SWS 5605C — (Environmental) Soil Physics

Instructor

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Office Hours: By appointment

Teaching Assistant: -

Course Structure

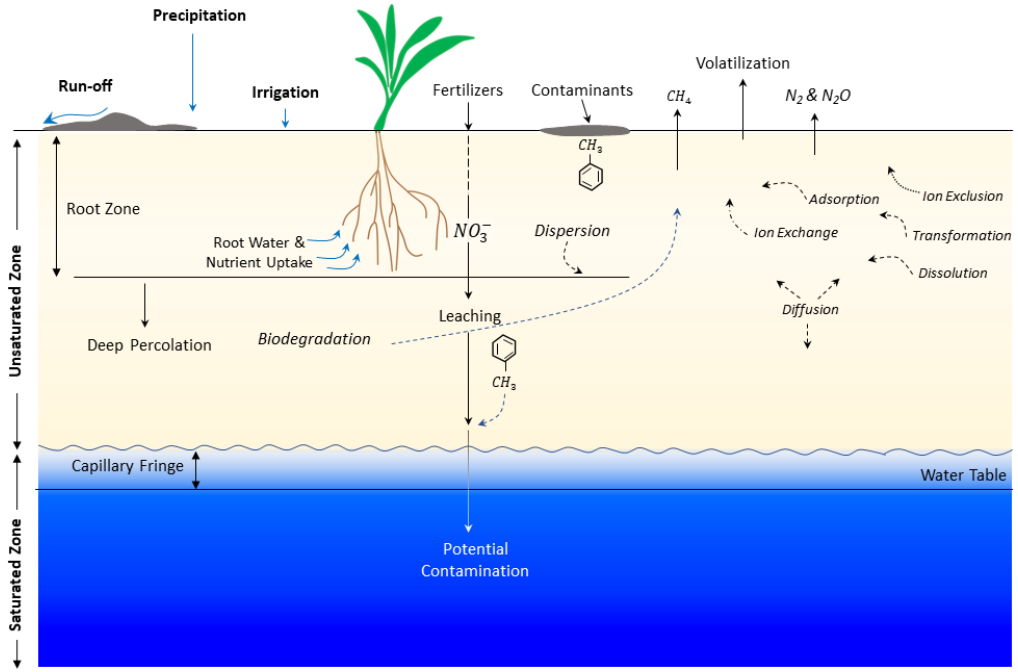
Credit-hours: 3
Format**: In-Person**

Class Location & Time:
Lectures: 2 lectures per week; Classroom: **McCarty A, 3194**
Tuesdays (**11:45 AM - 12:35 PM**): Thursdays (**11:45 AM - 12:35 PM**) (Period 5)

Laboratory: 8 laboratory and field sessions; Classroom: **McCarty B, 3108**
Tuesdays (**12:50 PM - 3:50 PM**) (Period 6-8)
Field trips will be held at UF Energy Research & Education Park
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 zone and vadose zone. Students will gain hands-on experience in measuring soil physical and hydraulic properties and processes in both laboratory and field settings, work with state-of-the-art sensors and data acquisition systems, process and interpret data with relevant software, and excel spread sheet functions. By the end of the course, students will have developed practical skills that are directly 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

Required:
- Lectures (Power Point slides)
- Class-notes "Environmental Soil Physics" (downloadable as pdf-version via Canvas)
- Laboratory handouts

Supplemental (recommend 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.*

Additional materials such as research articles and web links will be made available on the course web page (Canvas). 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 assignments 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.

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

Laboratory & Field Trip

Experiments: The course includes approximately 'five' lab experiments and 'three' field trips. Students will work in small groups to conduct experiments and collect data. Active participation will be assessed and graded. The instructor will guide students through the data analysis process. Students are required to collaborate with their lab partner(s) during data collection.

