UNIVERSITY OF SARGODHA

DEPARTMENT OF SOIL & ENVIRONMENTAL SCIENCES, UNIVERSITY COLLEGE OF AGRICULTURE

COURSE OUTLINE SPRING 2020

Course Title: Soil Chemistry

Course Code: SAES-7102

Credit Hours: 3(2-1)

Instructor: Dr. Mukkram Ali Tahir

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| **DESCRIPTION & OBJECTIVES** |

**Aims of the course**: Learning of this course, understand the basic rules of soil chemical reactions. As soil chemistry is youngest branch of soil science, understanding the chemistry, explaining and illustrating the issues of soil formation and nutrient availability. This course also aims at modern soil chemistry level given information’s about soil plasma and soil matrix. The soil chemistry also define the chemical nature of mineral and rocks by which we understand the soil charge development and at environmental site learn the issues of organic and inorganic contaminates entry into earth ecosystem.

**Objectives of the course**: At the completion of the course, the students will become able to:

1. Understand key mechanism of nutrient availability and recycling
2. Learn about soil chemical reactions, soil electrochemical and chemical potential
3. Study the colloidal chemistry of the soil humus and its division into humified and non humified colloidal fraction
4. View implication of soil chemistry reactions in environmental quality
5. Define crystal lattice, its unit cell information
6. Understand how final fraction of soil (clay) grouped into crystalline amorphous and para crystalline clays

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| **READINGS** |

1. Tan, K. H. 2011.Principles of Soil Chemistry. Fourth Edition. Taylor & Francis Group. CRC Press , New York, USA.
2. Essington, M.E. 2004. Soil and Water Chemistry, An Integrative Approach. Taylor & Francis Group. CRC Press , New York, USA.
3. Sparks, D. L . 1998. Soil Physical Chemistry, Second Edition. Taylor & Francis Group. CRC Press , New York, U.S.A.

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| **CONTENTS** |

**Theory**

1. Chemical Principles
2. Water and Solute interactions
3. Soil solution-solid interaction
4. Mineral dissolution: Congruent and incongruent
5. Neo-formation of minerals in soil
6. Thermodynamics and applications in soil
7. Organic matter: composition and fractionation
8. Surface chemistry of soil matrix
9. Sorption and desorption: Chemical, Physical and Specific 9.1 Langmuir, freundlich and Vanselow models
10. Cation exchange: selectivity coefficients, equivalent fraction concept
    1. Hysteresis in ion exchange
    2. Anion exclusion
    3. Complementation effect
    4. Zeta Potential
11. Molecular retention: specific and non specific
12. Reactions of metal chelates in soil
13. Chemical behavior of ions/elements in aerated and submerged soils
14. Buffering reactions in soil
15. Chemical remediation of contaminated soils and waters

