

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：0307，節次：2

※ 考生請注意：本試題 可 不可 使用計算機

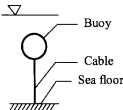
----- Some information -----

The thickness of laminar boundary layer can be approximated by:  $\delta = 4.79 \sqrt{\frac{\nu x}{U}}$ ,Fresh water's kinematic viscosity =  $1.12 \times 10^{-6} \text{ m}^2/\text{s}$ , density =  $1,000 \text{ kg}/\text{m}^3$ Seawater's kinematic viscosity =  $1.18 \times 10^{-6} \text{ m}^2/\text{s}$ , density =  $1,050 \text{ kg}/\text{m}^3$ The gravity acceleration =  $9.8 \text{ m}/\text{s}^2$ 

1. [10%] How is a fluid's viscosity defined? (5%) What is the definition of Newtonian fluids? (5%)

2. [25%] [Hydrostatics + Hydrodynamics]

Consider a spherical buoy having a diameter of 1.5m and is anchored to the sea floor with a cable as shown in the figure. The buoy weights 750N without air. The density of air inside the buoy is  $1.23 \text{ kg}/\text{m}^3$ . Assume the cable is neutrally buoyant. Determine: (a) the total weight of the buoy (3%), (b) the buoyant force of this buoy (2%), (c) the tension on the cable (5%).



If a horizontal current flows by this buoy at 1.5m/s, what is (d) the Reynolds number of the buoy (5%), (e) the drag force acting on the buoy, if the drag coefficient is 0.2? (7%) (f) What is the inclined angle of the cable then? (3%)

3. [15%] A submarine is designed to move through the seawater in the Pacific Ocean at the depth of 450m with velocity of 14.0m/s. (a) Determine the pressure at its stagnation point at bow. (5%) (b) What principle is the equation used to solve (a) based on? Conservation of what? (5%) (c) What are the assumptions behind this equation in this problem? (5%)

4. [10%] About potential flows (ideal fluid):

(a) What are the assumptions of potential flows? (4%)

(b) If ideal fluid is not realistic, why and how is it used in engineering problems? (6%)

5. [10%] The velocity components in an incompressible, two-dimensional flow field are given by the equations:  $u = 6xy$ ,  $v = 3(x^2 - y^2)$ . (a) Does it satisfy conservation of mass? Prove your answer. (3%) (b) Is this flow irrotational? Prove your answer. (4%) (c) What are the equations of conservation in fluid mechanics? Write out their names and corresponding physical quantities conserved. (3%)

(背面仍有題目,請繼續作答)

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6. [30%] 我們考慮一個簡化的流體動力問題。為發展新能源運輸工具，有一新式大型油輪設計於一大型淡水湖中以  $5.0\text{m/s}$  為巡航速度，其水線面之長寬深分別為  $250\text{m}$ 、 $50\text{m}$ 、 $12\text{m}$ 。為估算其阻力，要在水槽中以縮小比例  $1/100$  的模型實驗。實驗模型除了要求幾何相似，還需考慮流體動力相似，以便規劃實驗條件來測量阻力與速度之關係。
- (a) 若只考慮相對速度、流體密度、流體黏滯性、物體之尺寸、阻力、重力等物理量，請將此問題作因次分析。(10%)
- (b) 寫出 Froude number 的定義並解釋其物理意義，包括為何此問題中必須考慮此數，最後計算此實船的 Froude number。(3%+3%)
- (c) 若實驗條件要使模型與實船的 Froude number 相等，實驗速度應為多少？(3%)在此速度下的模型之 Reynolds number 又為多少？能否與實船相同？因此是否滿足動力相似？(5%)
- (d) 計算在模型船後 40 公分處外殼的層流邊界層厚度（假設為層流邊界層）。(3%) 此假設是否合理？為什麼？(3%)