SOIL, WATER, AND ECOSYSTEM SCIENCES

SWS 5605C — Environmental Soil Physics

Instructor

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Office Hours: By appointment

Course Structure

Credit-hours: 3
Format**: Distance Education**

Canvas

We will use CANVAS to communicate, share resources and post grades.

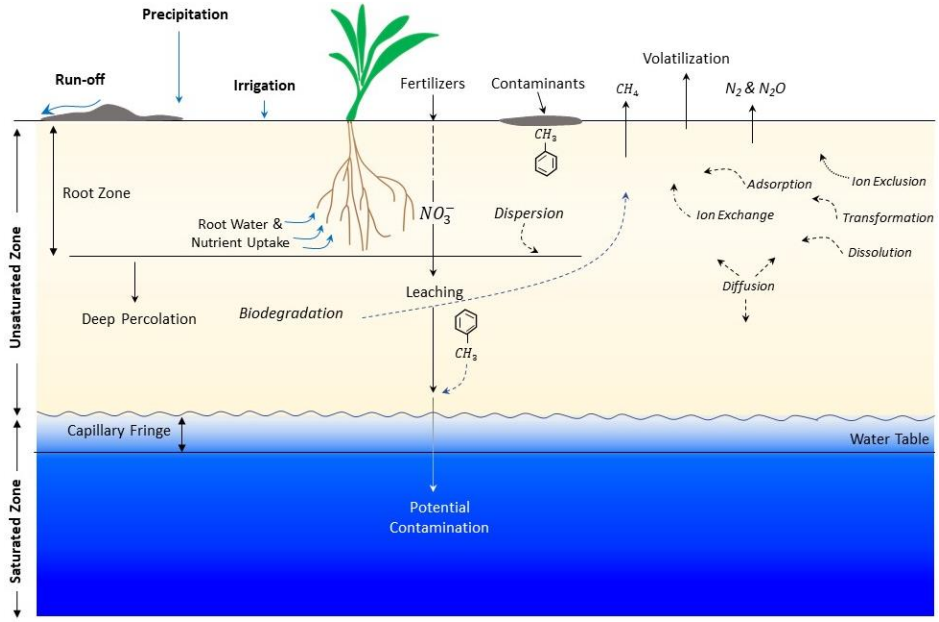
Course Meeting Times:

Lecture & Laboratory: Lectures are recorded and posted on Canvas in an Asynchronous format. Students can access these recorded lectures and pre-recorded laboratory/field experiments via Canvas at any time throughout the semester. Live chat sessions - held weekly or bi-weekly for nearly ~1 h - will take place via Zoom on Canvas. Initially, these sessions are scheduled for Thursdays from 6:30-7:30 pm ET, though this schedule may be adjusted during the first week of class if needed. An internet connection, video camera, microphone, and speakers are required.

Prerequisites: SWS 3022 or SWS 5050; PHY 2004 and MAC 2312 or equivalent courses.

Course Description

The goal of this course is to equip students with a deep understanding of the theoretical and practical basis of soil physical and hydraulic properties and processes. We will focus on multiple transport processes (water, solute, heat) within the root and vadose zones. Students will receive hands-on experience in measuring soil physical and hydraulic properties and processes in laboratory and field settings, work with state-of-the-art sensors and data acquisition systems, process and interpret data with relevant software, and gain experience in writing scientific reports. By the end of the course, students will have developed skills that are highly applicable to soil science, water science, agronomy, hydrology, ecology, environmental science and other related disciplines.



Course Objectives

- Gain an understanding of the fundamental concepts of soil physical and hydraulic properties, and how they influence soil chemical and biological processes.
- Learn standard and novel methods for measuring soil physical and hydraulic properties in laboratory and field settings.
- Acquire hands-on experience with environmental sensors used to monitor soil and environmental variables.
- Gain knowledge of advanced data analysis techniques for quantifying soil physical and hydraulic properties and transport processes under saturated and unsaturated conditions.

Learning Outcomes

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

- Describe soil physical properties and processes
- Install and apply laboratory and field methods for measuring soil physical and hydraulic properties and processes
- Perform data analysis and interpret results for environmental, hydrologic and agronomic applications
- Solve complex problems related to transport processes, such as water, nutrient, and heat in the soil-plant-atmosphere continuum.

