SYLLABUS – FALL 2025

UF UNIVERSITY of FLORIDA
Soil, Water, and Ecosystem Sciences Department

SWS 6932 — Environmental and Soil Transport Processes

Instructor

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Office Hours: After class and by appointment

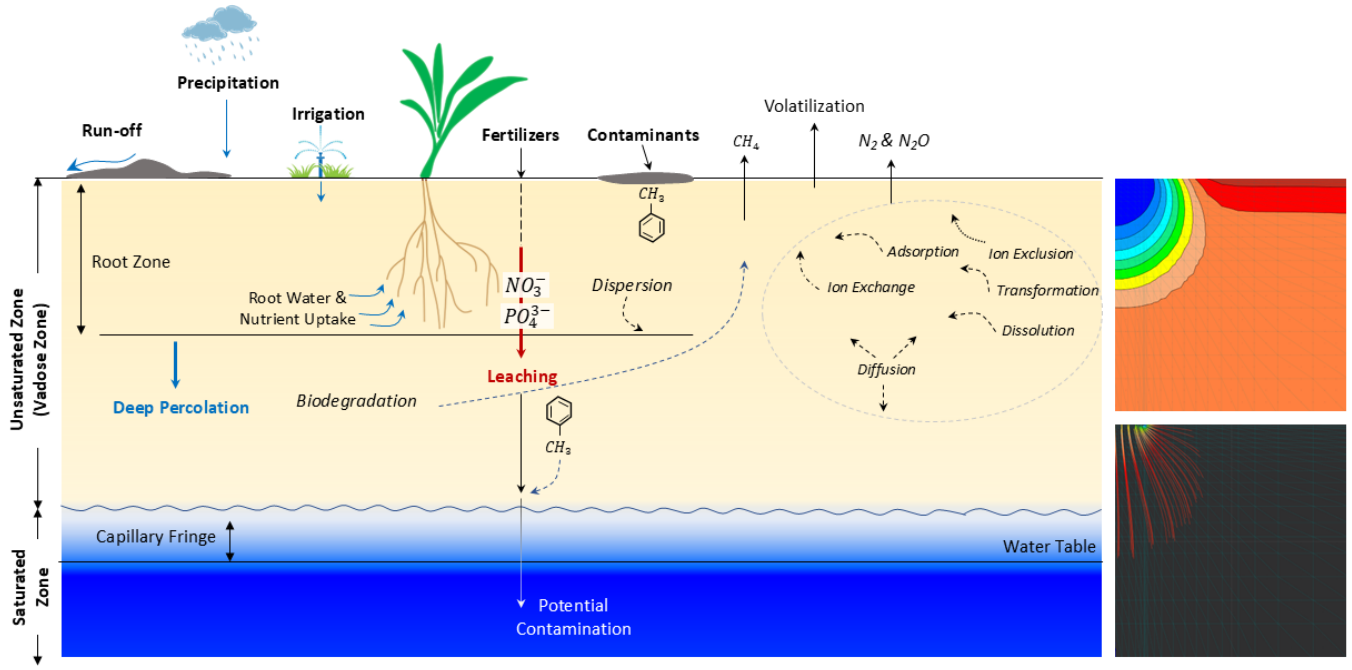
Course Structure

Credit-hours: 3
Enrollment Capacity: 15
Format**: On-campus**

Class Location & Time:
Lectures: 2.5 hrs. (1 Day a week); Day/Time: Wednesday (Period 6-8: 12:50-3:50 PM).
Prerequisites: SWS 5050, Environmental Soil Physics (SWS 4602/5605) or equivalent courses (contact the instructor) and basic proficiency in Python or R.

Course Description

The goal of this course is to equip students with a deep understanding of the theoretical, practical and computational basis of mass and energy transport processes (water, nutrients, contaminants, gas, and heat flow) in saturated and partially saturated soil conditions. The course focuses on the physical, chemical, and biological principles that control and drive the (coupled) transport processes. Hands-on training is an important aspect of this course with about half of the contact hours reserved for in-class use of the state-of-the-art numerical codes (i.e., HYDRUS, Python) to model multiple transport processes in soil. Halfway through the course students will select a real-life project to be solved via computer code simulations. Students will present the scope of their project, initial results, and the final solution to the class and instructor, who will provide constructive feedback. The final presentation of simulation outcomes will take place during the week of the finals.



Course Objectives

- Gain deep understanding of the fundamental principles of mass and energy transport in the soils.
- Gain knowledge of advanced data analysis methods for parameterizing mass and energy transport models.
- Gain practical experience with numerical modeling tools to simulate multiple/coupled transport processes (water, nutrients, contaminants, gas etc.) in the vadose zone.

