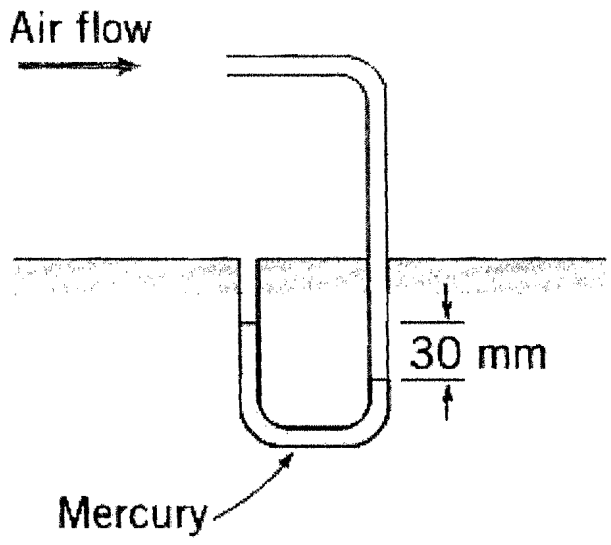
淡江大學 106 學年度日間部轉學生招生考試試題

系別：航空太空工程學系三年級　　科目：流體力學

考試日期：7 月 21 日(星期五) 第 2 節　　本試題共 10 大題， 3 頁

1. (5/100) What is the different between solid and fluid? From the mechanical(力學) point of view.
2. (5/100) What is the no-slip condition? What causes it?
3. (5/100) 詳細說明流體流動中使用 Bernoulli 方程式時，必須滿足的四項條件為何？
4. (5/100) 試從 速度勢（velocity potential）與流函數（stream function） 兩種方式說明勢位流的定義。
5. (5/100) 試說明何謂 material(particle, substantial) derivative？其通式為何？
6. (15/100) A pitot tube is inserted in an air flow (at STP) to measure the flow speed. The tube is inserted so that it points upstream into the flow and the pressure sensed by the tube is the stagnation pressure. The static pressure is measured at the same location in the flow, using a wall pressure tap. If the pressure difference is 30 mm of mercury, determine the flow speed.



[提示]： $\frac{p}{\rho} + \frac{V^2}{2} + gz = \text{constant}$, $SG_{Hg}=13.6$

7. (15/100) Air flows steadily at low speed through a horizontal nozzle (by definition a device for accelerating a flow), discharging to atmosphere. The area at the nozzle inlet is 0.1 m^2. At the nozzle exit, the area is 0.02 m^2. Determine the gage pressure required at the nozzle inlet to produce an outlet speed of 50 m/s.

背面尚有試題

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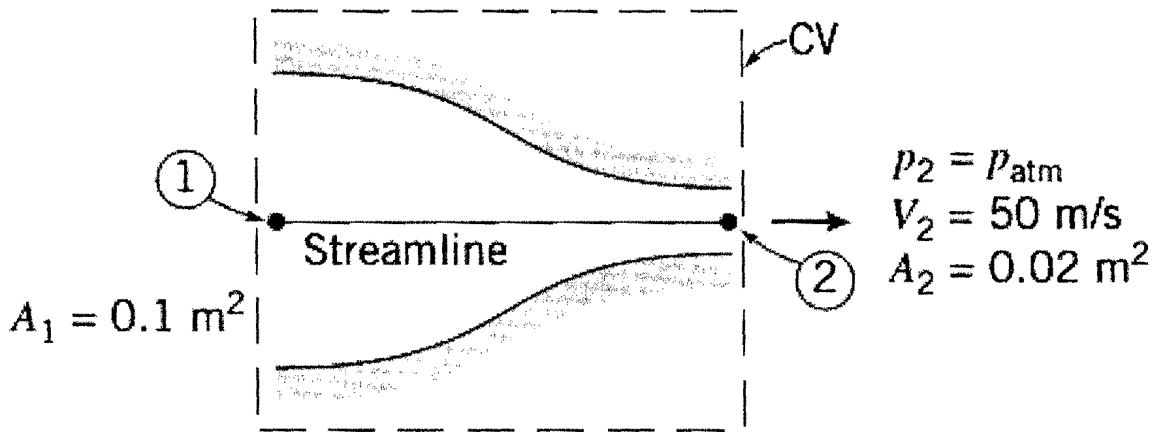
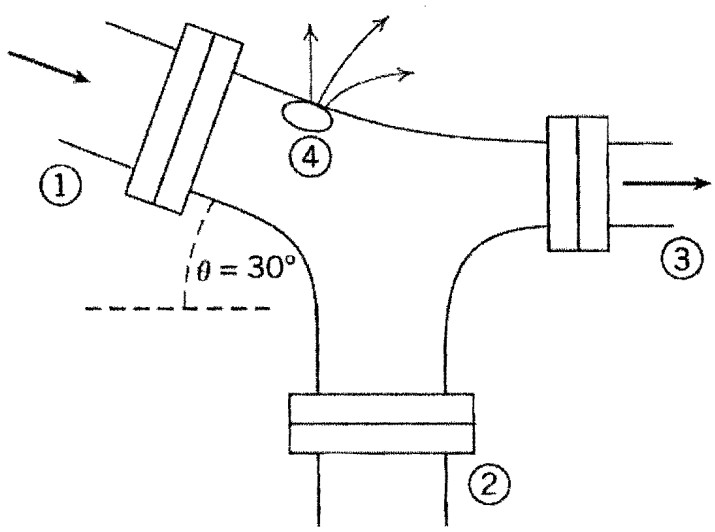


