NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Two Examination January 2008

TCE2105 Fluid Flow

Duration of Examination 3 Hours

Instructions to Candidates:
Answer ALL FIVE questions.
Each question carries equal marks.
Show all steps clearly in your calculation.
Start the answers for each question on a new page.

1.

(a) A differential "U"-tube manometer containing mercury of density 13000 kg/m^3 is used to measure the pressure drop along a horizontal pipe. If the fluid in the pipe is water and the manometer reading is 0.6 m what is the pressure difference between the two tapping points. (8 marks)
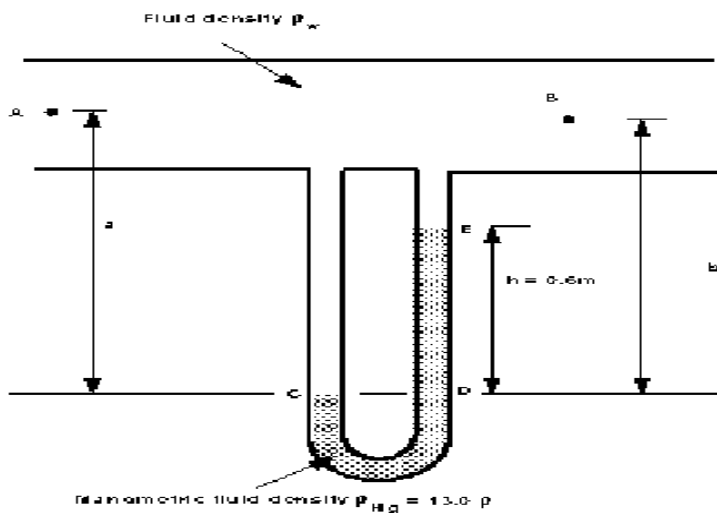

(b) Describe the following phenomenon and explain why they occur:

i.   The boundary layer;   (3 marks)
ii. Boundary layer separation;   (3 marks)
iii. Boundary layer separation at a T-junction;   (3 marks)
iv. The laminar sub-layer.   (3 marks)

2.

 Two vertical cylindrical tanks of *3m* and *2m* diameter containing water are joined at their bases by a pipe of diameter *0.05m*. This pipe is short enough to be treated as an orifice with a coefficient of discharge of *0.58*.

The *3 m* tank initially has a level *2 m* higher than the other, calculate how long it will take for the level difference to half.

Area A_1

Area A_2

h_1

h_2
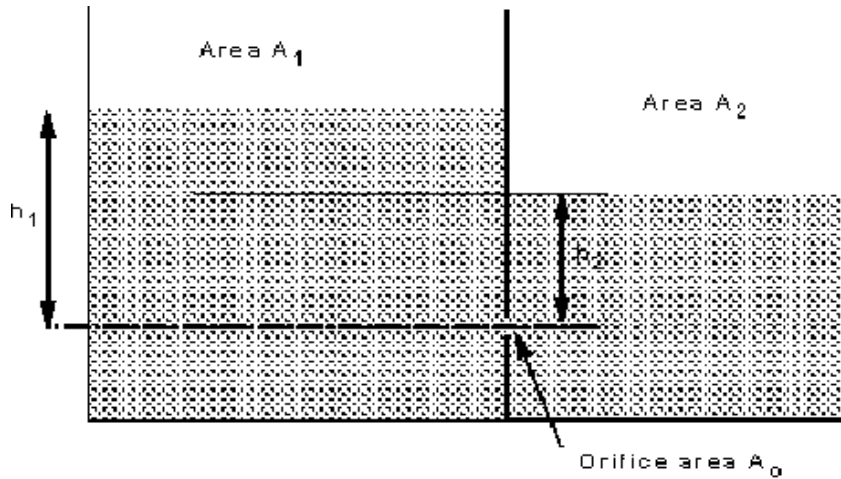
Orifice area A_o (20 marks)

3.

a) *600 cm³/s* of water at *320 K* is pumped in a *40 mm i.d.* pipe through a length of *150 m* in a horizontal direction and up through a vertical height of *10 m*. In the pipe there is a control valve which may be taken as equivalent to *200 pipe diameters* and other pipe fittings equivalent to *60 pipe diameters*. Also in the line there is a heat exchanger across which there is a loss in head of *1.5 m of water*. If the main pipe has a roughness of *0.0002m*, what power must be delivered to the pump if the unit is *60 %* efficient?

