NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Two Examination December 2005

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.

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1. a) 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)

   b) Oil flows in a pipe which contracts from 450mm diameter at point A to 300mm at point B then splits into to branches of diameters 150mm and 225mm discharging at C and D respectively.
   If the velocity at A is 1.8m/s and the velocity at D is 3.6 m/s, what is the discharge at C and D and the velocity at B and C? (3 marks)

   c) If point A is 10m higher than point B and the pressure at A is 10 kN/m^2, what is the pressure at point B? (3 marks)

2. Explain with a complete description of the mechanisms at work, what is meant by the following phrases.
   a. Laminar flow (5 marks)
   b. Turbulent flow (5 marks)
   c. Boundary layer (5 marks)
   d. Boundary layer separation (5 marks)

3. a) Where does most of the energy loss occur in a Venturi meter and why is this the case? (8 marks)

b) A Venturi meter is being calibrated in a laboratory. The meter is lying horizontally and has a diameter of 75mm at the entrance and 50mm at the throat. The flow rate is obtained by measuring the time required to collect a certain quantity of water. The average number of such measurements gives 0.614 m^3 of water flowing in 55.82 seconds. If the pressure gauge at the throat reads 20 kN/m^2 less than at the entrance, calculate the head loss due to friction using the Bernoulli equation. (12 marks)

4. a) Water flows at a rate of 0.5m^3/s round a 50˚ contracting pipe bend which lies in a horizontal plane. The diameter at the bend entrance is 700mm and at the exit 500mm as shown in Figure 1.

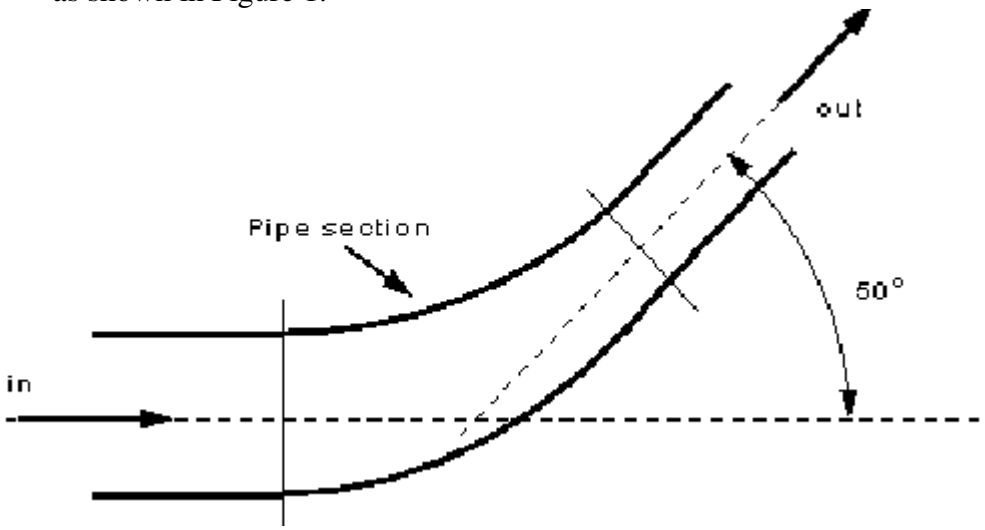

Figure 1.

If the pressure at the entrance to the bend is 200 kN/m^2 determine the magnitude and direction of the force exerted by the fluid on the bend. (17 marks)

b) Comment on the reason why frictional losses may be neglected in this analysis. (3 marks)

5. a) 75% sulphuric acid, of density 1650 kg/m^3 and viscosity 8.6 $mN.s/m^2$, is to be pumped for 0.8 km along a 50mm internal diameter pipe at the rate of 3.0 kg/s, and then raised vertically 15m by the pump. If the pump is electrically driven and has an efficiency of 50%, what is the power required? What type of pump would you use and of what material would you construct the pump and pipe? Take $R/\rho u^2 = 0.004$ (e = 0.046mm) where R is the resistance to flow per unit area of pipe surface. (15 marks)

b) Describe how an air lift pump works. (5 marks)