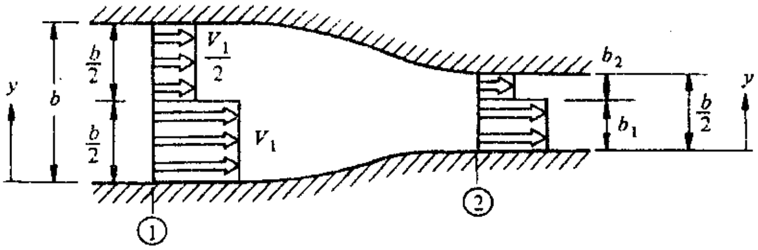
所別：機械工程學系碩士班 丙組(熱流)(一般生)　科目：流體力學及熱傳學　共 2 頁 第 1 頁

本科考試可使用計算器，廠牌、功能不拘　＊請在試卷答案卷（卡）內作答

流體力學 (50 分)

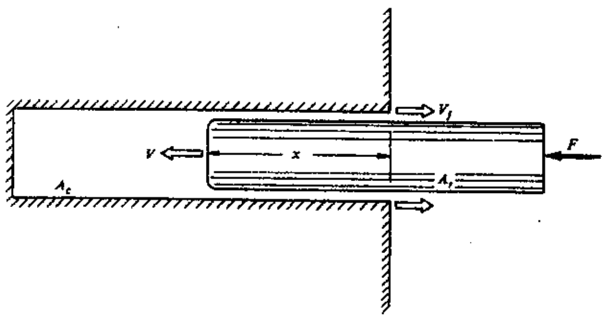
1. The inlet of a two-dimensional duct is of width b and contains a frictionless fluid of constant density ρ. The velocity in one half of the duct is V_1 and that in the other half is $V_1/2$. The two streams do not mix. The outlet of the duct is of width b/2. The flow is parallel at the duct entrance and exit so that the pressure is uniform across these two sections. By writing the continuity equation and Bernoulli equation, determine the pressure change p_1-p_2 across the duct contraction and the individual dimensions b_1, b_2 of the two fluid streams at the exit section. (10%)



2. A frequently used hydraulic brake consists of a movable ram that displaces water from a slightly larger cylinder as shown below. The cross-sectional area of the cylinder and the ram are A_c and A_r, respectively. The ram velocity V does not change with time. Assume that the gap between the cylinder and the ram is much smaller than the displacement of the ram x.

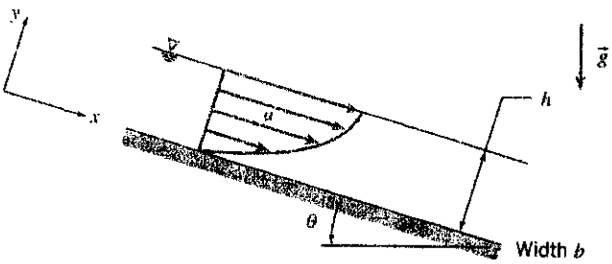
(a) Determine the pressure at the end of the cylinder (where the velocity is assumed to be zero) and the jet velocity V_j. (7%)

(b) Find the force F on the ram in terms of A_r, A_c, and V. Assume that the cylinder is initially full of water and that gravity effects are negligible. (8%)



3. Please proof the shear stress relation $\tau_{xy} = \tau_{yx} = \mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)$ is correct, where μ is dynamic viscosity and u and v are velocity componnment in x and y direction respectively (6%)

4. As shown in the figure below, a viscous liquid flows down an inclined plate in a steady, fully developed laminar film of thickness h. Assume the plate width is b and inclined with angle θ to the horizontal plane.



(a) Derive simplified Navier-Stokes equations to describe the flow. (Please describe your simplify assumptions in the answer.) (8 %)

(b) Obtain the velocity profile u(y) and average velocity of the flow (7%)

(c) Assume the fluid is Newtonian fluid, find the expression of shear distribution of the flow. (4%)

參考用

注意：背面有試題

熱傳學 (50 分)

1. A solid steel sphere with radius r is experiencing a uniform volumetric heating Q. Assume 1D heat conduction in the radial direction and steady state.
   (a) How does the heat flux vary with radius? (3%)
   (b) How does the heat transfer rate vary with radius? (2%)
   (Please give short explanations for problem (a) and (b).)
   (c) If the sphere surface is coated with a thin polymer layer and the outer surface of the polymer layer is exposed to a water flow for which $h = 100$ W/m^{2}K and $T_\infty = 25$ °C, estimate the surface temperature of the steel sphere (i.e. the inner surface temperature of the polymer layer). The polymer layer thickness is 2 mm and with constant thermal conductivity 0.2 W/mK. Use $r = 0.5$ m and $Q = 10^4$ W/m^3. (5%)

2. A new design of infrared sensor uses a thin film strip of length L, thickness t, and width W, whose two ends is thermally join to two large heat sinks that are maintained at temperature T_0. The sensor is packaged in a vacuum environment. The top surface of the thin film strip is subjected to a uniform radiation heat flux q''.
   (a) Derive the differential equation that determines the steady-state temperature distribution $T(x)$ along the strip. (5%)
   (b) Solve the forgoing equation for the temperature distribution. (5%)

3. Obtain the equation of the net rate of radiation heat transfer q_{rad} from a small surface at temperature T_s, which is surrounded by a much larger surface at temperature T_{sur} ($T_s \neq T_{sur}$). Use the symbols ε, α, and A for the emissivity, absorptivity, and area of a surface, respectively; use the subscripts s and sur for the small surface and the surrounding, respectively. (5%)

4. Please write down the definitions of Biot number and the Nusselt number. What is the difference of physical significance between these two parameters? (6%)

5. Please plot the variation of (i) velocity, (ii) boundary later thickness and (iii) heat transfer coefficient for uniform airflow over a flat plate. (9%)

6. Fully developed flow in a circular tube is heated with constant heat flux. The mean flow velocity is 2.0 m/s, and the tube inside diameter is 12 mm. Please calculate the convective heat transfer coefficient for air at temperature of 300K. (10%)
   (hint: please check that the flow regime is laminar or turbulent first).
   The physical properties of air at 300 K are listed below:
   density: 1.1614 kg/m^3, specific heat: 1.007 kJ/kg K, viscosity: 184.6 x 10^{-7} Ns/m^2, conductivity: 0.0263 W/m K, Prandtl number: 0.707.

參考用

注意：背面有試題