**The University of Jordan**

**Faculty of Agriculture Department of Land, Water, and Environment**

**Program: 2013-2014/ First Semester**

**Environmental Soil Chemistry (644221)**

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| **Credit hours** | **3** | **Level** | **Third Year** | **Pre-requisite** | **Fundamentals of Soil Science, Analytical Chemistry** |
| **Coordinator/ Lecturer** | **Dr. ‘Mohammed Hashem’ Stietiya** | **Office number** |  | **Office phone** | **22447** |
| **Course website** | <http://www2.ju.edu.jo/sites/academic/h.stietiya/default.aspx> | **E-mail** | h.stietiya@ju.edu.jo | **Place** | **Abu-Gharbieh Hall** |

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| --- |
| **Office hours** |
| **Day/Time** | **Sunday** | **Monday** | **Tuesday** | **Wednesday** | **Thursday** |
| **Office hrs** | **10-12** | **10-12** |  |  | **10-12** |
| **Lecture** |  | **12-1** |  | **12-1** |  |
| **Lab** |  |  |  | **3.30-6.00** |  |

**Course Description**

The course applies principles of chemistry to the understanding of soil related properties and processes including soil clay mineralogy, soil organic matter genesis and their properties, mineral solubility, adsorption and desorption, ion exchange, oxidation and reduction, acidity, and alkalinity. The course includes problem sets that expose students to practical situations of soil contamination, degradation, contaminant transport, and release.

**Learning Objectives**

The objectives of this course are to introduce students to chemical processes occurring in the soil environment, to quantify those process and reactions, and to use the fundamentals of chemistry for problem solving of practical situations. At the end of the course, the student will be able to quantify and describe chemical relations in the soil that are important from an agricultural perspective.

**Intended Learning Outcomes (ILOs):**

Successful completion of the course should lead to the following outcomes:

**A. Knowledge and Understanding:** Student is expected to

A1- Apply principles of chemistry to soil related processes such as nutrient availability, precipitation, and dissolution.

A2- Understand the chemistry of soil formation from rocks and minerals.

A3- Use the concepts of chemical bonds to explain mineral weathering susceptibility.

A4-Apply the laws of Thermodynamics to explain processes occurring in the soil environment.

A5- Understand the concept of contaminant adsorption and its environmental importance.

A6- Understand the chemistry of oxidation reduction reactions in the soil and their impact on crop production.

**B. Intellectual Analytical and Cognitive Skills:** Student is expected to

B1- Become competent in analyzing chemistry-related problems of the soil environment.

B2-Use the concepts of chemistry to help improve the soil environment and enhance its productivity.

B3- Enhance mathematical skills and ability to use mathematical equations to help solve practical situation.

**C. Subject- Specific Skills:** Students is expected to

C1- Know how to deal with nutrients in the soils of calcareous nature.

C2- Management practices to follow in soil environments under reduced conditions.

C3- Use the concept of adsorption to remediate contaminated soils and waters.

**D. Transferable Key Skills:** Students is expected to

D1- Manage problematic soils related to chemical processes at the farm level

D2- Manage soil amendment and preservation.

# ILOs: Learning and Evaluation Methods

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| --- | --- | --- |
| **ILO/s** | **Learning Methods** | **Evaluation Methods** |
| **A**. Knowledge and Understanding (**A1-A6**) | Lectures and Discussions | Exam, Classwork, Homework |
| **B**. Intellectual Analytical and Cognitive Skills (**B1-B3**) |  Lectures and Discussions | Exam, Classwork, Homework |
| **C**. Subject Specific Skills (**C1-C3**) | Lectures and Discussions | Exam, Classwork, Homework |
| **D**.Transferable Key Skills (**D1-D2**) | Lectures and Discussions | Exam. Homework |

