

# CWR6537 CONTAMINANT SUBSURFACE HYDROLOGY

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**3 credits/Fall Semester 2018**

**T 6-7, R 6-7 (12:50 PM - 2:45 PM) Room: CHE 0316**

Instructor: Michael D. Annable, Professor  
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Office hours will be follow class lecture.

Course Description: This course describes solute transport in porous media from granular to karst aquifers. The course material should be of interest to graduate students in both science and engineering. Course discussion topics will include:

- Description and quantification of solute transport processes (diffusion, dispersion, advection, sorption, transformations, etc.)
- Formulation and solution of solute transport equations
- Modeling of water flow and solute transport
- Ground water Surface water exchange, hyporheic zone processes
- Applications: Groundwater contamination, remediation, and nutrient point and non-point sources
- Emerging contaminants including 1,4-Dioxane and Perfluorinated Compounds (PFOS Perfluorooctane Sulfonate and PFOA Perfluorooctanoic Acid often used in AFFF Aqueous Film-Forming Foam).

Prerequisites and Expected Background: Students should be familiar with the physics of water flow in the subsurface and should be comfortable with the use of differential equations to describe physics and chemistry problems. Mathematics is the language of physics, and the problems of interest are transient and spatially variable so partial differential equations result. Some familiarity with solution techniques (both analytical and numerical) is beneficial but these techniques are not the focus of this course. Contact instructor if there are problems registering due to prerequisites.

## Course Objectives

- (a) Learn advanced concepts of water and solute retention and transport in the vadose zone (unsaturated media) and groundwater (saturated media).
- (b) Explore the theoretical aspects of water and solute transport in porous media.
- (c) Examine the inter-relationships among various physical, chemical, and biological processes that influence solute retention, transformations, and transport in porous media.
- (d) Discuss the theoretical bases for experimental methods used to measure various physical and chemical properties relevant to water retention & flow and solute retention & transport in porous media.

- (e) Apply analytical and numerical modeling approaches to solve laboratory- and field-scale problems, including process coupling and the design and evaluation of management strategies.
- (f) Investigate emerging contaminant behavior including 1,4-Dioxane and PFAS/PFOA site conceptual models.

Grading System: Two midterm exams (25% each), homework (30%), contaminant transport project (20%). No final exam.

Grades on assignments submitted after the due date will be penalized in proportion to the elapsed time after the due date. The UF policy on points assigned for letter grades can be found here <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Textbook not Required: There is no required textbook for the course. Additional lecture notes and references to specific papers will be provided during the semester. The following texts may provide useful background and additional reference information.

It is emphasized that this course will not follow any of these books in a traditional textbook manner. Purchase of any of these books is recommended for students who appreciate the value of a supplemental text and reference. If such additional materials are not useful for you, then you should not feel compelled to purchase one of these books.

1. Fetter, C. W., *Contaminant Hydrogeology* (1993) Macmillan, NY.
2. Domenico, P. A. and F. W. Schwartz, *Physical and Chemical Hydrology* (1990) Wiley, NY.
3. Charbeneau, R. J., *Groundwater Hydraulics and Pollutant Transport* (2000) Prentice Hall, NJ.
4. Bedient, P. B., et al. *Ground Water Contamination* (1994) Prentice Hall, NJ.
5. Freeze, R. A. and J. A. Cherry, *Groundwater* (1979) Prentice Hall, NJ.
6. Chiang, W-H., and W. Kinzelbach, *3D-Groundwater Modeling with PMWIN* (2001), Springer-Verlag, New York
7. Kutilek, M. and D. R. Nielsen, *Soil Hydrology* (1994) Catena Verlag, Germany.
8. Hillel, D., *Environmental Soil Physics* (1998) Academic Press, New York.
9. Bear, Cheng, Alexander, *Modeling Groundwater Flow and Contaminant Transport*, 2010
10. Chlorinated Solvent Source Zone Remediation, (2014). DOI: 10.1007/978-1-4614-6922-3; ISBN: 978-1-4614-6921-6, Bernard H. Kueper, Hans Stroo Hans Stroo, Catherine M. Vogel, C. Herb WardC. Herb Ward, SERDP/ESTCP publication.

Reading and Homework Assignments: Approximately 6 quantitative homework problems will be assigned throughout the semester. The expected effort to solve these problems varies between 2 to 8 hrs.

Contaminant Transport Project: Each student will independently analyze an interesting contaminated site (or general contaminant transport problem). Analyses must include discussion of each of the following elements: site history, contaminant origins, sources at the site, exposures (past, present, future), impacts from exposure, actions to minimize risk (past, present, future) and regulatory process description. All projects should include mathematical modeling of transport processes. Sites may be under active study, from the literature or from other sources. *Students are encouraged to exercise their creativity.*

#### Academic Honesty

*As a result of completing the registration form at the University of Florida, every student has signed the following statements: "I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."*

#### UF Counseling Services

*Resources are available on-campus for students having personal problems or lacking clear career and academic goals which interfere with their academic performance. There resources include:*

- 1. University Counseling Center, 301 Peabody Hall, 392-1575, personal and career counseling;*
- 2. Student Mental Health, Student Health Care Center, 392-1171, personal counseling;*
- 3. Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161, sexual assault counseling; and*
- 4. Career Resources Center, Reitz Union, 392-1601, career development assistance and counseling.*

#### Accommodation for Students with Disabilities

*Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.*

#### Software Use

*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. We, the members of the University of Florida, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.*