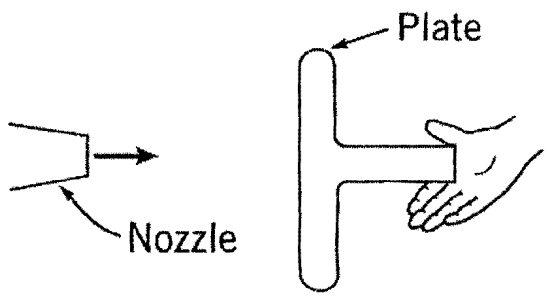
[提示]：$\frac{p_1}{\rho} + \frac{V_1^2}{2} + gz_1 = \frac{p_2}{\rho} + \frac{V_2^2}{2} + gz_2$，$V_1A_1 = V_2A_2$

8. (15/100) Consider the steady flow in a water pipe joint shown in the diagram. The areas are: A_1=0.2 m^2, A_2 =0.2 m^2, and A_3=0.15 m^2. In addition, fluid is lost out of a hole at (4) estimated at a rate of 0.1 m^3/s. The average speeds at sections (1) and (3) are V_1=5 m/s and V_3=12 m/s, respectively. Find the **velocity at section (2)** .

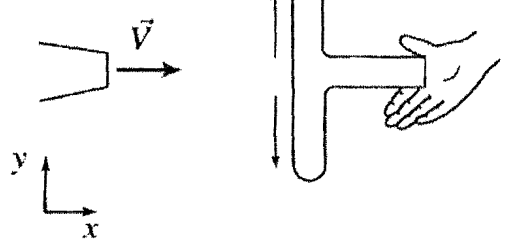


Hints: (1)繪製 CV，(2)定義截面位置，(3)簡化質量守恆方程式求解之。

9. (15/100) Water from a stationary nozzle strikes(撞擊) a flat plate as shown. The water leaves the nozzle at 15 m/s; the nozzle area is 0.01 m^2. Assuming the water is directed normal to the plate, and flows along the plate, determine the **horizontal force** you need to resist to hold it in place.



簡化圖示：



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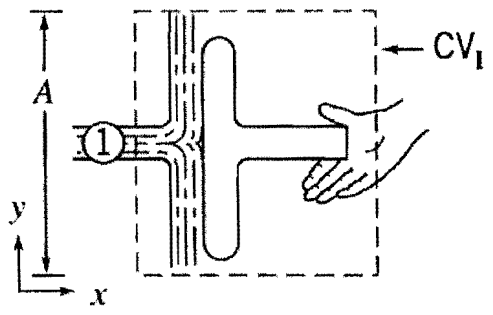
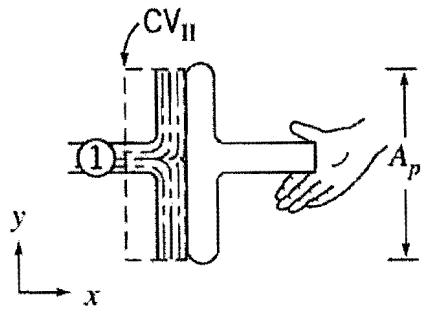


求解：(a) CV I：



；(b) CV II：

簡化質量與動量守恆方程式求解之。

10. (15/100) Consider the flow field given by $\psi=ax^2+ay^2$, where $a=3\ s^{-1}$. Show that the flow is **irrotational**. Determine the **velocity potential** for this flow.

