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



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : CVX3340 – Introduction to Hydraulics and Hydrology
Academic Year : 2023/24
Date : 10th February, 2026
Time : 1330 - 1630
Duration : 3 hours

General Instructions

1. This is a Closed Book Test (CBT).
 2. There are 5 questions on 4 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
 8. Please contact the Supervisor in case of any doubts
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1) Water flows out of a large tank, X, to the atmosphere through a pipeline ABCDE, as shown in Figure 1. All the pipes have a diameter of 2 cm and a length of 3 m. The last section, DE, is hinged at D so that the angle θ marked in Figure 1 can vary from 0 to 90 degrees.

Assume that the flow is steady and neglect all energy losses.

- State the Bernoulli equation and list the conditions required for it to be valid. (10%)
- Calculate the discharge through the pipeline when the angle $\theta = 30$ degrees as shown in Figure 1. Explain your answer (30%)
- When $\theta = 30$ degrees sketch, on graphs placed one above the other, the variation of the Elevation Head, the Velocity Head, the Pressure Head and the Total Head from O, which is a point on the free surface of the tank, through A, B, C, D to E. State the datum you have selected for the Elevation. (40%)
- Sketch the variation of the discharge through the pipeline when the angle θ varies from $\theta = 0$ degrees to $\theta = 90$ degrees. Explain your answer. (20%)

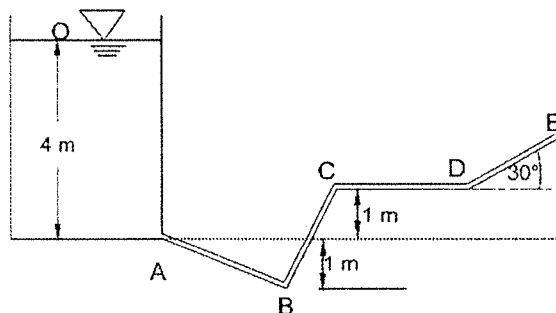


Figure 1

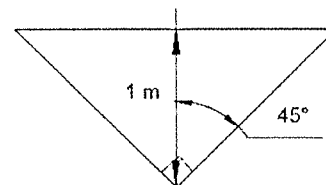


Figure 2

- Explain, using neat diagrams, how a positive displacement type domestic water meter works. (25%)

The cross-section of a conical water tank is shown in Figure 2. The tank is placed with its vertex at bottom. The tank has a half-angle of 45 degrees and the has a depth of 1 m, as shown in the figure.

The tank is empty at the time $t = 0$. From $t = 0$ the tank is filled with water with a variable discharge of Q litres/second, where Q is given by the equation

$$Q = 0.1t \text{ (litres/second)}$$

and t is the time in seconds.

(continued ...)

2) (..... continued)

b) State the equation of Conservation of Mass for a fluid Control Volume as an equation and identify the terms. (10%)

c) Calculate the time taken to fill the tank. (20%)

d) Use the principle of Conservation of Mass to derive an expression for the water level in the tank as a function of the time t . (30%)

e) Sketch the variation of the volume of water in the tank with time and the variation of the water level in the tank with time on the same graph. Explain your answer. (15%)

3) Water flows in a horizontal pipe of circular cross-section that has a contraction from a diameter of 5 cm at A to a diameter of 2 cm at B, as shown in Figure 3. Water flows steadily in this pipe with a discharge of 0.3 litres/second – but the direction of flow is not known.

Simple manometers open to the atmosphere are connected at A and B, and the water level in the manometer connected to A is 80 mm above the centreline of the pipe, while the water level in the manometer connected to B is 50 mm above the centreline of the pipe, as shown in the figure.

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

b) Calculate the Total Head at A and B. (20%)

c) In what direction is the water flowing? Explain your answer. (10%)

d) Calculate the magnitude and direction of the force on the pipe section AB due to this flow. Use a neat sketch to identify your Control Volume and mark the relevant forces and momentum fluxes. (60%)

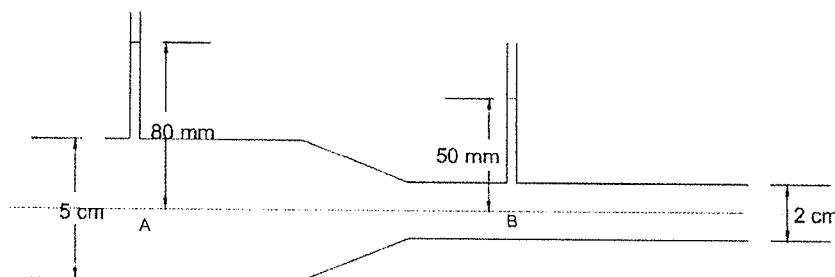


Figure 3

4) a) Draw neat sketches of the three targets used in the Impact of Jets laboratory class, showing how the water flows after the jet hits the target. (15%)

b) Derive an expression relating the force on the target, F , to the discharge of the jet, Q . State all your assumptions and explain clearly where each assumption is used in the derivation. (50%)

c) Sketch the graph of F against Q^2 that you obtained from your measurements for all three targets on the same graph. Explain the differences. (15%)

d) Use your observations of the flow over the targets and the assumptions made in the derivation to predict which target will give experimental results closest to the theoretical result. (20%)

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

A heavy storm causes an average 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 $1 \text{ m}^3/\text{s}$ 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 $1 \text{ m}^3/\text{s}$ by 2400 on the 3rd (66 hours after the start of the storm).

a) Explain what is meant by term “catchment area”. (5%)

b) Define the runoff coefficient. (5%)

c) Sketch the hydrograph and mark the peak flow and the base flow. (10%)

d) Calculate the total volume of precipitation in this catchment due to this storm. (10%)

e) Assuming an average runoff coefficient of 0.85 for this catchment, calculate the peak discharge in the canal. (40%)

f) If the same storm takes place 10 years in the future what differences would you expect to see in the flood hydrograph? Explain your answer with a sketch of the hydrograph today and the hydrograph you expect in the future. (30%)