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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology IIonours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX3532 Hydraulics and Hydrology**
Academic Year	: 2017/18
Date	: 07th February, 2019
Time	: 0930-1230 hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions
2. This question paper consists of **Eight (8)** questions in **Seven (7)** pages
3. Answer ALL QUESTIONS in SECTION A and TWO (2) questions from SECTION B. All questions carry equal marks
4. Answer for each question should commence on a new page
5. Relevant charts/ codes are provided
6. This is a Closed Book Test (CBT)
7. Answers should be in clear hand writing
8. Do not use a red pen

PART A

Answer **all three** questions

1) A pipe with circular cross-section has a smooth change of diameter from 5 cm to 2.5 cm between points A and B, as shown in Figure 1. As the change in diameter is smooth it can be assumed that there are NO ENERGY LOSSES when water flows from A to B.

Simple water manometers are connected at A and B. The water levels in these manometers are h_A and h_B, respectively. These levels are NOT KNOWN. When water (density 1000 kg/m^3) flows steadily in the pipe from A to B at a discharge of 1 litres/second it is found that the force on the pipe section is 4 N in the direction of the flow.

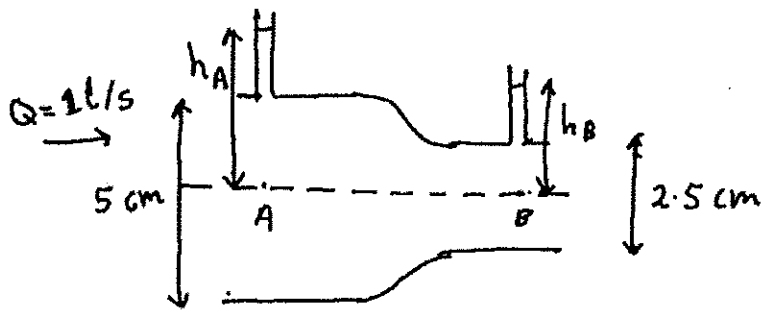

Figure 1

a) Use the Bernoulli Equation to calculate the quantity $(h_A - h_B)$.

b) Apply the principal of conservation of momentum to a fluid control volume between A and B and obtain another relationship between h_A and h_B.

c) Calculate the values h_A and h_B from your results in sections a) and b).

2) a) State Newton's law of viscosity as an equation and identify all the variables in the equation.

b) What are the dimension and the SI unit of the coefficient of dynamic viscosity .

c) The equation $\mathbf{f = 64/Re}$ is used for laminar flow in a pipe of circular cross-section. Show that the head loss between two points along the pipe is proportional to the average velocity in the pipe under these conditions.

d) Sketch the Moody diagram. Identify and define the variables on the two axes of the diagram. Label the main sections of the diagram.

e) Water flows in a long uniform pipeline of diameter $\mathbf{d}$. The head loss between two points spaced a distance $\mathbf{L}$ apart is found to be $\mathbf{H}$. The density of water is ρ and the dynamic viscosity of water is μ . Explain how you would use these values and the Moody diagram to calculate the discharge in the pipeline.

3) Water is discharged from a large tank to the atmosphere through a pipeline ABCDEF, as shown in Figure 3. The pipes AB, BC, DE and EF have a diameter of 2 cm , while the pipe CD has a diameter of 1 cm.

Neglect all energy losses in the system.

a) Explain why this flow can be assumed to be steady.

b) Sketch, on graphs placed one above the other, the variation of Elevation Head, Velocity Head, Pressure Head and Total Head from O, a point on the free surface of the tank, past A, B, C, D and E, to the atmosphere at F.

c) Calculate the discharge in the pipeline.

d) Calculate the lowest pressure in the pipeline.

