



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND
TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION (SCIENCE)
2ND YEAR 1ST SEMESTER 2016/17
MAIN REGULAR**

COURSE CODE: ALS 3214

COURSE TITLE: SOIL CHEMISTRY

EXAM VENUE:

STREAM: (BED SCI)

DATE:

EXAM SESSION: 2.00 – 4.00 PM

TIME: 2:00HRS

Instructions:

- 1. Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room**

Section A. Answer all the questions (30 marks)

Question 1

- a) Briefly discuss the contents of inorganic soil fraction often called the mineral fraction. (3 marks)
- b) Using examples, explain the importance of the soil organic fraction to the environment. (3 marks)
- c) The soil liquid phase (soil moisture) plays an important role to the chemistry of soils. Briefly discuss the importance of this phase. (3 marks)
- d) Discuss the importance of soil air to the chemistry of soils. (3 marks)
- e) Briefly discuss the following phenomenon that happens in soils. (4 marks)
- i. Sodic soils
 - ii. Saline soils
- f) Explain, in brief, the function of the following physical-chemical soil properties to the chemistry of soils in a particular region. (4 marks)
- i. Dissolved Oxygen
 - ii. Dissolved Carbon (IV) oxide
 - iii. Biological Oxygen Demand
 - iv. Soil Air
- g) Soil acidification is a major concern in plant growth. Outline the major soil acidification processes under the following subtopics
- i. Acidification from water
 - ii. Acidification from CO₂

- iii. Acidification from organic acids
- iv. Acidification from oxidation of S and N

(4 marks)

h) Soil silicates can be classified according to the arrangements of the SiO_4 tetrahedral in their structure. Give the observed morphology of the following classifications: (6 marks)

- i. Cyclosilicates
- ii. Inosilicates
- iii. Nesosilicates
- iv. Phyllosilicates
- v. Sorosilicates
- vi. Tectosilicates

Section B. Answer any TWO questions

Question 2.

In soil science, cation-exchange capacity (CEC) is the number of exchangeable cations per dry weight that a soil is capable of holding, at a given pH value, and available for exchange within the soil water solution. CEC is used as a measure of soil fertility, nutrient retention capacity, and the capacity to protect groundwater from cation contamination. It is expressed as milli-equivalent of hydrogen per 100 g of dry soil ($\text{m}_{\text{eq}}^+/\text{100g}$), or the SI unit centi-mol per kg (cmol^+/kg). Briefly discuss the CEC process and explain the fate of CEC to plants grown in soils rich in the following environments.

- i. Rich in Aluminium ions (5 marks)
- ii. Low pH (5 marks)
- iii. High organic matter (5 marks)
- iv. High sodium levels (5 marks)

Question 3

a) The structural chemistry of clay materials can be used to characterize different soil types. Soil clays can exist in crystalline, structurally disordered, or amorphous form. These soil clay features can be identified using techniques of x-ray diffraction analysis. Give a brief explanation of how the x-ray diffraction analysis works and sketch a possible spectra resulting from an x-ray diffractometer machine.

(8 marks)

b) A part from x-ray diffraction analysis, clay soils can also be categorized using the infrared spectrometer technique. Briefly explain how this technique works.

(4 marks)

c) The surface chemistry of soil clays can be divided into at least 3 categories. Briefly describe these categories.

(8 marks)

Question 4

a) Name at least two common minerals of the following phyllosilicate minerals in soils.

(6 marks)

- i. Kaolinite
- ii. Pyrophyllite
- iii. Chlorite

b) In case of a soil analysis by X-ray diffraction and the spectra shows featureless curves, Explain diagrammatically two other methods that can be employed to classify the soil.

(4 marks)

- c) Many, if not all, of the chemical reactions of soil clays are surface phenomena (e.g. cations exchange, and adsorption of water). Clay surfaces can be divided into at least 3 categories. Briefly describe these classifications. (10 marks)

Question 5

- a) Discuss human soil acidification using the Ammonium based fertilizers and Urea based fertilizers. Hence determine the fertilizers with the highest acidification properties. (10 marks)

- b) Discuss soil acidification under the following subtopics

- i. Ferrous materials
- ii. Elemental sulfur
- iii. Acid rain
- iv. Mining wastes
- v. Role of aluminum in soil acidification

(10 marks)

Periodic table

		Atomic number, Z																18																																																						
		Element symbol																																																																						
		Relative atomic mass, A _r																																																																						
		1	2		3			4			5			6			7			8			9			10			11			12			13			14			15			16			17			18																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
		H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	Ba	La-Lu	Cs	Fr	Ra	Ac-Lr	Pb	Bi	Po	At	Rn						
		1.008	4.00	6.94	9.01	10.81	12.01	14.01	16.00	19.00	20.18	22.99	24.31	26.98	28.09	30.97	32.06	35.45	39.95	39.10	40.08	44.96	47.90	50.94	52.01	54.94	55.85	58.93	63.54	65.41	69.72	72.59	74.92	78.96	83.80	85.47	87.62	88.91	91.22	92.91	95.94	98.91	101.07	102.91	106.42	107.87	112.40	114.82	121.75	127.60	126.90	131.30	132.91	137.34	132.91	223	226.03	207.19	208.98	210	210	210	210	222								
Lanthanoids		57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu																																									
Actinoids		89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr																																									