39

UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER

PROGRAMME: DIPLOMA IN AGRICULTURE AND DIPLOMA IN AGRICULTURE EDUCATION YEAR 3

COURSE CODE: LUM 302 (M)

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 PERMISSION HAS BEEN GRANTED BY THE CHIEF INVIGILATOR

SECTION A: COMPULSORY QUESTION

QUESTION 1

a. Design a parabolic grass waterway to convey peak flow of $5m^3s$-1 on a 1.0 % slope over an erodible sandy soil with Bermuda grass vegetation, in a good stand cut to a height of 50mm. Allow an 18% freeboard. The roughness coefficient is 0.035 and velocity is 2.0m/s. Use Manning's formula for velocity:

$$v = \frac{R^{2/3} \quad S^{1/2}}{n}$$

20 marks

b. Describe how the following factors influence soil erosion;

i. Climate
ii. Soil
iii. Vegetation
iv. Topography

20 marks

SECTION B. CHOOSE ANY TWO QUESTIONS

QUESTION 2

a. Describing the mechanisms that result in detachment and transportation of soil particles, demonstrate the differences between rill erosion and sheet erosion.

20 marks

b. Explain the difference between storm duration and time of concentration.

5 marks

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

5 marks

QUESTION 3

a. Estimate the monthly evaporation rate for a pond using Daltons Law, when the water temperature is 13.6^{0c} and air temperature is 20.3^{0c}, when the wind speed and relative humidity are is 6.2 km/hr and 35% respectively.

10 marks

b. Explain how the length of slope and surface culture affect the total amount of runoff?

10 marks

SECTION A: COMPULSORY QUESTION

QUESTION 1

a. Design a parabolic grass waterway to convey peak flow of $5m^3s$-1 on a 1.0 % slope over an erodible sandy soil with Bermuda grass vegetation, in a good stand cut to a height of 50mm. Allow an 18% freeboard. The roughness coefficient is 0.035 and velocity is 2.0m/s. Use Manning's formula for velocity:

$$v = \frac{R^{2/3} \quad S^{1/2}}{n}$$

20 marks

b. Describe how the following factors influence soil erosion;

i. Climate
ii. Soil
iii. Vegetation
iv. Topography

20 marks

SECTION B. CHOOSE ANY TWO QUESTIONS

QUESTION 2

a. Describing the mechanisms that result in detachment and transportation of soil particles, demonstrate the differences between rill erosion and sheet erosion.

20 marks

b. Explain the difference between storm duration and time of concentration.

5 marks

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

5 marks

QUESTION 3

a. Estimate the monthly evaporation rate for a pond using Daltons Law, when the water temperature is 13.6^{0c} and air temperature is 20.3^{0c}, when the wind speed and relative humidity are is 6.2 km/hr and 35% respectively.

10 marks

b. Explain how the length of slope and surface culture affect the total amount of runoff?

10 marks

c. Mulching is one technique used to conserve water, explain the science behind this technique, i.e. how it achieves this purpose. 10 marks

QUESTION 4

a. With the aid of a diagram, describe the different stages during formation of a donga. 15 marks

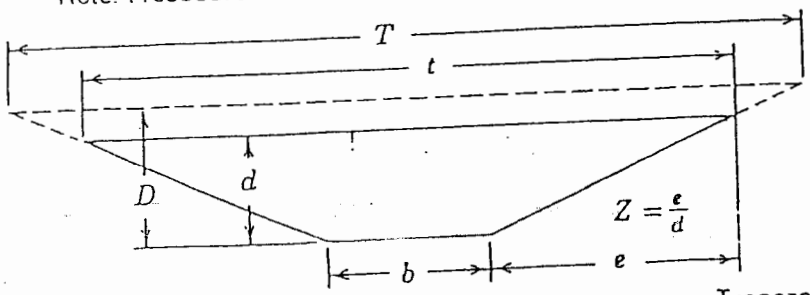
b. Given that 30 ha of the catchment area was sandy loam, relatively flat and fair with a coefficient of 0.5, while another portion (20 ha) of the catchment area was hilly, with clay soil and good, with a coefficient of .065. Taking the rainfall intensity to be 100 mm/hr, compute the peak run off rate using the Rational formula. Give your answer in m^3/s.

15 marks

Table 1. Saturated vapour pressure as a function of temperature t (negative values of t refer to conditions over ice: 1 mm Hg = 1.33 mbar).