Course Readings

The course materials are provided through the course webpage (Canvas) (UF E-Learning Portal: *https://elearning.ufl.edu/* : Log in to E-Learning with your username & password.

Required:

- Recorded lectures (Power Point slides) and laboratory experiments
- Class-notes "Environmental Soil Physics" (downloadable as pdf-version)
- Laboratory handouts (downloadable as pdf-version)

Supplemental (recommended for interested students)*:

- Textbook "Environmental Soil Physics" by D. Hillel, Elsevier Science, 1998, Academic Press, ISBN 0-12-348525-8

Additional (only for interested students)*:

- Hillel, D. 1982. Introduction to Soil Physics. Academic Press, 364 pp.
- Hillel, D. 1980. Fundamentals of Soil Physics. Academic Press, 410 pp.
- Don Scott, H. 2000. Soil Physics: Agricultural and Environmental Applications. Iowa State Univ. Press, 421 pp.
- Kirkham, D., and Powers, W.L. 1984. Advanced Soil Physics. John Wiley & Sons. 530 pp.
- Rose, C.W. 1966. Agricultural Physics. Pergamon Press, New York.
- Marshall, T.J., J.W. Holmes, and C.W. Rose .1996. Soil Physics. Third edition, Cambridge University Press, 453 pp.
- Hanks, R.J. and G.L. Ashcroft .1980. Applied Soil Physics. Springer-Verlag.

**Are available as hard copy or e-book at the UF library.*

Students will receive course materials including recorded lectures, PowerPoint slides (pdf), laboratory handouts, excel spreadsheets, and class-notes via Canvas. Additional materials such as research articles and web links will be made available on the course web page. If needed large files such as videos will be shared through a cloud service.

Homework Assignments

Assignments: The course includes 5-6 homework assignments (approximately one for each chapter).

***Submission*:** Homework assignments are due 'one' week after being assigned. Students are expected to make every effort to submit assignments on time. If an assignment will be late, please contact the instructor at least '24 hrs' before the due date. Assignments must be submitted in electronic format (pdf or doc) prior to the deadline. Late submissions will receive a 20% reduction for each late day (up to 2 days). Homework turned on or after the 3rd day will not be graded!

Instructor Feedback: Feedback and grades will be provided in a timely manner for homework and reports submitted by the deadline. An assignment key will be provided along with feedback. Students will arrange a meeting with the instructor if they have additional questions.

Laboratory & Field Trip

Experiments: The course includes approximately 5 lab experiments and 3 field trips. Students will download experiment procedure and pre-recorded videos for each experiment. The instructor will share experiment data collected by on-campus students. The students will receive recorded videos (Zoom) that walk students through the data analysis process.

Lab Reports: Lab reports consist of collected data, analysis and answers to questions provided by the instructor. Although students may analyze data cooperatively, lab reports must be written and submitted independently, except as noted by the instructor. Lab reports are due at the beginning of the following lab session (see lab schedule in Table 2). If a report will be late, please contact the instructor 24 hrs before the due date. Late submissions will receive a 20% reduction for each late day (up to 2 days). Reports turned in or after the 3rd day will not be graded! Reports must be submitted in electronic format (pdf or doc). The required format for lab reports will be provided on Canvas

Exam

Mid-term exam (held before spring break) and final exam both are open-book and offered during class time. The final exam is scheduled for **5/1/2025** at **10:00 AM–12:00 PM ET**. Students will have choice to answer a combination of simple, intermediate, and more challenging questions (additional detailed will be provided before the exam).

Make-up exams are rarely authorized. Any requests for a make-up exam due to technical issues must include the ticket number received from LSS when the problem was reported. This ticket number will document the date and time of the problem. You must email your instructor within 24 hours of the technical difficulty if you wish to request a make-up. Requirements for make-up exams follow the university policies outlined at:
Attendance Policies < University of Florida (ufl.edu)

Evaluation, Grading Policy & Scale

The evaluation and final grades will be based on:

Assessment Type	Scale	Qty	Point Value	Final Grade
Class Discussion	10%			100 pts
Assignments & Quizzes	35%	5-6	100 Pts each	700 Pts
Laboratory Reports	35%	8	100 Pts each	800 Pts
Mid-term Exam	10%	1	100 Pts each	100 Pts
Final Exam	10%	1	100 Pts each	100 Pts
Total	100%			1800 Pts

