國立中央大學94學年度碩士班考試入學試題卷

所別：大氣物理研究所碩士班　　科目：流體力學

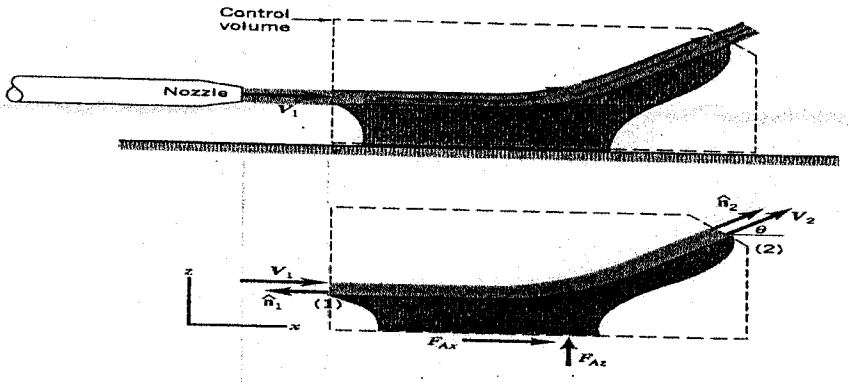
1. Describe the Newton's viscosity concept model and explain the conditions using this model that the shear stress will not exist in the flow. (10%)

2. Please show that the volumetric dilatation rate is equal to divergence $\nabla \cdot \vec{V}$ for an infinitesimal volume $\delta \forall = \delta x\, \delta y\, \delta z$. (10%)

3. A two-dimensional forced vortex is described by $\vec{V} = -\Omega y\, \hat{i} + \Omega x\, \hat{j}$ where Ω is a constant.

   (a) Determine the vorticity vector. (5%)
   (b) Prove that $\vec{V} \bullet (\vec{V} \times \nabla \times \vec{V}) = 0$. (5%)
   (c) Explain why the streamfunction exists but the velocity potential doesn't. (10%)

4. Given below is incompressible inviscid water flowing over the plate with a mass inflow rate $\dot{m}$. Assuming that both pressure and flow speed are the same in the entrance (1) and exit (2) regions, and gravity and fluid viscosity can be neglected, please determine the anchoring forces in the x- and z-directions, F_{AX} and F_{AZ}, respectively, with relation to the angle (θ), if the flow has reached a steady state. (20%)



5. Please write down the Navier-Stokes momentum equations for incompressible Newtonian flow and express your idea how to nondimensionalize the equations. (10%)

6. Assume average velocity $\overline{u}$ of the flow near the ground is related to several guessed variables (y, ρ, μ, τ_0) such that $\overline{u} = \mathbf{F}(y, \rho, \mu, \tau_0)$ where ρ is density, μ molecular (dynamic) viscosity, τ_0 surface stress on the ground, and y the distance to the ground. Please find out a possible nondimensional relationship using the π-method (MLT dimensions) and explain the meaning of each nondimensional π–variable. (20%)

7. What is the Reynolds number? Explain why this physical parameter can be used to identify the generation of turbulence. (10%)