SWS 4602C & 5605C — Environmental Soil Physics

Instructor

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Office Hours: After class and by appointment

Teaching Assistant: TBA

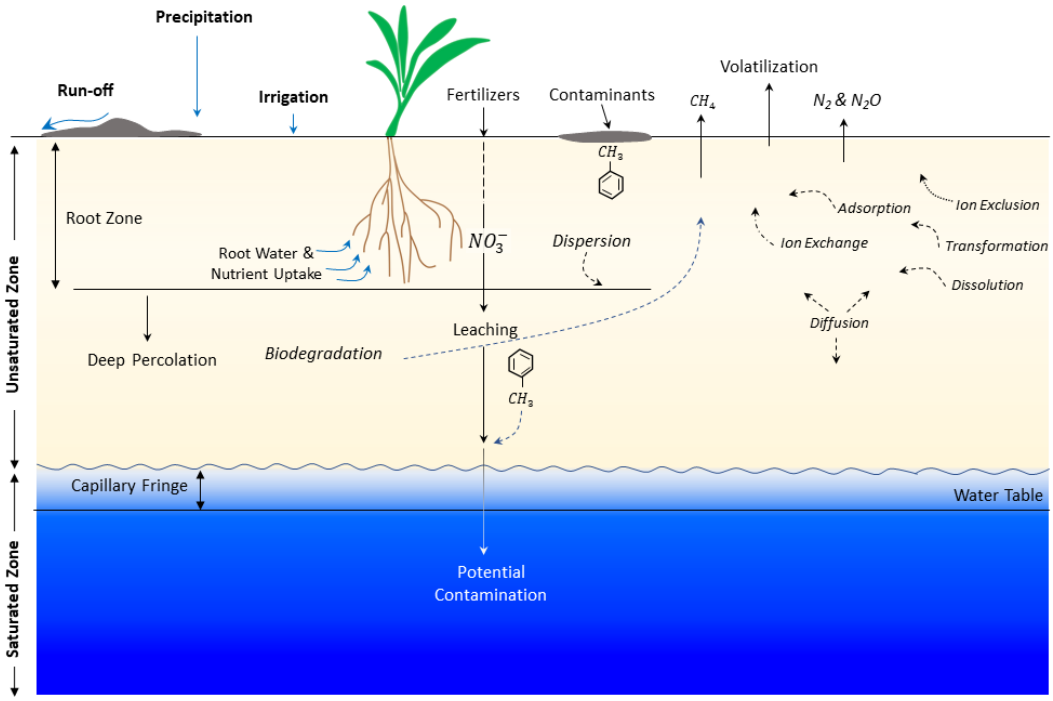
Course Structure

Credit-hours: 3
Format**: On-campus**

Class Location & Time:
Lectures: 2 lectures per week / G001 McCarty Hall D
Tuesdays (11:45-12.35): Thursdays (11:45-12:35)
Laboratory: 7 laboratory and field sessions / 3108 McCarty Hall B
Tuesdays (12:50-3:50)
Day/location is tentative and subject to changes.
Prerequisites: SWS 3022 or SWS 5050, Knowledge of math and physics.

Course Description

The goal of this course is to provide students with a deep understanding of the theoretical and practical basis of soil physical properties and processes. We will focus on multiple transport processes (water, solute, heat) through the root zone and vadose zone. Students will receive hands-on training 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 using relevant software, and write scientific reports. Students will obtain skills applicable to soil science, water science, agronomy, hydrology, ecology, environmental science and other related disciplines.



Course Objectives

- To gain an understanding of the fundamental concepts of soil physical and hydraulic properties and their impact on soil chemical and biological processes;
- To learn standard and novel methods for measurement of soil physical and hydraulic properties in the laboratory and field setting;
- To gain hands-on experience with environmental sensors used to monitor soil and environmental variables;
- To gain knowledge of advanced data analysis techniques for quantifying soil physical and hydraulic properties and transport processes in saturated and unsaturated conditions.

Learning Outcomes

After completion of this course, students will acquire knowledge necessary for:

- Describing soil physical properties and processes
- Installing and applying laboratory and field methods for measuring soil physical and hydraulic properties and processes
- Data analysis and interpretation of results for environmental, hydrologic and agronomic applications
- Solving complex problems related to transport processes (water, nutrient, heat) in the soil-plant-atmosphere continuum

Course Readings

Required:

- Power point slides
- Class-notes "Soil Physical Properties and Processes" by Sadeghi, M. et al (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. Pergemon 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

Homework: The course includes nearly 6 homework assignments for each course topic.

***Submission*:** Homework assignments are due 1 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 24 hrs prior to the due date. Assignments need to be submitted in electronic format (pdf or doc) before 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 timely for homework and reports submitted before the due date. Along with the feedback, the key for assignments will be provided. Students will arrange a meeting with the instructor if there are additional questions regarding the assignments.

Canvas: We will communicate through Canvas to share resources and grades. Students are encouraged to share intellectual views and to freely discuss principles and applications of the course materials. Students are encouraged to work with lab partner(s) during data collection in a laboratory or field exercise.

Laboratory & Field Trip

Experiments: The course includes approximately 4 lab experiments and 3 field trips. Students will work together in small groups to conduct experiments and collect data. Participation will be assessed and graded. The instructor will 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, table 2). If a report will be late, please contact the instructor 24 hrs prior to the due date. Late submissions will receive a 20% reduction for each late day (up to 2 days). Reports turned on or after the 3rd day will not be graded! Reports need to be submitted in electronic format (pdf or doc). The format for lab reports will be provided on Canvas.

