

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



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Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: CVX3340 – Introduction to Hydraulics and Hydrology
Academic Year	: 2022/2023
Date	: 2024.02.16
Time	: 1400 – 1700

General Instructions

1. This is a Closed Book Test (CBT).
2. There are 5 questions on 6 pages (including this page)
3. Read all instructions carefully before answering the questions.
4. Answer all FIVE (05) questions.
5. All questions are allotted equal marks.
6. The marks for each section (a), b), etc) of a question is given as a percentage of the total mark for the question at the end of each section.
7. Use the following values : Density of water 1000 kg/m^3 , Acceleration due to gravity 9.81 m/s^2

- 1) a) Explain, using a neat figure, how a domestic water meter works. (20%)
- b) Discuss the differences between the domestic water meter and instruments such as the Venturimeter and the Orifice Meter that you studied in the laboratory class. (10%)
- c) What was the least count of the water meter you studied in Learning Activity 1? (5%)
- d) The quantity of water supplied is measured in Units. What is the volume of 1 Unit of water? (5%)
- e) What is the lowest tariff (rate) for 1 Unit of water for domestic consumers? (5%)

A spherical tank has a radius of 0.5 m. The tank is empty at time $t = 0$. At time $t = 0$ the tank is filled at a constant rate of 2 litres/second.

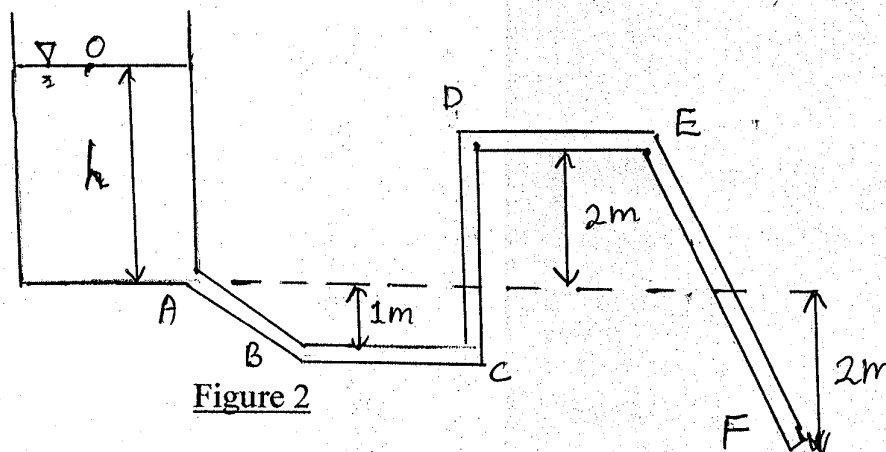
- f) Calculate the time, t_r , taken to fill the tank. (10%)
- g) Sketch a graph of the variation of the depth of water in the tank, $h(t)$, with time, t . (15%)
- h) Explain the following aspects of your answer using the principle of Conservation of Mass for a Control Volume. (30%)
 - i) The slope of the line at the time $t = 0$
 - ii) The slope of the line at the time $t = t_r$
 - iii) The slope of the line at the time $t = t_r/2$

2) An open tank, X, discharges water to the atmosphere through a pipeline ABCDEF, as shown in Figure 2. All the pipes have a diameter of **2 cm**. Point O is on the free surface of the tank. The cross-sectional area of the tank is much greater than the cross-sectional area of the pipes.

The elevation of B is **1 m below the bottom** of the tank while the elevation of D is **2 m above the bottom** of the tank, as shown in the figure. The pipes BC and DE are horizontal, while the pipe CD is vertical. The elevation of point F, where the water is discharged to the atmosphere, is **2 m below the bottom** of the tank.

At the time $t = 0$ the water level in the tank is **h m** and there is a steady discharge of **3 litres per second** through the pipeline.

- State the Bernoulli Theorem. (10%)
- List the four conditions that should be satisfied to use the Bernoulli Theorem. (10%)
- Calculate the height of water, **h** , in the tank at the time $t = 0$. Neglect all energy losses. (20%)
- For the value $t = 0$, sketch, on graphs placed one above the other, the variation of the Elevation Head, Velocity Head, Pressure Head and Total Head from O through A, B, C, D and E, to F. Identify your datum for the elevation. (30%)
- Calculate the lowest pressure in the pipeline at the time $t = 0$. (15%)
- Sketch the variation of the water level in the tank with time. Explain your answer. (15%)



3) A pipe bend ABC is shown in Figure 3. The section AB is horizontal while the section BC is vertical. The pipe diameter changes from 2 cm at A to 5 cm at C. A simple water manometer is connected at A.

