編號： 114

國立成功大學 109 學年度碩士班招生考試試題

系　　所：工程科學系

考試科目：流體力學

考試日期：0211，節次：2

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

(5%) 1. What is the continuum hypothesis in fluid mechanics? Explain it in microscopic and macroscopic point of view. Sketch a plot to show the variation of density with respect to volume.

(10%) 2. Derive a formula showing the capillary rise or fall (Δh) of a column of a liquid with its surface tension σ as a function of the tube diameter D. The liquid contact angle on the surface is θ.

(15%) 3. A flow field is given by $\vec{V} = Ax\vec{\imath} + 2Ay\vec{\jmath}$ in Cartesian coordinate system. At time t=0, the fluid particle is located at x=2 and y=2. Find the equation for both pathline and streamline (10%). Are the two lines identical to each other? Why? (5%).

(20%) 4. Given the incompressible momentum equations: $\rho\left[\frac{\partial \vec{V}}{\partial t} + \vec{V}\cdot\nabla\vec{V}\right] = -\nabla P + \mu\nabla^2\vec{V} + \rho\vec{g}$, from this equation find **four** important dimensionless parameters.

(20%) 5. A small object is tested in a 2D wind tunnel. The object is located and fixed in the center of the tunnel. Assume the flow field is incompressible and steady shown **below (Fig.1)**. The in-flow has uniform velocity V, density ρ and pressure P_1. The out-flow has uniform pressure P_2, linear velocity with zero velocity at center and maximum velocity V_{max} at top and bottom surfaces. Find (a) the maximum velocity V_{max} =? (5%), and (b) the drag of the object (15%). Neglect viscous resistance at the tunnel walls.

Fig. 1

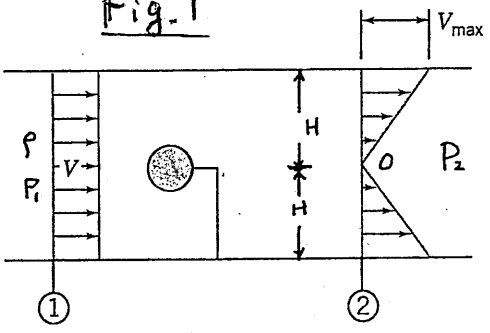
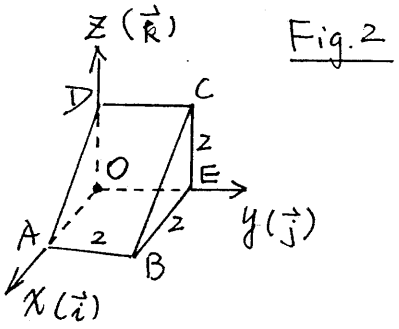


Fig. 2



(20%) 6. A flow has velocity given by $\vec{V} = ax\vec{\imath} + by\vec{\jmath}$ (a and b are constants) and fluid density is ρ.

(a) Assume the flow is incompressible, what is the relation between a and b? (2%)

(b) Evaluate the volume flow rate through five surfaces shown **above (Fig.2)**, namely, BEC (2%), ODA (2%), OABE (2%), OECD (2%) and ABCD (4%), respectively.

(c) Calculate the circulation for each surface of the above five surfaces. (2%)

(d) Is the flow rotational? Why? (4%).

(10%) 7. A 2-D steady incompressible uniform flow U with zero pressure gradient over a flat plate. It is known that the boundary is very thin when compared to its distance from the leading edge of the plate. Derive the boundary layer equations for this flow. You should do this with an order-of-magnitude analysis.