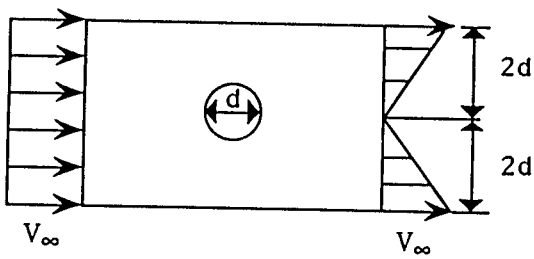
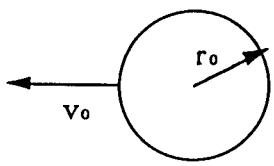
國立成功大學七十九學年度造船研究所入學考試

流體力學試題

1. In an experiment to determine drag, a circular cylinder of diameter d was immersed in a steady two-dimensional incompressible flow. Measurements of velocity and pressure were made at the boundaries of the control surface shown. The pressure was found to be uniform over the entire control surface. The x-component of velocity at the control surface boundary was approimately as indicated by Fig.1. From the measured data, calculate the drag force per unit length of the cylinder, based on diameter d and the free stream dynamic head ($1/2\ \rho V_\infty^2$).(20%)



2. A cylinder moving with a uniform velocity V_o through a fluid which is initially at rest, the velocity potential is $\phi = + v_o \frac{r_o^2}{r} \sin\theta$.(20%)
Show that



(a) $\Psi = - v_o \frac{r_o^2}{r} \sin\theta$.

(b) $(KE)_{fluid} = \frac{1}{2}\rho\,\pi\,r_o^2 v_o^2$.

3. Plane Couette flow : The wall y=0 is fixed, and the rigid wall y=a moves at steady speed V in its own plane. Solve the Navier-Stokes equations for the case ρ=constant to show that a possible flow is $\vec{V} = Vy/a\,\vec{i}$. (20%)

4. Consider a steady, two-dimonsional, incompressible, turbulent boundary-layor flow along a flat plate at zreo incidence in the positive x-direction. Assume that the turbulent boundary layer grows from leading edge with the velocity distribution $\frac{\overline{U}}{U_\infty} = \left(\frac{y}{\delta}\right)^{1/9}$ and the wall shear stress is $T_0 = 0.0233\ \rho U_\infty^2 \left(\frac{U}{\rho U_\infty^2}\right)^{1/4}$.

   (a) Find the the turbulent boundary-layer thickness.(20%)
   (b) Calculate the total frictional force of the plate.

5. Answer the following questions briefly.(20%)

   (a) Prove that : " In a turbulent incomprossible flow, both the fluctuation and the time-averaging valocity components satisfy the continuity equation. "

   (b) Prove that : " The volume rate of flow between any two streamlines in a two-dimensional planar flow is numerically equal to the difference in their Ψ-values."

   (c) Explain an important use of dimensional analysis in experimental fluid dynamics.

   (d) What is the "boundary layer control"?