1st SEM.2019/2020

UNIVERSITY OF ESWATINI
FINAL EXAMINATION PAPER

PROGRAMME: BSC ABE III

COURSE CODE: ABE401

TITLE OF PAPER: RURAL WATER SUPPLY AND HYDROLOGY

TIME ALLOWED: TWO (2) HOURS

INSTRUCTIONS: ANSWER THE COMPULSARY QUESTION ONE AND ANY TWO OTHER QUESTIONS.

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SECTION I: COMPULSARY

QUESTION 1

A) A small rural community of **1000 households (X)** had a water supply project to conduct in order to meet its annual water consumption patterns. The community had **500 livestock.** The per capita water requirements were identified as **40 L/ TLU**, and **20 L / capita/ person (y)** and the average number of people per households **(Y)** was **4**.

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

ii. Calculate the annual water demand or consumption for this community using equation **1.** **(10 marks)**

$$R = (1+E)\,D \times X\,(Yy + Zz) \quad (1)$$

Where:

R - Domestic and livestock water requirement (Litres/ year).

E - Extra allowance for population growth usually taken as 50% increase i.e. 0.5.

D - Number of days for which the stored water supply is needed.

X - Number of households using the water.

Y - Average number of people in a household.

y - Average daily water consumption per person in the area (l/c/d)

Z - Average number of tropical livestock units (TLU) in a household.

z – Average daily water consumption per TLU (L/TLU/d).

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

ii. Why is it not advisable to directly use **run- off** from the catchment for rural water supply? **(3 marks)**

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

C) 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**.

i. Determine if the catchment is capable of providing enough water for the required storage of **140, 000 m³ (Table 1).** **(5 marks)**

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

(5 marks)

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

[40 marks]

SECTION II: ANSWER ANY TWO QUESTIONS

QUESTION 2

A) i. State and briefly discuss the other water conveyance method other than pipe flow. In the discussion, highlight the energy that is used to convey the water from intake to storage or point of use. **(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)**

iv. 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 3

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

B) **i.** If the excavated reservoir is to have a uniform depth of **8.0 m** above datum, **complete** and **calculate** the mean level using the data in **Table 1**. **(8 marks)**

Table 1. Volume calculation from spot heights grid.

Station	Reduced Level (R L) (m)	Number of Times RL is used (n)	Product (RL x n) (m)
A	12.16	1	
B	12.48	2	
C	13.01	1	
D	12.56	2	
E	12.82	4	
F	13.53	2	
G	12.94	1	
H	13.27	2	
I	13.84	1	
Total		**16**	

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

iii. Calculate the **volume** of excavation if the grid had a length of **30 m** and a width of **15 m**.

(8 marks)

[30 marks]

QUESTION 4

A) Discuss briefly with the aid of a diagram the **water distribution** system. **(6 marks)**

B) i. What are the **two water bodies** that could be used for rural water supply **intake** to channel water for domestic applications? **(4 marks)**

ii. The recommended velocity **(V)** of flow through an intake is less than **0.1 m/s.** If the channel cross-sectional area **(A)** was **970 m^2** with a discharge **(Q) of 100 m^3/s**. Prove that this intake velocity was suitable using **equation 1.**

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

(4 marks)

iii. Why should the **velocity** of water be this low at the water intake? **(1 mark)**

C) The Mdlwayiza canal in Malkerns uses the continuity equation principle to convey water by gravity over a distance of more than **40 km** from the Great Usuthu River water intake at Mhlabubovu. Discuss how this hydraulic principle was utilized in the **design and construction** of the canal to convey water over such a long distance. **(15 marks)**

[30 marks]