國立中央大學 107 學年度碩士班考試入學試題

所別： 大氣科學學系大氣物理 碩士班 不分組(一般生)
大氣科學學系大氣物理 碩士班 不分組(在職生)

科目： 流體力學

本科考試禁用計算器 *請在答案卷(卡)內作答

1. Hail is produced by the repeated rising and falling of ice particles in the updraft of a thunderstorm. When the hail becomes large enough, the aerodynamic drag from the updraft can no longer support the weight of the hail., and it falls from the storm cloud. Estimate the velocity W of the updraft needed to make D= 3 cm diameter hail. Discuss all the parameters used to do this estimation. (15 %)
2. What is the Reynolds number? Explain the characteristics of high Reynolds number flow and low Reynolds number flow. How to estimate the boundary layer thickness and boundary layer displacement thickness? (20 %)
3. Assume that the drag, D, acting on a spherical particle that falls very slowly through a viscous fluid is a function of the particle diameter, d , the particle velocity, V , and the fluid viscosity, μ. What is Buckingham Pi Theorem? Determine, with the aid of dimensional analysis, how the drag depends on the particle velocity. (15 %)
4. The three components of velocity in a flow field are given by the equations

   $u = x^2 + y^2 + z^2$

   $v = x\,y + y\,z + z^2$

   $w = -3\,x\,z - z^2 / 2 + 4$

   (a) Determine the volumetric dilatation rate and interpret the results.(5 %)

   (b) Determine an expression for the rotation vector. Is this an irrotational flow field? (5 %)

   (c) Determine the expressions for the three rectangular components of acceleration. (5 %)
5. An incompressible viscous fluid is placed between two large parallel plates. The bottom plate is fixed and the upper plate moves with a constant velocity, U. That is u = 0 as y = 0, and u = U as y = H. Derive the velocity distribution between the plates(5 %) and determine

   (a) the volumetric dilatation rate (5 %)

   (b) the rotation vector (5 %)

   (c) the vorticity (5 %)

   (d) the rate of angular deformation (5 %)
6. The streamlines in a certain incompressible, two dimensional flow field are all concentric circles so that $V_r = 0$. Determine the stream function for

   (a) $V_\theta = A\,r$ and for (b) $V_\theta = A\,r^{-1}$, where A is constant. (10 %)