

系所組別： 系統及船舶機電工程學系甲組

考試科目： 流體力學

考試日期： 0219 · 節次： 2

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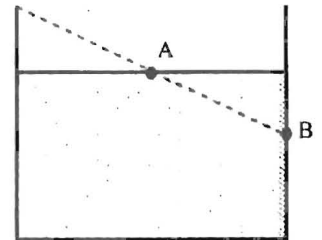
----- Some information -----

Fresh water's kinematic viscosity =  $1.12 \times 10^{-6} \text{ m}^2/\text{s}$ , density =  $1,000 \text{ kg}/\text{m}^3$ .Pressure of 1 atm,  $P_{\text{atm}} = 101.33 \text{ kPa}$ The gravity acceleration =  $9.8 \text{ m}/\text{s}^2$ 

## 1. [Statics](20%)

A tank on a moving vehicle is 2.0m long and 1.3m high as the figure shown. The water level is 1.0m high when the vehicle is still.

- (a) How much constant acceleration will make the water spill out of tank? (5%)
- (b) When the water level is about to spill out, what is the pressure at point B in SI unit? What is the pressure difference between point A and B? (5%)
- (c) In addition to make a cover on the top, is there any other way to prevent water from spilling out? Please show at least two different designs, and explain the reason or mechanism. (10%)



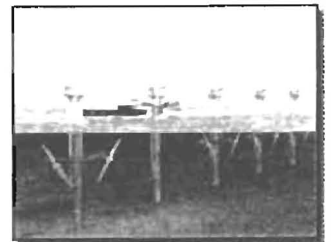
## 2. [Governing Equation](20%)

Bernoulli Equation is a form of conservation of energy, and a special case of The First Law of Thermodynamics.

- (a) What are the assumptions of Bernoulli Equation? (8%)
- (b) Write down a form of Bernoulli Equation. (3%)
- (c) Explain or interpret each term's meaning, especially why it is a form of energy. (9%)

## 3. [因次分析] (20%)

為解析水流發電機的旋轉葉片（見圖）問題，若只考慮的物理量包括流速  $U$ ，葉片半徑  $R$ ，水的密度  $\rho$ ，水的黏性  $\mu$ ，產生的阻力  $D$ ，轉矩  $Q$ ，轉速（旋轉的頻率） $n$ ，請以因次分析的方法討論此問題。除了推導無因次量之外，也請解釋每項的物理意義（不只是名稱）。



## 4. [Potential Flow] (20%)

The potential flow around a circular cylinder can be expressed as:  $\phi = Ur(1 + a^2/r^2)\cos\theta$  where  $a$  is its radius and  $U$  is mean flow velocity.

- (a) Derive its velocity distribution on the surface of the cylinder. (10%)
- (b) Explain the reason why the total drag of the cylinder is 0. (The d'Alembert's paradox)(5%)
- (c) According to (b), what is the benefits and limit of using potential flow theory? (5%)

## 5. [Boundary Layer] (20%)

- (a) What is "boundary layer separation"? Introduce this phenomenon (5%) and the effects it might generate for a moving body. (5%)
- (b) The following picture is the relationship between drag coefficient and Reynolds number for smooth and rough spheres. Please explain difference between Golf ball and smooth sphere using mechanisms

(背面仍有題目,請繼續作答)

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related to “boundary layer separation”. Hint: remember to mention the difference between laminar and turbulent flows. (7%)

(c) Why the minimum drag coefficient of a Golf ball larger than a smooth sphere’s? (3%)

