**The University of Jordan**

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

**Program: Fall Semester/2015-2016**

**Environmental Systems Modeling (0604903)**

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| **Credit hours** | 3 | **Level** | Ph.D. | **Pre-requisite** | 604222 |
| **Coordinator/ Lecturer** | Prof. Ayman Suleiman | **Office number** | 124 | **Office phone** | 22377 |
| **Course website** |  | **E-mail** | ayman.suleiman @ju.edu.jo | **Place** | Faculty of Agriculture |
| **Time** | 15:30 – 17:00 Sun & Tue |  |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **Office hours** | | | | | |
| **Day** | **Sunday** | **Monday** | **Tuesday** | **Wednesday** | **Thursday** |
| **Time** | 10 – 11 am | - | 10 – 11 am | - | 10– 11 am |

**Course Description**

This course provides students with a solid background in environmental systems modeling concepts. This course introduces students to the science of modeling environmental systems. Students will learn the basic steps of modeling: problem definition, model development, evaluation, and application. Models will typically involve describing natural with mathematical approximations of their behavior. Lectures will help students learn how to translate “word problems” into model components. Labs will provide students with hands-on experience with environmental models and their uses. Applications will be drawn from a range of environmental issues including water flow in porous media, crop simulation models, climate change, and natural resource management.

**Learning Objectives**

1. To enable the students to develop mathematical and quantitative skills needed to apply environmental systems models successfully to their needs.
2. .To provide the students with advanced knowledge in conservation laws and rate equations related to of mass and energy in soil-plant-atmosphere continuum.
3. To enable the students to use soil water dynamics models in solving water transport problems.
4. To enable the students to identify and understand the up-to-date research areas in environmental modeling worldwide and relate them to Jordan agriculture and environment

**Intended Learning Outcomes (ILOs):**

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

## A) Knowledge and Understand in: Student is expected to understand the

A1. Definition of environmental systems models, the different kinds of environmental systems models and importance of environmental systems modeling.

A2. Sources of uncertainties in environmental systems modeling.

A3 Model development and application.

A4. Crop simulation modeling.

A5. Water flow modeling.

## B) Intellectual Skills: Student is expected to understand the

B1. Implementation of different approaches for modeling environmental systems.

B2. Examination of the different components of environmental systems models.

B3. Analysis of fate and transport of mass and energy within environmental systems.

**C) Subject Specific Skills:** Student is expected tounderstand the

C1. Implementation of mathematical and physical background in of environmental systems models.

C2. Identifying the uncertainties if of environmental systems models.

C3. Determination of strengths and weaknesses in environmental systems models.

**D) Transferable Skills:** Student is expected tounderstand the

D1. Adoption of scientific approach in the environmental systems modeling.

D2. Solving problems related to of environmental systems models.

# ILOs: Learning and Evaluation Methods

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| --- | --- | --- |
| **ILO/s** | **Learning Methods** | **Evaluation Methods** |
| **A**. Knowledge and Understanding (**A1-A6**) | Lectures, discussions and assignments | Quizzes, a term paper and Exams |
| **B**. Intellectual Analytical and Cognitive Skills (**B1-B3**) | Lectures, discussion and assignments | Quizzes, a term paper and Exams |
| **C**. Subject Specific Skills (**C1-C3**) | Lectures, discussion and assignments | Quizzes, a term paper and Exams |
| **D**.Transferable Key Skills (**D1-D2**) | Lectures, discussion and assignments | Quizzes, a term paper and Exams |

