所別：大氣物理研究所碩士班 一般生 科目：流體力學

1. Provide a physical interpretation and list the assumptions that must be satisfied for the different forms of Bernoulli's equation to be valid. (10 %)

2. A fluid whose density distribution is given by $\rho(Z) = \rho_H - (\rho_B - \rho_H)\left[\left(\frac{Z}{H}\right)^2 - 1\right]$ is at rest in Earth's gravity field, where ρ_H, ρ_B are constant. Find the pressure gradient acting in the fluid at a depth of 2H/3. (10 %)

3. Provide a physical interpretation of Reynolds transport theorem as applied to a system and a control volume. (10 %)

4. The velocity field for a flow is given by $\vec{u} = \frac{-C \cdot y}{\sqrt{x^2 + y^2}}\ \hat{i} + \frac{C \cdot x}{\sqrt{x^2 + y^2}}\ \hat{j}$ where C is a constant. Determine the equations for the streamlines and make a sketch. (10 %)

5. Given the velocity field $\vec{v} = \left(x^2 - y^2\right)\ \hat{i} - 2xy\ \hat{j}$

   (1) determine the velocity gradient (5 %)
   (2) determine the vorticity field (5 %)
   (3) determine whether the flow is an incompressille flow(5 %)

6. (1) Using scale analysis to derive the two dimensional Prandtl boundary layer equations. (10 %)
   (2) Show that the thickness of the boundary layer δ is propotional to $\sqrt{x}$ where x is distance from the leading edge of the plate. (5 %)

7. Explain the following terms (definition and physical interpretation): (20 %)
   (1) potential flow and irrotational flow
   (2) Kelvin's circulation theorem
   (3) barotropic flow and baroclinic flow
   (4) circulation and vorticity
   (5) gradient and divergence

8. The temperature at a point 50 km north of a station is 3 $°C$ cooler than at the station. If the wind is blowing from the northeast at 20 ms^{-1} and the air is being heated by radiation at the rate of 1 $°C\ hour^{-1}$. What is the the local temperature change at the station ? (10 %)