編號： 70

國立成功大學 104 學年度碩士班招生考試試題

系所組別：機械工程學系甲組

考試科目：流體力學

考試日期：0211，節次：1

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

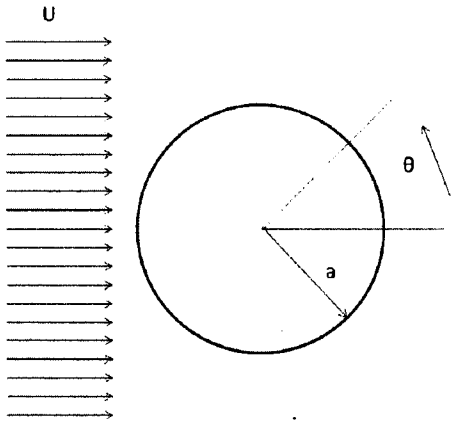
1. (30%) A patient is taking an injection step where dye is injected into his heart through a 1 m long thin tube from a syringe to obtain x-ray images of his heart. Assume the dye has a constant density and the injection process is performed steadily.

(1) If the dye is injected from a syringe outside the body which is 1 cm in diameter, what is the average velocity at the syringe tip to deliver 10 cm^3 in 1 second? (5 %)

(2) What is the average velocity of the dye at the tube tip if the tube tip is 3 mm in diameter? (5 %)

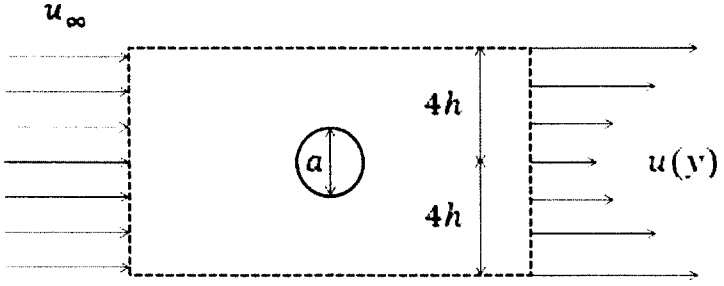
(3) What is the peak force required to inject the dye into his heart if the mean systolic blood pressure of the patient is 120 mmHg. Assume the density and dynamic viscosity of the dye are 1.3 g/cm^3 and 0.04 dyn s/cm^2 and, respectively. 1 mmHg = 1333 dyn/cm^2. (20 %)

2. (10%) Starting from the method of superposition, sketch how a uniform stream passes through a circular cylinder with a velocity of U and generate an expression for the pressure gradient in the direction of flow on the surface of the cylinder.



3. (10%) A cylindrical rod was submerged in a uniform flow with a characteristic length of a, calculate the drag per unit length on the rod based on the velocity profile in the downstream using integral mass and momentum equations.

$$u(y) = \frac{u_\infty}{4}\left(1 + \frac{y}{h}\right);\ 0 \le y \le 4h$$



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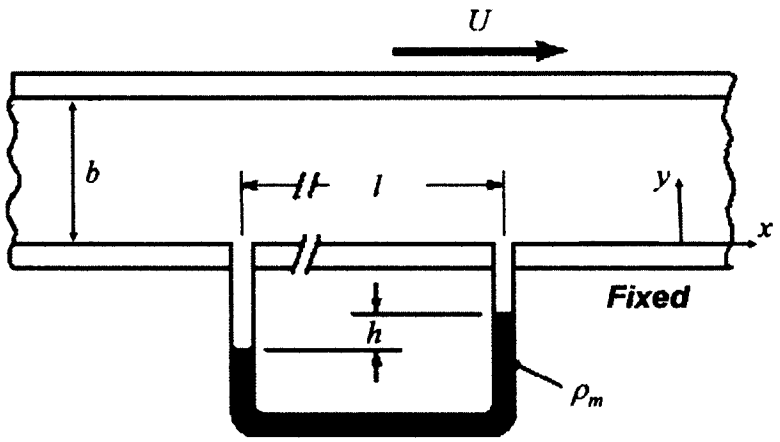
4. (20%) The laminar flame speed of a combustible mixture, S_L, is known to be a function of flame thickness δ, the gas density ρ, the thermal diffusivity α, and the mass diffusivity D.

(1) Determine the functional form of this dependence in terms of dimensionless parameters. Note that α and D have the same dimension as kinematic viscosity. (15 %)

(2) If the Lewis number, which is defined as the ratio of thermal diffusivity to mass diffusivity, equals 1, find an explicit relationship for S_L. (5%)

5. (30 %) A fluid is contained between two infinite, horizontal parallel plates spaced by a distance of b as shown in the figure below. The density and viscosity of the fluid are ρ, and μ, respectively. The fluid moves between the plates under the action of a pressure gradient, and the upper plate moves with a velocity, U, while the bottom plate is stationary. A U-tube manometer connected between two points along the bottom. The distance between the two points is l, and the differential reading of the manometer is h. The density of the manometer fluid is ρ_m.



(1) Derive the velocity profile of the flow, $u(y)$, in terms of the parameters given. LIST ALL NECESSARY ASSUMPTIONS AND SHOW YOUR DERIVATION STEP BY STEP. (18%)

(2) Sketch the shear stress distribution in the fluid. (6%)

(3) At what distance from the bottom plate does the maximum velocity in the gap between the two plates occur? (6 %)