90–100	**A**	80–86.9	**B**	70–75.9	**C**	60–66.9	**D**
87–89.9	**B+**	76–79.9	**C+**	67–69.9	**D+**	Below 60	**E**

Current UF grading policies for assigning grade points: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Attendance

For online participations, the requirements are consistent with the university policies: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Special Needs & Accommodations Statement

Students who need special accommodation or services should contact the **Disability Resource Center**, 1316 Museum Rd, Gainesville, FL 32611, (352) 392-8565, FAX (352) 392-8570, email: DRC@ufsa.ufl.edu; accommodations@ufsa.ufl.edu, https://disability.ufl.edu/students/accommodations/. You must register and request that the Center or DRC send me official notification of your accommodations needs as soon as possible. Please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. **The need for accommodations must be documented by the appropriate office.**

Confidentially of Student Records

The University of Florida is committed to providing services and support to meet your needs and achieve your educational goals. We are equally committed to protecting your privacy. For information regarding the confidentiality of student records please visit: https://catalog.ufl.edu/UGRD/academic-regulations/ferpa-confidentiality-student-records/

Copyright for Instructional Materials & Software Use

The materials used in this course are subject to copyright protection and are only for the use of students officially enrolled in this course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course. Materials may be given through a link or reference so that students may access them securely through the library.

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.

UF copyright information policies: https://security.ufl.edu/resources/copyright-information/

University Honesty Policy

Students at University of Florida are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students 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."

The Honor Code: (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates

academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Course Evaluation

At the end of the semester, students are expected to provide feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Student will be notified when the evaluation period opens. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results.

Campus Resources

On-campus resources are available to students who are experiencing difficulties or who lack clear career and academic goals:

Health and Wellness:

- ***Counseling and Wellness Center***: http://www.counseling.ufl.edu/cwc and 392-1575.
- ***Sexual Discrimination, Harassment, Assault, or Violence***: If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu
- ***Sexual Assault Recovery Services (SARS)***: Student Health Care Center, 392-1161.
- ***University Police Department***: at 392-1111 or 9-1-1 for emergencies, or http://www.police.ufl.edu/

Academic Resources:

- ***E-learning technical support***: 352-392-4357 (select option 2) or e-mail to *Learning-support@ufl.edu*. https://lss.at.ufl.edu/help.shtml , http://lss.at.ufl.edu.
- ***Teaching Center***: Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.
- ***Career Resource Center***: Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.
- ***Student Complaints Campus***: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.
- ***Library Support***: http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.
- ***Writing Studio***: 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.
- ***On-Line Students Complaints***: http://www.distance.ufl.edu/student-complaint-process

Course Topics & Schedule

* This schedule is tentative and subject to changes.

