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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	:**CVX 3340 Introduction to Hydraulics & Hydrology**
Academic Year	: 2020/21
Date	: 21st January 2022
Time	: 0930-1230hrs
Duration	: **03 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **FIVE (05)** questions on **THREE (03)** pages.
3. Answer **ALL FIVE (05)** questions. They carry different marks as indicated.
4. Answer for each question should commence from a new page.
5. Necessary additional information is provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.
9. Take,

Density of water = 1000 kgm^{-3} Acceleration due to gravity = 9.81 ms^{-2}

Question 01

A rectangular tank of size 3 m x 3 m discharges water to the atmosphere at point F through a pipeline, as shown in Figure Q1. All the pipes have a diameter of 38 mm, and the lengths of the pipes are as indicated.

(a) Sketch, on graphs, placed one above the other, the variation of the *Elevation Head*, *Velocity Head*, *Pressure Head* and *Total Head* from O, a point on the free surface of the tank, past the points A, B, C, D and E to F. Identify the elevation datum used. Neglect all forms of losses.

(08 marks)

(b) Calculate the discharge through the pipeline approximating a total head loss of $31\ (v^2/2g)$, where v is the flow velocity along the pipeline.

(04 marks)

(c) Determine the head required by a pump installed at point C to improve the flow velocity in the system to 3.0 m/s. Consider the same total head loss approximated in part (b).

(03 marks)

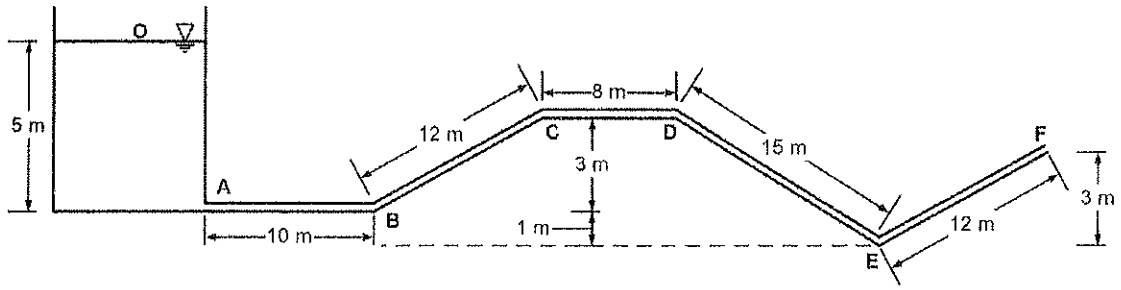

Figure Q1

Question 02

A tapering pipe bend (in horizontal plane) is supported at point A and connected to a water flow system by flexible couplings at sections 1 and 2, as shown in Figure Q2. Find the torque, T_A that must be resisted at support A. The gauge pressures at sections 1 and 2 are 720 kN/m^2 and 476 kN/m^2, respectively. Flow rate along the system is 0.045 m^3/s.

(20 marks)

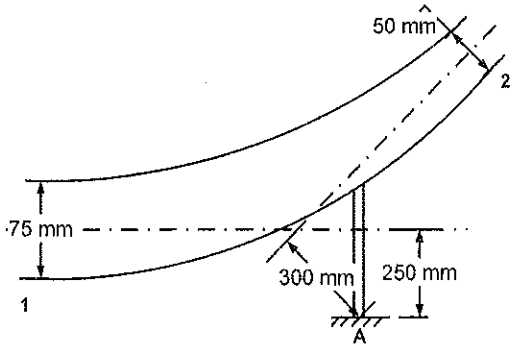

Figure Q2

Question 03

(a) Differentiate between laminar flow and turbulent flow.

(04 marks)

(b) A solid cone of radius, r_0 and vertex angle, θ is to rotate at an angular velocity ω as shown in Figure Q3. An oil of dynamic viscosity, μ fills the gap thickness, h between the cone and the housing.

(i) Obtain expressions for the torque and the power required to rotate the cone.

(ii) Determine the power required to overcome viscous resistance for a shaft running at 600 rpm fitted with a conical bearing. The radius and the height of the cone are 250 mm and 500 mm, respectively. The 1.8 mm uniform clearance between the cone and the housing is filled with oil of dynamic viscosity 0.018 Ns/m^2.

(16 marks)

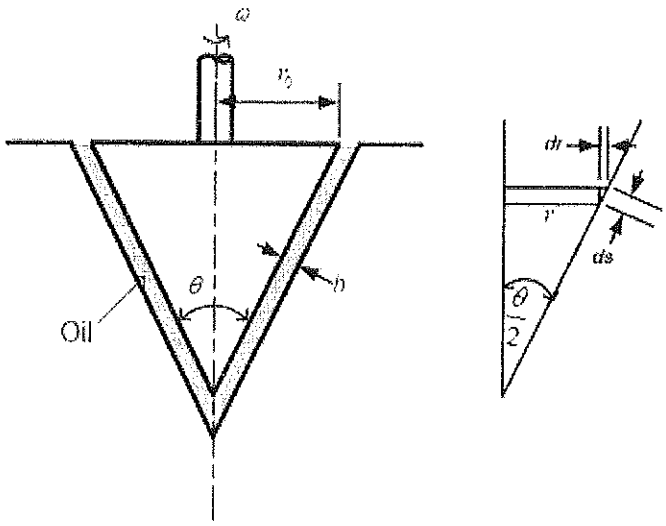

Figure Q3

Question 04

(a) Show that the head loss, H_l in the inlet section (i.e. between the inlet and the throat) of a venturimeter is given by,

$$H_l = (1 - C_d^2)\Delta h$$

where, C_d is the coefficient of discharge of the venturimeter and Δh is the piezometric head difference between the inlet and the throat.

(10 marks)

(b) A venturimeter of throat diameter 75 mm is fitted into a 200 mm diameter water supply line.

(i) Compute the flow rate along the pipeline when a mercury-water differential U-tube manometer connected between the inlet and the throat shows a reading of 250 mm. The coefficient of discharge of the meter is 0.97. The specific gravity of mercury is 13.6.

(ii) If the head loss in the diverging cone of the meter is three times the head loss between the inlet and the throat, calculate the total head loss.

(10 marks)

Question 05

(a) Describe briefly how ϕ-index for a catchment is determined in practice.

(06 marks)

(b) Explain what "The One-Hour Unit Hydrograph" means for a catchment indicating its practical uses.

(04 marks)

(c) The following data represent the gauged stream flow for a river resulting from a gauged precipitation of uniform intensity 50 mm/hr lasting for 15 minutes. The ϕ-index for the catchment is 8 mm/hr. During the period corresponding to the given stream flow, the baseflow is approximated to be constant at 15 m^3/s.

Time (hr)	0	1/4	1/2	3/4	1	5/4	3/2	7/4	2	9/4	5/2	11/4	3
Gauged stream flow (m^3/s)	15	21	34	62	80	77	68	56	46	37	29	21	15

(i) Obtain the "Half-Hour Unit Hydrograph" from the data provided and plot it.

(ii) Determine the maximum surface runoff discharge resulting from a uniform intensity rainfall of 70 mm/hr lasting for 30 minutes.

(15 marks)