SWS 5406
Soil and Water Chemistry
Distance Education Section

Instructor: Dr. Samira Daroub, Professor, Soil and Water Sciences Dept.

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Office hours: Always open. Please call or email for an appointment.

Course Prerequisites: SWS 3022 or SWS 5050 (or equivalent); General Chemistry (CHEM 2046 or equivalent).

Credit Hours: 3 credits

Delivery Method: Web, Fall semester odd years.

Enrollment Cap: 20

Online meetings /Chat sessions: Thursdays 6-7:30 pm. Chat dates and topics are listed on lecture schedule (in this syllabus). We will use the same URL for all chats. No need for password, but please log in as a Guest using your full name. You may participate by typing or using a microphone/ webcam. Adobe has a guide for participants that includes a link to their Connect Test page that will check your computer for required plug-ins and connection speed. You can access the Guide Here. For further orientation on how to use Adobe Connect and other resources, please check the "Resources" page on class website on Canvas. Please not all chats are recorded and posted the following day under the" Chat" tab on main banner.

First chat for spring 2017 is Aug 24 @ 6 pm ET. The URL for the whole semester is
http://mbreeze.ifas.ufl.edu/r38mclnvo17/

Course Overview:
The course will cover the basic principles of soil and water chemistry. The class will cover the fundamentals principles of the properties of soil components and soil reactions that affect plant growth and environmental quality.

Course Objectives:

In this course, we will describe the soil solid and solution phases, introduce the chemical principles necessary to examine the soil environment, and identify the chemical processes that occur in the soil environment and ultimately impact the fate and behavior of substances in soil and other natural water systems.

After finishing this class, you will be able to:

1. Discuss the importance of the soil solution phase in which almost all chemical reactions in the soil occur, and be able to use and understand applications of speciation models.
2. Identify the common primary and secondary minerals, and solids that compose soils; explain their characteristics and potential reactivity in the environment.
3. Distinguish between ion exchange, adsorption, and precipitation reactions.
4. Debate the importance of pH and reduction/ oxidation (redox) status of a soil in dictating the aqueous speciation of an element, as well as reactivity, mobility, and toxicity; develop solubility and pH vs. Eh diagrams; and given the chemical and mineralogical properties of a soil determine which of these processes would dominate.
5. Characterize the chemistry, diagnosis, and reclamation of problematic soils like acid and alkaline soils.

Course Requirements: Students must have an e-mail account, Internet access, access to a computer that meets the University of Florida computer standards

Required Text: Soil and Water Chemistry: An Integrative approach. M. E. Essington. 2015 (2nd edition) CRC Press ISBN 9781466573154 (*first edition is OK to use also*)

Course Web Site: Narrated lectures of the class, handouts and assignments are posted on the class website **on Canvas**. Go to http://elearning.ufl.edu/ , log on using your Gatorlink. You need to have a gatorlink account http://www.gatorlink.ufl.edu/ to be able to log on to the class. Please note that E-learning needs Java to work properly. You can download Java from the same website.

Supplemental Reading Materials (Selected materials from other books posted on class website)

1. Environmental Chemistry of Soils. M. **McBride**. 1994. Oxford University Press.
2. The Chemistry of Soils. G. **Sposito**.1989., 2nd edition Oxford University Press.
3. Soil Chemistry. **Bohn,** McNeal, O'Connor, and Myer. 2001 3rd edition. John Wiley publishers.
4. Chemical Equibiria in Soils. W.L. **Lindsay**. 1979. John Wiley and Sons.
5. Selected Journal articles.

Students Responsibilities

Students are expected to study the assigned text sections and listen to narrated lectures prior to lecture coverage in class. Students are expected to actively participate in class chat discussions.

HW, Class Discussions and Exams:

This class has required HW, discussion posts, and exams as follows: 8 HW, 4 discussion posts, 3 bonus exercises and three on-line exams. Your final grade will be based on the cumulative score for the lecture exams, homework assignments, discussion posts, and short exercises.

GRADING:

HW:	8 HW @ 20 points each	= 160 points
Exams:	3 exams @ 100 points each	= 300 points
Discussions:	4 discussions @10 points each	= 40 points (+5 bonus points)
Bonus points:	3 Exercises @ 5 points each	= 15 bonus points

Total = 500 + 20 bonus = 520 points

Grade Scale:

A	≥ 450 pts	C+	≥ 380 pts
A-	≥ 440 pts	C	≥ 360 pts
B+	≥ 425 pts	C-	≥ 335 pts
B	≥ 405 pts	D+	≥ 315 pts
B-	≥ 395 pts	D	≥ 300 pts

For information on current UF policies for assigning grade points, see https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Attendance and Make-Up Work

Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx.

Online Course Evaluation Process;

Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at https://evaluations.ufl.edu. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results

Academic Honesty

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: *We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.* You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment*."

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information

regarding the Student Honor Code, please see:
http://www.dso.ufl.edu/SCCR/honorcodes/honorcode.php.

