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UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER

PROGRAMMES: BSC AG ED 3

COURSE CODE: ABE301

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 One

a. Using examples, explain the difference between agronomic and mechanical soil conservation practices? **15 marks**

b. It is alleged that the combination of agronomic and mechanical soil conservation practices are more effective in prevention of soil erosion and its rehabilitation. Describe a situation where the combination of the soil conservation practices would be useful (Use sketches to illustrate). **15 marks**

c. Given that air and water temperatures are 18.5^{oC} and 13.2^{oC} respectively, estimate the daily evaporation rate for a pond using Dalton's law, when the wind speed is 5 km/hr and relative humidity is 30%. **10 marks**

[40 marks]

SECTION B. ANSWER ANY TWO QUESTIONS

Question Two

a. Using the Zimbabwe method, determine the recommended spacing between terraces constructed on a grazing field (meadow)with highly erodible soils (4.0) with an average slope of 1.8^0. Express your answer in metres when: 1ft = 0.3048m.
If the grazing field has the following dimensions 800m by 400m, estimate the peak run off from the field when rain intensity is 110mm/hr and the field is under perennial grass cultivation (pasture), and the soil group is A. Design a **parabolic** grass waterway (using Manning's formula) to convey the peak runoff at the flow velocity is 1.5m/s and roughness coefficient of 0.035.

$$V = \frac{R^{2/3} \; S^{1/2}}{n}$$

[30 marks]

Question Three

a. Describe the hydraulic characteristics of surface flow in relation to detachment and movement of soil particles using the Reynolds' and Froudes' numbers.

10 marks

b. Explain the effect of the potential and kinetic energy on soil erosion by rainfall.

10 marks

c. Explain the three phase system of soil erosion process. **10 marks**

[30 marks]

Question four

a. Describe how the following influence the infiltration capacity of soil;

i. Vegetation /5

ii. Soil texture and structure /5

iii. Soil additives /5

iv. Slope /5 **20 marks**

b. Determine the time of concentration (Tc) for a catchment area with maximum length of 2.8 km and an elevation of 40 m from the higher point to the lower point of the catchment. **10 marks**

$\mathbf{Tc = 0.0195L^{0.77} S^{-0.385}}$ **[30 marks]**

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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

Cover and hydrologic condition	Coefficient C for rainfall rates of:		
	25 mm/h (1 iph)	100 mm/h (4 iph)	200 mm/h(8 iph)
Row crop, poor practice	0.63	0.65	0.66
Row crop, good practice	0.47	0.56	0.62
Small grain, poor practice	0.38	0.38	0.38
Small grain, good practice	0.18	0.21	0.22
Meadow, rotation, good	0.29	0.36	0.39
Pasture, permanent, good	0.02	0.17	0.23
Woodland, mature, good	0.02	0.10	0.15

Table 2.1 : Runoff Coefficient "C" for Agricultural Watersheds (Soil Group B)
Source : Horn and Schwab (1963) As Cited by Schwab et al (1981).

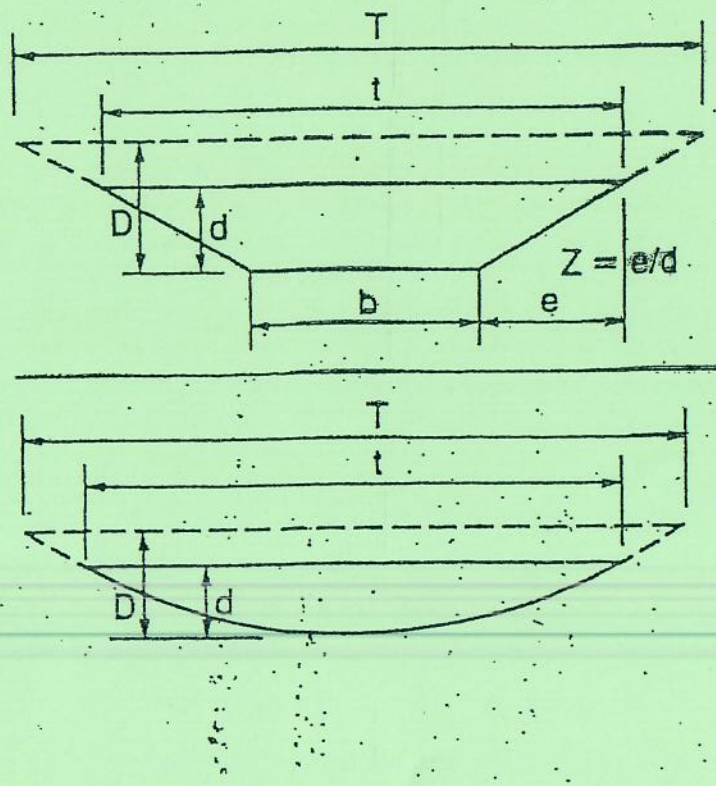
Cover and hydrologic condition	Factors for converting the runoff coefficient C from group B soils to:		
	Group A	Group C	Group D
Row crop, poor practice	0.89	1.09	1.12
Row crop, good practice	0.86	1.09	1.14
Small grain, poor practice	0.86	1.11	1.16
Small grain, good practice	0.84	1.11	1.16
Meadow, rotation, good	0.811	1.13	1.18
Pasture, permanent, good	0.64	1.21	1.31
Woodland, mature, good	0.45	1.27	1.40

Factors were computed from table 2.3 by dividing curve number for the desired soil group by the curve number for group B.

Table 2.2 : Hydrologic Soil Group Conversion Factors
Source : Horn and Schwab (1963) As Cited by Schwab et al (1981).

Approach

The design procedures are based on the principles of open-channel hydraulics. The method presented here represents an application of the Manning equation of flow velocity (Eq. 2.13). The cross-section of the waterway may be triangular, trapezoidal or parabolic. Triangular sections are not recommended because of the risk of scour at the lowest point. Since channels which are excavated as a trapezoidal section tend to become parabolic in time, the procedure described here is for a parabolic section.



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	$\frac{t^2d}{1{\cdot}5t^2 + 4d^2}$ (approx.) $\frac{2d}{3}$
Top width	$t = \frac{3a}{2d}$ $T = t(\frac{D}{d})^{\frac{1}{4}}$

Basic dimensions of common channel sections