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 information that you would require to determine the water demand requirements for a small rural community. **(15 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) A small rural community in the **Middleveld of Swaziland** identified the following water needs for its annual operations.

- **1000** Livestock - 20 – 2- L/TLU/day.
- **400** day scholars - 15 – 30 L/pupil/ day.
- **200** private house water connections - 30 – 60 L /capita/day.

i. Calculate the total annual water needs for the community assuming no losses. **(5 marks)**

ii. If **surface water sources** were the only available to the community, briefly discuss the inherent problems of such sources of water. **(5 marks)**

[40 marks]

SECTION II: ANSWER ANY TWO QUESTIONS

QUESTION 2

A) Define the following terms as used in groundwater

i. Porus media.

ii. Vadose zone

iii. Aquifer.

iv. Unconfined aquifer.

v. Specific yield. **(10 marks)**

B) A **well** fully penetrates a **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 **150 m** from the **well** were observed to be **3 m** and **1.2 m**, respectively. Determine the following:

i. Hydraulic conductivity. **(3 marks)**

ii. Transmissivity. **(3 marks)**

iii. A well penetrates a **confined aquifer** of **course gravel 7.0 m thick** and is screened throughout the thickness of the aquifer. Hydraulic conductivity measurements made in a well in the same region yield a value of **10 m/d.** Two observation wells are installed at radial distances of **20 m** and **120 m** from the pumped well. The well is to be tested by pumping at a constant discharge of **2725 m^3/d.** If the draw down in the observation well at **120 m** distance is **1.26 m** under steady state conditions, **compute the expected drawdown in the well at 20 m distance.** **(4 marks)**

C) Given that a well test data from a constant rate test in a confined aquifer shows; **t_o = 0.42 minutes** and **Δs = 0.60 m** with an observation well located **60 m** from the pumped well. The discharge from the pumped well was held constant at **2500 m3/d.** Compute the transmissivity and storativity of the aquifer. **(10 marks)**

[30 marks]

QUESTION 3

A) **i.** What are the major **sources** of pollution for rooftop water harvesting? **(5 marks)**

ii. State the **design feature** that could be specified to minimise the pollution.

(2 marks)

B) Discuss briefly with the aid of sketches, the typical components of a rooftop rainwater harvesting system. **(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 20litres/day. **Equation 1** may be used for this calculation. **(8 marks)**

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

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

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)

[30 marks]

QUESTION 4

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

B) **Figure 1** shows spot heights of a levelling grid for an excavated water reservoir site intended for use as a pond for water storage.

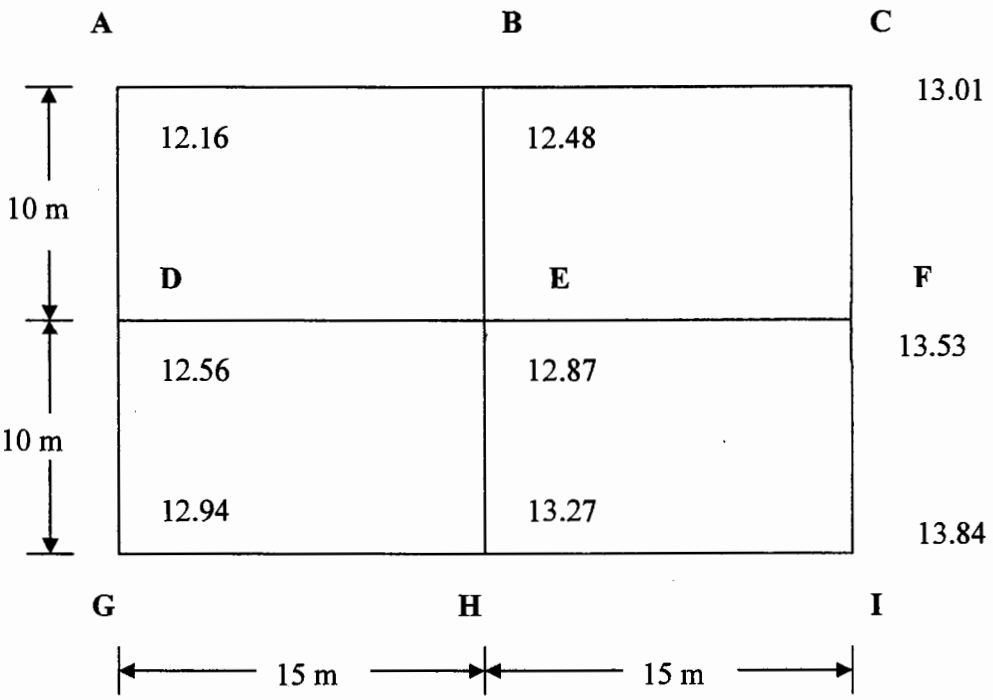

Figure 1. Reservoir spot heights for a levelling grid

i. If the excavated reservoir is to have a uniform depth of **8.0 m** above datum, calculate the mean level using **equation 2** and **Table 2**. **(8 marks)**

$$\text{Mean level} = \frac{\Sigma(\text{RL x n})}{\Sigma \text{n}} \qquad \textbf{(2)}$$

ii. Calculate the **depth** of excavation. **(8 marks)**

iii. Calculate the **volume** of excavation. **(8 marks)**

[30 marks]

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Table 2. Volume calculation from spot height levelling grid

Station	Reduced level (RL) (m)	Number of Times RL is used (n)	Product (RL x n) (m)
Total			