FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY

Bachelor of Science Honors in Fisheries and Marine Sciences Degree/ Bachelor of Science Honors in Marine and Freshwater Sciences Degree

Level IV, Semester I Examination -2023/2024

LIM 4122- Water Resources Management **Time: 2 hours**

Answer only 4 (four) questions. Each question carries 25 marks.

1. **Streamflow measurement plays a vital role in hydrological studies and effective water resource management.**
   a. Explain the significance of reliable streamflow measurements in hydrological studies and how they support decision-making in water resource management. (6 marks)

   b. Describe the two methods used to measure streamflow and explain the principles behind each. (8 marks)

   c. Briefly describe the accuracy of different streamflow measurement methods under varying field conditions, including channel geometry, flow variability, and accessibility. (11 marks)

2. **The unit hydrograph is a key concept in surface hydrology used to model the direct runoff response of a watershed to a unit depth of effective rainfall over a specified duration.**

   a. Describe the essential steps and key assumptions involved in developing a unit hydrograph for a watershed. (7.5 marks)

   b. Briefly explain how the following watershed characteristics influence the shape and response of the unit hydrograph.
      - time of concentration
      - storm duration
      - land use,
      - slope,
      - soil type

      (7.5 mark)

c. Compare graphical and statistical methods for deriving a unit hydrograph highlighting their advantages, limitations, and appropriate applications. (10 marks)

3. **Derive and apply probabilistic expressions for hydrologic event occurrence, typically based on return periods.**
   a. Define the probability of occurrence using the return period T and explain how the expressions P =1/T and P =1−1/T represent the probabilities of occurrence and non-occurrence each year. (8 marks)

   b. Derive the expression for the probability that an event occurs at least once in N consecutive years, starting from the probability of non-occurrence over N years. (8 marks)

   c. Explain how these probabilistic formulas are used in i) hydrologic risk assessment, ii) flood management, and iii) infrastructure design, and discuss their advantages and limitations in practical applications. (9 marks)

4. **Hydrologic variables, such as streamflow and rainfall, exhibit inherent uncertainty. Frequency analysis applies statistical methods to quantify event magnitudes and their probabilities.**

   a) Briefly explain the role of random variables in hydrology and how continuous frequency distributions are applied to represent hydrologic data. (8 marks)

   b) Describe how statistical methods quantify uncertainty in hydrologic observations and compare the advantages of probabilistic and deterministic approaches. (8 marks)

   c) Briefly explain how frequency analysis relates the magnitude of hydrologic events to their probabilities for hindcasting and forecasting and discuss its main limitations in practice. (9 marks)

5.

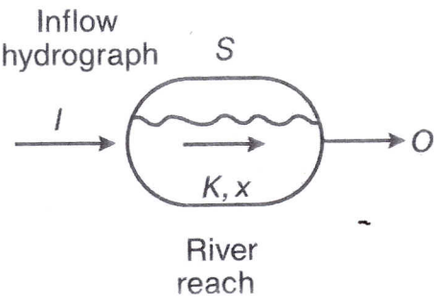

Figure: Q5: A schematic of a river reach

The figure shows a schematic of a river reach with a known inflow hydrograph, storage parameters, and estimated routing coefficients. Using the Muskingum method, answer the following questions:

a. Explain the Muskingum method for river routing, derive the continuity equation used, and define the Muskingum parameters K and x, including their impact on the shape and timing of the outflow hydrograph. (8 marks)

b. Using the given data (Muskingum parameters: K=4 hours, x=0.2-time step Δt=2 hours, inflows I_0=100 m3/s, I_1=150 m3/s, I_2=200 m3/s, and initial outflow O_0=90 m3/s), calculate the outflows O_1 and O_2 using the Muskingum routing equation. (10 marks)

c. Discuss the main limitations of the Muskingum method in practical river routing. Briefly explain when its assumptions may break down and suggest possible improvements or alternative methods. (7 marks)

6. **Droughts are complex natural hazards with significant environmental, economic, and social impacts.**

a. Define drought and describe its four main types—meteorological, agricultural, hydrological, and socioeconomic—highlighting their differences in onset, indicators, and impacts. (9 marks)

b. Explain the role of drought indices in monitoring drought conditions and describe the calculation and application of one specific index (e.g., SPI, PDSI, or NDVI) in drought management. (8 marks)

c. Identify one technological and one policy-based strategy for reducing community vulnerability to droughts. (8 marks)