

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Two Examination December 2006

TCE2105 Fluid Flow

Duration of Examination 3 Hours

Instructions to Candidates:

1. Answer ALL FIVE questions.
2. Each question carries equal marks.
3. Show all steps clearly in your calculation.
4. Start the answers for each question on a new page.

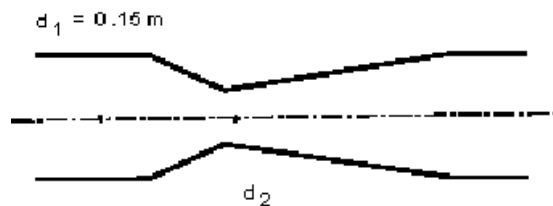
1. a) What would the pressure in kN/m^2 be if the equivalent head is measured as 400mm of (a) mercury $\gamma=13.6$ (b) water (c) oil specific weight 7.9 kN/m^3 (d) a liquid of density 520 kg/m^3 ? **(6 marks)**

b) Define the following terms in connection with the flow of a liquid (a minimum of three lines per description is required – preferably more with simple examples):

- i. Uniform flow
- ii. Steady flow
- iii. Unsteady flow
- iv. Mean velocity
- v. Discharge
- vi. Mass flow rate
- vii. Continuity

(14 marks)

2. A Venturi meter is to be fitted in a horizontal pipe of 0.15m diameter to measure a flow of water which may be anything up to $240 \text{ m}^3/\text{hour}$. The pressure head at the inlet for this flow is 18m above atmospheric and the pressure head at the throat must not be lower than 7m below atmospheric. Between the inlet and the throat there is an estimated frictional loss of 10% of the difference in pressure head between these points. Calculate the minimum allowable diameter for the throat.



(15 marks)

b) Explain why the velocity measured by the pitot tube is higher than that measured by the venturi meter. **(5 marks)**

3. a) Use the Bernoulli equation to show that the relationship between flow and depth over a sharp-edged triangular weir is given by $Q = C_d \frac{8}{15} \tan \frac{\theta}{2} \sqrt{2gH^{5/2}}$

(10 marks)

b) A rectangular weir and a V-notch weir are located in parallel channels of the same dimensions. Both weirs have an opening 0.3 m wide at the top and 0.3 m deep. Both have a C_d of 0.6. What head would be required over the rectangular weir to pass the same flow as over the V-notch weir when it has a head of 0.29 m?

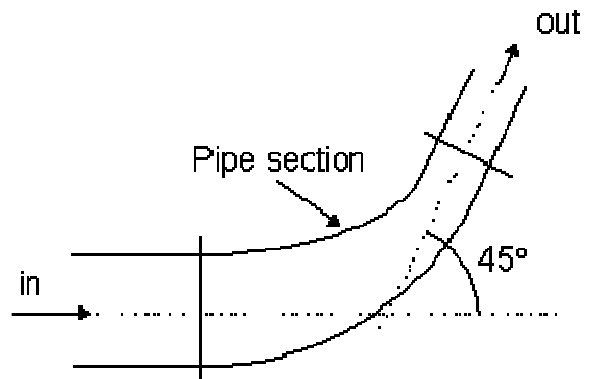
(For a rectangular weir $Q = C_d \frac{2}{3} b \sqrt{2gH^{3/2}}$) **(10 marks)**

4. a) A pipeline carries water around a horizontal 45° bend. The entrance diameter of the bend is 500mm and the velocity of flow is 1 m/s. The bend tapers gradually to 200 mm diameter at its exit. If the pressure just upstream of the entrance is measured at 200 k N/m^2 , what is the force, and its line of action, exerted by the water on the bend?

(17 marks)

b) Comment on the reason why frictional losses may be neglected in this analysis.

(3 marks)



5. a) Calculate the power required to pump oil of specific gravity 0.85 and viscosity 3 mN s/m^2 at $4000 \text{ cm}^3/\text{s}$ through a 50 mm pipeline 100 m long, the outlet of which is 15 m higher than the inlet. The efficiency of the pump is 50%.

Take: $e = 0.05$, $e/d = 0.001$, $R/\rho u^2 = 0.0031$

(12 marks)

b) State factors that influence the choice of pump for a particular operation

(8 marks)