ABE 6265
Vadose zone water and solute transport modeling
(Short title: Vadose Zone Modelling)
Summer A- Course Syllabus

1. **Catalog Description**: 3 credits. Soil unsaturated zone modeling of water flow and solute transport processes. Comparative analysis of alternative mechanistic modeling approaches of different complexity (Offered Summer A, alternative years).

2. **Instructor(s): Dr. Rafael Muñoz-Carpena, Professor**

   a. Office location: 287 Rogers Hall
   b. Telephone: Work - 352-392-1864 x287
   c. E-mail address: (Use CANVAS email for class correspondence)
   d. Class web site (CANVAS): http://lss.at.ufl.edu (Click on "Log in to E-learning")
   e. Office hours: immediately after class and by appointment.

3. **Pre-requisites and Co-requisites:** None. Recommended basic use of high level computer language or numerical computing environment (i.e. Matlab, Mathematica, etc.) that allows the student to test algorithms and read existing modeling source code

4. **Course Objectives:**
   - Undertanding fundamentals of soil hydrology: flow, solute transport, and water quality.
   - Step-by-step development and testing of numerical code for flow and solute transport through the vadose zone.
   - Exploring the oportunities of functional/simplified vs. numerical approaches for modeling water and solute transport in the unsaturated Vadose Zone.
   - Use of advanced tools for formal model calibration and evaluation.
   - Analysis of prediction uncertainty and global sensitivity analysis of models.
   - Knowledge of High Performance Computing (HPC) throughput simulation tools for global sensitivity and uncertainty analysis of models.
   - Application to student's own research area.

5. **Meeting Times: M-F, 9:30-10:45 am**

6. **Meeting Location:** Frazier Rogers Hall, Classroom TBA

7. **Recommended Reading (partial list)**

Ravi, V. and J.R. Williams. 1998. Estimation of Infiltration Rate in the Vadose Zone: Compilation of Simple Mathematical Models. Volume I. EPA/600/R-97/128a, Washington DC: EPA.
Smith et al. 2002. Infiltration Theory for Hydrologic Applications (AGU)
Corwin et al. 1999. Assessment of Non-Point Source Polution in VZ (AGU)
Tindall and Kunkel, 1999. Unsaturated Zone Hydrology for Scientists and Enginering
Warrick, 2002. Soil Physics Companion (CRC)
Wilson et al. 1995. Handbook of VZ Characterization & Monitoring (CRC)

Alvarez-Benedi and Muñoz-Carpena. 2005. Soil-water-solute Process Characterization: An Integrated Approach (CRC)
Raats et al. 2002. Environmental Mechanics: Water, Mass, and Energy Transfer in Biosphere (AGU)
Hillel. 1998. Environmental Soil Physics (APress)
Fleming. 1975. Computer simulation techniques in hydrology (Elsevier)
Kutilek and Nielsen. 1990. Soil Hydrology (Catena Verlag)
Haan et al. 1982. Hydrologic Modeling of Small Watersheds (ASAE)
Hank and Ritchie. 1991. Modeling Plant and Soil Systems (ASA/CSSA/SSAA)

8. Course Outline[1]:

Topic 1. Introductory comments - course outline
Topic 2. Water! (and hydrology) - A soil water relations "refresher"
Topic 3. Soil water and energy: Capillarity theory - Hydrostatic soil conditions
Topic 4. Hydrodynamic conditions: Saturated Flow: Darcy's Law; Unsaturated flow: Darcy-Buckingham and Richards Equation
Topic 5. Soil Surface Infiltration: Description, Factors and Simplified Models
Topic 6. Richards Equation - Finite Difference Approximation and Programming
Topic 7. An Improved Green-Ampt Soil Infiltration And Redistribution Method and Its Application to 1D and 3D (Point Source) Flow Domains
Topic 8. Preferential Flow – Description, Factors and Models
Topic 9. Global Sensitivity and Uncertainty Analysis of models
Topic 10. Evaluation of Model Goodness-of-Fit (GoF) criteria with statistical significance
Topic 11. Solute transport in porous media: Advetive-Dispersive-Reactive (ADR) transport equation
Topic 12. Modeling solute transport in porous media: ADR numerical solution, ADR Analytical Solutions, Simplified approaches - SLIM model
Topic 13. Nitrogen cycle in soils: Basis and numerical modeling with WAVE
Topic 14. The Modeling Trilemma: Complexity, Uncertainty and Relevance
Topic 15. Soils, Natural Science and Models

9. Attendance and Expectations:

Active class participation is necessary to satisfactorily complete this course.

10. Grading:

4 Projects	80%
Video Quizzes	10%
Class participation	10%

(All work to be submitted via CANVAS)

Projects: These assignments will consist of application of relevant literature in the field through model development and testing to build the student modeling skills and in-depth understanding of the modeling alternatives in vadose zone modeling projects.
Assignments will be penalized 10% for each business day late beyond the due date. All assignments must be returned to receive grade in the course.

[1] Tentative and can be modified to suit students' research focus

Exams: There will be no exams. The grade will be assessed on the basis of project work and class participation.

All deliverables should be submitted electronically. All assignments must be formatted so that they can be printed on standard 8.5" by 11" paper.
Electronic documents must be a **SINGLE** text document (i.e., Word or PDF file) that clearly answers each question and shows the work done to arrive at the answer. Any relevant graphs, tables, and equations that support your answer must be included (i.e., pasted) in this document and must be numbered, labeled, and captioned appropriately. If you do not sufficiently explain your work, you will only get partial credit—and no credit for a wrong answer. You may, and probably should, attach additional material (i.e., well-organized and labeled programs –source code, executables and in/out files, spreadsheets or other calculations), **IN ADDITION** to the required text report.

15. **Grading Scale:** Percent Grade: A (94.0-100), A- (90.0–93.9), B+ (87.0–89.9), B(83.0–86.9). B- (80.0-82.9), C+(77.0-79.9), C (74.0-76.9), C- (70.0-73.9), D+ (67.0-69.9), D (64.0-66.9), D- (60.0–63.9), E (0 –59.9)

    More information on UF grading policy may be found at:
    https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

16. **Honesty Policy –** All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

17. **Accommodation for Students with Disabilities** – Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

18. **UF Counseling Services** – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
    - University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
    - SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
    - Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
    - Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

19. **Software Use – All faculty, staff and student 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 community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.