

NATIONAL UNIVERSITY OF LESOTHO
FACULTY OF AGRICULTURE
DEPARTMENT OF SOIL SCIENCE & RESOURCE CONSERVATION

SSR220/4 – FUNDAMENTALS OF SOIL SCIENCE

FINAL EXAMINATION

Programmes:

**B.Sc. Agriculture – Soil Science, Crop Science, Agricultural Extension and Agricultural
Economics options;**

B.Ed and B.Sc.Geography, and B.Sc. Environmental Sciences

Year 2

May 2015

Total marks = 100

Time: 3 Hours

INSTRUCTIONS: ALL Questions in Section A are compulsory
Answer Any TWO Questions in Section B
And
Only ONE Question in Section C

Section A: Questions 1 and 2 are compulsory

Question1

- (a) List the soil formation factors in their order of significance. [5 marks]
- (b) Give a definition of soil that relates to the soil formation factors. [5 marks]
- (c) Soil formation processes involve:
- (i) Physical breakdown (weathering) of the parent rock into loose materials that can easily be moved and deposited at a different location by water or wind; normally followed by a sequence of physical and chemical weathering processes, which consist of gains and losses of some elements and/or compounds, with transformation of original parent minerals into new soil minerals.
TRUE/FALSE?
 - (ii) Transformations, translocations, additions and losses of some minerals and organic compounds.
TRUE/FALSE?
 - (iii) Transformations, translocations, additions and losses of some minerals and organic compounds; and mixing of unconsolidated materials by action of organisms, resulting in the development of layers of different characteristics.
TRUE/FALSE?
 - (iv) Physical disintegration of the parent rock into loose materials that can easily be attacked by biological and chemical factors through diverse chemical weathering processes into a product soil, without necessarily having been deposited by some agents, but still undergone gains, losses and mixing processes, resulting into the development of different soil layers.`
TRUE/FALSE?
- (d) The sand and silt particles of soil are produced through physical weathering of parent rocks and minerals, with minimal alteration of their chemical composition.
TRUE/FALSE?

- (e) Following continuous physical disintegration, the chemical weathering (chemical decomposition) of parent rock minerals by minor chemical alterations or complete dissolution of original minerals, and the synthesis of new minerals, two group of soil minerals are produced, namely (1) silicate clays and some very resistant clay minerals like oxides of iron and aluminium, and (2) silicate primary minerals which include very resistant minerals such as quartz. TRUE/FALSE?

- (f) Give three examples of

(i) Silicate clay minerals [3 marks]

(ii) Primary minerals other than quartz. [3 marks]

- (g) *The Table below show elemental chemical composition of the parent minerals and the possible resultant soil.*

Elemental chemical composition	Analysis (mg/kg)		Change (%)
	Column 2 =	Column 3 =	
Calcium (Ca)	27.2	0.184	−99
Sodium (Na)	36.2	0.197	−99
Magnesium (Mg)	5.28	1.38	−74
Phosphorus (P)	0.496	0.383	−23
Potassium (K)	9.79	7.88	−20
Silicon (Si)	324	308	−5
Aluminium (Al)	88.1	128	+45
Iron (Fe)	20.8	40.1	+93
Copper (Cu)	0.003	0.022	+633
Si/Al ratio	3.7	2.4	−35

Source: Brady, N.C. & Weil, R.R. (2002). Nature and Properties of Soils, 13th Edition

(i) Give appropriate labels for columns 2 and 3, respectively. [2 marks]

(ii) Give your critical analysis of the variation in elemental chemical composition between the materials for the columns 2 and 3 as labelled in (i) above.

[4 marks]

Question 2

- (a) Name the following soil parent materials: [2 marks each]
- (i) Residual material weathered from the underlying rock
 - (ii) Rock fragments detached from the heights above, and carried down-slope normally by gravitational force (sometimes plus frost action)
 - (iii) Materials deposited by wind.
 - (iv) Aeolian materials consisting of very fine particles (1 – 10µm) that can remain suspended in air, usually deposited with rain.
 - (v) Aeolian materials of very fine glassy ash particles blown down from the volcano during volcanic eruptions.
 - (vi) Weathered rock materials deposited into the lake/sea/ocean by the stream, normally near the mouth of the stream, forming a delta.....
 - (vii) Weathered materials that end up in the sea/estuaries/gulfs and later raised above the sea as the elevation of the later (sea/...) and the land changes into coastal plains.....
 - (viii) Sediments deposited in lakes by water melting from the glaciers (glacial lakes), including delta material and beach deposits, valley fills and outwash plains.....
 - (ix) Sediments deposited by ice or associated water.....
 - (x) Organic materials of varying origin, accumulating in wet places where decomposition rate is reduced, then sink in water.

SECTION B: Answer Only TWO Questions in this Section

Question 3

Describe the criteria for soil structural determination.

[15 marks]

Question 4

(a) Give two main soil chemical processes that control nutrients availability for plant use.

[4 marks]

(b) What is cation exchange capacity?

[5 marks]

(c) Which factors determine cation exchange capacity of soil?

[6 marks]

Question 5

(a) Which of the following movements of soil water is/are important for soil water availability to plants?

[4 marks]

(i) Capillary water movement

(ii) Saturated flow

(iii) Unsaturated flow

(iv) Vapour flow

(b) Rank the following in their decreasing order of magnitude:

●Gravitational water,

●Hygroscopic water,

●Readily available water,

●Slowly available water

[4 marks]

(c) Rank the following in their increasing order of magnitude:

●Field capacity,

●Hygroscopic coefficient,

●Wilting coefficient,

[3 marks]

(d) Differentiated between matrix potential and submergence potential.

[4 marks]

SECTION C: Answer Only ONE Question in this Section

Question 6

Give the elements that serve as nutrients for plants in soils, and the two main groups into which they belong. [10 marks]

Question 7

- (a) Which form of acidity is measured through:
 - (i) Measurement of pH in water? [1.5 marks]
 - (ii) Measurement of pH in salt solution? [1.5 marks]
- (b) Give all the components of soil pH (*without description*). [4 marks]
- (c) Give the normal range of soil pH. [1.5 marks]
- (d) Give an average soil pH range that is most favourable for plant growth, nutrients availability and microbial activities. [1.5 marks]