**Course Contents**

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| **No. of 1.5 hour lecture (s) /Week** | **Subject** | **Sources** | **ILOs** |
| **4 / 1st and 2nd wk** | 1. Introduction  * Definition of modeling * Complexity types * Types of models * Simulation types * Advantages and disadvantages of modeling | Korzukhin et al. (1996) | **A1,D1** |
| **4/ 3rd and 4th wk** | 1. Uncertainty in Environmental Modeling  * Definition of uncertainty * Sources of Uncertainty | Pineiro etal. (2008) | **A2, C2** |
| **4 5th and 6th wk** | 3. Model development   * Problem identification * Define modeling objectives * Formulation of a model * Selection and study of numerical solution * Model calibration * Model verification * Model validation * Documentation of model * Update and support of model | Jakeman et al. (2006) | **A3,B1,B2,B3,C1,C3,D1,D2** |
| **10/7th , 8th 9th, 10th and 11th wk** | 4. Decision Support System for Agrotechnology Transfer (DSSAT)   * Introduction * Minimum data set * Files structures * Water balance * Growth and development * Phasic development * Plant morphological development * Development of the root system * Sink-source concept * Dry matter production * Stresses * Nitrogen components | Tsuji et al. 1998 (Chapter 1,2,3,4,5,7 and 8) | **A4,B1,B2,B3,C1,C3,D1,D2** |
| **6/7th , 8th and 9th wk** | 5. Water flow modeling   * Hydrus-1D model description * Nonlinear and/or Nonequilibrium reactions between the solid and liquid phases * Linear equilibrium reactions between the liquid and gaseous phases * Zero order production * Two First-order degradation reactions * Fickian-based advection dispersion equations | Šimůnek et al. (2008) | **A5,B1,B2,B3,C1,C3,D1,D2** |
| **4/15th and 16th wk** | Projects presentations. |  |  |

**Learning Methodology**

# Question and answer teaching method will be used in this course; therefore, the students are encouraged to participate in classroom discussions. All study material will be circulated electronically, made available at the instructor’s website. The lectures will focus on comprehensive understanding of the course material and problem solving. The homework problem sets are designed to help the students to widen their understanding of the course material and practice their problem solving skills. The students will have the opportunity to demonstrate their newly acquired knowledge through a series of quizzes.

# Evaluation

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| --- | --- | --- |
| **Evaluation** | **Point %** | **Date** |
| **Midterm Exam** | 30 | 6/04/2015 |
| **Quizzes, homework, term papers, and seminar** | 30 |  |
| **Final Exam** | 40 | Exam week |

**Main Reference/s:**

Hamby. 1994. A review of techniques for parameter sensitivity analysis of environmental models. *Environmental Monitoring and Assessment* 32:135-154.

Hanks and Ritchie (ed.), 1991. Modeling plant and soil systems. Agron. Monogr. 31, ASA, CSSSA, SSSA, Madison, WI.

Holzbecher, 2012. Environmental modeling using Matlab.

Jakeman et al. 2006. Ten iterative steps in development and evaluation of environmental models. *Environmental Modelling and Software* 21:602-614.

Korzukhin et al. 1996. Process versus empirical models: which approach for forest ecosystem management? *Canadian Journal of Forest Research* 26:879-887.

Pineiro etal. 2008. How to evaluate models: observed vs. predicted or predicted vs. observed? *Ecological Modeling* 216:316-322.

Šimůnek, J., M. Th. van Genuchten, and M. Šejna, 2008. Development and applications of the HYDRUS and STANMOD software packages, and related codes, Vadose Zone Journal, doi:10.2136/VZJ2007.0077, Special Issue ”Vadose Zone Modeling”, 7(2), 587-600.

Tsuji et al. 1998.Understanding Options for Agricultural Production. Systems Approaches for Sustainable

**Grading Scale**

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| --- | --- | --- | --- | --- |
| From (%) | To (%) | Scale | Letter Grade | Result |
| 86 | 100 | 4 | A | Excellent |
| 83 | 85 | 3.75 | A- | Excellent |
| 77 | 82 | 3.5 | B+ | Very Good |
| 74 | 76 | 3.0 | B | Very Good |
| 71 | 73 | 2.75 | B- | Very Good |
| 65 | 70 | 2.5 | C+ | Good |
| 62 | 64 | 2.0 | C | Good |
| 59 | 61 | 1.75 | C- | Good |
| 53 | 58 | 1.25 | D+ | Accepted |
| 50 | 52 | 1.00 | D | Accepted |
| 36 | 49 | 0.75 | D- | Fail |
| 0 | 35 | 0 | F | Fail |

**Notes and class room policies**

* Regular and timely attendances are expected from all students. University regulations concerning class attendance will apply
* The students are expected to submit homework in due time, a late submission will not be accepted
* Exams absentees are allowed to write makeup exams only if an acceptable and documented excuse is provided; for example, a medical report. Makeup exam are usually more difficult than regular exams
* Zero tolerance for cheating and plagiarism
* For more details on University regulations please visit: <http://www.ju.edu.jo/rules/index.htm>