Modeling Project

Graduate students will choose and present a simple modeling project based on their interests. The project will focus on simulation of water, solute, or heat transport in soil under steady-state or transient conditions with a numerical computer code (HYDRUS-1D) at column or field scale. Student will draft one page project proposal and discuss with the instructor to receive feedback. Final simulations will be presented to the class as a 15 min oral presentation in the last day of class.

Exam

Mid-term and final exams are open book and offered during the class time. Students will have choice to answer a combination of simple, intermediate and more challenging questions.

Grading Policy & Scale

Evaluation for graduate (GRD) and undergraduate (UGRD) students differ. GRD students will be assigned with additional homework in form of supplemental problems and a modeling project. The final grades for both UGRD and GRD students will be based on the following:

Assessment Type	Scale	Qty	Point Value	Final Grade
Homework Problems & Quizzes	30%	1-6	100 Pts each	600 Pts
Laboratory Reports	30%	1-6	100 Pts each	600 Pts
Mid-term Exam	10%	1	100 Pts each	100 Pts
Final Exam	10%	1	100 Pts each	100 Pts
Modeling Project*	20%	1	100 Pts each	100 Pts
Total	100%			1400-1500 Pts

*Graduate students

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

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. For on-campus and 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 may be 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.

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

* This schedule is tentative and subject to changes.

Chapter 1: Introduction / Soil Physics Applications		
Week #	***Topic***	***Reading***
1	Importance of soil physics and applications in other fields Physical quantities, units and dimensions	PPT
Chapter 2: Basic Physical Properties of Soils and Other Porous Media		
Week #	***Topic***	***Reading***
2	Soil phases, definitions, and basic mass and volume relationships	PPT, Class notes (section 2.1)
2-3	Soil texture and particle size distribution Stock's law	PPT, Class notes (section 2.2)
3	Specific surface area and soil structure ***Homework (1)***	PPT, Class notes (section 2.3)
Chapter 3: Soil Water and Measurement		
Week #	***Topic***	***Reading***
4	Definitions and measurement methods (gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry)	PPT, Class notes (section 2.4)
4	Application of soil water content Water balance equation Field capacity, Permanent wilting point, and Plant available soil water ***Homework (2)***	PPT, Class notes (section 2.4)
Chapter 4: Soil Water Retention and Potential (Hydrostatics)		
Week #	***Topic***	***Reading***
5	The energy state of soil water Total water potential and components Properties of water (molecular, surface tension, and capillary rise)	PPT, Class notes (section 2.4.2)
5	Units and calculations of potentials under equilibrium Measuring soil water potentials	PPT, Class notes (section 2.4.2)
6	Soil water characteristic (retention) curve and measurement Fitting parametric models to soil water retention measurements Hysteresis and scanning curves ***Homework (3)***	PPT, Class notes (section 2.4.3)
Chapter 5: Water Flow in Soils (Hydrodynamics)		
Week #	***Topic***	***Reading***
7	Laminar flow in tubes (Poiseuille's Law) Darcy-Buckingham Law	PPT, Class notes (section 3.1)
8	Conditions and states of flow Saturated flow Hydraulic conductivity and measurement	PPT, Class notes (section 3.1, 3.3)
9-10	Unsaturated flow Steady-state and non-steady flow and models	PPT, Class notes (section 3.2)
10-11	Infiltration process and models (empirical and physically based) Field methods for soil hydraulic property determination ***Homework (4)***	PPT, Class notes (section 3.3)
Chapter 6: Solute Transport in Soils and Salinity		
Week #	***Topic***	***Reading***
12	Soil salinity	PPT,

		Class notes (section 4.7)
13	Convection, diffusion, and dispersion of solutes Breakthrough curves Convection-dispersion equation (CDE) Analytical solutions to pulse and continuous solute application	PPT, Class notes (section 4.1, 4.2, 4.3)
14	Salt balance and salinity management ***Homework (5)***	PPT, Class notes (section 4.7)
Chapter 7: Soil Temperature and Heat Flow		
Week #	***Topic***	***Reading***
14	Soil thermal properties Steady state heat flow	PPT, Class notes (section 5.1, 5.3, 5.4)
15	Non-steady heat flow Estimation of soil thermal properties ***Homework (6)***	PPT, Class notes (section 5.2, 5.3, 5.4)

Laboratory Experiments & Schedule

This schedule is tentative and subject to changes.

Lab #	Topic	Date	
		Experiment	Report Due
1	Basic Soil Properties including: - Undisturbed core sampling - Bulk density, Gravimetric/Volumetric water content, Particle size distribution	Jan. (3rd week)	Jan. (4th week)
2 (Field Trip)	Soil water Content & Potential - TDR, Tensiometer	Jan. (4th week)	Feb. (1st week)
3	Soil Water Characteristic - HYPROP, Tempe Cells, WP4C	Feb. (2nd week)	Feb. (4th week)
	- Data Analysis	Feb. (3rd week)	
4	Soil Hydraulic Conductivity - Constant head method (Ks) - Modeling (Unsaturated K)	Feb. (4th week)	Mar. (2nd week)
	- Data Analysis	Mar. (1st week)	
5 (Field Trip)	Infiltration Process - Mini disk infiltrometer - Field Ks - Modeling	Mar. (2nd week)	Mar. (4th week)
	- Data Analysis	Mar. (3rd week)	
6 (Field Trip)	Infiltration / Field Water Intake (3D) - Guelph Infiltrometer	Mar. (4th week)	Apr. (2nd week)
	- Data Analysis	Apr. (1st week)	
7	Solute Transport - Miscible displacement - Breakthrough curve & Modeling	Apr. (2nd week)	Apr. (4th week)
	- Data Analysis	Apr. (3rd week)	