

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



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : **DMX4203 Applied Fluid Dynamics I**
Academic Year : 2024/25
Date : 11th March 2026
Time : 13.30hrs -16.30 hrs
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Four (4)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).
7. *All equations are represented by standard notation.*

Question - 01

- a) What are the major losses and minor losses in pipe flow? 2-marks
- b) Write down the Darcy–Weisbach formula for friction loss. 2-marks
- c) A horizontal pipeline, **225m** long, connects to a water tank at one end and discharges freely into the atmosphere at the other end as shown in the Figure Q1. The water level in the tank is maintained at **12m** above the centerline of the pipe. 14-marks

Assuming a friction factor of $f = 0.01$ for all segments and considering all head losses, determine the volumetric flow rate through the system.

- d) Sketch the Total Energy Line (TEL) and the Hydraulic Gradient Line (HGL) for the entire system. 2-marks

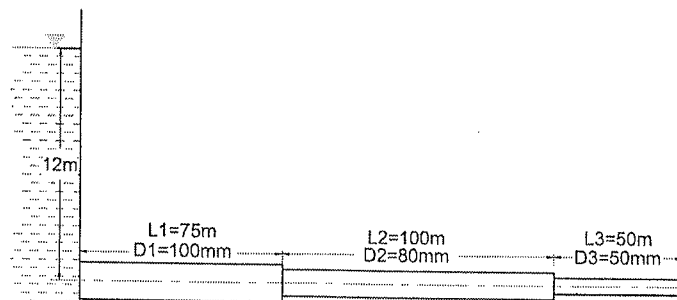


Figure Q1

Question-02

2-marks

- a) State **two** practical applications of **forced vortex motion** in engineering product design.
- b) By considering the rotation of a fluid element in a liquid mass rotating as a solid body, show that the parabolic profile of the free surface in **standard notation** is given by:

$$z = \frac{\omega^2 r^2}{2g} + C$$

10-marks

Where C is a constant of integration

- c) A cylindrical tank, **300 mm** in diameter and **1.2 m** in height, is initially filled with water to a depth of **1.0 m**.

4-marks

- I. Determine the angular speed ω at which the cylinder must rotate about its vertical axis such that the water surface just touches the bottom at the axis of rotation.

4-marks

- II. Calculate the volume of water that will spill out of the tank when rotating at this speed.

Question -03

- a) The shear stress τ_0 at the bed of a rough channel depends upon the depth of flow y , velocity of the fluid V , roughness height of the bed σ , the fluid density ρ and the viscosity μ . Show that τ_0 can be expressed in the dimensionless form as,

10-marks

$$\frac{\tau_0}{\rho V^2} = \phi \left(\frac{\mu}{\rho V y}, \frac{\sigma}{y} \right)$$

- b) What is meant by dynamic similarity?

4-marks

- c) Oil of density **917 kgm⁻³** and dynamic viscosity **0.29 Pa s** flows in a pipe of diameter **15 cm** at a velocity of **2.0 ms⁻¹**. What should be the velocity of the flow of water in a **1.0 cm** diameter pipe, to make the two flows dynamically similar? [NB: Viscosity of water is **1.31x10⁻³ Pa s**]

6-marks

Question – 04

A water jet is issued out of a pipe with a velocity of 13ms^{-1} as shown in the Figure Q4.

- Find the angle of inclination of the water jet to the horizontal.
- Determine the volumetric flow rate of water striking the window.

12-marks

8-marks

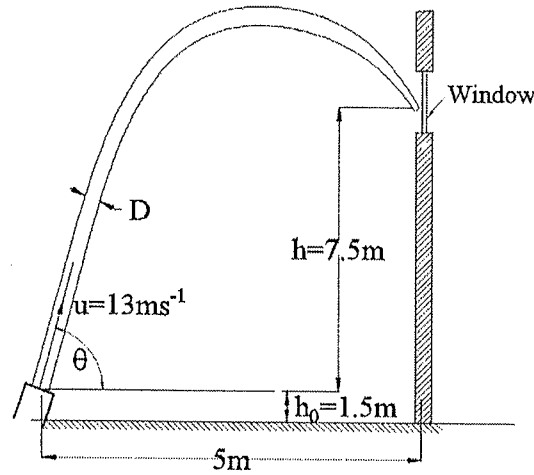


Figure Q4

Question -05

- Compare and contrast the pipe flow and open channel flow.

2-marks

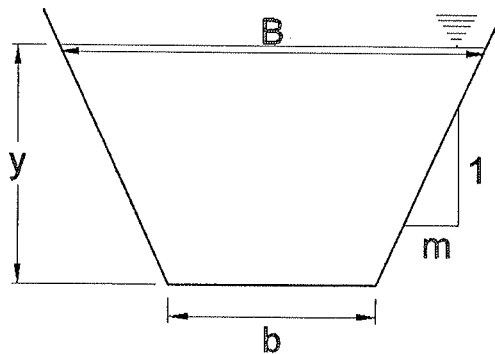


Figure Q5

- By considering the trapezoidal open channel shown in Figure Q5, show that the hydraulic radius (R) of the channel is given by,

$$R = \frac{y(b + my)}{(b + 2y\sqrt{1 + m^2})}$$

8-marks

- c) A trapezoidal open channel is to be designed to convey water at a discharge rate of $20\text{m}^3\text{s}^{-1}$. The channel is concrete-lined ($n = 0.014$) with a longitudinal bed slope of 0.0005 and side slopes of $1:2$ (vertical to horizontal).

6-marks

- I. Determine the dimensions (bottom width b and depth y) of the most economical section, given that for any trapezoidal section to be most efficient, the hydraulic radius $R = y/2$.

4-marks

- II. Calculate the resulting flow velocity (V).

Manning's equation: $Q = \frac{1}{n} AR^{\frac{2}{3}} S_0^{\frac{1}{2}}$

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