國　立　清　華　大　學　命　題　紙

97 學年度　核子工程與科學研究所　甲組 (工程) 碩士班入學考試

科目 流體力學 科目代碼 3104 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. (40%) Answer the following questions

(a) Please write down the critical Reynolds numbers for a pipe flow and flow through the parallel plates? Please specify the characteristic length for both cases.

(b) please use two English keywords to characterize laminar and turbulent flows

(c) Is the entrance length longer for laminar flow than for turbulent flow? Why?

(d) Please write down the expressions for turbulent and laminar shear stress and give the physical meanings, use Cartesian coordinates

(e) Please define Darcy's friction factor, f. Please write down the relation between f and Re for laminar pipe flow,

(f) Please define hydraulic diameter? Please write down the equation with variables defined and calculate it for a flow through parallel plates

(g) Please use words, illustration diagrams and equations to define separation points

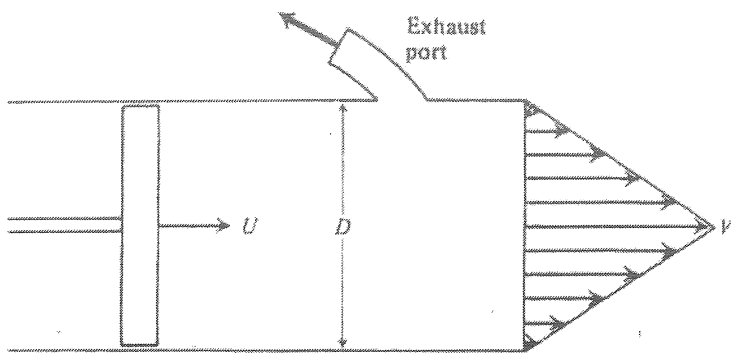
(h) Please define boundary layer thickness δ and write down the relating equation with Reynolds number for flows over a plate

(i) Please describe and write down the equation for no slip condition, what is it for?

(j) Please list the design guidelines of the shape to minimize the drag for a flying object?

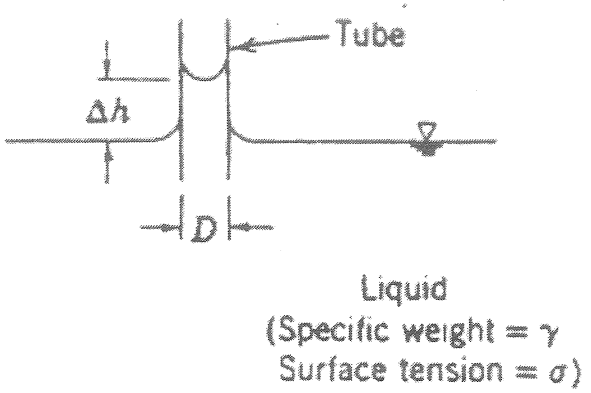
3 (10%)An idealized velocity distribution is given by $u = \frac{x}{1+t}$, $v = \frac{y}{1+2t}$, w=0, Calculate (a) the streamline; (b) the pathline; and (c) the streakline which pass through the point $(x_o, y_o, 0)$ at time t=0

4 (10%) Consider a piston moving with velocity U in one end of a cylinder of diameter D. Liquid leaves the open end with a conical velocity profile and a maximum velocity V. Develop an expression for the volume flow rate leaving through the exhaust port.



5. (14%) To get a numerical result for laminar flow over a flat-plate, we can assume the form for a cubic velocity profile polynomial as $u=A+By+Cy^2+Dy^3$, and then momentum thickness (θ) and wall shear stress (τ) can be obtained via momentum-integral relation $D(x) = \int_0^{\delta(x)} u(U-u)dy$, (a) please derive the values of A,B,C, and D via appropriate boundary conditions and assumptions. (b) derive the boundary layer thickness in terms of Reynolds number

6. (14%) When a small tube is dipped into a pool of liquid, surface tension causes a meniscus to form at the free surface, which is elevated or depressed depending on the contact angle at the liquid-solid-gas interface. Experiments indicate that the magnitude of this capillary effect, Δh, is a function of the tube diameter, D, liquid specific weight, γ, and surface tensions, σ. Given: $\Delta h=f(D, \gamma, \sigma)$, find the independent dimensionless parameters. (hint: use Buckingham Pi theorem)



7. (12%) Please derive the velocity distribution for flow flowing between parallel plates (hint: write down the continuity equations and x-momentum equations first)