Programme	B.Sc. (Hons) Agriculture (Major: Soil Science)	Course Code	SS-303	Credit Hours	3(2-1
Course Title	**CHEMICAL PROPERTIES OF SOIL**				

Course Introduction

Chemical properties of soil with their role in nutrient availability, chemical processes and soil condition for plant growth are discussed. The students should be able to measure and interpret the chemical properties and their role for plant growth and pollutant behavior.

Learning Outcomes

Upon successful completion of this course, students will be able to:

Understand Soil pH and Electrolytes:

- Comprehend the significance of soil pH in various agricultural and environmental contexts.
- Measure soil pH accurately using different electrolytes and soil-to-water ratios.
- Analyze the impact of varying soil-to-water ratios on soil pH readings.

Identify and Measure Soil Cations:

- Distinguish between soluble and extractable cations in soil.
- Employ appropriate laboratory techniques to determine the concentration of common cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) in soil samples.
- Interpret the results of cation measurements to make informed soil management decisions.

	Course Content (Theory)	Assignments/Readings
Week 1	**Unit 1** 1.1. Introduction to Soil Colloids 1.1.1. Overview of soil colloids, types, and their importance 1.1.2. Inorganic and organic colloids in detail	
Week 2	**Unit 2** 2.1. Layer Silicate Clays, Tectosilicates, and Sesquioxides	**Reading:** "The Nature and Properties of Soils" by Nyle C. Brady

	2.1.1. Structure and types of layer silicate clays	and Ray R. Weil (Chapter on Soil Colloids)
Week 3	2.1.2. Tectosilicates and sesquioxides	
Week 4	**Unit 3** 3.1. Charge Characteristics of Colloids 3.1.1. Sources of charge in soil colloids	Write a comparative essay on the properties and roles of inorganic and organic soil colloids in soil fertility and structure
Week 5	3.1.2. Significance of charge characteristics	
Week 6	**Unit 4** 4.1. Ion Exchange and Zero Point of Charge	Describe the structural differences between layer silicate clays, tectosilicates, and sesquioxides and explain their implications for soil chemistry and plant growth
Week 7	4.1.1. Ion exchange mechanisms 4.1.2. Ion exchange processes	
Week 8	4.1.3. Zero point of charge	
Week 9	4.1.4. Importance of Zero point of charge	
Week 10	**Unit 5** 5.1. Diffuse Double Layer Theory 5.1.1. Introduction to diffuse double layer theory	Discuss the sources of charge in soil colloids and their significance in soil nutrient availability and pollutant retention
Week 11	5.1.2. Applications and significance of the theory	
Week 12	**Unit 6** 6.1. Soil pH and Buffering Capacity	

	6.1.1. Factors affecting soil pH	
Week 13	6.1.2. Buffering capacity 6.1.3. Role in soil chemistry	
Week 14	**Unit 7** 7.1. Base Saturation Percentage 7.1.1. Definition and calculation of base saturation percentage 7.1.2. Impact of base saturation on soil fertility	Explain the concept of ion exchange and zero point of charge. Provide examples of their importance in soil fertility and environmental protection.
Week 15	**Unit 8** 8.1. Exchange Equations 8.1.1. Langmuir and Freundlich isotherms 8.1.2. Gapon equation and its applications	
Week 16	**Unit 9** 9.1. Sorption and Desorption in Soils 9.1.1. Processes of sorption in soils 9.1.2. Desorption mechanisms and factors affecting it	Write a detailed report on the processes of sorption and desorption in soils. Include case studies demonstrating the environmental significance of these processes
Course Content (Practical)		**Assignments/Readings**
Week 1	**Unit 1** 1.1. Introduction to soil pH 1.1.1. Basics of soil pH and its importance 1.1.2. Factors influencing soil pH	
Week 2	1.1.3. Soil pH measurement techniques 1.1.4. Measuring pH with different electrolytes 1.1.5. Common electrolytes used (e.g., KCl, CaCl2)	Practical notebook completion
Week 3	1.1.6. Soil to water ratios and their impact on pH measurement 1.1.7. Standard ratios (1:1, 1:2, 1:2.5, etc.) 1.1.8. Effect of different ratios on pH readings	

