

# **SWS 5605C CAMPUS AND DE-STUDENTS**

## **SYLLABUS**

**Course Name:** Environmental Soil Physics: SWS 5605C

**Credits:** 3 credit-hours

**Prerequisites:** SOS 5050, CHM 2040, PHY 2004, MAC 2312

**Instructors:** Peter Nkedi-Kizza

Soil and Water Science Department

G199 McCarty Hall

Tel: 392-1951/236

E-Mail: [Kizza@ufl.edu](mailto:Kizza@ufl.edu)

Mr. Kafui Awuma (Senior Biologist)

McC-1196

Tel: 352-392-1952/234

### **Course Objectives:**

1. Gain basic understanding of measuring soil properties/parameters which influence crop root penetration and growth, and the potential for agrochemicals to pollute groundwater.
2. Comprehend transport processes for water, gases, solutes, and heat in soils that influence the physical environment of the root zone for plant growth and that may lead to pollution of water resources (surface and groundwater).
3. Perform laboratory and field experiments to measure selected physical properties (parameters) of soils and appropriate fate and transport parameters of agrochemicals, gases, and heat in soils.
4. Use mathematical models to quantify transport processes for water, gases, heat and solutes in water saturated and unsaturated soils.
5. Upon completion of the course, students should be able to apply the principles governing the flow and retention of water and solutes in the root zone, solve problems involving water and nutrient management of soil-water-systems used in agriculture.

## **Course Description:**

The course will focus on the understanding of transport processes for water, gases, solutes, and heat in the soil. Important soil properties (physical, chemical, and biological) which influence transport processes will be characterized in the field and laboratory. Field and laboratory experiments will be designed to exemplify theoretical principals and measurements that yield quantitative results important to transport processes in soils. Data from the experiments or literature will be simulated with appropriate processes oriented models. All students will receive computer-assisted instructions.

## **Laboratories:**

The laboratory experiments will be conducted in order to illustrate and test theoretical principles and also to develop research orientation which provides basic experience with physical measurements that yield quantitative results of important transfer processes in the vadose-zone. Each experiment will be accompanied by theoretical development in sufficient detail to provide a clear understanding of the methods to be used, the calculations required, and the significance of the final results. Data from the experiments will be simulated with appropriate models that either exist in the literature or developed specifically for the course. All students in the course are expected to be computer literate. Guidelines for writing laboratory reports are outlined in the laboratory manual.

## **Format:**

Two lectures per week, and one laboratory session per week.

Lectures: Tuesdays (11:45-12:35): Thursdays (11:45-12:35)

Laboratory: Tuesdays (12:50-3:50)

Office hours: Mondays and Fridays (10-12)

## **Textbooks:**

1. Environmental Soil Physics, by Daniel Hillel, 1998. Academic Press, Inc. San Diego, California.
2. Syllabus and lecture notes, examples of problem sets similar to examination problems and handouts will be provided. The laboratory manual will be provided as a hard copy or on the Website.

## **LECTURE TOPICS:**

### **I. Introduction: Lectures 1 and 2**

- A.
  - i. Soil Physics before the 70s (Hillel xix-xxv)
  - ii. Soil Physics in relation to Natural Sciences and Soil Science.
- B. Practical Application of Soil Physics (slides )
  - i. Transfer processes in soils
  - ii. Use of transfer processes to manage soils for plant growth.
  - iii. Mismanagement of transfer processes in soils
- C. Application of Physics in Soil Physics(slides )
  - 1. How to acquire Physics knowledge by Scientific Methods
  - 2. Application of Physics laws in Soil Physics
  - 3. Fundamental and derived physical quantities and System of units

### **II. Basic Physical Properties of Soils (Hillel pages 3-18; 59-72; 101-123) Lectures 3**

- a. Soil as a porous medium, volume and mass relationships
- b. Soil texture, specific surface area, soil structure and aggregation
- c. Pore size and distribution, and pore geometry