Learning Outcomes

After completing this course, students will acquire the knowledge and skills necessary for:

- Solving complex mass and energy transport processes in soil under saturated and unsaturated conditions via application of advanced numerical modeling tools, with a focus on HYDRUS and other relevant simulation software.
- Explaining and interpreting key mass and energy transport characteristics of soils, including water flow, solute transport, heat transfer, gas movement, and their interactions with soil properties and environment.
- Execute real-word numerical simulations of mass and energy transport in the vadose zone, analyzing results, and applying insights to address challenges in agriculture, hydrology, and environment.

Course Readings

Required: (will be made available on the course web page)

- Class notes and Lectures (PowerPoint slides)
- HYDRUS Software & user manual (free license, downloadable from PC-Progress)
- Research articles, datasets, web links, etc.

Supplemental (recommend for interested students)

- Soil Physics with HYDRUS-1D
- HYDRUS 2/3D software user manual

Assignments

Assignment: The course includes ~5 in-class assignments (one for each topic/module).

***Submission*:** Assignments are due 1 week after being assigned. Students are expected to make every effort to submit assignments on time. If the assignment is 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's 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.

Evaluation, Grading Policy & Scale

The final grades will be based on the following:

Assessment Type	Scale	Qty	Point Value	Final Grade
Assignments & Class Activities	30%	5	6 Pts each	30 Pts
Presentation of Project Scope	20%	1	20 Pts each	20 Pts
Presentation of Final Results	20%	1	20 Pts each	20 Pts
Final project Presentation	30%	1	30 Pts each	30 Pts
Total	100%			100 Pts

90–100	**A**	80–85	**B**	70–75	**C**	60–65	**D**
86–89	**B+**	76–79	**C+**	66–69	**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 accommodation and how my course requirements and activities may impact your ability

to fully participate. **The need for accommodation 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.

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/.

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Course Modules & Schedule

* *The schedule is tentative and may subject to changes.*

Module 1: Introduction		
Week #	***Topic***	***Reading***
1	Introduction to mass and energy transport processes in the soil and vadose zone; transport types, importance and applications.	Class-notes, PPT Software manual
Module 2: Soil Hydraulic Properties and Processes		
Week #	***Topic***	***Reading***
2-3	Laboratory and field techniques for measuring soil hydraulic properties and parameters; Soil Water Retention (SWR) models; fitting, saturated and unsaturated hydraulic conductivity functions and parameters; Diffusivity function, Dual porosity (mobile-immobile) models	Class-notes, PPT Software manual Research Articles
2-3	**Assignment (1):** Parameterization of Soil Water Retention data (van Genuchten, Brooks-Corey, Durner models, etc.)	
Module 3: Modeling Water Flow in Soil		
Week #	***Topic***	***Reading***
4-5	Richard-Richardson Equation (RRE) for transient water flow; Initial and boundary conditions, IC/BC (constant, variable, atmospheric, surface runoff, deep drainage, seepage etc.), Setting up simulation model parameters (flow domain, space and time discretization, IC, BC etc.), HYDRUS software package, user interface and tools.	Class-notes, PPT Software manual Research Articles
4-5	**Assignment (2):** One dimensional simulation of the effect of water table fluctuations on vadose zone water flow and soil water storage and distribution	
Module 4: Modeling Water Infiltration into Soil		
Week #	***Topic***	***Reading***
6-7	Infiltration process and models, layered and homogeneous soil profile, ponded infiltration, inverse modeling for soil hydraulic parameters characterization	Class-notes, PPT Software manual Research Articles
6-7	**Assignment (3)**: One-dimensional simulation of water infiltration into homogeneous and layered soil profiles and monitoring moisture, matric potential and flux variations in space and time	
Module 5: Plant Root Water Uptake and Stress		
Week #	***Topic***	***Reading***
8-9	Root water uptake models and transpiration (Feddes, S-shaped model), evaporation, atmospheric data, drip/sprinkler irrigation system	Class-notes, PPT Software manual Research Articles
8-9	**Assignment (4)**: Water flow and root water uptake simulations in an agricultural field soil profile under grass and comparison with bare soil (forward and inverse problems) and evaluations	
Module 6: Modeling Transport of Solutes (Nutrients, Contaminants) in Soil		
Week #	***Topic***	***Reading***
10-12	transport mechanisms, advection/convection (mass flow), dispersion, and diffusion, reactive transport, ion adsorption/desorption, equilibrium/non-equilibrium adsorption, breakthrough curves (BTCs), single and multiple pulse, solute initial/boundary conditions, solute uptake models, nitrification/denitrification etc.	Class-notes, PPT Software manual Research Articles
10-12	**Assignment (5)**: Nutrient transport (e.g., phosphorous, nitrate) simulations in agricultural fields with flood, drip, sprinkler irrigation systems	
Final Presentation and outlook		
Week #	***Topic***	
13-14	Final presentations, feedback and evaluations	