UNIVERSITY OF MALAYA

Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE : NMB21203
SUBJECT TITLE : FLUID MECHANICS 1
LEVEL : BACHELOR
TIME / DURATION : 9.00 AM – 12.00 PM (3.0 HOURS)
DATE : 30 DECEMBER 2014

INSTRUCTIONS TO CANDIDATES

1. This is an OPEN BOOK Examination. Only ONE (1) main reference text book are allowed.
2. Please read the instructions given in the question paper CAREFULLY.
3. This question paper is printed on both sides of the paper.
4. Please write your answers on the answer booklet provided.
5. Answer should be written in blue or black ink except for sketching, graphic and illustration.
6. This question paper consists of 5 questions. Choose and answer four (4) questions only.
7. Answer all questions in English.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.
Question 1

a) Saturated refrigerant-134a liquid at 10°C is cooled to 0°C at constant pressure. Using coefficient of volume expansion data, determine the change in the density of the refrigerant.

(7 marks)

b) Carbon dioxide enters an adiabatic nozzle at 1200 K with a velocity of 50 m s⁻¹ and leaves at 400 K. Assuming constant specific heats at room temperature, determine the Mach number

i. at the inlet

(6 marks)

ii. at the exit of the nozzle

(12 marks)
Question 2

a) The pressure of water flowing through a pipe is measured by the arrangement, as shown in Figure 1 below. For the values given, calculate the pressure in the pipe.

![Figure 1](image1.png)

Figure 1

(10 marks)

b) The two sides of a V-shaped water trough are hinged to each other at bottom where they meet, with a width of 3 m, as shown in Figure 2 below. The two parts are held together by a cable and turnbuckle. Calculate the tension in each cable when the trough is filled to the rim.

![Figure 2](image2.png)

Figure 2

(15 marks)
Question 3

a) Electric power is to be generated by installing a hydraulic turbine-generator at a site 110 m below the free surface of a large water reservoir, as shown in Figure 3 below that can supply water steadily at a rate of 900 kg/s. If the mechanical power output of the turbine is 800 kW and the electric power generation is 750 kW, determine the turbine efficiency and the combined turbine generator efficiency of this plant. Neglect loss in the pipes.

![Figure 3](image)

(b) The air velocity in the duct of a heating system is to be measured by a Pitot-static probe inserted into the duct parallel to the flow, as shown in Figure 4. The air temperature and pressure in the duct are 45°C and 98 kPa respectively. If the differential height between the water columns connected to the two outlets of the probe is 2.4 cm, determine the pressure rise at the tip of the probe, and the flow velocity.

![Figure 4](image)
Question 4

a) A student team is to design a human-powered submarine for a design competition. The overall length of the prototype submarine is 4.85 m, and its student designer’s hope that it can travel fully submerged through water at \(0.44 \text{ ms}^{-1}\). The water is freshwater (a lake) at \(T = 15^\circ\text{C}\). The design team builds a one-fifth scale model to test in their university’s wind tunnel, as shown in Figure 5 below. A shield surrounds the drag balance strut so that the aerodynamic drag of the strut itself does not influence the measured drag. The air in the wind tunnel is at \(25^\circ\text{C}\) and at one standard atmosphere pressure. Determine at what air speed do they need to run the wind tunnel in order to achieve similarity?

b) Repeat Question 4 (a) as above, with all the same conditions except that the only facility available to the students is a much smaller wind tunnel. Their model submarine is a one-twenty-fourth scale model instead of a one-fifth scale model. Determine at what air speed do they need to run the wind tunnel in order to achieve similarity?
Question 5

The conical container with a thin horizontal tube attached at the bottom, as shown in Figure 6 below, is to be used to measure the viscosity of oil. The flow through the tube is laminar. The discharge time needed for the oil level to drop from $h_1$ to $h_2$ is to be measured by a stopwatch. Develop an expression for the viscosity of oil in the container as a function of discharge time $t$.

![Figure 6](image-url)

(25 marks)

- END OF QUESTION -