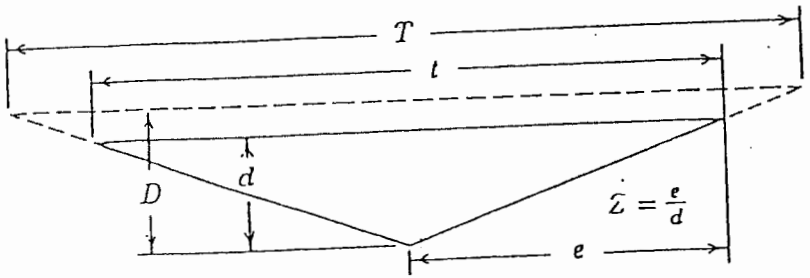
	c_s									
t (°C)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
−10	2.15									
−9	2.32	2.30	2.29	2.27	2.26	2.24	2.22	2.21	2.19	2.17
−8	2.51	2.49	2.47	2.45	2.43	2.41	2.40	2.38	2.36	2.34
−7	2.71	2.69	2.67	2.65	2.63	2.61	2.59	2.57	2.55	2.53
−6	2.93	2.91	2.89	2.86	2.84	2.82	2.80	2.77	2.75	2.73
−5	3.16	3.14	3.11	3.09	3.06	3.04	3.01	2.99	2.97	2.95
−4	3.41	3.39	3.37	3.34	3.32	3.29	3.27	3.24	3.22	3.18
−3	3.67	3.64	3.62	3.59	3.57	3.54	3.52	3.49	3.46	3.44
−2	3.97	3.94	3.91	3.88	3.85	3.82	3.79	3.76	3.73	3.70
−1	4.26	4.23	4.20	4.17	4.14	4.11	4.08	4.05	4.03	4.00
−0	4.58	4.55	4.52	4.49	4.46	4.43	4.40	4.36	4.33	4.29
0	4.58	4.62	4.65	4.69	4.71	4.75	4.78	4.82	4.86	4.89
1	4.92	4.96	5.00	5.03	5.07	5.11	5.14	5.18	5.21	5.25
2	5.29	5.33	5.37	5.40	5.44	5.48	5.53	5.57	5.60	5.64
3	5.68	5.72	5.76	5.80	5.84	5.89	5.93	5.97	6.01	6.06
4	6.10	6.14	6.18	6.23	6.27	6.31	6.36	6.40	6.45	6.49
5	6.54	6.58	6.54	6.68	6.72	6.77	6.82	6.86	6.91	6.96
6	7.01	7.06	7.11	7.16	7.20	7.25	7.31	7.36	7.41	7.46
7	7.51	7.56	7.61	7.67	7.72	7.77	7.82	7.88	7.93	7.98
8	8.04	8.10	8.15	8.21	8.26	8.32	8.37	8.43	8.48	8.54
9	8.61	8.67	8.73	8.78	8.84	8.90	8.96	9.02	9.08	9.14
10	9.20	9.26	9.33	9.39	9.46	9.52	9.58	9.65	9.71	9.77
11	9.84	9.90	9.97	10.03	10.10	10.17	10.24	10.31	10.38	10.45
12	10.52	10.58	10.66	10.72	10.79	10.86	10.93	11.00	11.08	11.15
13	11.23	11.30	11.38	11.75	11.53	11.60	11.68	11.76	11.83	11.91
14	11.98	12.06	12.14	12.22	12.96	12.38	12.46	12.54	12.62	12.70
15	12.78	12.86	12.95	13.03	13.11	13.20	13.28	13.37	13.45	13.54
16	13.63	13.71	13.80	13.90	13.99	14.08	14.17	14.26	14.35	14.44
17	14.53	14.62	14.71	14.80	14.90	14.99	15.09	15.17	15.27	15.38
18	15.46	15.56	15.66	15.76	15.96	15.96	16.06	16.16	16.26	16.36
19	16.46	16.57	16.68	16.79	16.90	17.00	17.10	17.21	17.32	17.43
20	17.53	17.64	17.75	17.86	17.97	18.08	18.20	18.31	18.43	18.54
21	18.65	18.77	18.88	19.00	19.11	19.23	19.35	19.46	19.58	19.70
22	19.82	19.94	20.06	20.19	20.31	20.43	20.58	20.69	20.80	20.93
23	21.05	21.19	21.32	21.45	21.58	21.71	21.84	21.97	22.10	22.23
24	22.27	22.50	22.63	22.76	22.91	23.05	23.19	23.31	23.45	23.60
25	23.75	23.90	24.03	24.20	24.35	24.49	24.64	24.79	24.94	25.08
26	25.31	25.45	25.60	25.74	25.89	26.03	26.18	26.32	26.46	26.60
27	26.74	26.90	27.05	27.21	27.37	27.53	27.69	27.85	28.00	28.16
28	28.32	28.49	28.66	28.83	29.00	29.17	29.34	29.51	29.68	29.85
29	30.03	30.20	30.38	30.56	30.74	30.92	31.10	31.28	31.46	31.64
30	31.82	32.00	32.19	32.38	32.57	32.76	32.95	33.14	33.33	33.52

Note: Freeboard = $D-d$ for all sections



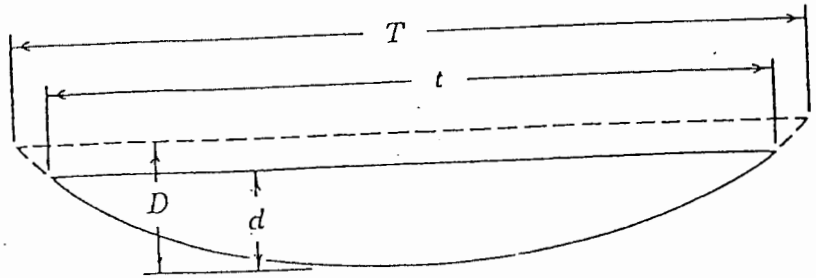
Cross-Sectional Area a	Wetted Perimeter, p	Hydraulic Radius $R=\frac{a}{p}$	Top Width
$bd + Zd^2$	$b + 2d\sqrt{Z^2+1}$	$\frac{bd + Zd^2}{b + 2d\sqrt{Z^2+1}}$	$t = b + 2dZ$ $T = b + 2DZ$

Trapezoidal cross section



Zd^2	$2d\sqrt{Z^2+1}$	$\frac{Zd}{2\sqrt{Z^2+1}}$ or $\frac{d}{2}$ approx.	$t = 2dZ$ $T = \frac{D}{d}t$

Triangular cross section



$\frac{2}{3}td$	$t + \frac{8d^2}{3t}$	$\frac{t^2d}{1.5t^2 + 4d^2}$ or $\frac{2d}{3}$ approx.	$t = \frac{a}{0.67d}$ $T = t\left(\frac{D}{d}\right)^{\frac{1}{2}}$

Parabolic cross section

Fig. 1.1 Channel cross section, wetted perimeter, hydraulic radius, and top width formulas.