UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF ENGINEERING TECHNOLOGY *: INDUSTRIAL*
SUBJECT	:	**SUBJECT: THERMOFLUIDS 1B**
CODE	:	**THFMIB1**
DATE	:	SUMMER EXAMINATION 21 NOVEMBER 2017
DURATION	:	(SESSION 1) 12:30 - 15:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100
ASSESSOR	:	ASSESSOR: DR. D. KALLON
MODERATOR	:	MODERATOR: E. BAKAYA-KYAHURWAFILE NO: 2203
NUMBER OF PAGES	:	PAGES: 5 excluding the cover page plus Annexure A and B.
INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

1. This paper contains 5 questions
2. PLEASE ANSWER **ALL** QUESTIONS
3. Make sure that you understand what the question requires before attempting it.
4. Any additional examination material is to be placed in the answer book and must indicate clearly the question number, and Student number.
5. Draw proper sketches where required with all relevant information
   Answers without calculations will not be considered.
   Answers without units will not be considered.
   All answers to be to the 4th decimal point.
   Number all answer according to the numbering in question paper.

REQUIREMENTS : Steam Property Tables; simple scientific calculators.

SECTION ONE: THOERY

QUESTION 1: THEORY QUESTIONS [20 MARKS]

1.1 Explain what is meant by flow energy in relation to control volumes. (2)

1.2 For a body immersed into a fluid define its resultant force and center of pressure. (4)

1.3 Using the Bernoulli equation for fluid flow define pressure head, velocity head and elevation head (3)

1.4 What are the forms of energy that contribute to the internal energy of a system? (4)

1.5 Define the Triple-point of a pure substance. (1)

1.6 Draw the T-v diagram to show the following:
- i) Compressed liquid region. (1)
- ii) Superheated vapor region. (1)
- iii) Saturated liquid-vapor region (1)
- iv) Critical point. (1)
- v) Saturated liquid line. (1)
- vi) Saturated vapor line. (1)

SECTION TWO: FLUID MECHANICS

QUESTION 2: HYDROSTATIC FORCES ON SUBMERGED BODIES [20 MARKS]

A retaining wall against a mud slide is to be constructed by placing 1.2m-high and 0.25m-wide rectangular concrete blocks (with density = 2700 kg/m^3) side by side, as shown in figure 1. The friction coefficient between the ground and the concrete blocks is $f = 0.3$, and the density of the mud is about 1800 kg/m^3. There is concern that the concrete blocks may slide or tip over the lower left edge at point A as the mud level rises. Determine the mud height at which:

2.1 The blocks will overcome friction and start sliding. (14)

1.2 The blocks will tip over. (6)

3/...

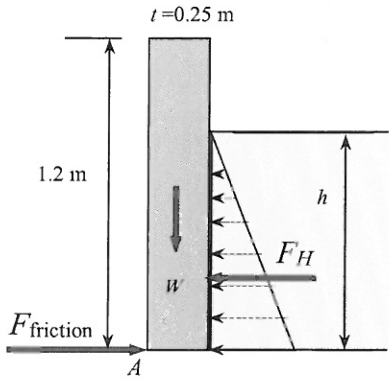

Figure 1

Use following unit conversion factor: $\left(\frac{1\,N}{1kg.m/s^2}\right)$

QUESTION 3: BERNOULLI EQUATION **[20 MARKS]**

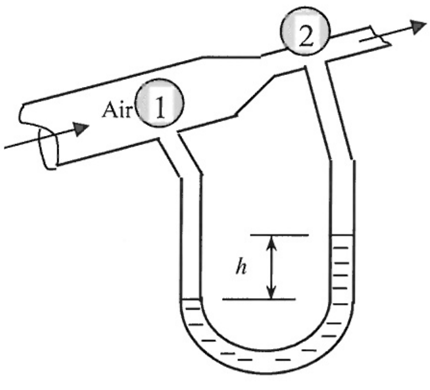

Figure 2

Air at 110 kPa and 50 °C flows upward through a 6 cm-diameter inclined duct at a rate of 0.045 m^3/s. The duct diameter is then reduced to 4 cm through a reducer, as shown in figure 2. The pressure change across the reducer is measured by a water manometer. The elevation difference between the two points on the pipe where the two arms of the manometer are attached is 0.20 m. Determine the differential height between fluid levels of the two arms of the manometer. (20)

Take the gas constant of air to be R = 0.287 KJ/kg·K and use the following unit conversion factor:

$$\left(\frac{1\,N}{1kg.m/s^2}\right)$$

SECTION THREE: THERMODYNAMICS

QUESTION 4: THE FIRST LAW OF THERMODYNAMICS **[20 MARKS]**

An isolated cylinder with a volume of 0.1 m^3 is filled with air at 25 °C such that the air receives no heat from the surroundings, see figure 3. A paddle wheel inserted into the cylinder is used to stir the air thereby doing work of 28 kJ on the air at a constant pressure of 400 kPa. If the air does 13 kJ of work on its surroundings in expansion, determine the final temperature. (20)

[Hints: Use table A-1 for the gas constant of air, table A-2 for the specific heat capacity of air and table A-17 for the ideal gas properties of air]

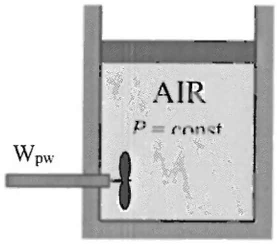

Figure 3

Use following unit conversion factor: $\left(\frac{1\,N}{1 kg.m/s^2}\right)$

QUESTION 5: PROPERTIES OF PURE SUBSTANCES **[20 MARKS]**

It is desired to examine the ideal gas assumption of superheated steam. Figure 4 shows 2.841 kg of superheated steam at a pressure of 0.6 MPa contained in a tank of 1 m^3 volume. Determine the temperature of the superheated steam using:

- *(i)* The ideal gas relation (9)
- *(ii)* The van de Waal equation, (7)
- *(iii)* Steam tables (use table A-6) (2)
- *(iv)* Give reason(s) for any differences in the results from the three approaches. (2)

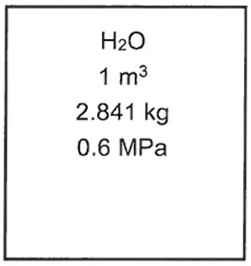

Figure 4

TOTAL = 100