UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER

PROGRAMME: BSC ABE III

COURSE CODE: ABE 304

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: COMPULSORY

QUESTION 1

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

B) I. A small rural community of **10 000 people** in the Highveld of Swaziland had water requirements of **40L/h/d** with a peak day factor **(PDF)** of **1.2**. **Calculate** the **design capacity** for this community in **m^3/day** and **m^3/ h**.

(10 marks)

II. What kind of material would you recommend to be used for the construction of the water storage tank for the community water supply? **(5 marks)**

C) I. Derive the **equation** of the **rate of discharge, Q**, for a confined aquifer.

(5 marks)

II. A well fully penetrates **25 m** thick confined aquifer. After a long period of pumping at a constant rate of **0.05 m^3/s**, the draw down at distances of ~~**50 m and**~~ **50 m** and **150 m** from the **well** were observed to be **3 m** and **1.2 m**, respectively.

i. Calculate the **hydraulic conductivity** of the **soil material**. **(5 marks)**

ii. Determine the **transmissivity** of the **aquifer**. **(5 marks)**

iii. If you were **supervising** the **drilling** of this well, **explain** what these results mean. **(5 marks)**

[40 marks]

SECTION II: ANSWER ANY TWO QUESTIONS

QUESTION 2

A) Define **run-off** as used in small rural community **water supply.** **(2 marks)**

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

i. **What** are the **two (2)** water bodies that could be used for rural water supply intake to channel water for domestic applications? **(2 marks)**

ii. The velocity of flow through an intake is suppose to be less than **0.1 m/s** to reduce the drawing in of silt and suspended matter. If the cross sectional area **(A)** of the channel was **900 m^2** with a discharge **(Q)** of **100 m^3/s**. Prove if this intake velocity was suitable using **equation 1.** **(6 marks)**

$$Q = V \times A \qquad (1)$$

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 2** may be used for this calculation **(5 marks)**

ii. How many days will this water last the household? **(5 marks)**

$$\textit{Rooftop}\ \text{water yield} = A \times R \times C \qquad (2)$$

Where:

A - Rooftop area (m^2)

R - Annual rainfall (mm)

C - Water yield (0.8 Litres/mm/m^2)

[30 marks]

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)

QUESTION 3

A) i. The **Mdlwayiza canal** in **Malkerns, Swaziland** uses the **"continuity principle"** to convey water by gravity over a distance of more than **14 km**. Discuss briefly how this hydraulics principle **works** and explain its **relevance** in rural water supplies. **(5 marks)**

ii. Water flows from a tank into a pipe at a rate of **1.0 L/s**. Calculate the velocity of entrance into the pipe if the internal diameter of the inlet is **45 mm**. **(5 marks)**

iii. The pipe does not maintain its size as its outlet has a diameter of **50 mm**; calculate the new velocity at that section of the pipe. **(5 marks)**

B) Briefly discus the following concepts as used in rural water supply.

i. Water harvesting. **(5 marks)**

ii. Water collected from rivers and streams. **(5 marks)**

iii. Ground water. **(5 marks)**

[30 marks]

QUESTION 4

An earth dam is to be constructed to provide storage of at least **115, 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 **115, 000 m^3 (Table 2).** **(10 marks)**

ii. Calculate the design peak runoff to accommodate the 100 mm/h storm using **equation 3.** **(10 marks)**

$$Q = \frac{CiA}{360} \qquad (3)$$

B) **i.** Name the three (3) most common types of earth dams. **(5 marks)**

ii. Briefly discuss the role of water storage in agricultural production.

(5 marks)

[30 marks]

Table 2. 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)