

國立中央大學 105 學年度碩士班考試入學試題

所別： 機械工程學系 碩士班 熱流組(一般生)

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科目： 流體力學及熱傳學

本科考試可使用計算器，廠牌、功能不拘

*請在答案卷(卡)內作答

1. Please define or answer briefly the following questions.

- (a) What is a Newtonian fluid? (2%)
- (b) What is the condition for the non-slip condition to be valid? (2%)
- (c) Define the gage pressure and absolute pressure. (2%)
- (d) What are the streamline, the streakline and the pathline? (6%)
- (e) Please use the force ratio to define the Reynolds number. (2%)
- (f) Please use the force ratio to define the Froude number. (2%)
- (g) What is the total (substantial or material) derivative $D\vec{v}/Dt$? (3%)
- (h) What is the simplest version of the Bernoulli equation? Also, write down its associated four assumptions. (6%)

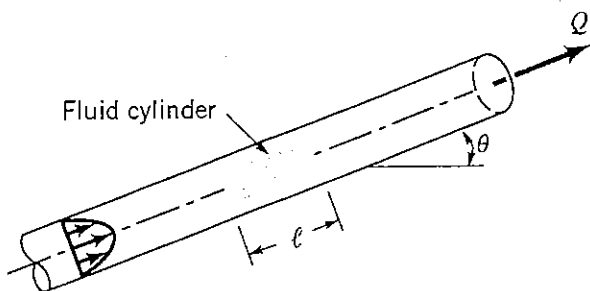
2. Consider a steady, fully-developed, laminar, incompressible, Newtonian fluid flows through a non-horizontal pipe.

- (a) Write down the fully developed condition for the flow. (2%)
- (b) Take the fluid cylinder indicated in Figure (a) as the control volume. Using the control volume analysis show that

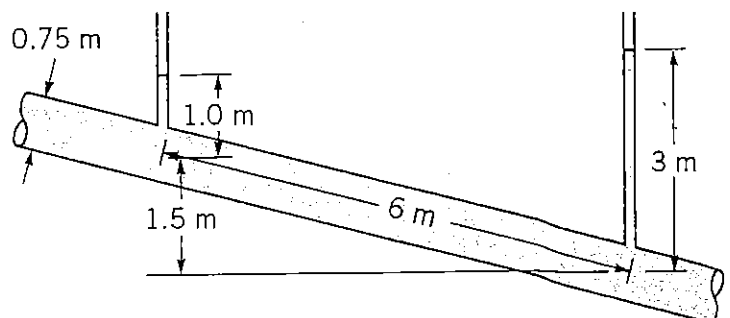
$$\frac{\Delta p - \rho g l \sin \theta}{l} = \frac{2\tau}{r}$$

where Δp is the pressure drop across the axial length l , ρ the fluid density, g the gravitational acceleration, and τ is the magnitude of shear stress at radius r . (5%)

- (c) Solve the volumetric flow rate Q . Express your solution in terms of ρ , g , l , θ , Δp , the fluid viscosity μ , and pipe diameter D . (5%)
- (d) Consider the fluid with $\rho = 1000 \text{ kg/m}^3$ and $\mu = 0.5 \text{ N}\cdot\text{s/m}^2$ flows through the pipe shown in figure (b). Determine the direction of flow. (3%)
- (e) Determine the shear stress at the inner wall of pipe for the flow in figure (b). (5%)
- (f) Determine the average velocity for the flow in figure (b). (5%)



(a)



(b)

注意：背面有試題

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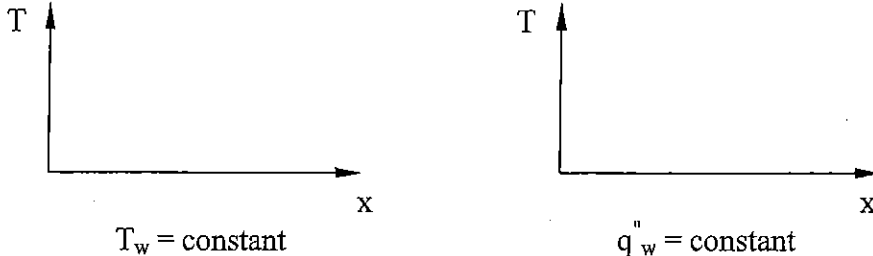
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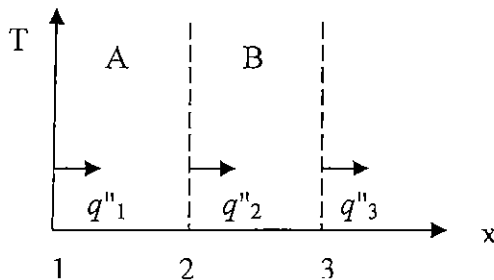
3. Please plot the axial variation of tube wall temperature (T_w) and fluid mean temperature (T_m) for a **fully developed** flow in a circular tube at (a) constant wall temperature and (b) constant heat flux conditions. (8%)



4. Air at temperature of 300 K and velocity of 3.0 m/s flows over a heating surface at temperature of 350 K. The length and width of the plate are 2.0 m and 0.5 m respectively.
- What temperature should you use for evaluating the fluid properties? (2%)
 - If the properties are listed below, what is the Reynolds number for this flow at the end ($x=2.0$ m) of the plate? (3%)
 - Is this a laminar flow or turbulent flow? (2%)
 - Please calculate the heat transfer coefficient at the midpoint ($x=1.0$ m) of the flow path on the plate. (5%)
 - Please calculate the average heat transfer coefficient over the entire plate. (5%)

	ρ (kg/m ³)	μ (N s/m ²)	k (W/m K)	Pr
Air	1.078	19.64×10^{-6}	0.02815	0.7035

5. Heat is conducted through a composite wall as shown in the figure. The wall is composed of two different materials, A and B, with constant thermal conductivity k_A and k_B , respectively, and $k_A > k_B$. Material A and B have the same thickness. The heat flux cross the surfaces located at $x = 1, 2,$ and 3 are denoted as $q''_1, q''_2,$ and q''_3 , respectively. Assume 1D heat conduction to the right.
- Sketch the steady-state temperature distribution in the composite wall. (5%)
 - Which material has larger thermal resistance? Explain. (5%)
 - Comment on the relative magnitudes of $q''_1, q''_2,$ and q''_3 . (5%)



- What is the definition of Biot number and what is its importance in transient heat conduction? (5%)
- What are the differences between the radiation emitted by a blackbody and that by a real surface? (5%)

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