UNIVERSITY OF ESWATINI

FINAL EXAMINATION PAPER

PROGRAMME: BSC ABE IV

COURSE CODE: ABE 401

TITLE OF PAPER: RURAL WATER SUPPLY AND HYDROLOGY

TIME ALLOWED: TWO (2) HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.

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SECTION I: COMPULSARY

QUESTION 1

A) Discuss briefly the **two (2)** most important sources of small rural community water supply in Swaziland. **(5 marks)**

B) **i.** Define **run-off** as used in small rural community water supply. **(1 mark)**

ii. Discuss briefly the factors that affect the quantity of run-off that could be harvested from a given catchment. **(10 marks)**

C) **i.** Calculate the **potential water yield** that could be harvested from the roof by a household family size of 5 persons in the **Lubombo Plateau (Table 1)**, with a rooftop area of **50.0 m^2** and per capita water requirements of **20 Litres/day**. **Equation 1** may be used for this calculation. **(5 marks)**

ii. How many days will this water last the household? **(7 marks)**

$$Rooftop\ \text{water yield} = A \times R \times C \qquad (1)$$

Where:

A - Rooftop area (m^2)
R - Annual rainfall (mm)
C - Water yield (0.8 Liters/mm/m^2)

Table 1. Monthly mean rainfall data for Agro-ecological zones (1997-2007)

Month	Ecological Zones Mean Rainfall (mm)					
	Highveld	Middleveld		Lowveld		Lubombo Plateau
		Upper	Lower	Eastern	Western	
January	166.7	133.30	130.18	125.47	126.20	167.96
February	158.04	161.14	166.40	105.04	141.26	149.41
March	130.65	97.74	181.01	69.04	95.31	109.95
April	65.04	59.90	59.15	37.27	60.75	53.63
May	22.07	7.14	20.16	12.14	14.95	13.08
June	15.61	8.78	14.75	11.18	9.23	12.52
July	12.54	5.05	9.02	9.64	7.28	14.25
August	16.14	8.29	45.42	17.59	9.45	16.46
September	44.17	30.23	27.23	22.73	28.13	35.26
October	98.80	63.76	71.19	56.25	52.33	78.38

Source: Meteorology Department, (2008)

D) **i.** What are the sources of pollution for rooftop water harvesting? **(4 marks)**

ii. State the **design feature** that could be specified to minimise the pollution. **(2 marks)**

E) Briefly describe the information that is required to calculate the demand for small rural community water supply. **(6 marks)**

[40 marks]

SECTION II: ANSWER ANY TWO QUESTIONS

QUESTION 2

A) Briefly describe the **three (3) major sources** of rural water supply for domestic use in Swaziland? **(9 marks)**

B) The Swaziland Water Services Cooperation is responsible for providing water to the urban areas in Swaziland. Discuss any **five major challenges** of extending this social responsibility to all rural areas in Swaziland? **(11 marks)**

C) Briefly discuss how each of the **above challenges** can be **overcome.** **(10 marks)**

[30 marks]

QUESTION 3

An earth dam is to be constructed to provide storage of at least **120, 000 m^3** of irrigation water. The catchment from which the water will be obtained has a total size of 144 ha of sandy clay soil. The catchment is **800 m** wide, and has a maximum length of **1800 m** with a slope of **10 m** fall over the full length. The area receives an average rainfall of **800 mm/year.** The rainfall intensity for the catchment area is **100 mm/h** with a runoff coefficient **(C) of 0.36**.

A) i. Determine if the catchment is capable of providing enough water for the required storage of **120, 000 m^3 (Table 1).** **(10 marks)**

ii. Calculate the **design peak runoff** to accommodate the **100 mm/h** storm using **equation 1**. **(10 marks)**

$$Q = \frac{CiA}{360} \quad \textbf{(1)}$$

B) i. What are the **three (3)** types of **earth dams?** **(6 marks)**

ii. Briefly discuss the role of water storage in agricultural crop production. **(4 marks)**

Table 1. Runoff from catchment areas.

Average rainfall, R (mm)	Total Annual Evaporation. (mm)	Reliability (yrs out of 10)	Runoff as a % of Average Rainfall, Y			
			Shallow sand or loam soils (%)	Sandy clays (%)	Elastic clays	Clay pans, inelastic clays or shales (%)
> 1100	-	8	10 – 15	0 – 15	15 – 20	15 - 25
	-	9	6.5 – 10	6.5 – 10	10 – 13	10 – 16.5
	-	8	10 – 12.5	10 – 15	12.5 – 20	15 - 20
	-	9	6.5 – 8	6.5 – 10	8 – 13	10 - 13
901-1100	-	8	10-12.5	10 – 15	12.5 – 20	15 – 20
	-	9	6.5 – 8	6.5 – 10	8 – 13	10 - 13
501- 900	< 1300	8	7.5 -10	7.5 – 15	7.5 – 15	10 - 15
		9	5 – 6.5	5 – 10	5 – 10	6.5 - 10
	1300-1800	8	5-7.5	5-12.5	5-10	10-15
		9	3-5	3-8	3-6.5	6.5-10
401-500	1300-1800	8	2.5-5	5-10	2.5-5	7.5-12.5
		9	1.5-3	3-6.5	1.5-3	5-8
250-400	<1800	8	0-2.5	0-5	0-2.5	2.5-7.5
		9	0-1.5	0-3	0-1.5	1.5-5
	≥1800	8	0	0-2.5	0	2.5-5
		9	0	0-1.5	0	1.5-3

Source: Nelson (1985)

QUESTION 4

A) Name any **three (3)** methods used to determine of **reservoir capacity** for **water storage** other than the **spot height** method. **(6 marks)**

B) **i.** Discuss the design features of the Mdlwayiza canal that utilizes the continuity equation to convey water by gravity over a 40 km distance from Mhlabubove to Malkerns. **(8 marks)**

iii. Calculate the **rate of flow** in a concrete lined channel of trapezoidal cross section with the following specifications: **(8 marks)**

- Top width = 1.8 m.
- Bottom width = 1.0 m.
- Depth of channel = 0.85 m.
- Freeboard = 0.25 m.
- Velocity of flow = 1.5 m/s.

The following equations may be useful:

$$\mathbf{A = bd + zd^2} \qquad \textbf{(1)}$$

$$z = \frac{e}{d} \qquad \textbf{(2)}$$

$$e = \frac{(T-b)}{2} \qquad \textbf{(3)}$$

iv. Draw a fully labelled sketch of the cross section. **(4 marks)**

C) Discuss briefly with the aid of a diagram the **water distribution** system.

(4 marks)

[30 marks]