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	: CVX3340 – Introduction to Hydraulics and Hydrology
Academic Year	: 2021/2022
Date	: 2023.02.16
Time	: 13.30 – 16.30

General Instructions

1. This is a Closed Book Test (CBT).

2. There are 5 questions on 5 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^2/s

1) a) Draw a rough map of the major completed elements of the Mahaweli Development Project. Show and identify the following in your map. (40%)

i) The main river channel of the Mahaweli Ganga and the following tributaries - the Amban Ganga, Ulhitiya Oya, and Kotmale Oya

ii) The following reservoirs – Upper Kotmale, Kotmale, Victoria, Randenigala, Bowatenna, Moragahakanda, Ulhitiya-Ratkinda

iii) The Polgolla dam

iv) The Minipe anicut

iv) Major water diversions – use different line types for tunnels, artificial canals and natural river channels

v) Major hydropower plants

vi) Locations of trans-basin diversions (i.e. water diverted out of the Mahaweli River basin) – indicate the river basin to which the water is transferred

b) A dam of height 100 m has a vertical upstream face in the shape of right-angle triangle, as shown in Figure 1b. Calculate the total horizontal force acting on the dam if the water level is 10 m below the top of the dam. (30%)

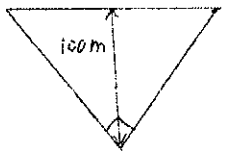

Figure 1b

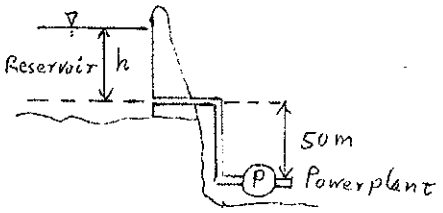

Figure 1c

c) The schematic diagram of a reservoir and hydropower plant are shown in Figure 1c. The variation of the usable volume stored in the reservoir with height of the water level above the intake to the hydropower plant is shown in Table 1. The power plant is 50 m below the level of the intake, as shown in the figure.

Make your best estimate of the energy that can be generated by the hydropower plant when the water level of the reservoir is 35 m above the intake. Explain your answer. Assume that the efficiency of the hydropower plant is 90%.(30%)

Height of water level (h) (m)	0	10	20	30	40
Usable volume of water (10^6 m^3)	0	25	75	175	375

Table 1

2) a) What is the definition of the physical quantity known as the "head" of a flowing fluid? (5%)

b) What is the dimension of the physical quantity known as the "head" of a flowing fluid? (5%)

A tank of uniform cross-section has a height of 5 m and contains water to a depth of 4 m , as shown in Figure 2. This tank is to be emptied using the pipeline ABCDE, shown in the figure. All the pipes have a diameter of 50 mm . The flow is to be started by reducing the pressure at C until water flows from A to C.

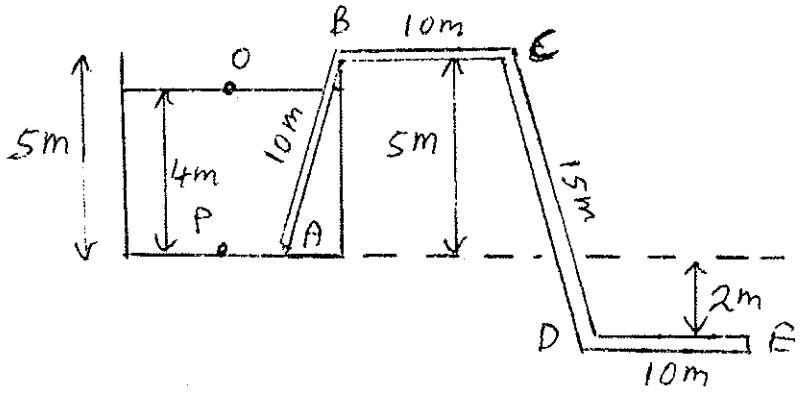

Figure 2

c) What value of the gauge pressure at C will start the flow? Assume that there are no energy losses in the pipeline. (10%)

d) Sketch, on graphs placed one above the other, the variation of the Elevation Head, Velocity Head, Pressure Head and Total Head from a point O on the free surface of the tank, through a point P on the bottom of the tank, through the pipeline ABCDE, once a steady flow is established in the pipeline. Neglect all energy losses. (40%)

e) Calculate the discharge through the pipeline when the water level in the tank is 4 m . Neglect all energy losses. (20%)

f) Sketch a graph of the water level in the tank with time as the tank empties. Explain your answer. (20%)

