

UNIVERSITY OF RUHUNA

FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY

Academic Year – 2022 / 2023

Bachelor of Science Honors in Marine and Freshwater Sciences Degree

Level IV Semester I Examination – April / May 2024

LIM 4122: Water Resource Management

Time: 1 hour and 30 minutes

Section A

(Answer All questions in Section A)

Question 01

(40 marks)

Recent flooding due to the impact of climate change in the low-lying area along the Nilwala River has necessitated the implementation of a flood mitigation project. A comprehensive flood mitigation project is planned for the area for which a hydrological study has to be done. The main objective of this study is to estimate the peak discharge from the catchment for a specified design storm pattern. Recent data have shown that for an excess rainfall of intensity 50 mm/hr occurring over the catchment, the runoff ordinates (Q) are as given in Table 1-1.

Table 1-1

Time (hrs)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Q (m ³ /s)	2	8	38	68	49	36	9	4	2

From the analysis of past rainfall data, a decision was made to consider a design storm pattern as shown in Table 1-2.

Table 1-2

Time (hrs)	0-0.5	0.5-1.5	1.5-2.0
Rainfall (mm)	15	50	15

Assuming a constant baseflow of 2 m³/s and total losses from rainfall as 10 mm/hr (initial losses + infiltration), answer the following.

A) Sketch the design storm hyetograph and specify the rainfall excess values over the three storm durations. (10 marks)

B) Develop the **half-hour** and **one-hour** unit hydrographs. Refer to Table 1-3 in page 03. (15 marks)

C) Determine the ordinates of the direct runoff hydrograph and the peak discharge. Refer to Table 1-4 in page 03. (15 marks)

Table 1-3

Time (hrs)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Runoff (m ³ /s)	2	8	38	68	49	36	9	4	2
Direct Runoff Ordinate									
Half Hour Unit Hydrograph									
Lagging by time									
One hour Hydrograph									

Table 1-4

Time	Excess Rainfall	Unit Hydrograph Ordinates								Direct Runoff
0.5										
1.0										
1.5										
2.0										
2.5										
3.0										
3.5										
4.0										
4.5										
5.0										

Section B

(Answer **only two** (2) questions)

Question 02

Students in the Limnology and Water Technology Department, are tasked with investigating flood levels at a specific section of the Mahaweli River, which is crucial for designing a hydraulic structure. An inflow hydrograph developed for a cross-section at an upstream location is shown in Table 1-1:

Table 1-1

Time (hours)	Inflow (m ³ /s)
0	10
4	15
8	40
12	60
16	54
20	42
24	32
28	26
32	20
36	15

Combining the Muskingum equation and Continuity equation, Q_2 can be expressed as:

$$Q_2 = C_1 I_2 + C_2 I_1 + C_3 Q_1,$$

$$\text{Where } C_1 = \frac{\Delta t - 2Kx}{2K(1-x) + \Delta t}, C_2 = \frac{\Delta t + 2Kx}{2K(1-x) + \Delta t}, C_3 = \frac{2K(1-x) - \Delta t}{2K(1-x) + \Delta t}$$

- A) Calculate the values of C_1 , C_2 , and C_3 for the specified location along the Mahaweli River assuming $K=5$ hours, $x=0.15$, and an initial condition where outflow equals inflow. (12 marks)
- B) Determine the outflow hydrograph using the Muskingum method. (18 marks)

Question 03**(30 marks)**

Droughts are complex natural phenomena that have significant socio-economic and environmental impacts. Understanding drought and developing effective management strategies are crucial for mitigating its adverse effects.

- A) Briefly explain the Meteorological Drought and Agricultural Drought. (10 marks)
- B) Rainwater harvesting has gained significant attention as a sustainable water management practice in drought regions. Discuss the concept of rainwater harvesting, including its principles, techniques, and potential benefits for both urban and rural communities. (10 marks)
- C) Explain the key challenges in managing reservoir water during drought periods and propose effective strategies to address these challenges. (10 marks)

Question 04**(30 marks)**

Flooding is a major challenge in many regions worldwide, often leading to significant damage to property and infrastructure. Recognizing the significance of flood analysis in managing and reducing these risks is essential.

- A) Write down the steps involved in conducting floodplain analysis. (10 marks)
- B) As part of a sustainable flood management plan, the government intends to construct a bridge over a river. The bridge is designed to withstand floods with a return period of 100 years and is expected to have a lifespan of 25 years. Determine the risk associated with this hydrologic design. (08 marks)
- C) Discuss three flood control methods suitable for Sri Lanka, considering its geographical and socio-economic characteristics. (12 marks)

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