Introduction / Soil Physics Applications		
Week #	***Topic***	***Reading***
1	Introduction to Soil Physics; Importance and applications of soil physics in other disciplines Physical quantities, units, and dimensions ***Assignment***	PPT Class notes (section 1.1)
Chapter 1: The Soil Phases and Basic Relationships Under Equilibrium Conditions		
Week #	***Topic***	***Reading***
1-2	Basic and Derived Units and Dimensions; Basic Properties of Soil, Soil as a Three-Phase System; Mass-Volume Relationships	PPT, Class notes (sections 1.2 to 1.6)
2-3	Characterization of the Solid Phase Soil texture and particle size distribution methods	PPT, Class notes (section 1.7)
3	Specific surface area and soil structure ***Homework Assignment (1)***	PPT, Class notes (sections 1.8 to 1.9)
Chapter 2: Characterization of The Liquid Phase in Soil		
Week #	***Topic***	***Reading***
4	Definitions and measurement methods for soil water content (gravimetric, neutron scattering, electromagnetic sensors, etc.)	PPT, Class notes (sections 2.1 to 2.2)
4	Application of soil water content Water balance equation Field capacity, Permanent wilting point, and Plant available soil water ***Homework Assignment (2)***	PPT, Class notes (sections 2.3 to 2.4)
Chapter 3: Energy State of Water in Soil (Hydrostatics)		
Week #	***Topic***	***Reading***
5	Energy state of soil water Total water potential and its components (gravitational, matric, pressure, osmotic, and hydraulic potentials) Properties of water (surface tension, contact angle, capillarity, capillary rise)	PPT, Class notes (sections 3.1 to 3.5)
5-6	Units and calculations of potentials Measuring soil water potentials under equilibrium and non-equilibrium conditions	PPT, Class notes (sections 3.6 to 3.7)
6	Soil Water-Energy Relationships; Soil water characteristic (SWC) curve and measurement; air entry pressure, Parameterizing SWC models using soil water retention measurements; Hysteresis process ***Homework Assignment (3)***	PPT, Class notes (sections 3.8 to 3.9)
Chapter 4: Water Flow in Soils (Hydrodynamics)		
Week #	***Topic***	***Reading***
7	Steady Saturated Flow in Soil; Laminar flow in tubes (Poiseuille's Law) Darcy's Law	PPT, Class notes (sections 4.1 to 4.2)
8	Saturated Steady Flow; Flow through layered Soils; Laboratory Methods for measuring Saturated Hydraulic Conductivity	PPT, Class notes (sections 4.3 to 4.6)
9-10	Unsaturated flow; Unsaturated Hydraulic Conductivity and Models;	PPT,

	Unsaturated Steady State and transient Flow; Richards Equation; Numerical Solution to Richards Equation	Class notes (sections 4.7 to 4.13)
10-11	Infiltration process and models (empirical and physically based) Measurement of Infiltration and Field methods for soil hydraulic Conductivity ***Homework Assignment (4)***	PPT, Class notes (sections 4.14 to 4.19)
Chapter 5: Solute Transport in Soils and Soil Salinity		
Week #	***Topic***	***Reading***
12	Soil salinity	PPT, Class notes (section 5.1)
13	Mechanisms for Solute Transport in Soil (Convection, diffusion, and dispersion); Breakthrough curves; Convection-dispersion equation (CDE) ; Analytical solutions to pulse and continuous solute application	PPT, Class notes (section 5.2 to 5.7)
14	Measurement of Solute Concentration; Salt balance and salinity management ***Homework Assignment (5)***	PPT, Class notes (sections 5.8 to 5.9)
Chapter 6: Soil Temperature, Thermal properties, and Heat Transport in Soils		
Week #	***Topic***	***Reading***
14	Surface Energy Balance; Transport of Heat in Soils; The Heat Conservation Equation; Soil thermal properties Steady state and transient heat flow	PPT, Class notes (sections 6.1 to 6.5)
15	Diurnal and Seasonal Variations in Soil Temperature; Analytical Solutions to Heat Transport ***Homework Assignment (6)***	PPT, Class notes (section 6.6 to 6.7)

Laboratory Experiments & Schedule

* This schedule is tentative and subject to changes.

Lab #	Topic	Date	
		Experiment	Report Due
1	Basic and Physical Properties of Soil including: - Undisturbed core sampling - Bulk density, Gravimetric/Volumetric water content, Particle size distribution	Jan. 21 & 28	Feb. 4
2	Measurement of soil water Content (TDR)	Feb. 4	Feb. 11
3 (Field Trip)	Soil water Content (TDR300 & TEROS 12) & Matric Potential (TEROS21); Data logger	Feb. 11	Feb. 18
4	Soil Water Characteristic - Tempe Cells, WP4C	Feb. 18	Mar. 4
	- Data Analysis	Feb. 25	
5	Soil Hydraulic Conductivity (Ks) - Constant head method - Falling head method	Mar. 4	Mar. 11
Spring Break (Mar. 15th to 22nd)			
6 (Field Trip)	Infiltration Process - Mini disk infiltrometer - Field Ks - Modeling	Mar. 11	Apr. 1
	- Data Analysis	Mar. 25	
7 (Field Trip)	Infiltration / Hydraulic Conductivity (3D) - Guelph Infiltrometer	Apr. 1	Apr. 15
	- Data Analysis	Apr. 8	
8	Solute Transport - Miscible displacement - Breakthrough curve & Modeling	Apr. 15	Apr. 29
	- Data Analysis	Apr. 22	