3) A horizontal pipe of circular cross-section has a reduction of diameter, from 50 mm to 20 mm between points A and B, as shown in Figure 3. Water flows steadily in this pipe from A to B, and the average velocity at A is 0.2 m/s. The water level in a simple manometer connected at A is found to be 250 mm above the centreline of the pipe.

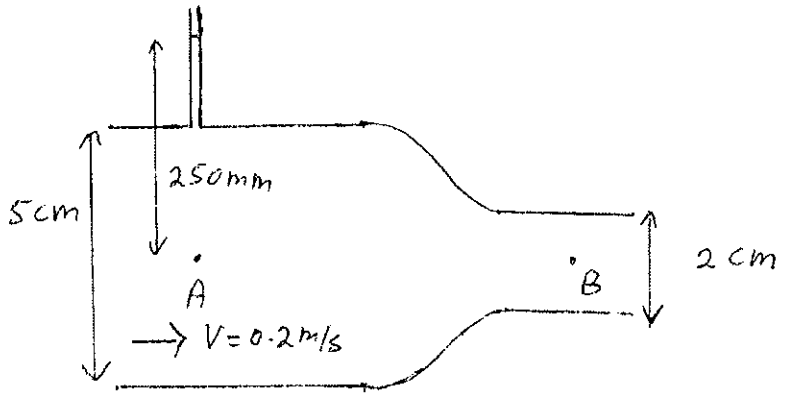

Figure 3

a) State the principle of Conservation of Momentum for steady flow through a fluid control volume as a sentence. (10%)

b) Calculate the pressure at the centreline of the pipe at B. Assume that there are no energy losses between A and B. Explain your answer. (40%)

c) Calculate the force acting on the pipe section AB. Explain your answer. (50%)

4) a) "An artesian well is a well that brings groundwater to the surface without pumping" *Wikipedia*. Explain, using neat figures, the surface and underground features and the water flows needed to create the conditions required for the existence of artesian wells. (30%)

b) Explain, using sketches of flood hydrographs, the effect of dams on floods. (20%)

(continued .....)

4) (.... continued) c) A certain catchment has an area of 600 ha . A storm lasting 1 hour results in a uniform rainfall of 150 mm in the catchment. The discharge measured at the outlet of the catchment is given in Table 4.

Time from start of storm (hours)	0	1	2	3	4	5	6
Discharge (m3/s)	0.5	3	9	6	4	2	0.5

Table 4

Estimate the run-off coefficient of the catchment for this storm. State all your assumptions and explain your answer. (50%)

5) a) Explain, using neat figures, how a domestic water meter works. (15%)

b) The quantity of water supplied for domestic use is measured and billed in "units". What is the volume of one "unit" of water? (5%)

c) Explain, using neat figures, what a pitot-static tube is. Use the relevant fundamental principle to explain the relationship between what is observed with a pitot-static tube and the property of the flow that can be calculated from that observation. (40%)

d) A U-tube mercury manometer is connected to two pressure tappings at A and B on a horizontal pipe of uniform diameter, carrying water as shown in Figure 5d. The difference in the mercury levels is as shown in the figure and is found to be 3 mm . The specific gravity of mercury is 13.6 .

i) Calculate the difference in pressure between the points A and B

ii) What is the direction of the flow in the pipe? Explain your answer. (40%)

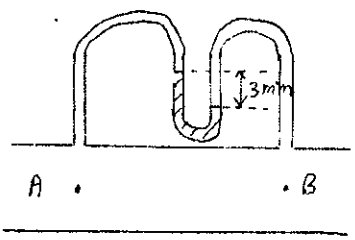

Figure 5d