**Practical**

1. Determination of exchangeable ions
2. Comparison of freundlich and Langmuir models
3. Developing titration curves

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| **COURSE SCHEDULE** | | | | | |
| **Week** | **Topics and Readings**: *Give Reading No from your list of readings above and its Page Nos. relevant to the topic(s) covered each week* | | | | **Dates** |
| **Lecture** | **Topics** | **Pages** | **Book** |
| 1 | 1 | Geochemistry, environmental soil chemistry | (Chapter no 1&2)2-4 | Principles of Soil Chemistry | 02-03-2020 to  06-03-2020 |
| 2 | Atom and atomic structures | 7-13 |
| 3 | String theory and atomic model of Rutherford and Bohr | 13-24 |
| 2 | 1 | Sampling soil solution 98 | (Chapter No.3) 98,99,100 | Soil physical chemistry | 09-03-2020 to  13-03-2020 |
| 2 | Concept of soil solution 99 |
| 3 | Soil solution equilibrium 100 |
| 3 | 1 | Solid substitution and solid extraction | (Chapter No.3)121-125 | Soil physical chemistry | 16-03-2020 to  20-03-2020 |
| 2 | Solid phase stability |
| 3 | Solubility products and ion activity |
| 4 | 1 | Surface micro topography | (Chapter No.5)198-206 | Soil physical chemistry | 23-03-2020 to  27-03-2020 |
| 2 | Solubility product |
| 3 | Relative saturation |
| 5 | 1 | Solid solution precipitations | (Chapter No.5) 200,216,220 | Soil physical chemistry | 30-03-2020 to  03-04-2020 |
| 2 | Congurant verses incongurant dissolution |
| 3 | Solid solution |
| 6 | 1 | DDA analysis | (Chapter no 6)133,135,155 | Principles of soil chemistry | 06-04-2020 to  10-04-2020 |
| 2 | Clay fraction of soil |
| 3 | Neo formation of soil |
| 7 | 1 | Application of chemical thermodynamics to soil solution | (Chapter no 3)  98,102,105 | Soil physical chemistry | 13-04-2020 to  17-04-2020 |
| 2 | Variable states and thermodynamic states |
| 3 | Standard states and concentration states |
| 8 | 1 | Determination of soil organic carbon concentration | (Chapter no 4) 131 | Soil and Water chemistry | 20-04-2020 to  24-04-2020 |
| 2 | Organic matter in soil |
| 3 | Organic functional group |
|  |  | **Mid exams** |  |  | 27-04-2020 to  01-05-2020 |
| 9 | 1 | Soil organic matter | (Chapter no 4) 131 | Soil and Water chemistry | 04-05-2020 to  08-05-2020 |
| 2 | Genesis of soil humic and non humic sustances |
| 3 | humic substances |
| 10 | 1 | Adsorption kinetics and desorption hysteresis | Chapterno,7 311,313, 322,373 | Soil and Water chemistry | 11-05-2020 to  15-05-2020 |
| 2 | Surface functional group and complexes |
| 3 | Soil particle surfaces and source of charge |
| 11 | 1 | Adsorption isotherm langmuir equations | 18-05-2020 to  22-05-2020 |
| 2 | Surface charge density, point zero charge, organic functional group |
| 3 | Do |
| 12 | 1 | CEC, cation exchange reactions | Chapter N0.8 210,212,213,214 | Principles of soil chemistry | 25-05-2020 to  29-05-2020 |
| 2 | Imparical equation of cation reactions |
| 3 | Langmuir, freundlich and Vanselow equations |
| 13 | 1 | Adsorption isotherm freundlich equations | 01-06-2020 to  05-06-2020 |
| 2 | Cation exchange a begning for soil chemistry | (Chapter N0.8) 99 | Soil and water chemistry |
| 3 | Hysteresis in ion exchange |
| 14 | 1 | Anion exclusion |  | 08-06-2020 to  12-06-2020 |
| 2 | Complementation effect |
| 3 | Zeta Potential |
| 15 | 1 | Molecular retention: specific and non specific | (Chapter No. 12)  293-309 | Principles of soil chemistry | 15-06-2020 to  19-06-2020 |
| 2 | Reactions of metal chelates in soil |  |
| 3 | Chemical behavior of ions/elements in aerated and submerged soils |
| 16 | 1 | Buffering reactions in soil | (Chapter No. 7)  372-396 | Soil physical chemistry | 22-06-2020 to  26-06-2020 |
| 2 | Chemical remediation of contaminated soils and waters |
| 3 | Wetland soil, creating wetland and their conservation |

***Note****: You can reserve one week for sessional or mid-term exam, and if you wish, one week for student presentations of the assigned research project*

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| **RESEARCH PROJECT** |

Soil clay formation and its model and identification

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| **ASSIGNMENT CRITERIA** |

Sessional: 08

Project: 04

Presentation: 02

Participation: 02

Mid Exam: 12

Final Exam: 20

Practical: 20

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| **RULES AND REGULATIONS** |

75% class attendance is compulsory.

No class assignments after due date will be entertained.