



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2022

Module Number: CE 6302

Module Name: Engineering Hydrology (C-18)

[Three Hours]

[Answer all questions, each question carries 12.5 marks]

- Q1. a) i) Explain different types of precipitation.  
ii) State the methods available to measure rainfall. [2.0 + 2.0 Marks]
- b) i) Briefly explain the influencing factors that govern evaporation from an open water surface.  
ii) 'Estimation of evaporation loss is important in hydrology'. Explain the above statement giving examples.  
iii) A reservoir had an average surface area of 50 km<sup>2</sup> during a month having 30 days. In that month, the mean rate of inflow was 20 m<sup>3</sup>/s, outflow was 25 m<sup>3</sup>/s, monthly rainfall was 10 cm and change in storage was estimated as 15 MCM. Assuming the seepage losses to be 1.8 cm, estimate the depth of evaporation from the reservoir during the month. [2.0 + 2.0 + 2.0 Marks]
- c) An isolated storm in a catchment produced a runoff of 3.5 cm. The mass curve of the average rainfall depth over the catchment is given in Table Q1. Calculate the constant loss rate ( $\phi$  index) for the storm. [2.5 Marks]
- Q2. a) Distinguish between  
i) water table and piezometric surface.  
ii) aquifer and aquiclude. [2.0 + 2.0 Marks]
- b) Darcy's Law was developed to relate the moisture flux ( $q$ ) to the rate of head loss per unit length of medium ( $S_f$ ) by  $q = K S_f$  where  $K$  is the hydraulic conductivity. Briefly explain how it operates in an unsaturated porous medium. [2.0 Marks]
- c) i) State Dupit's assumptions for analysing the flow of groundwater towards a well in a pervious stratum.  
ii) How far the above assumptions are valid in practice? [2.0 + 2.0 Marks]

- d) There are two canals separated by an aquifer formation of 5 km (Figure Q2). If the permeability of the aquifer (K) is 20 m/day, what is the seepage flow per metre length of the canal?

[2.5 Marks]

- Q3. a) i) Briefly explain the factors that affect the shape of a streamflow hydrograph.  
ii) Explain the procedure for deriving a unit hydrograph from an isolated storm hydrograph.  
iii) Explain three limitations associated with the Unit Hydrograph (UH) theory emphasizing suggestions to overcome each of them.

[2.0 + 2.0 + 2.0 Marks]

- b) Two successive storms A and B, each of 4-h duration produced a rainfall excess of 2 cm and 3 cm, respectively, where A was followed by B. The flood hydrograph ordinates generated from these storms are given in Table Q3. Considering a constant baseflow of 5 m<sup>3</sup>/s, derive the first 5 ordinates of a 4-h unit hydrograph.

[3.0 Marks]

- c) The peak of a flood hydrograph due to a 6-h storm is 535 m<sup>3</sup>/s. The mean depth of rainfall is 8 cm. Assuming an average infiltration loss of 0.25 cm/hour and a constant base flow of 15 m<sup>3</sup>/s, estimate the peak discharge of a 6-h unit hydrograph.

[3.5 Marks]

- Q4. a) i) Describe the double mass curve technique to check the consistency of rainfall record.  
ii) The average annual rainfall at stations P, Q and R are 1600 mm, 1800 mm and 2000 mm, respectively. In the year 2020, the station Q became inoperative, and stations P and R recorded annual rainfall of 1700 mm and 1800 mm, respectively. Estimate the annual rainfall at station Q for the year 2020.

[1.0 + 2.0 Marks]

- b) i) What is meant by an IDF curve?  
ii) Explain with clear sketches how the IDF curves are used to derive design-storms.

[1.0 + 2.0 Marks]

- c) A one-day rainfall of 200 mm at a station was found to have a return period of 25 years. Determine the probability that a one-day rainfall of this or larger magnitude

- i) will occur at the station in the next year.  
ii) will not occur at the station in the next 20 years.

[2.0 + 2.0 Marks]

- d) The maximum annual rainfall data at a meteorological station from 1970 to 2020 (50 hydrological years) were ranked in descending order. The 5<sup>th</sup> highest rainfall was found to be 2300 mm. What is the probability that this event will occur at least once within a 50-year period? Use the Weibull formula with usual notations,  $p = \frac{m}{N+1}$

[2.5 Marks]

Table Q1

Time (h)	0	1	2	3	4	5	6
Accumulated Rainfall (cm)	0	0.05	1.65	3.55	5.65	6.80	7.75

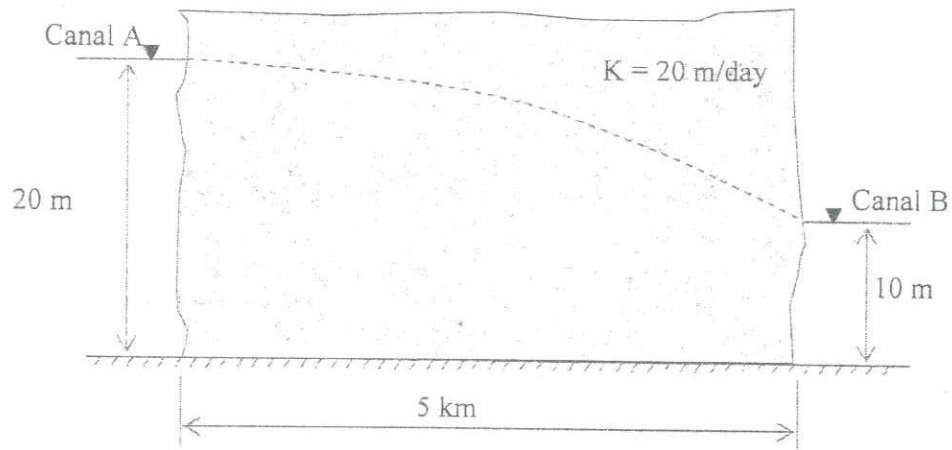


Figure Q2

Table Q3

Time from start of rainfall (h)	0	4	8	12	16	20	24	28
Flood hydrograph ordinate ( $\text{m}^3/\text{s}$ )	5	20	45	55	50	25	15	8