Week 4	1.1.9. Practical applications and laboratory exercises 1.1.10. Data analysis and interpretation	Practical notebook completion
Week 5	1.1.11. Soil pH measurement-Practical demonstration	
Week 6	**Unit 2** 2.1. Soluble and Extractable Cations in Soil 2.1.1. Introduction to soil cations 2.1.2. Definition and significance of soluble and extractable cations 2.1.3. Common cations found in soil (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+})	Practical notebook completion
Week 7	2.1.4. Methods for determining soluble cations 2.1.5. Laboratory techniques (e.g., extraction methods, flame photometry, atomic absorption spectrometry)	
Week 8	2.1.6. Methods for determining extractable cations 2.1.7. Comparison of different extraction methods (e.g., ammonium acetate, Mehlich-3)	Practical notebook completion
Week 9	2.1.8. Practical applications and laboratory exercises 2.1.9. Hands-on determination of soluble and extractable cations 2.1.10. Data analysis and interpretation	
Week 10	**Unit 3** 3.1. Cation Exchange Capacity (CEC) of Three 3.1.1. Different Textured Soils 3.1.2. Understanding cation exchange capacity (CEC) 3.1.3. Definition and importance of CEC 3.1.4. Factors affecting CEC	Practical notebook completion
Week 11	3.1.5. CEC measurement techniques 3.1.6. Common methods (e.g., ammonium acetate method, BaCl2 method)	
Week 12	3.1.7. Practical applications and laboratory exercises 3.1.8. Hands-on measurement of CEC in three different textured soils 3.1.9. Data analysis and comparison	Practical notebook completion
Week 13	**Unit 4** 4.1. Base Saturation Percentage 4.1.1. Introduction to base saturation percentage	

	4.1.2. Definition and significance 4.1.3. Factors influencing base saturation	
Week 14	4.1.4. Calculation and interpretation of base saturation percentage 4.1.5. Methods for determining base saturation 4.1.6. Practical applications in soil fertility management	Practical notebook completion
Week 15	**Unit 5** 5.1. Estimation of Gypsum Requirement 5.1.1. Understanding soil salinity and sodicity 5.1.2. Introduction to saline and sodic soils 5.1.3. Impact of excess sodium on soil structure and fertility	
Week 16	5.1.4. Estimation of gypsum requirement 5.1.5. Methods for calculating gypsum requirement 5.1.6. Laboratory exercises on gypsum requirement estimation	Practical notebook completion

Textbooks and Reading Material

1. Bohn, H. L., D. L. McNeal and G. A. O'Connor. 2001. Soil Chemistry. 3rd Ed. John Wiley & Sons. Inc., NY, USA.
2. Essington, M.E. 2004. Soil and Water Chemistry: An Integrated Approach. CRC Press, Boca Raton, FL, USA.
3. Sparks, D.L. 2003. Environmental Soil Chemistry. 2nd Ed. Academic Press, Inc., San Diego, CA, USA.
4. Sposito, G. 2008. The Chemistry of Soils. 2nd Ed. Oxford University Press, NY, USA.
5. Tan, K.H. 2009. Environmental Soil Science. 3rd Ed. CRC Press, Greensboro, GA, USA.

Teaching Learning Strategies

1. Multimedia
2. White Board
3. Group discussion
4. Quiz/Assignments
5. Demonstration/Activity

Assignments: Types and Number with Calendar

- **Reading:**
- "The Nature and Properties of Soils" by Nyle C. Brady and Ray R. Weil (Chapter on Soil Colloids)

- Write a comparative essay on the properties and roles of inorganic and organic soil colloids in soil fertility and structure
- Describe the structural differences between layer silicate clays, tectosilicates, and sesquioxides and explain their implications for soil chemistry and plant growth
- Discuss the sources of charge in soil colloids and their significance in soil nutrient availability and pollutant retention
- Explain the concept of ion exchange and zero point of charge. Provide examples of their importance in soil fertility and environmental protection
- Write a detailed report on the processes of sorption and desorption in soils. Include case studies demonstrating the environmental significance of these processes

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.