**Course Contents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Content** | **Reference**  | **Week** | **ILO/s** |
| The Soil Environment  | Sparks, D. L. 2003. Environmental Soil Chemistry.  | Wk 1 (lecture 1) |  |
| Review of Chemistry Fundamentals | Sparks, D. L. 2003. Environmental Soil Chemistry. | Wk 1 (lecture 2) | **A-1** |
| Soil Mineralogy* + Chemical Bonds
	+ Soil Minerals
	+ Pauling’s Rules
	+ Structure of Clay Minerals
	+ Primary Soil Minerals
	+ Secondary Soil Minerals
	+ Source of Charges
	+ Oxides and Oxyhydroxides
	+ Mineral Weathering and Stability
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach – Chapter 1 | Wk 2-4 | **A1-A3 , B-1 , B-2, B-3, D-1, D-2** |
| Soil Water Chemistry* + Review of Chemical Equilibrium
	+ Chemistry of Water
	+ Lewis Acids and Bases
	+ Hard-Soft Acid-Base Theory
	+ Colligative Properties
	+ Hydrolysis of Cations
	+ Distribution Diagrams
	+ Ion Speciation in Soil Solution
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach  | Wk 5-7 | **A-4 , B-1 , C-1 , C-3, D-1, D-2,** |
| Mineral Solubility* + Review of Laws of Thermodynamics
	+ Chemical Equilibrium and Free Energy of Reaction
	+ Ion Activity Product
	+ Saturation Index
	+ Stability Diagrams
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach  | Wk 8-10 | **B-2,C-1,C-2,C-34,**  |
| Adsorption* + Importance and Concepts
	+ Surface Functional Groups
	+ Surface Complexation
	+ Adsorption Isotherms
	+ Sorption of Anions and Cations
	+ Point of Zero Charge
	+ Adsorption Kinetics and Equilibria
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach  | Wk 11-13 | **C1-C3, D1-D2** |
| Soil Organic Matter* + Genesis and Characteristics
	+ Fractionation of Humic Substances
	+ Functional Groups
	+ Structure of Soil Organic Matter
	+ Charge Characteristics
	+ Humic Substance Interaction with Metals
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach  | **Wk 14-15** | **A1-A4,B1-B3,C1-C3** |
| Oxidation-Reduction Reactions in Soils* + Importance and Concepts
	+ Redox Reactions in Soils
	+ Electrode Potential
	+ Equilibrium Constant and pE
	+ Free Energy and pE
	+ pE – pH diagrams
 | Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach  | Wk 16 | **A1-A4,B1-B3,C1-C3** |

**Learning Methodology**

## The course will include lecturing, discussion, classwork, homeworks, and lab work. Through classworks students will be able to apply the concepts they learn in class immediately through these class exercises. Also through lab work students will be able to apply first-hand the theoretical aspects of soil chemistry to practical situations

# Evaluation

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| --- | --- | --- |
| **Evaluation** | **Point %** | **Date** |
| **First and Second Exams** | 25 | November 18th, 2013 and December 19th, 2013 |
| **Labwork** | 15 | Weekly |
| **Classwork** | 5 | Daily |
| **Homework**  | 5 | Weekly |
| **Final Exam**  | 50 | To be determined |

**Main Reference/s:**

Essington, M.E. 2004, Soil and Water Chemistry: An Integrative Approach. CRC Press, Boca Roton.

# Sparks, D. L. 2003. Environmental Soil Chemistry. Acad. Press. New York.

**Intended Grading Scale (Optional)**

Grades will be awarded according to the following criterion:

|  |  |
| --- | --- |
| Grade percentage  | Letter Grade |
| 83 – 100  | A |
| 79 – 82  | A- |
| 75 – 78  | B+ |
| 68 – 74  | B |
| 63 – 66  | B- |
| 59 – 62  | C+ |
| 51 – 58  | C |
| 47 – 50  | C- |
| 43 – 46  | D+  |
| 35 – 42  | D |
| 31 – 34  | D- |
| 0 – 30  | F |

**Notes:**

* Concerns or complaints should be expressed in the first instance to the module lecturer; if no resolution is forthcoming, then the issue should be brought to the attention of the module coordinator (for multiple sections) who will take the concerns to the module representative meeting. Thereafter, problems are dealt with by the Department Chair and if still unresolved the Dean and then ultimately the Vice President. For final complaints, there will be a committee to review grading the final exam.
* For more details on University regulations please visit:

 <http://www.ju.edu.jo/rules/index.htm>