Take: $R/\rho u^2 = 0.0042$ (15 marks)

 b) The advantages and disadvantages of reciprocating pumps in general over centrifugal pumps.   (5 marks)

4.

The outlet pipe from a pump is a bend of 45 rising in the vertical plane (i.e. and internal angle of 135). The bend is 150mm diameter at its inlet and 300mm diameter at its outlet. The pipe axis at the inlet is horizontal and at the outlet it is 1m higher. By neglecting friction, calculate the force and its direction if the inlet pressure is 100kN/m² and the flow of water through the pipe is 0.3m³/s. The volume of the pipe

is 0.075m³.
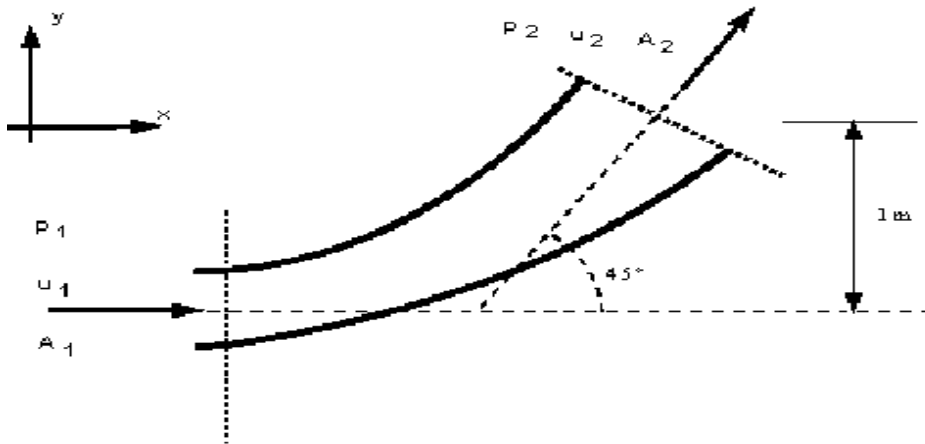
(20 marks)

5.
(a) A Venturimeter of throat diameter *0.076m* is fitted in a *0.152m* diameter vertical pipe in which liquid of relative density *0.8* flows downwards. Pressure gauges are fitted to the inlet and to the throat sections. The throat being *0.914m* below the inlet. Taking the coefficient of the meter as *0.97* find the discharge
a) when the pressure gauges read the same b) when the inlet gauge reads *15170 N/m²* higher than the throat gauge.

$d_1 = 0.152 \, m$

$d_1 = 0.076 \, m$
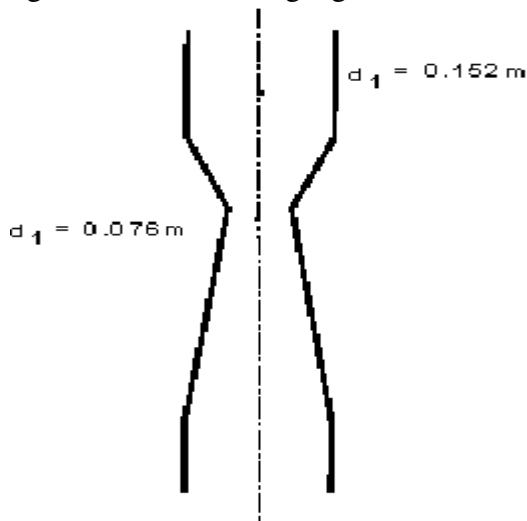
(15 marks)

(b) Describe some uses for dimensional analysis. Your explanation should include the meanings and relevance of the terms *geometric similarity, dynamic similarity* and *kinematic similarity.*   (5 marks)
(requires at least 5 lines per description)