Software Use:
All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Services for Students with Disabilities
The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation
0001 Reid Hall, 352-392-8565, www.dso.ufl.edu/drc/

Campus Helping Resources
Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

1. *University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575,* www.counseling.ufl.edu/cwc/
   - Counseling Services
   - Groups and Workshops
   - Outreach and Consultation
   - Self-Help Library
   - Training Programs
   - Community Provider Database

2. U Matter We Care, www.umatter.ufl.edu/
3. *Career Resource Center,* First Floor JWRU, 392-1601, www.crc.ufl.edu/

Distance Classes:
Each online distance learning program has a process for, and will make every attempt to resolve, student complaints within its academic and administrative departments at the program level. See http://distance.ufl.edu/student-complaints for more details.

Lecture Outline

Module I: Introduction: Soil Chemistry, Soil Solution & Soil Solids

Section 1: Introduction & Overview of Basic Chemical Principles

Definition of Soil Chemistry

Review of Chemical Principles

Section 2: The Soil Solution

Lecture 1: Soil water sampling; Composition of soil solution

Activity concept, estimation of coefficients & measurements

Lecture 2: Water and ion water interactions

Lecture 3: Chemical Speciation (use of speciation programs-Minteq2)

Section 3: Soil Solids

Lecture 1: Elemental Composition of Soil

Lecture 2: Soil Minerals

Secondary Minerals

Soil Organic Matter

Week	Section 1 Introduction and Overview of Basic Principles	Chat Date Thursdays 6-7:30pm	Assessment Check due dates on Canvas
1 Aug 21 Classes start	I. Definition of Soil Chemistry; Relation to Plant Growth & Environmental Quality II. Review of chemical Principles (review handout) ***Read:*** 1. **McBride Chapter 1: Review of Chemical Principles** Sec. 1.2 a, b, d, g (PDF files posted) 2. Review of chemical principles handout	**Chat 1** **Aug 24** Introduction	**Exercise # 1** (5 bonus points) Review of Chemical Principles
	Section 2: The Soil Solution		
2 & 3 Aug 28 & Sept 5 ***Sept 4- Holiday*** ***Labor Day***	I. Soil Solution Part I: Soil Water Sampling; Composition of Soil Solution & Activity Concepts (sec 5.10; 5.3, 5.6) II. Soil Solution Part II: Water and Ion Water Interactions; Chemical reactions (sec 5.1, 5.2, 5.4, 5.5) ***Read:*** 1. **Textbook Essington Chapter 5 (skip sections 5.6.2; 5.6.3; and 5.11)** 2. Also (McBride) Chapter: Sec. 1.2 c, e (PDF posted)	**Chat 2: Aug 31** Questions: Exercise 1 & HW 1 **Chat 3: Sept 7** Questions on Soil solution and HW1	**HW #1** Soil Solution
4 Sept 11	Chemical Speciation (use of speciation programs-Minteq2) ***Read:*** I. Textbook Essington **Chapter 5:** (sec 5.8 & 5.9)	**Chat 4:** **Sept 14** Chemical speciation and HW 2	**HW # 2** Speciation *(Note HW 2 is due after exam 1)*
	Section 3: Soil Solids		
5& 6 Sep 18 & Sept 25	I. Soil Solids Part I: Elemental Composition of Soil, Principles of ionic solid structure & primary minerals II. Soil Solids Part II: Secondary minerals, Layer silicates, oxides & soil organic matter ***Read:*** I. Textbook Essington **Chapter 2: Soil Minerals (Sections 2.3 and 2.7 are FYI)**	**Chat 5:** **Sept 21** Soil solids ***No chat 6 on Sept 28 Due to travel*** Soil solids and Exam 1 Questions	**Exercise # 2** Soil solids (for 5 bonus points) **Exam # 1** **Sep. 30- Oct 2nd**

Module II
Soil Chemical Reactions

Section 1: Ion Exchange

Lecture 1: Concept & Source
Methods of CEC Measurements
Quantitative Description of Cation Exchange
A. Cation Exchange Equations

Lecture 2: Quantitative Description of Cation Exchange
B. The exchange isotherm
Point of Zero Charge

Section 2: Adsorption Reactions

Lecture 1: Introduction and definition
Surface functional groups
Surface complexes
Adsorption reactions
Diffuse double layer
A. Gouy Chapman Model
B. Stern Theory

Lecture 2: Quantitative description of Adsorption
A. Adsorption Isotherms
Surface complexation models

Section 3: Precipitation and Dissolution Reactions

Lecture 1: Precipitation – Dissolution Equilibria
Kinetics of mineral precipitation & dissolution
Precipitation in the soil environment

Lecture 2: Unified phase diagram: construction & interpretation
Double function parameters
Co-precipitation of trace elements

