



**UNIVERSITY OF SWAZILAND  
FINAL EXAMINATION PAPER**

**PROGRAMME: BSC AGRIC III (LWM)**

**COURSE CODE: LUM 304 (New Programme)**

**TITLE OF PAPER: RURAL WATER SUPPLY AND  
HYDROLOGY**

**TIME ALLOWED: TWO (2) HOURS**

**SPECIAL MATERIAL REQUIRED: NONE**

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO  
OTHER QUESTIONS**

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GRANTED BY THE CHIEF INVIGILATOR**

**SECTION I: COMPULSORY QUESTION**

**QUESTION 1**

- a) With the aid of a clearly labelled diagram, describe the runoff process. (15 marks)
- b) A geological map shows that a 45-m thick confined aquifer lies beneath an area where several homesteads are settled. Analysis of several piezometers drilled through the aquifer shows that the piezometric surface is 25 m below the ground surface. The groundwater is confined at a pressure of 154 kPa. With the aid of calculations and a clearly labelled diagram show how deep the top and bottom boundaries of the aquifer are from the ground surface. (25 marks)

**SECTION II: ANSWER TWO QUESTIONS FROM THIS SECTION**

**QUESTION 2**

- (a) What is meant by time of concentration in runoff process, and how is it accounted for in estimating peak runoff from a catchment using methods such as the ration formula? (10 marks)
- (b) An impermeable limestone at the depth of 1.2 m underlies a 120-ha catchment with good drainage properties. The catchment has negligible surface storage and the field capacity of the soil overlying the limestone is  $0.125 \text{ cm}^3 \text{ cm}^{-3}$ . During the wet part of the year the following measurements of rainfall and potential evaporation are taken:

Parameter	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Mean rainfall (mm)	85	90	70	65	60	135	200	65
Potential evapo-transpiration (mm)	70	65	45	90	85	80	95	100

At the end of August, the soil profile had 120 mm of water. From these data, draw up a monthly balance sheet of water in the catchment and estimate the amount of runoff ( $\text{m}^3$ ) potentially available during the eight-month period. State the assumptions used in your estimation of the runoff (20 marks)

**QUESTION 3**

Hydrologically, Swaziland has many rivers that flow through the country, and yet the country faces water shortage. Discuss this apparent paradox (30 marks)

**QUESTION 4**

Discuss the major challenges Swaziland faces regarding the problem of water pollution, and how the country is tackling the problem. (30 marks)

**USEFUL EQUATIONS**

***Thiem's equation for confined aquifer***

$$q = \frac{2 \pi K D (h_2 - h_1)}{\ln (r_2/r_1)} \tag{1}$$

where

- q = the well discharge (m<sup>3</sup>/d)
- K = hydraulic conductivity (m/d)
- D = aquifer thickness (m)
- r<sub>1</sub> and r<sub>2</sub> = respective distances of the piezometers from the pumped well (m)
- h<sub>1</sub> and h<sub>2</sub> = the respective steady-state elevations of the water levels (from the bottom of the pumped well) in the observation wells (m)

***Thiem's equation for unconfined aquifer***

$$q = \frac{\pi K (h_2^2 - h_1^2)}{\ln (r_2/r_1)} \tag{2}$$

where

- q = the well discharge (m<sup>3</sup>/d)
- K = hydraulic conductivity (m/d)
- r<sub>1</sub> and r<sub>2</sub> = the respective distances of the observation wells from the pumping well (m)
- h<sub>1</sub> and h<sub>2</sub> = the respective steady-state elevations of the water levels (from the bottom of the pumped well) in the observation wells (m)