所別：太空科學研究所碩士班 一般生 科目：流體力學

1. Write down the governing equations for ideal, compressible and adiabatic fluid in gravitational field $\vec{g}$. Under what assumptions, the pressure contours are also contours of density? (15 %)

2. For given flow velocity distribution $\vec{V}(x,y,z,t)$, how to obtain the streamline equations? What is the Kelvin's theorem or the law of conservation of circulation and what is the potential flow? (15 %)

3. Considering an ideal, compressible, laminar flow past a spherical object (neglecting the gravity). Draw the streamlines surrounding the object and point out the stagnation point. If the flow velocity and pressure in the upstream far away from the object are, respectively, to be U and P_0, obtain the pressure at the stagnation point. Please derive the necessary relations from the basic equations. (20%)

4. Considering an incompressible ideal fluid contained in a cylindrical vessel which rotates about its vertical axis $\hat{z}$ with a constant angular velocity Ω under a gravitational field $-g\,\hat{z}$. Write down the equations of motion in $\hat{x},\hat{y},\hat{z}$ components and obtain the integral of these equations. What is the shape of the surface of constant pressure? (25%)

5. Write down the Navier-Stokes equation for incompressible Newtonian viscous fluid. Based on this equation, give the meaning of Reynolds number. (15%)

6. The temperature in a fluid is denoted as $T(x,y,z,t)$. Explain the meaning of $\frac{\partial T}{\partial t}$ and $\frac{dT}{dt}$ and give a specific example to illustrate the difference. (10 %)