2nd SEM.2016/2017

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: (I) ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS, (II) MARKS WILL BE GIVEN TO LOGICALLY PRESENTED NUMERICAL SOLUTIONS

DO NOT OPEN THIS PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE CHIEF INVIGILATOR

SECTION I: COMPULSARY

QUESTION 1

A) i. What are the three components of a rooftop rainwater harvesting system? **(3 marks)**

ii. 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)

Rooftop water yield = A x R X C **(1)**

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

iii. Name two sources of pollution for rooftop water harvesting? **(2 marks)**

iv. State the design feature that could be specified to minimise the pollution. **(1mark)**

B) i. Explain the **"continuity principle"** in hydraulics. **(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 **40 mm**. **(5 marks)**

iii. The pipe does not maintain its size as its outlet has a diameter of **45 mm**; calculate the new velocity at that section of the pipe. **(4 marks)**

C) The Swaziland Water Services Cooperation has the responsibility to provide metered water supply to urban areas in Swaziland. Discuss briefly what challenges it could face if it had to extend this service to the rural areas in Swaziland. **(5 marks)**

[40 marks]

SECTION II: ANSWER ANY TWO QUESTIONS

QUESTION 2

A) Discuss briefly the information that is required to determine the water demand requirements for a small rural community water supply. **(15 marks)**

B) A rural community of **15 000** people in Terrabethea had water requirements of **40 l/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)**

C) What kind of material could be recommended for the construction of the water storage tank for the community water supply? **(5 marks)**

[30 marks]

QUESTION 3

A) 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)**

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

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

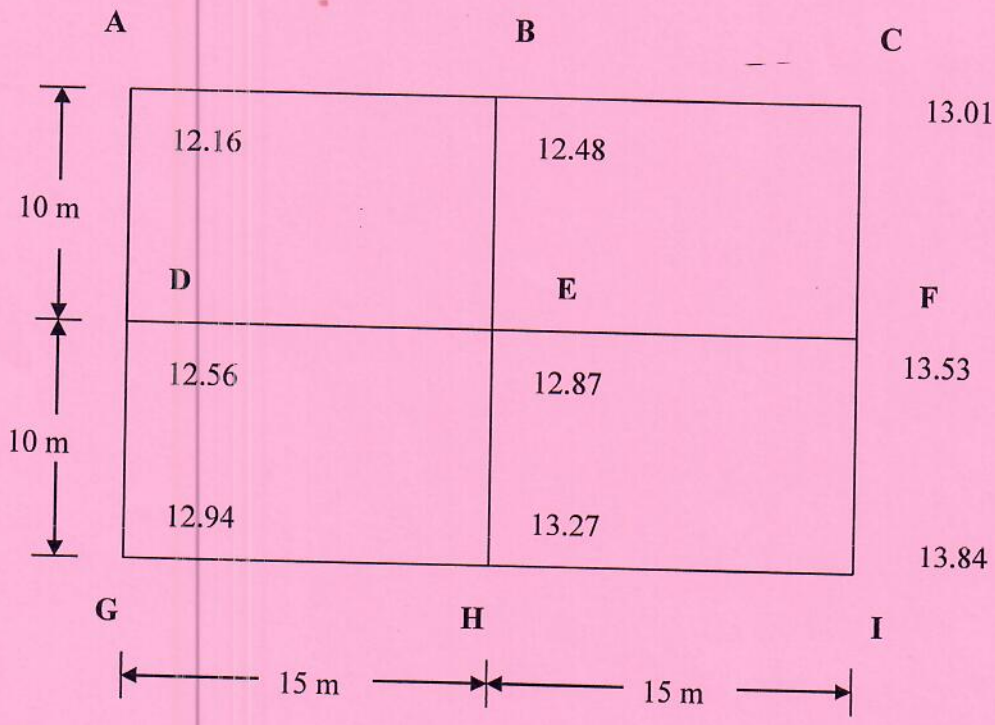

Figure 1. Reservoir spot heights for a levelling grid

iii. 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 (the table should be drawn on the answer sheet).** **(7 marks)**

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

iv. Calculate the depth of excavation. **(2 marks)**

v. Calculate the volume of excavation. **(3 marks)**

[30 marks]

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			

QUESTION 4

A) 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.**

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

(10 marks)

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

$$Q = \frac{CiA}{360} \qquad \textbf{(2)}$$

Table 3. Runoff from catchment areas

Average rainfall, R (mm)	Total annual evap. (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)

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

ii. Briefly discuss the role of water storage in land and water management. **(7 marks)**

[30 marks]