	Module II Soil Chemical Reactions	Chat Date Thursdays 6-7:30pm	Assessment Check due dates on Canvas
Week	**Section 1: Ion exchange**		
7 & 8 Oct. 2 & Oct 9	I. Ion Exchange Part 1: Source, CEC measurement and CEC equations II. Ion Exchange Part 2: Exchange Isotherm, point of zero charge ***Read:*** 1. Essington textbook: **Chapter 8** (1st ed.): pages 399-416 & 418-420 only); OR **Chapter 9** (2nd ed.): pages 489-507 & 514-531) 2. McBride Chapter 3 3. Review Tutorial on CEC	**Chat 7: Oct. 5** Questions on speciation exercise **Chat 8: Oct 12** Review of ion exchange and questions on HW3	HW # 3 **Ion Exchange**
	Section 2: Adsorption Reactions		
9 Oct. 16	I. Adsorption reactions Part 1: Surface functional groups and chemisroption (sec 7.1, 7.2) II. Adsorption reactions Part 2: Diffuse double layer and Adsorption isotherms (sec 7.2.3, 7.3) ***Read:*** 1. Essington textbook **Chapter 7 (**1st ed.); OR **Chapter 8** (2nd ed) 2. Review Tutorial on P adsorption	**Chat 9 and 10:** **Oct. 19 and Oct. 26** Sorption reactions and HW 4 *SSSA meetings Oct 22-25 soils.org*	HW # 4 Soil sorption
	Section 3: Precipitation and Dissolution Reactions		
10 & 11 Oct. 23 & Oct. 30	I. Precipitation and dissolution rxs Part 1: Equilibria and kinetics II. Precipitation and dissolution rxs Part 2: Unified phase diagram and double function parameters ***Read:*** 1. Essington textbook Chapter 6 (SKIP sections 6.2, 6.5.3, 6.5.4, 6.5.5, and 6.6) 2. Lindsay Chapter 12 (PDF posted) 3. Review tutorial on Unified solubility phase diagram	**Chat 11: Nov. 2** Precipitation reactions and HW 5	HW # 5 soil precipitation ***Exercise 3*** *Speciation exercise for 5 bonus points* ***(Due after exam2)*** Exam 2: Nov 4-6

Module III
Soil Chemical Reactions

Section 1: Soil Acidity

Lecture 1: Origin & Source
Classification of Soil Acidity
Aluminum Theory of Soil Acidity

Lecture 2: Buffer Ranges in Soils
Lime Requirements
Potential Hazards of Solid Acidification

Section 2: Oxidation Reduction Reactions

Lecture 1: Concept & Definitions
Thermodynamics Relationships
Redox Limits in Soils

Lecture 2: Oxidations-Reductions in Soils

A. The source of electrons
B. Electron acceptors in soil
C. Important redox couples in soils

Section 3: Salt Affected Soils

Lecture 1: Sources of Salinity and Alkalinity
Carbonate Equilibria

A. Sources of carbonates in the environment
B. Carbonate species found in solution
C. Equations to describe carbonate equilibrium
D. Carbonate equilibrium diagram.

Equations to describe the $CaCO_3$-CO_2-H_2O equilibria
Measures of salinity and alkalinity

Lecture 2: Clay Swelling and Dispersion
Effects of Salt degraded soils on plants
Reclamation of salt-degraded soils.

	Module III Soil Chemical Reactions	Chat Date Thursdays 6-7:30pm	Assessment Check due dates on Canvas
Week	Section 1: Soil Acidity		
12 Nov. 6 *Veterans Day Nov 10 (Holiday)*	I. Soil Acidity Part 1: Source, Classification and Al theory of soil acidity II. Soil Acidity Part 2:Buffers, Lime requirement and hazards of soil acidification Read 1. Essington textbook **Chapter 10** 2. Chapter 5 McBride 3. Additional reading materials: 2 papers on origin of acidity and liming 4. Review tutorial on soil acidity calculations	**Chat 11: Nov 9** **Soil Acidity**	HW # 6 soil acidity
	Section 2: Oxidation-Reduction Reactions		
13 & 14 Nov.13 & 20	I. Oxidation-Reduction Part 1: Definitions and thermodynamic relationships II. Oxidation-Reduction Part 2: Electron acceptors and redox couples in soils Read 1. Essington textbook **Chapter 9 (1st ed) OR Chapter 7 (2nd ed)** 2. Additional reading materials: **Lindsay** Chapters 2 (pp 23-30), 10 and 11 (PDF posted)	**Chat 12 Nov. 16** **No Chat Nov.23 (Thanksgiving: Nov 22-24 Holiday)**	HW # 7 Redox reactions
	Section 3: Salt-Affected Soils		
15 Nov. 27	I. Salt Affected Soils Part 1: Sources of salinity and alkalinity, carbonate equibiria II. Salt Affected Soils Part 2: Clay dispersion, reclamation of salt degraded soils Read 1. Essington textbook **Chapter 11** 2. Download handout on irrigation water quality	**Chat 13: Nov. 30** **Red-Ox reactions** **&** **Salt affected soils**	HW # 8 Salt affected soils
	Classes END Dec. 6 Reading Days: Dec. 7-8 Dec.		Exam 3: Dec 9-11