Hints：

$$\frac{1}{2}\nabla \times \mathbf{V} = \frac{1}{2}\begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ u & v & w \end{vmatrix}$$

$$= \frac{1}{2}\left(\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}\right)\hat{\mathbf{i}} + \frac{1}{2}\left(\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}\right)\hat{\mathbf{j}} + \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)\hat{\mathbf{k}}$$

Irrotation：$\vec{\nabla} \times \mathbf{V} = 0$ and

Stream function：$u = \dfrac{\partial \psi}{\partial y} \qquad v = -\dfrac{\partial \psi}{\partial x}$

Velocity potential：$u = \dfrac{\partial \phi}{\partial x} \qquad v = \dfrac{\partial \phi}{\partial y} \qquad w = \dfrac{\partial \phi}{\partial z}$

Approximate Physical Properties of Some Common Gases at Standard Atmospheric Pressure (SI Units)

Gas	Temperature (°C)	Density, ρ (kg/m³)	Specific Weight, γ (N/m³)	Dynamic Viscosity, μ (N · s/m²)	Kinematic Viscosity, ν (m²/s)	Gas Constant,[a] R (J/kg · K)	Specific Heat Ratio,[b] k
Air (standard)	15	1.23 E + 0	1.20 E + 1	1.79 E − 5	1.46 E − 5	2.869 E + 2	1.40
Carbon dioxide	20	1.83 E + 0	1.80 E + 1	1.47 E − 5	8.03 E − 6	1.889 E + 2	1.30
Helium	20	1.66 E − 1	1.63 E + 0	1.94 E − 5	1.15 E − 4	2.077 E + 3	1.66
Hydrogen	20	8.38 E − 2	8.22 E − 1	8.84 E − 6	1.05 E − 4	4.124 E + 3	1.41
Methane (natural gas)	20	6.67 E − 1	6.54 E + 0	1.10 E − 5	1.65 E − 5	5.183 E + 2	1.31
Nitrogen	20	1.16 E + 0	1.14 E + 1	1.76 E − 5	1.52 E − 5	2.968 E + 2	1.40
Oxygen	20	1.33 E + 0	1.30 E + 1	2.04 E − 5	1.53 E − 5	2.598 E + 2	1.40

Approximate Physical Properties of Some Common Liquids (SI Units)

Liquid	Temperature (°C)	Density, ρ (kg/m³)	Specific Weight, γ (kN/m³)	Dynamic Viscosity, μ (N · s/m²)	Kinematic Viscosity, ν (m²/s)	Surface Tension,[a] σ (N/m)	Vapor Pressure, p_v [N/m² (abs)]	Bulk Modulus,[b] E_v (N/m²)
Carbon tetrachloride	20	1,590	15.6	9.58 E − 4	6.03 E − 7	2.69 E − 2	1.3 E + 4	1.31 E + 9
Ethyl alcohol	20	789	7.74	1.19 E − 3	1.51 E − 6	2.28 E − 2	5.9 E + 3	1.06 E + 9
Gasoline[c]	15.6	680	6.67	3.1 E − 4	4.6 E − 7	2.2 E − 2	5.5 E + 4	1.3 E + 9
Glycerin	20	1,260	12.4	1.50 E + 0	1.19 E − 3	6.33 E − 2	1.4 E − 2	4.52 E + 9
Mercury	20	13,600	133	1.57 E − 3	1.15 E − 7	4.66 E − 1	1.6 E − 1	2.85 E + 10
SAE 30 oil[c]	15.6	912	8.95	3.8 E − 1	4.2 E − 4	3.6 E − 2	—	1.5 E + 9
Seawater	15.6	1,030	10.1	1.20 E − 3	1.17 E − 6	7.34 E − 2	1.77 E + 3	2.34 E + 9
Water	15.6	999	9.80	1.12 E − 3	1.12 E − 6	7.34 E − 2	1.77 E + 3	2.15 E + 9