The National University of Lesotho

B.Sc. Supplementary Examination

PG 2401 : Principles of Hydrology

August, 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.

Question 1

With the help of appropriate diagrams explain what you understand by the following terms:

(a) Potential evapotranspiration
(b) Effective precipitation
(c) Time of concentration
(d) Recharge area
(e) Confined aquifer (5 each)

[25]

Question 2

(a) About 97% of the world's water is stored in oceans. Describe the natural physical processes involved in the translation of the oceanic water to an upland stream. (13)

(b) A hydrologist is required to assess the quantity of water available in a particular catchment in the in the lowlands of Lesotho.

(i) What phases of the hydrological cycle would he/she have to consider and why? (7)

(ii) What measurements would you recommend him/her to make? (5)

[25]

Question 3

(a) Explain the importance of solar radiation in driving the hydrological processes (8)

(b) Sketch a diagram of the hydrological cycle showing all the processes that can take place. Also write short notes explaining the conditions under which each process takes place. (17)

[25]

Question 4

(a) Summarise in the form of a clearly labelled diagram, the processes of water exchange between the atmosphere, land and oceans. (9)

(b) A parcel of moist air initially at the temperature of 20^oC at 300m above sea level (asl) is forced to rise over a mountain ridge to 4000m asl and then descend to 1000m asl on the other side. Assuming that a rise to 2500m asl produces saturation and condensation, and that the SALR is $4.5^oC/km$ while the DALR is $9.8^oC/km$. What is the final temperature of the parcel of air on the other side of the mountain ridge? (16)

[25]

Question 5

(a) The evaporation loss from a reservoir can be estimated by the water budget method. Identify the necessary items in a water budget and describe how they can be measured.

(12)

(b) A practical realisation of the vapour flow equation ($E_o = f(u)(e_s - e_d)$) for open water evaporation incorporates the area of the lake/reservoir as follows;

$$E_0 = 0.291A^{-0.05}U(e_s - e_d)$$

Where E_o is in $mm\,day^{-1}$, A is in m^2, U is in $m\,s^{-1}$ and e_s and e_d are in mb.

Calculate the volume of water (m^3) lost over the months of October to March from a lake of surface area 10.86 km^2, given that the mean wind speed is $4.64ms^{-1}$ and the values of e_s and e_d are 15.3 and 11.2 mb, respectively. (13)

[25]

Question 6

(a) Summarise in the form of a clearly labelled diagram, the processes of water exchange between the atmosphere, land and oceans. (9)

(b) A parcel of moist air initially at the temperature of 20^oC at 300m above sea level (asl) is forced to rise over a mountain ridge to 4000m asl and then descend to 1000m asl on the other side. Assume that a rise to 2500m asl produces saturation and condensation, and that the SALR is $4.5^oC/km$ while the DALR is $9.8^oC/km$. What is the final temperature of the parcel of air on the other side of the mountain ridge?

(16)

[25]