

The National University of Lesotho

B.Sc. Examinations

PG 4401 : Hydrology and Water Resources

May, 2023

Marks: 100

3 Hours

Instructions:

- Answer any **four (4)** questions.
 - Where applicable illustrate your answer with equations and diagrams.
 - Each question carries 25 marks.
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Question 1

Explain the meaning of the following phrases as used in Flood Frequency Analysis:

- (a) Flood probability distribution (5)
- (b) Exceedance probability (5)
- (c) Return period (5)
- (d) Peaks-over-threshold series (5)
- (e) Annual maximum series (5)

[25]

Question 2

- (a) Distinguish between Reservoir Routing and Channel Routing. (5)
- (b) The Muskingum constants K and x are estimated for a given river reach to be 12 hours and 0.2 respectively. Assuming an initial steady flow, route the inflow hydrograph given in table 2.1 through the reach. (12)
- (c) Plot both the inflow and outflow hydrograph on the same graph and comment on the magnitude and time of the peak flows. (8)

Table 2.1

t (hrs)	0	6	12	18	24	30	36	42
Inflow (m^3/s)	25.0	32.5	58.0	65.0	59.4	49.5	42.5	35.0

[25]

Question 3

- (a) Sketch a typical flow hydrograph for a complete year and indicate on it those quantities that can be subjected to frequency analysis. On separate diagrams, indicate those that increase and those that decrease with return period. (12)
- (b) A sequence of 15 annual flows (in m^3/s) for a small river is as follows;

38, 41, 20, 33, 34, 33, 39, 42, 53, 40, 23, 34, 32, 40, 50.

Using a Mass Diagram Analysis or an equivalent numerical procedure, determine the amount of storage that would be necessary to satisfy a water demand of $37 m^3/s$ by a nearby village. (13)

[25]

Question 4

- (a) Using appropriate illustrations, explain what you understand by the following concepts;
 - (i) Cone of depression
 - (ii) Potentiometric surface
 - (iii) Homogeneous and isotropic aquifer (3 each)
- (b) Derive a formula for calculating the discharge at steady state from a well that penetrates an unconfined aquifer. (9)

- (c) A well that penetrates fully into an unconfined aquifer of thickness 8.2 m is pumped at a rate 65 l/s until a steady state cone of depression is established. The drawdowns measured at two observation wells situated 15 m and 31 m from the pumped well are found to be 1.8 m and 1.4 m respectively. Determine the average transmissivity of the aquifer. (7)
[25]

Question 5

Discuss how dominant hydrological processes and the land use changes within the Metolong catchment can threaten the capacity of the Metolong Dam.

[25]

Question 6

Global warming models show that, in general, the Southern African region is getting hotter and drier. How do you think this is affecting the hydrological cycle in this region and what are the likely effects of this climatic change on the water resources of Lesotho? [25]