UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER

PROGRAMME: DIPLOMA IN AGRICULTURE 3
DIPLOMA IN AGRICULTURAL EDUCATION 3

COURSE CODE: LUM 302

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.

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SECTION A: COMPULSORY QUESTION

QUESTION 1

a) Discuss the 3 methods of areal rainfall data analysis. **[12 marks]**

b) Name and illustrate the different classes of storms. **[12 marks]**

c) A smallholder farmer in the lower Middleveld of Swaziland owned a maize storage warehouse with a roof area of 11.0m x 22.0m in plan view. The average annual rainfall received in this area was reported to be 750mm. Assuming a 20% loss, taking into account evaporation and other losses,

i) Calculate the amount of rainfall water that could be harvested annually. **[5 marks]**

ii) Calculate the amount of rainfall that could be collected or harvested per day, assuming it rained everyday. **[5 marks]**

iii) If for some reason, the farmer has to store all the water, and he finds that only 30,000-liter capacity tanks are available, how many does he have to purchase to store the amount of water harvested in the year. **[6 marks]**

SECTION B: ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION 2

a) The Infiltration rate was monitored as a function of cumulative rainfall and found to be 20mm/h when a total of 100mm had infiltrated. If the eventual steady state infiltration was 5mm/h, estimate the infiltration rate at cumulate infiltration of 200mm and 400mm, using the Green-Ampt equation.

$i(t) = ic + b/I$ **[15 marks]**

b) Define and illustrate the concept of steady state infiltration. **[3 marks]**

c) Discuss four factors that influence infiltration. **[12 marks]**

QUESTION 3

a) About 7% of the country (Swaziland) is in an eroded state. Another 31.5% is under high risk of erosion (Manyatsi, 1997). Outline the causes of the worsening state of erosion in Swaziland. **[5 marks]**

b) Swazis are traditionally and predominantly livestock farmers. Briefly describe the activities of these livestock as they influence land degradation. **[10 marks]**

c) Describe in detail the general approaches of soil conservation in cultivated land. **[15marks]**

QUESTION 4

a) Describe briefly the factors that affect rainfall erosivity. **[5 marks]**

b) Design a parabolic grass waterway to convey peak flow of $6m^3/s$ on a 1% slope over an erodible sandy soil with Bermuda grass vegetation, which stands in a good stand cut to a height of 5cm. **[15 marks]**

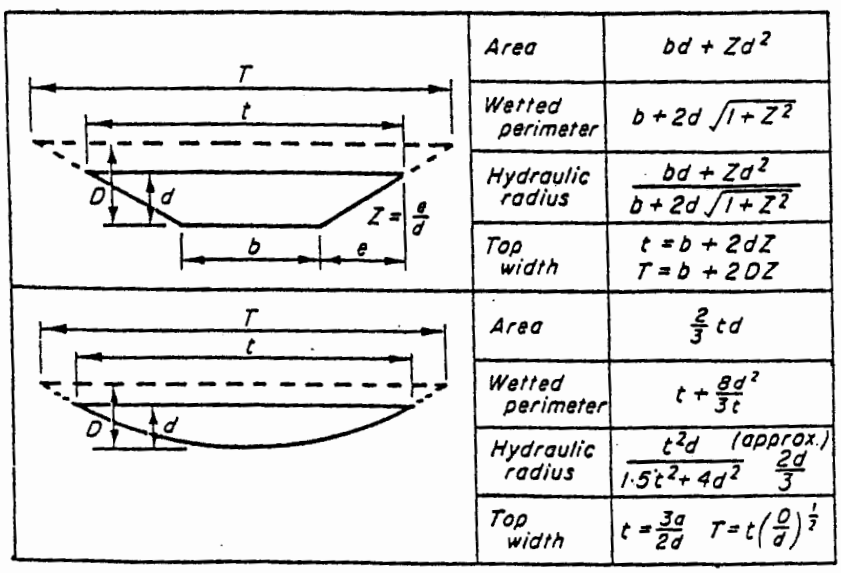
c) Several factors are responsible for the onset, rate and amount of soil erosion due to water. Explain. **[10 marks]**

LUM 302

Guide values for Manning's *n*

Land use or cover	Manning's *n*
Bare soil	
roughness depth <25 mm	0.010–0.030
roughness depth 25–50 mm	0.014–0.033
roughness depth 50–100 mm	0.023–0.038
roughness depth >100 mm	0.045–0.049
Bermuda grass – sparse to good cover	
very short (>50 mm)	0.015–0.040
short (50–100 mm)	0.030–0.060
medium (150–200 mm)	0.030–0.085
long (250–600 mm)	0.040–0.150
very long (>600 mm)	0.060–0.200
Bermuda grass – dense cover	0.300–0.480
Other dense sod-forming grasses	0.390–0.630
Dense bunch grasses	0.150
Kudzu	0.070–0.230
Lespedeza	0.100
Natural rangeland	0.100–0.320
Clipped rangeland	0.020–0.240
Wheat straw mulch	
2.5 t/ha	0.050–0.060
5.0 t/ha	0.075–0.150
7.5 t/ha	0.100–0.200
10.0 t/ha	0.130–0.250
Chopped maize stalks	
2.5 t/ha	0.012–0.050
5.0 t/ha	0.020–0.075
10.0 t/ha	0.023–0.130
Cotton	0.070–0.090
Wheat	0.100–0.300
Sorghum	0.040–0.110
Concrete or asphalt	0.010–0.013
Gravelled surface	0.012–0.030
Chisel-ploughed soil	
<0.6 t/ha residue	0.006–0.170
0.6–2.5 t/ha residue	0.070–0.340
2.5–7.5 t/ha residue	0.190–0.470
Disc-harrowed soil	
<0.6 t/ha residue	0.008–0.410
0.6–2.5 t/ha residue	0.100–0.250
2.5–7.5 t/ha residue	0.140–0.530
No tillage	
<0.6 t/ha residue	0.030–0.070
0.6–2.5 t/ha residue	0.010–0.130
2.5–7.5 t/ha residue	0.160–0.470
Bare mouldboard-ploughed soil	0.020–0.100
Bare soil tilled with coulter	0.050–0.130

After Petryk and Bosmajian (1975), Temple (1982) and Engman (1986).



Area	$bd + Zd^2$
Wetted perimeter	$b + 2d\sqrt{1+Z^2}$
Hydraulic radius	$\frac{bd + Zd^2}{b + 2d\sqrt{1+Z^2}}$
Top width	$t = b + 2dZ$ $T = b + 2DZ$
Area	$\frac{2}{3}td$
Wetted perimeter	$t + \frac{8d^2}{3t}$
Hydraulic radius	$\frac{t^2d}{1.5t^2 + 4d^2}$ (approx.) $\frac{2d}{3}$
Top width	$t = \frac{3a}{2d}$ $T = t\left(\frac{D}{d}\right)^{\frac{1}{2}}$

Basic dimensions of common channel sections

Maximum safe velocities (m/s) in channels based on covers expected after two seasons

Material	Bare	Medium grass cover	Very good grass cover
very light silty sand	0.3	0.75	1.5
light loose sand	0.5	0.9	1.5
coarse sand	0.75	1.25	1.7
sandy soil	0.75	1.5	2.0
firm clay loam	1.0	1.7	2.3
stiff clay or stiff gravelly soil	1.5	1.8	2.5
coarse gravels	1.5	1.8	*
shale, hardpan, soft rock etc	1.8	2.1	*
hard cemented conglomerates	2.5	*	*