Data Analysis: Data analysis consist of collecting data during the experiment, performing the required calculations, and answering questions provided by the instructor. Students are expected to be present, actively engaged in the hands-on activities, and to contribute to discussions as data are analyzed during the lab session. Collaboration with lab partners during data collection and analysis is encouraged; however, no separate written lab report is required unless otherwise specified by the instructor.

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 **4/27/2026** 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

Evaluation for graduate (GRD) and undergraduate (UGRD) students differ. GRD students will be assigned with additional homework assignments, exam questions, as well as more advanced laboratory questions and data analyses. Final grades for both UGRD and GRD students will be based on the same grading components, but with higher expectations and supplemental work for GRD students, as outlined below:

Assessment Type	Scale	Qty	Point Value	Final Grade
Class Discussions	20%			100 pts
Assignments	30%	5	100 Pts each	500 Pts
Laboratory Engagement*	30%	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%			1600 Pts

* Evaluated based on attendance, active participation in group experiments, contribution to in-class data analysis, and responses to instructor questions (no separate lab report required).

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

Use of AI Tools (e.g., ChatGPT)

Students may use AI tools like ChatGPT to support their learning (e.g., reviewing concepts, alternative explanations, or exploring additional examples). However, use of ChatGPT (or other AI tools) **is not allowed for completing or generating answers for graded work** (homework assignments, lab analyses, quizzes, and exams). All submitted work must be your own. Using AI-generated text or solutions for graded work will be treated as an academic integrity violation. Students are also advised that AI tools can produce **incorrect, incomplete, or misleading information**, and may fabricate references or numerical results. Any information obtained from AI tools should be treated as a starting point only and must be checked with course materials, textbooks, and other reputable sources. Students are ultimately responsible for the accuracy and correctness of the work they submit.

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

Presence at all lectures and lab sessions is highly recommended and deemed necessary to successfully complete the course. In an emergency, please notify the instructor as soon as possible. Missing a lab is strongly discouraged. 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

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

Materials & Software Use

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.

Diversity Statement

The Soil and Water Sciences Department is committed to diversity and inclusion of all students. We acknowledge, respect, and value the diverse nature, background and perspective of students and believe that it furthers academic achievements. It is our intent to present materials and activities that are respectful of diversity: race, color, creed, gender, gender identity, sexual orientation, age, religious status, national origin, ethnicity, disability, socioeconomic status, and any other distinguishing qualities.

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. Information on CANVAS tools is available via the Student Intro to ELS link at 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/.

Course Topics & Schedule

* *The schedule is tentative and may subject to some 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)	PPT, Class notes (sections 3.1 to 3.5)

	Properties of water (surface tension, contact angle, capillarity, capillary rise)	
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; Unsaturated Steady State and transient Flow; Richards Equation; Numerical Solution to Richards Equation	PPT, 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
1	Basic and Physical Properties of Soil including: - Undisturbed core sampling - Bulk density, Gravimetric/Volumetric water content, Particle size distribution	20 & 27 Jan.
2	Measurement of soil water Content (TDR)	3 Feb.
3 (Field Trip)	Soil water Content (TDR300 & TEROS 12) & Matric Potential (TEROS21); Data logger	10 Feb.
4	Soil Water Characteristic - Tempe Cells, WP4C	17 Feb.
	- Data Analysis	24 Feb.
5	Soil Hydraulic Conductivity (Ks) - Constant head method - Falling head method	3 Mar.
Spring Break (14 to 21 March)		
6 (Field Trip)	Infiltration Process - Mini disk infiltrometer - Field Ks - Modeling	10 Mar.
	- Data Analysis	24 Mar.
7 (Field Trip)	Infiltration / Hydraulic Conductivity (3D) - Guelph Infiltrometer	31 Mar.
	- Data Analysis	7 Apr.
8	Solute Transport - Miscible displacement - Breakthrough curve & Modeling	14 Apr.
	- Data Analysis	21 Apr.

End of classes: April 22, 2026