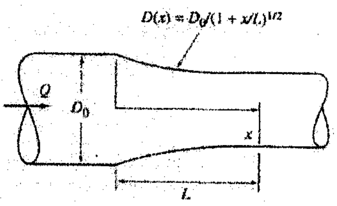
所別：機械工程學系碩士班丙.戊組 科目：流體力學

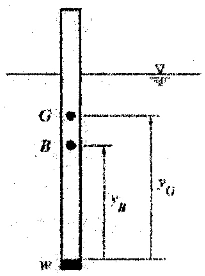
1. Plot the relation between τ (shear stress) and $\dot{\gamma}$ (strain rate) for the Newtonian and the non-Newtonian fluid. (4%)

2. Explain the following terms: (8%)
   (a) pressure gradient, (b) kinematic viscosity, (c) continuum fluid, (d) Bernoulli equation.

3. A steady, incompressible (density= ρ) flow with constant volumetric flow rate Q is accelerated through a nozzle of length L and diameter $D(x)$ ($D(x)=D_o/(1+x/L)^{0.5}$). Assuming one-dimensional flow and a uniform velocity over any cross section perpendicular to the flow and the pressure at the inlet (at D_o) to the nozzle is p_o. Find the fluid acceleration and pressure at any position in the nozzle. (10%)



4. A square rod (width=a) with length L (specific weight= γ_r) is floating on water (specific weight= γ_w). What is the minimum weight W that must be added to one end to have the rod float vertically? Assume that the volume of the weight is negligible. (13%)



5. If for a steady flow, streamlines are converging straight lines, which of the following statements are true? (4%)
   (a) Only convective normal acceleration is present.
   (b) Only convective tangential acceleration is present.
   (c) Both convective normal and tangential accelerations are present.
   (d) No local acceleration is present.
   (e) There is no acceleration.

6. For two-dimensional flows, which of the following statements are true? (4%)
   (a) If ϕ exists, ψ will also exist.
   (b) If ψ exists, the flow will be either rotational or irrotational.
   (c) If ϕ exists, the flow will be either compressible or incompressible.
   (d) If ψ exists, the flow will be both irrotational and incompressible.
   (e) If ϕ exists, the flow will be both irrotational and incompressible.
   (ϕ: velocity potential, ψ: stream function)

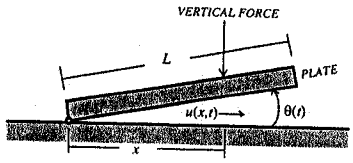
參考用

7. Explain how fluid pressure, density and velocity vary through a converging duct for an isentropic flow of an ideal gas when the flow is (a) subsonic, (b) supersonic. (6%)

注意：背面有試題

所別：機械工程學系碩士班丙.戊組 科目：流體力學

8. A flat plate is hinged at one side to the floor and held at a small angle θ_0 relative to the floor. The entire system is submerged in a liquid of density ρ. At $t=0$, a vertical force is applied and adjusted continually so that it produces a constant rate of decrease of the plate angle θ, $-d\theta/dt=\omega=$constant. Consider the flow is incompressible and inviscid.



(a) Derive an expression for the velocity $u(x,t)$ at position x and time t. (7%)

(b) Assuming the plate has negligible mass, find the horizontal force $F(t)$ exerted by the hinge on the floor. (10%) (Obtain the answers of (a) and (b) based on $\theta_0 << 1$)

9. A fluid of density ρ and viscosity μ flows through a long pipe of diameter D at the volume rate Q. Assume the flow is steady and fully developed in the mean.

(a) Demonstrate the mean pressure gradient in the direction of flow has the form

$$dP/dx=\left(\rho Q^2/D^5\right)\cdot\phi\left(\rho Q/\mu D\right). \quad (7\%)$$

(b) Further assume the flow is laminar, simplify the above form without knowing any possible expressions of ϕ. (5%)

(c) Using the force balances, explain the difference between (a) and (b). (5%)

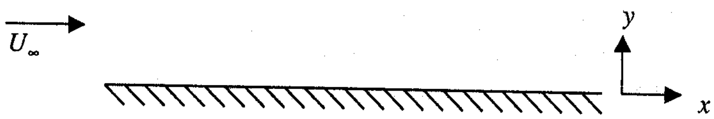
10. The steady, two-dimensional, incompressible Navier-Stokes equations are

$$\rho\left(u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)$$

$$\rho\left(u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)$$

Consider a two-dimensional incompressible laminar boundary-layer flow, as sketched below.

(a) Write down the appropriate boundary-layer equations for this flow. (4%)



參考用

If the plate is made of porous media to which suction is applied with the suction speed at the plate surface being a constant V_0, then for small values of V_0/U_∞, the laminar boundary layer may become constant in both thickness and velocity at large distances from the leading edge. For large distances from the leading edge, find

(b) the velocity profile in terms of U_∞, V_0, ρ, μ and y, (5%)

(c) the displacement thickness, (4%)

(d) the skin-friction coefficient $2\tau_w/\rho U_\infty^2$. (4%)