

1st SEM.2018/2019

PAGE 1 OF 6



**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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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 Highveld (Table 1), with a rooftop area of **50.0 m²** and per capita water requirements of 20 Litres/day. Equation 1 may be used for this calculation. (5 marks)

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

Where: A - Rooftop area (m²) R - Annual rainfall (mm)
C - Water yield (0.8 litres/mm/m²)

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

Rainfall data for Agro-ecological zones (1997-2007)						
Month	Ecological Zones Mean Rainfall (mm)					Lubombo Plateau
	Highveld	Middleveld		Lowveld		
		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)						

Source: Meteorology Department, (2008)

- iii. Name two sources of pollution for rooftop rainwater 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 Eswatini 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)

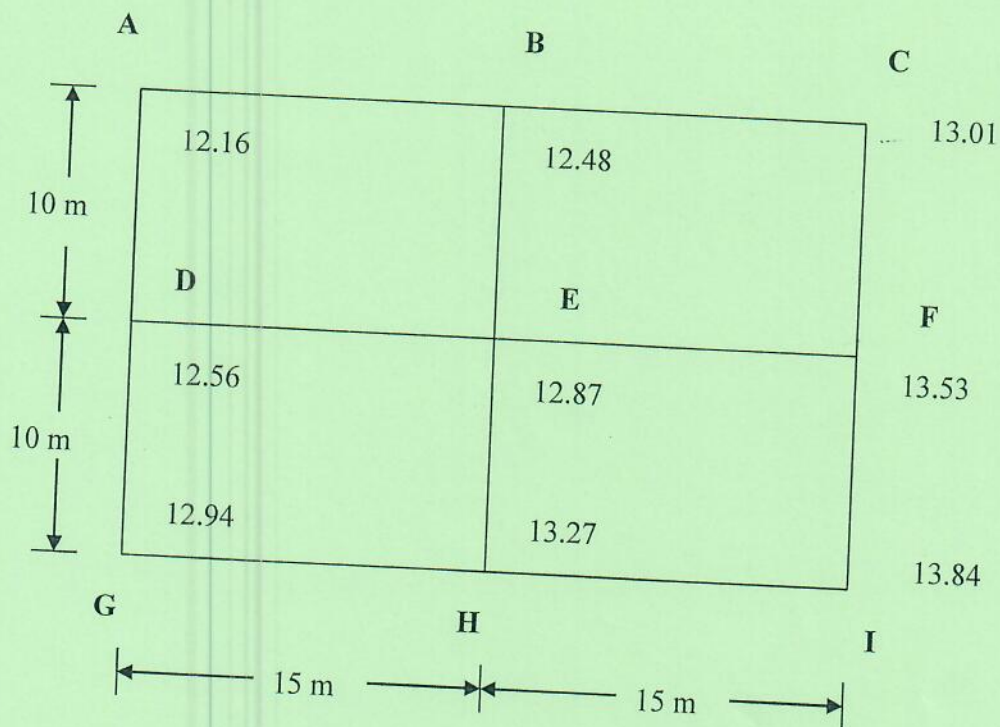
[40 marks]

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. Use examples from Eswatini to reflect the institutions where the information could be sourced from.
- (15 marks)
- B) A rural community of 20, 000 people in Neverland 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 Neverland community water supply?
- (5 marks)
- [30 marks]

QUESTION 3

- A) Briefly discuss the following concepts as used in rural water supply.
- Water harvesting.
 - Water collected from streams and rivers.
 - Ground water.
- (5 marks)
(5 marks)
(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.
- (15 marks)
- [30 marks]



- 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 (Please attach the table to the answer sheet). (7 marks)

$$\text{Mean level} = \frac{\sum(RL \times n)}{\sum n} \quad (2)$$

- iv. Calculate the depth of excavation. (2 marks)
- v. Calculate the volume of excavation. (3 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			

QUESTION 4

- A) An earth dam is to be constructed to provide storage of at least **120,000 m³** 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**.
- Determine if the catchment is capable of providing enough water for the required storage of **120,000 m³** (**Table 3**). **(10 marks)**
 - Calculate the design peak runoff to accommodate the **100 mm/h** storm. **(10 marks)**

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

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
	1300-1800	8	5 - 6.5	5 - 10	5 - 10	6.5 - 10
		9	5 - 7.5	5 - 12.5	5 - 10	10 - 15
401 - 500	1300-1800	8	3 - 5	3 - 8	3 - 6.5	6.5 - 10
		9	2.5 - 5	5 - 10	2.5 - 5	7.5 - 12.5
250 - 400	< 1800	8	1.5 - 3	3 - 6.5	1.5 - 3	5 - 8
		9	0 - 2.5	0 - 5	0 - 2.5	2.5 - 7.5
	≥ 1800	8	0 - 1.5	0 - 3	0 - 1.5	1.5 - 5
		9	0	0 - 2.5	0	2.5 - 5
			0	0 - 1.5	0	1.5 - 3

Source: Nelson (1985).

- B)
- Name the **three (3)** types of earth dams. **(3 marks)**
 - Briefly discuss the role of water storage in land and water management. **(7 marks)**
- [30 marks]**