When water flows steadily through this pipe bend the horizontal force on the pipe bend ABC is found to be 0.5 N to the right. The water level in the manometer is found to be 10 cm above the centreline of the pipe, as shown in the figure.

a) State the Principle of Conservation of Momentum for a Control Volume as a sentence. (10%)

b) Is the direction of the flow from A to C or C to A? Explain your answer using the Principle of Conservation of Momentum and neat diagrams. (20%)

c) Calculate the discharge through the pipe bend. Explain your answer. (35%)

d) Calculate the vertical force on the pipe bend at this discharge. Assume that there are no energy losses in the flow. (35%)

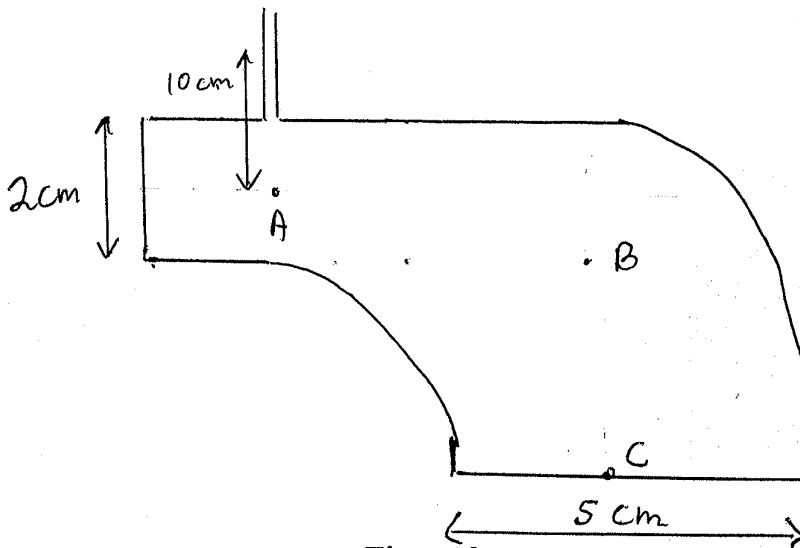


Figure 3

4) A student plans to use the pipe section ABC, shown in Figure 4, as an instrument to measure the discharge of water in a pipeline. The section ABC consists of an expansion section AB where the pipe diameter increases to a maximum at B and a contraction section BC where the pipe diameter decreases to the original diameter at C.

The student plans to attach simple water manometer tubes at A and B as shown in the figure and obtain the discharge by measuring the difference in the water levels in these tubes.

a) Explain what is meant by the term “calibration” with respect to measuring instruments. (20%)

b) Which manometer tube will have a higher level when water flows through this instrument? Explain your answer. (20%)

c) Obtain a relationship between the difference in the manometer levels and the discharge through the instrument. State all your assumptions and explain your answer. (40%)

d) Propose, with explanations, how you would improve the design of this instrument. (20%)

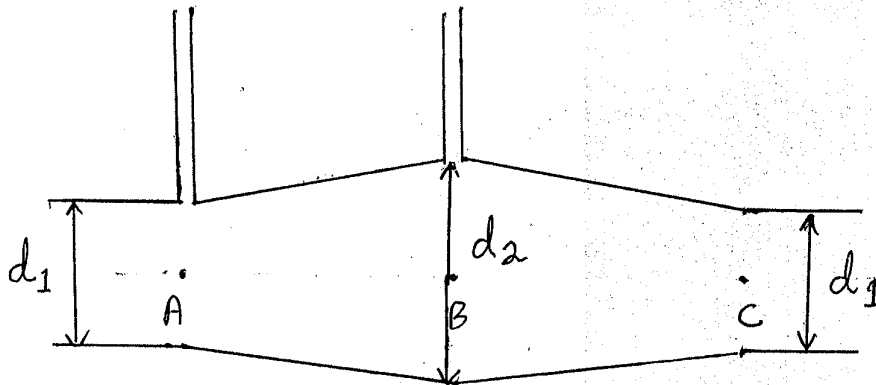


Figure 4

5) a) Explain, using sketches of the inflow and outflow hydrographs on the same graph, the impact of a reservoir on a flood hydrograph. (25%)

The discharge of a river at a certain location was measured over 10 hours and the results are given in Table 5. The value at $t = 3$ hours could not be measured due to practical difficulties. However, the total volume that flowed past the measurement location was estimated to be **225,000 m³** using information from a reservoir downstream.

Time (hours)	0	1	2	3	4	5	6	7	8	9	10
Discharge (m ³ /s)	1	3	9	?	11	8	6	4	3	2	1

Table 5

b) Estimate the discharge at the time $t = 3$ hours. (30%)

c) If the catchment area is **7.5 km²** and has a runoff coefficient of **0.7** estimate the average rainfall over the catchment during this 10 hour period. State all your assumptions. (20%)

d) Explain, using neat sketches, what is meant by the term “confined aquifer” and how a confined aquifer is recharged. (25%)