls of the channel. Within the boundary layers, the velocity component in the streamwise direction, u is given as a function of the normal distance from the wall, n, as

$$u = \mathrm{V}(1 - e^{-5n/\delta}),$$

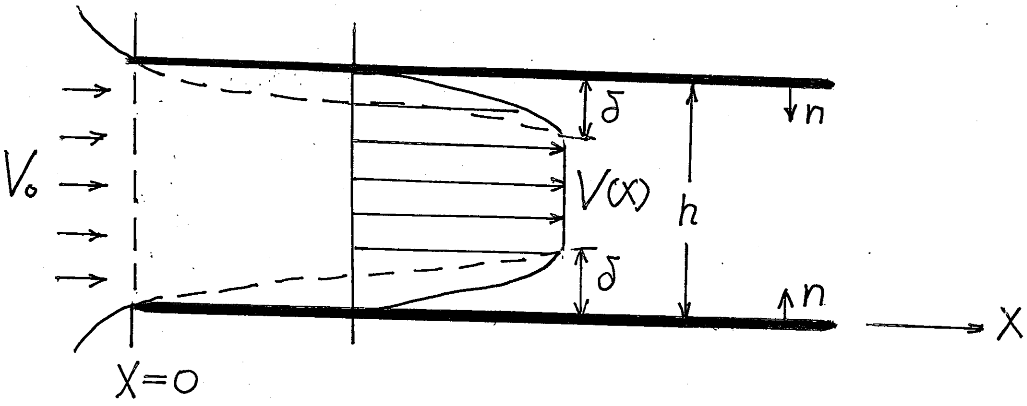
where

$$\delta = 6\sqrt{\frac{vx}{V_0}}$$

v is the kinematic viscosity, x is the streamwise distance form the channel origin, V is the velocity outside the boundary layer (i.e., when $n \gg \delta$) ,and $V_0 = V(x=0)$.

(a) Derive and expression relating the flow rate Q whit the local free stream velocity V. This expression will involve h, v and x.

(b) Evaluate the pressure drop from x=0 to x=x_0=constant, provided $i \ll \hbar$ at x=x_0.



4. (20%)Find the boundary layer thickness δ, momentum thickness σ_2, friction drag coefficient C_{fL} from the Von Kármán integral momentum equation which is

$$\frac{\tau_w}{\rho} = U_\infty^2 \frac{d\delta_2}{dx} + (2\delta_2 + \delta_1) U_\infty \frac{dU_\infty}{dx}$$

If the velocity profile is assumed to be

$$\frac{U}{U_\infty} = a + b(\frac{y}{\delta}) + c(\frac{y}{\delta})^2 + d(\frac{y}{\delta})^3 + e(\frac{y}{\delta})^4,$$

Where a, b, c, d, e need to be found, in laminar boundary layer on a flat plate.

5. (20%)請閱讀下段英文敘述，然後明確指出文中的的哪些描述(包括名詞與情形)與哪些流體力學的現象或原理有關，再盡你所知分別詳細解釋這些流體力學的現象及原理。請以條列式回答，每條依序包括(a)原文(英文)中的關鍵字詞及所在的行數、(b)流體力學的現象或原理的中文名稱、(c)你的解釋

(1) At the beginning of the twentieth century both the fields of theoretical
(2) hydrodynamics and experimental hydraulics were highly developed, and attempts
(3) were being made to unify the two. In 1904 a classic paper was presented by a
(4) German professor, Ludwig Prandtl(1857–1953), who introduced the concept of a
(5) “fluid boundary layer,” which laid the foundation for the unification of the theoretical
(6) and experimental aspects of fluid mechanics. Prandtl’s idea was that for flow next to
(7) a solid boundary a thin fluid layer(boundary layer) develops in which friction is very
(8) important, but outside this layer the fluid behaves very much like a frictionless fluid.
(9) This relatively simple concept provided the necessary impetus for the resolution of
(10) the conflict between the hydrodynamicists and the hydraulicists. Prandtl is generally
(11) accepted as the founder of modern fluid mechanics.