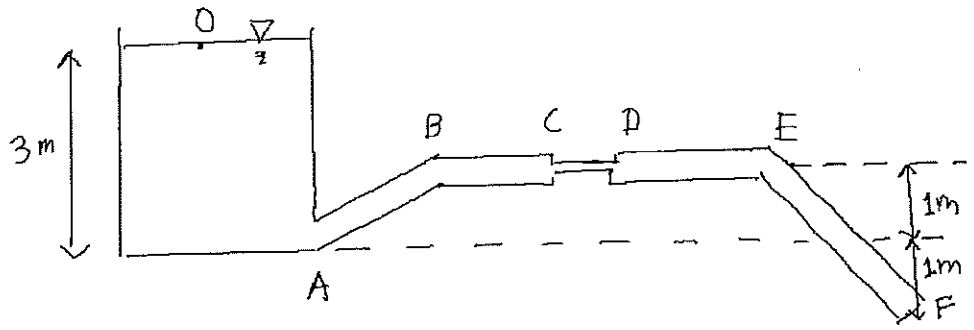

Figure 3

PART B

Answer **any two** questions

4) Many areas of Colombo are drained by the canal that passes the Open University. The catchment area of the canal at Narahenpita is approximately 75 km^2 .

A heavy storm causes a rainfall of 150 mm over Colombo in four hours beginning at 0600 on the 1st of September. Due to this rainfall the discharge in the canal at Narahenpita varied linearly from 1 m^3/s at 0600 to a maximum value at 1200. The discharge then decreased linearly to 50% of this maximum value by 2400 on the 1st and then decreased linearly back to 1 m^3/s by 2400 on the 3rd (66 hours after the start of the storm).

a) Explain what is meant by term "catchment area".

b) Define the runoff coefficient.

c) Sketch the hydrograph and mark the peak flow and the base flow.

d) Calculate the total volume of precipitation in this catchment due to this storm.

e) Assuming an average runoff coefficient of 0.85 for this catchment, calculate the peak discharge in the canal.

f) If the same storm takes place 10 years in the future (2023) what differences would you expect to see in the flood hydograph? Explain your answer with a sketch.

5) a) What is meant by the word "calibration"? Your answer should be relevant to the laboratory class entitled "Flow Measurement".

b) Explain how the procedure followed in the laboratory class entitled "Flow Measurement" is related to your answer in section a). Your answer should consider EACH the instruments studied in this class SEPARATELY.

c) Why is it necessary to calibrate a venturimeter?

d) Show, beginning from the principles of conservation and energy, that the Coefficient of Discharge for a venturimeter is always less than 1 .

6) A student measures the force exerted by a jet of water on a conical target. The student uses the arrangement shown in Figure 6, where the target is directly above a pipe. The half-angle of the target is θ , as shown in the figure.

a) Derive, beginning from the basic principles of hydraulics, a theoretical equation for the force **F** exerted by the jet on the target in terms of ρ the density of water, **Q** the discharge of the jet and **A** the cross-sectional area of the jet.

b) List the assumptions that you have made in section a) and identify the points in your derivation where these assumptions have been used.

c) For each assumption listed in section b), discuss whether the assumption will result in the force calculated by the theoretical equation being greater than or less than the actual force on the target.

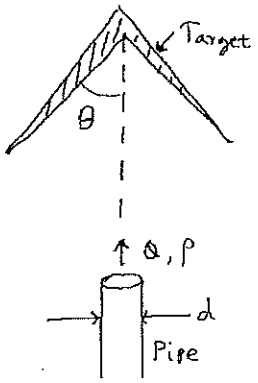

Figure 6

7) a) Explain how you would estimate the Manning's coefficient of a laboratory open channel. Your answer should include the following

i) A neat, labeled diagram of the apparatus used.
ii) The procedure to be followed
iii) A list of the measurements to be made
iv) The calculations to be made using these measurements

b) The flow should meet certain special conditions before measurements are made.

i) What are these special conditions?
ii) Why should these special conditions be met?

c) Discuss the practical difficulties that you may encounter while you make these measurements.

d) Explain the practical importance of knowing the Manning's coefficient.