UNIVERSITY OF SWAZILAND
MAIN EXAMINATION PAPER

PROGRAMMES:

BSc. ABE 3, and BSc. Ag.Ed 3,

COURSE CODE: ABE 301

TITLE OF PAPER: SOIL AND WATER CONSERVATION

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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

SECTION A: COMPULSORY QUESTION

QUESTION 1

a. List and discuss the significance of any three (3) soil loss models in agriculture, clearly state the advantages and disadvantages of each. **[15 marks]**

b. A road is constructed through a forested area. Design features have to resist average annual erosion until vegetation is established. One section of the road side was cut into a hill of sandy material. The hill side leading to the road has a slope of 18% and a slope length of 100 m. It has no vegetative residues or topsoil on it. It has the following characteristics:

Table 1: Average monthly rainfall for Lavumisa

Month	**Rainfall (mm)**
March	0.0
April	10.0
May	76.0
June	110.0
July	95.0
August	53.0
September	39.0
October	8.0

Organic matter content - 0%; Silt 30%; fine sand 15%; sand 40%, structure is very fine granular; and permeability is moderate. Using the USLE, determine;

i. The *R* factor **[5 marks]**

ii. The *K* factor **[5 marks]**

iii. The *LS* factor **[5 marks]**

iv. Assuming no erosion control blankets are used but vegetation is allowed to grow, calculate the erosion that would occur from the first year in 10 year storm. **[10 marks]**

SECTION B: ATTEMPT ANY TWO (2) QUESTIONS

QUESTION 2

a. Give an in-depth description of the effect of vegetation on surface water runoff and erosion control. **[10 marks]**

b. You are tasked to design a trapezoidal waterway with batters of 1:3 to accommodate a discharge of 3 m^3/s on a land slope of 2%. Assume that the vegetation in the waterway will be maintained at a constant retardance of *C* and the design velocity is 1.2 m/s.

i. Determine the required cross-sectional area of the waterway **[3 marks]**

ii. Determine the required hydraulic radius of the waterway **[5 marks]**

iii. Determine the required bottom width and depth of flow **[2 marks]**

iv. Calculate constructed bank height **[3 marks]**

v. Calculate top width **[2 marks]**

vi. Calculate the Froude Number **[5 marks]**

QUESTION 3

a. Dr Zwane wants to harvest water on his 60 hectare farm. Given that the whole area have sandy loam soils, and that 45 hectares is hilly and good with a runoff coefficient of 0.65. The remainder is relatively flat and fair, with a coefficient of 0.40. If the average rainfall intensity was estimated at 25 mm/hr, calculate the peak runoff using the Rational Method. **[10 marks]**

b. About 7% of Swaziland is in an eroded state. Another 31.5% is under high risk of erosion. Discuss three (3) major causes of erosion in Swaziland, stating any three (3) major control measures that can be used. **[15 marks]**

c. Estimate the time of concentration for a watershed 500m long, with a difference of 60m in height when a storm of 90mm/hr lasts for 2 hours. **[5 marks]**

QUESTION 4

a. What are the major differences between the USLE and the RUSLE? **[5 marks]**

b. Discuss three (3) biophysical causes of land degradation **[15 marks]**

c. Discuss the significance of tied ridges and terraces in soil and water conservation, highlighting the conditions where they are most applicable. **[10 marks]**

APPENDIX

$$R = 0.297\left(\sum_{i=1}^{n}\frac{P_i^2}{P}\right)^{1.93}$$

$$R = 0.00373P^{2.2}$$

$$R = \frac{E \times I_{30}}{100}$$

$$E_j = 29(1 - 0.72e^{-0.05I_{15}})$$

$$LS = \left(\frac{l}{22.1}\right)^{x}(0.065 + 0.45s + 0.0065s^2)$$

$$K = [2.1 \times 10^{-4}(12 - M)[(S_i + f_s)(S_i + S)]^{1.14} + 3.35(A - 2) + 2.5(P - 3)]/759$$

$$B = \frac{sin\emptyset/0.0896}{[3.0(sin\emptyset)0.8 + 0.56]}$$

$$x = \frac{B}{(1 + B)} = 0.8$$

A = structure (classes 1-4)

1 = very fine granular (aggregates 1-2 mm diameter)
2 = fine granular (aggregates 2-3 mm diameter)
3 = medium or coarse granular (aggregates 3-5 mm diameter)
4 = blocky, platy, or massive (usually construction sites)

P = permeability class

1 = rapid (sandy soils, no layering)
2 = moderate to rapid (sandy loam)
3 = moderate (loam, silty loam soils)
4 = slow to moderate (clay loam, silt soils)
5 = slow (high clay content, or compacted soils of other textural

groups)
6 = very slow (high clay content, poor aggregation)

Figure 11.9 Waterway design chart for retardance C and land slope of 2%