

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	: 2019/20
Date	: 30 <sup>th</sup> September 2020
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 =  $1000 \text{ kgm}^{-3}$       Acceleration due to gravity =  $9.81 \text{ ms}^{-2}$

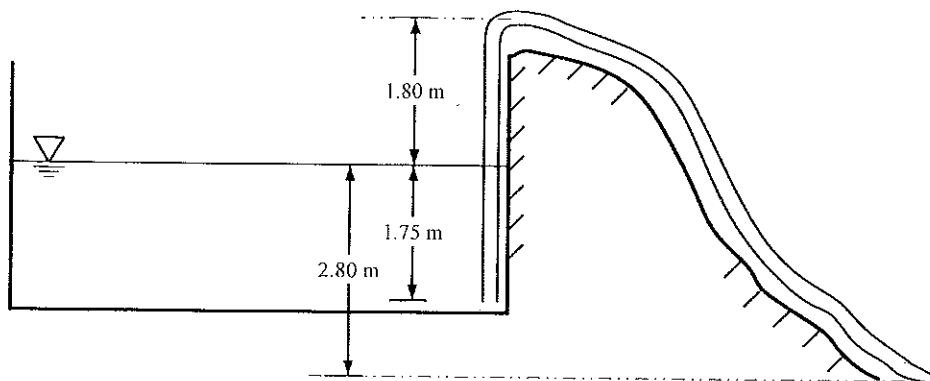
Kinematic viscosity of water =  $1.04 \times 10^{-06} \text{ m}^2/\text{s}$

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**Question 01**

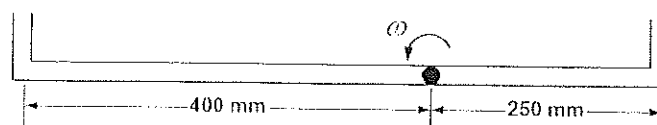
- (a) State the Bernoulli's equation and identify each term. (02 marks)
- (b) List the four conditions under the Bernoulli's equation is valid. (02 marks)
- (c) A tank in a fish farm is emptied using a siphon as shown in Figure Q1. The siphon has a uniform circular pipe of 125 mm diameter and consists of a bent pipe with its crest 1.8 m above water level discharging into the atmosphere at a level 2.8 m below water level. The total loss of head due to friction is  $1.08(v^2 / 2g)$ , where  $v$  is the velocity of flow. If the total length of the siphon is 9.0 m,
- Find the velocity of flow, the discharge and
  - the absolute pressure at crest level if the atmospheric pressure is equivalent to 10.0 m of water.
  - Plot the energy grade line and the hydraulic grade line.

(16 marks)

**Figure Q1****Question 02**

A sprinkler with unequal arms and jets of area  $75 \text{ mm}^2$  facing in the same direction is shown in Figure Q2. A flow of  $0.002 \text{ m}^3/\text{s}$  enters the assembly normal to the rotating arm.

- (a) Assuming the frictional torque to be  $0.115 \text{ Nm}$ , calculate the speed of rotation (10 marks)
- (b) What torque is required to hold it from rotating? (05 marks)

**Figure Q2**

**Question 03**

(a) What is a Newtonian fluid?

(03 marks)

(b) The vertical shaft of radius,  $a$  shown in the Figure Q3 rotates at an angular velocity,  $\omega$  in a bearing of length,  $H$ . The thrust at the lower end of the shaft is transferred by a flat disc of radius,  $b$  to a flat housing. The space between the shaft and bearing and between disc and housing is filled with an oil of dynamic viscosity,  $\mu$ . In each case the film thickness is  $h$  ( $\ll a, b$ ). Assuming that the velocity gradient is constant across the thickness of each oil film, show that the power absorbed in fluid friction is given by,

$$P = \frac{\pi\mu\omega^2}{2h} (4Ha^3 + b^4)$$

(12 marks)

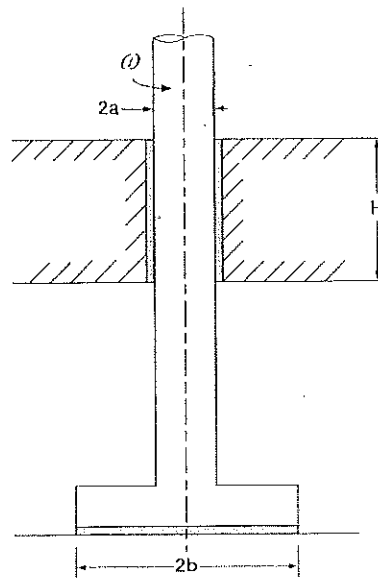


Figure Q3

**Question 04**

The coefficient of discharge,  $C_d$  of the submerged orifice shown in Figure Q4 is found to be equal to 0.63. The orifice diameter,  $d$  is 16 mm and the initial water levels above orifice level for tank 1 and 2 are 0.5 m and 0.14 m, respectively.

(a) What is the initial flow rate through the orifice?

(08 marks)

(b) If the cross-sectional areas of tank 1 and tank 2 are  $0.08 \text{ m}^2$  and  $0.04 \text{ m}^2$ , respectively, determine the time taken to bring the water levels in two tanks to the same level.

(12 marks)

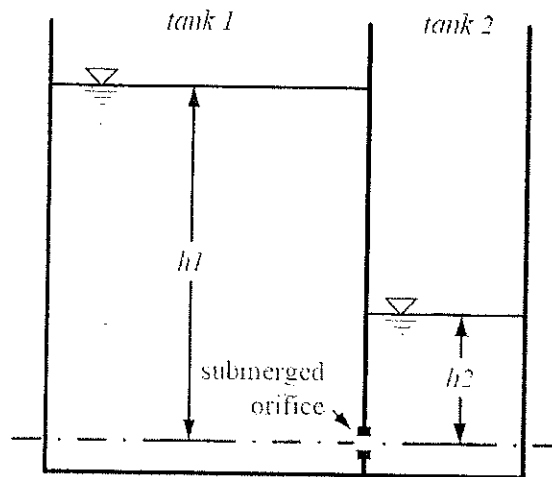


Figure Q4

## Question 05

(a) Briefly describe three streamflow measurement techniques.

(06 marks)

(b) Give a detailed account of the different runoff mechanisms.

(09 marks)

(c) The following direct runoff values were obtained after deducting baseflow components of a storm hydrograph following a single storm.

(i) Obtain the Unit Hydrograph from the data provided and plot it. The catchment area is estimated to be  $28.7 \text{ km}^2$ .

Time (hr)	1	2	3	4	5	6	7	8	9	10	11	12
Rainfall (mm)	1	8	4	23	11	5	1					
Direct Runoff ( $\text{m}^3/\text{s}$ )				0	1.25	12.91	18.33	9.60	5.49	3.31	1.12	0

(ii) Obtain the direct runoff for the following storm (not necessary to plot).

Time (hr)	1	2	3
Rainfall (mm)	15	5	18

(15 marks)