# UNIVERSITY OF BOLTON

## SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING

## BSc (HONS) CIVIL ENGINEERING

## SEMESTER TWO EXAMINATION 2010/2011

## HYDRAULICS

## MODULE NO: BLT 1008

**Date: Friday 3 June 2011** **Time: 2.00 pm – 4.00 pm**

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**INSTRUCTIONS TO CANDIDATES:**

**There are FOUR questions.**

**Answer THREE questions.**

**All questions carry equal marks.**

**Marks for parts of questions are shown in brackets.**

**A formula sheet is provided.**

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Semester Two Examination 2010/2011
Hydraulics
Module No: BLT1008

Q1. a) Briefly explain how water pressure varies with depth. If the pressure in a water main is 2 bar, determine the pressure head in metres.

(3+3 marks)

b) For the measurement system shown in figure Q1b below, the pipeline fluid is Brine and the manometric fluid is Mercury. If the densities of brine and mercury are 1100kg/m$^3$ and 13600 kg/m$^3$ respectively, find the pressure at Y.

(7 marks)

c) A rectangular plate 1.4m x 3.2m is submerged in water and makes an angle of 40° with the horizontal, the 1.4m sides being horizontal as shown in figure Q1c, below. If the top edge of the plate is 2.5 m below the water surface, calculate the magnitude of the force on the plate and the location of the point of force application, with reference to its top edge.

(5+7 marks)

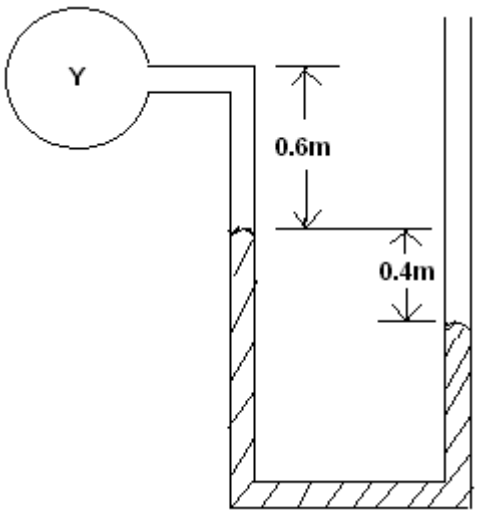


**Figure Q1 b**

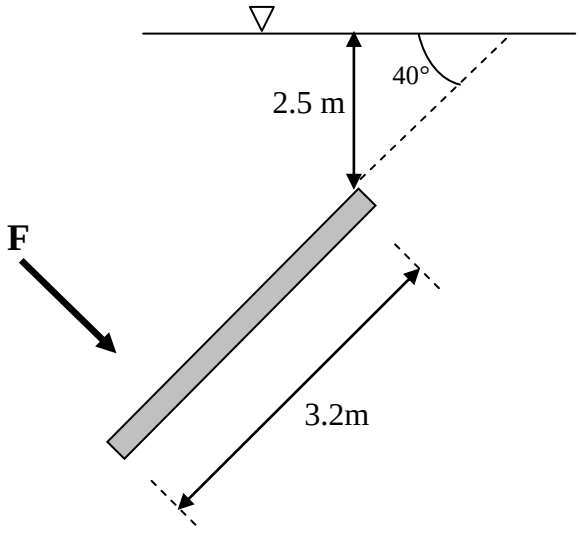


**Figure Q1 c**

**Total 25 marks**

**Please turn the page**

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Q2. a) i) What are the three basic equations that are commonly used in the analysis of Fluid Flow?

(3 marks)

ii) A 200mm diameter pipeline divides into two smaller pipelines, one being 100mm in diameter and the other being 150mm in diameter. If the velocity in the 100mm pipe is 0.3m/s and that in the 150mm pipe is 0.6m/s, calculate the flowrate in litres/s and the velocity in m/s in the 200mm pipe.

(5+4 marks)

b) A tapered section in horizontal pipeline carrying water reduces diameter from 450mm to 300mm in the direction of flow. The flow rate within the pipeline is 400l/s and the upstream pressure is 200kN/$m^2$. Ignoring the energy losses, calculate:

i) The downstream pressure

(8 marks)

ii) The magnitude and direction of force on the taper

(5 marks)

**Total 25 marks**

**Please turn the page**

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Q3. a) Briefly explain the difference between laminar and turbulent flow in a pipeline. In a given situation, explain how to predict whether the type of flow occurring is laminar or turbulent.

(5 marks)

b) Water is discharged from a tank into the atmosphere through a pipe 800m long. There is a sharp entrance to the pipe and the diameter is 200mm for 450m from the entrance. The pipe then enlarges suddenly to 400mm in diameter for the remainder of its length. A valve in the 200mm pipe has a $k_L$ = 1.5 when fully open. In order to maintain a flowrate of 150 l/s,

i) Calculate the required difference of level between the surface of the reservoir and the pipe exit.

(10 marks)

ii) Tabulate the energy head losses in this system.

(5 marks)

iii) Sketch the Total Energy and Hydraulic Grade Lines.

(5 marks)

Take Darcy's friction factor, λ as 0.02 for the 75mm pipe and 0.025 for the 100mm pipe.

**Total 25 marks**

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4. a) Explain the term 'steady uniform flow' as applied to flow in a rectangular open channel.

(5 marks)

b) Determine the flowrate in a 3.2 m wide rectangular channel when the uniform depth of flow is 0.75 m, the Chezy C value is 50 and the channel bed slope is 1 in 400.

(6 marks)

c) A trapezoidal channel has a Manning coefficient of 0.022 and side slopes of 1 vertical = 2 horizontal. When the steady uniform flowrate is 4.2 $m^3/s$, the depth of flow is 1.5 m and the mean velocity of flow is 0.6 m/s. Determine

(i) The horizontal base width of the channel. (8 marks)
(ii) The gradient of the channel bed. (6 marks)

**Total 25 marks**

**END OF QUESTIONS**

**Please turn the page**

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FORMULAE SHEET

$p = \rho g h$

$F = \rho g \bar{h} A$

$$x_P = \bar{x} + \frac{I_{CG}}{A\bar{x}} \qquad (I_{CG})_{rectangular} = \frac{bd^3}{12}$$

$Q = A_1 v_1 = A_2 v_2$

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \text{energy losses}$$

$$\frac{h_f}{L} = S_o \qquad h_f = \frac{\lambda L v^2}{2gd} = \frac{\lambda L Q^2}{12.1 d^5}$$

$$R_e = \frac{\rho v d}{\mu}$$

$$R = \frac{A}{P} \qquad Q = AC\sqrt{RS_o} \qquad Q = \frac{A}{n} . R^{2/3} S_o^{1/2}$$

$$H_{L\,entry} = K_L \frac{v^2}{2g} \qquad K_{L_{entry}} = 0.5$$

$$h_{L_{expansion}} = \frac{(v_1 - v_2)^2}{2g}$$