國立中央大學八十六學年度碩士班研究生入學試題卷

所別： 太空科學研究所 不分組 科目： 流體力學 共一頁 第1頁

[10%] 1. Derive the dispersion relation of sound waves in a neutral atmosphere.

[10%] 2. Show that a fluid can be considered as an incompressible fluid when the characteristic wave speed is much less than the sound speed.

[20%] 3. Determine the velocity distribution of a 3-D potential flow around a spherical barrier with radius a. The flow is uniform at $x = -\infty$ with flow velocity $\vec{V}(x = -\infty) = V_o \hat{x}$.

4. Consider an incompressible viscous fluid passing through a semi-infinite flat plate. Let the plane of the plate be the xz half plane with $x > 0$. The flow is uniform at $x < 0$, with flow velocity $\vec{V}(x < 0) = V_o \hat{x}$. The dynamic viscous coefficient of this fluid is $\nu=\eta/\rho$, (where η is the viscous coefficient, and ρ is the mass density of the fluid)

[10%] (a) Derive the Prandlt's boundary layer flow equation by scale analysis for velocity field $V_x(x,y)$ and $V_y(x,y)$ at $x > 0$ and $y > 0$.

[5%] (b) Find the dependence between boundary layer thickness and Reynolds number.

[5%] (c) Find the dependence between boundary layer thickness and distahce x from $x = 0$.

[20%] 5. Flow between rotating cylinders is often called Couettte flow. Consider the motion of an incompressible viscous fluid between two infinite coaxial cylinders with radii R_1 and R_2 ($R_2 > R_1$), rotating about their axis, z-axis, with angular velocities Ω_1 and Ω_2, respectively. Determine the velocity distribution $\vec{V}(r)$ of this Couettte flow.

6. Let us consider two special cases for the Couettte flow described in problem 5. Case A with $R_1 = 0$, and Case B with $R_2 \to \infty$, and $\Omega_2 = 0$. In both cases, a finite amount of fluid is sitting on a smooth surface at $z=0$ and is subject to a gravitational field.

[10%] (a) Determine the equation of fluid surface, $h(r)$, in Case A for $0 < r < R_2$ and boundary condition $h(r) = h_o$ at $r = 0$.

[10%] (b) Determine the equation of fluid surface, $h(r)$, in Case B for $r > R_1$ and boundary condition $h(r) = h_o$ at $r \to \infty$.