### **III. Soil Water (Hillel pages 19-50; 129-198; Lectures 3-6)**

- a. General properties of water
- a. Water rise in a capillary tube
- a. Soil water content
- a. Measurement of soil water content
- a. Energy status of soil water
- a. Soil moisture release curves
- a. Measurement of soil water potential

### **IV. Water Flow in Saturated Soils (Hillel pages 173-198 and Lectures 4-6 and 7-10)**

- a. Driving force for water flow
  - b. Darcy flux and pore water velocity
  - c. Darcy's law and Poiseuille's Law
  - d. Saturated hydraulic conductivity, permeability, and fluidity
  - e. Vertical and horizontal water flow
  - f. Water flow in layered soils
- V. Water Flow in Unsaturated Soils (Hillel pages 203-233, Lectures 10-14)
- a. Darcy's Law in unsaturated soils
  - b. Hydraulic conductivity as function of water content and potential
  - c. Estimation of hydraulic functions and diffusivity from soil moisture release curves, and from particle-and pore size distribution.
  - d. Equation of continuity and Richard's equation
  - e. Steady and unsteady water flow
  - f. Infiltration, redistribution and evaporation
- VI. Solute Transport and Retention in Soils (Hillel pages 243-268; Lectures 15-18)
- a. Types of solutes, sorption kinetics and equilibria (isotherms) in aqueous and mixed solvent systems
  - b. Molecular diffusion and mass flow
  - c. Miscible displacement and hydrodynamic dispersion in aqueous and mixed solvent systems
  - d. Solute transport during unsaturated unsteady water flow

## **LABORATORY SCHEDULE/EXPERIMENTS**

### **I. Soil Texture/Volume Mass Relationships**

1. Soil bulk density and particle density (Lab)
2. Volumetric water content (TDR, Gravimetric, Lab and Field)
3. Particle-size and pore size distribution (Lab)

## **II. Water Retention in Soils**

1. Soil moisture release curves (Lab)
2. Estimation of water retention using particle-and pore size distribution (Lab-simulation models)
3. In-situ measurement of water retention (Field and simulation models)

## **III. Water Flow in Soils**

1. Saturated hydraulic conductivity, permeability and fluidity (Lab)
2. One-dimensional infiltration in homogeneous and layered soils (Lab-simulation models)
3. Estimation of hydraulic conductivity and diffusivity functions (Lab-simulation models)
4. Instantaneous profile method for infiltration, redistribution of water and tracers, and measurement of soil hydraulic conductivity functions (Field-simulation models).

## **IV. Convective-Dispersive Solute Transport in Soils**

1. Sorption isotherms for pesticides in aqueous and mixed solvent systems (Lab-simulation models)
2. One-dimensional miscible displacement of tracers and pesticides in aqueous and mixed solvent systems (Lab-simulation models)

## **Grading System:**

Two tests at 30% each

\*Comprehensive final exam (optional)

60%

30%

Homework and Lab reports	28%
Class participation♥	2%
Total	100%

\* = **The final will be used to substitute for the lower of the two exams**

♥ = **Each student will participate in reviewing the course material before the examination**

**Grading scale:**

A ≥ 90%; A- = 86-89%; B+ =84-85%; B = 82-83%; B - = 80-81%; C+ = 76-79%; C = 74-75%  
C- = 70-73%

**Type of examination questions:**

Questions will be answered with short-answers, calculations, essays, and at times multiple-choices.

**Academic Honesty:**

As a result of completing the registration form at the University of Florida, every student has signed the following statement; “I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University.

**Accommodations for Students with Disabilities**

Students requesting classroom or laboratory 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.

**UF Counseling Services**

Resources are available on-campus for students having personal problems or lacking clear career and academic goals which interfere with their academic performance. These resources include:

University Counseling Center, 301 Peabody Hall. Personal and career counseling (392-1575).

Student Mental Health, Student Health Care Center. Personal counseling (392-1171).

Sexual Assault Recovery Service, Student Health Care Center. Sexual assault counseling (392-1161).

Career Resources Center, Reitz Union. Career development assistance and counseling (291-1601)

## **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.

We, the members of the University of Florida, pledge to hold ourselves and our peers to the highest standard of honesty and integrity.