**UNIVERSITY OF SARGODHA**

**DEPARTMENT OF SOIL & ENVIRONMENTAL SCIENCES, UNIVERSITY COLLEGE OF AGRICULTURE**

COURSE OUTLINE **Fall 2020-21**

Course Title: Chemical properties of soil

Course Code: SES-303

Credit Hours: 3(2-1)

Instructor: Dr. Mukkram Ali Tahir

Email: rai786@gmail.com

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| **DESCRIPTION AND OBJECTIVES** |

The aim of this course is to teach students regarding the concept of soil chemistry, soil composition and electrochemical potentials, colloidal chemistry of inorganic constitutes and impact of soil reactions on mineral nutrient availability.

At the completion of this course, students will be able to understand;

1. Soil chemistry and soil formations.
2. Need for acidic soil reactions; chemical characterization of saline and sodic soil.
3. Nature of clay –organics complex and its impact on soil fertility.

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| **INTENDED LEARNING OUTCOMES** |

After completion of this course, students will be able understand various chemical reactions occurring in the soil and impact of chemical properties of soil on plant growth along with management of plants according to the soil chemical nature.

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| **COURSE CONTENTS** |

Theory

1. Introduction
2. Silicate clay minerals: Structures and properties
3. Allophanes and sesquioxides
4. Soil colloids: Inorganic and organic
5. Charge characteristics of colloids: Sources and significance
6. Cation exchange and its significance
7. Zero point of charge
8. DDL theory: Assumptions and properties
9. Anion exchange and its significance
10. Soil pH: Description and significance
11. Basic cation saturation percentage: Description and significance; Buffering capacity of soils and significance
12. Exchange equations: Limitations and assumptions
13. Sorption in soil

Practical

1. Determination of pH of different soil water ratios and saturated soil paste
2. Determination of soluble and extractable cations in soil
3. Determination of CEC
4. Determination of basic cation saturation percentage
5. Determination of lime contents in soil

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| **READINGS** |

1. Sparks, D.L. 1998. Soil Physical Chemistry. 2nd Ed. CRC Press, Boca Raton, FL, USA.
2. Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA.
3. Essington, M.E. 2004. Soil and Water Chemistry: An Integrated Approach. CRC Press, Boca Raton, FL, USA.
4. Tan, K.H. 2005. Soil Sampling, Preparation, and Analysis. 2nd Ed. CRC Press, Greensboro, GA, USA.

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| **COURSE SCHEDULE** | | | |  | |
| **Week** | **Topics and Readings** | **Books with Page No.** | | **Dates** | |
|  | Introduction, Silicate Clay minerals: structure and properties, Soil Sampling and its types | Sparks, D.L. 1998. Soil Physical Chemistry. 2nd Ed. CRC Press, Boca Raton, FL, USA.  Tan .K.H. 2005. Soil Sampling, preparation and analysis.2nd ed.CRC Press, Greensboro, GA, USA. | | 12-10-2020  to  16-10-2020 | |
|  | Soil Colloids: inorganic and organic, Charge Characteristics of colloids: sources and significance, Mechanism of soil sampling | Tan .K.H. 2005. Soil Sampling, preparation and analysis.2nd ed.CRC Press, Greensboro, GA, USA.  Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 19-10-2020  to  23-10-2020 | |
|  | Zero point charge, DDL theory: assumptions and properties, Soil pH measurement | Tan .K.H. 2005. Soil Sampling, preparation and analysis.2nd ed.CRC Press, Greensboro, GA, USA.  Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 26-10-2020  to  30-10-2020 | |
| **4.** | Soil pH: description and significance, Basic cation saturation percentage: Description and significance; Buffering capacity of soils and significance, Types of soil reactions and their calculations | Tan .K.H. 2005. Soil Sampling, preparation and analysis.2nd ed.CRC Press, Greensboro, GA, USA. | | 02-11-2020  to  06-11-2020 | |
| **5.** | The clay fraction of soil, the structural chemistry of clay minerals, The identification of clay minerals | Sparks, D.L. 1998. Soil Physical Chemistry. 2nd Ed. CRC Press, Boca Raton, FL, USA. | | 09-11-2020  to  13-11-2020 | |
| **6.** | The dissociation of water, the dissociation of strong electrolytes,Colorimetric and potentiometric measurement | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 16-11-2020  to  20-11-2020 | |
| **7.** | The Henderson-Hasselbalch Equation, The colloidal system, electrochemical potential and pH measurement | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 23-11-2020  to  27-11-2020 | |
| **8.** | Soil humus, the colloidal chemistry of inorganic soil constituents, reagents and procedureof pHestimation | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 30-11-2020  to  04-12-2020 | |
| **9.** | Adsorption of cations by soil colloids, Cation Exchange Reactions, kinetic equation of cation exchange | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 07-12-2020  to  11-12-2020 | |
| **10.** | MID-TERM EXAMINATION |  | | 14-12-2020  to  18-12-2020 | |
| **11.** | WINTER BREAK |  | | 21-12-2020  to  25-12-2020 | |
| **12.** | Adsorption of anions by soil colloids, Non -specific & specific adsorption, Electrochemical potential of negative ions | Essington, M.E. 2004. Soil and Water Chemistry: An Integrated Approach. CRC Press, Boca Raton, FL, USA. | | 28-12-2020  to  01-01-2021 | |
| **13.** | Acid-Base Chemistry, Formulation of soil acidity & alkalinity, acid strength and ion pair | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 04-01-2021  to  08-01-2021 | |
| **14.** | Soil chemistry and soil formation, crystal chemistry and mineral properties, redox reaction limits in soil | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 11-01-2021  to  15-01-2021 | |
| **15.** | Amorphous clays, Active Surface areas of soil, CEC determination principles. | Sparks, D.L. 1998. Soil Physical Chemistry. 2nd Ed. CRC Press, Boca Raton, FL, USA. | | 18-01-2021  to  22-01-2021 | |
| **16.** | The Specific surface area, the origin of negative charges in soil clays, metal and water bridging | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 25-01-2021  to  29-01-2021 | |
| **17.** | The dissociation of exposed hydroxyl group, Soil Reaction, Different methods of CEC determination, | Tan, K.H. 2011. 2001. Principles of Soil Chemistry. 4th Ed. CRC Press, Boca Raton, FL, USA. | | 01-02-2021  to  05-02-2021 | |
| **18.** | Clay organic compound complex, chemistry of humic substances, determination of lime content in soil | Tan .K.H. 2005. Soil Sampling, preparation and analysis.2nd ed.CRC Press, Greensboro, GA, USA. | | 08-02-2021  to  12-02-2021 | |
| **19.** | FINAL TERM |  | | 15-02-2021  to  19-02-2021 | |
| **RESEARCH PROJECT/PRACTICAL/LABS/ASSIGNMENTS** | | |  | |

1. Determination of pH of different soil water ratios and saturated soil paste
2. Determination of soluble and extractable cations in soil
3. Determination of CEC
4. Determination of basic cation saturation percentage
5. Determination of lime contents in soil

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| **ASSESSMENT CRITERIA** |

Sessional: 08 (project, presentation, participation)

Project: 06

Presentation: 02

Mid exam: 12

Final exam: 20

Practical exam: 20