Soil Science 622 – Soil Physics (3 Credits)

Fall 2021

When: From September 9 to December 9, Tuesday and Thursday 9:30 AM – 10:45 AM

Where: 357 Soil Science Building (Lectures) and Room 204 Animal Science Building (Labs)

Instructor: Dr. Jingyi Huang (jhuang426@wisc.edu)

Office hours: Appointments required

Materials: Soil Physics (Jury and Horton, 2004, sixth edition; available at https://www.amazon.com/Soil-Physics-William-Jury/dp/047105965X)

Prerequisite(s): MATH 211, 217, 221, or 275 and PHYSICS 104, 202, 208, or 248

Breadths: P - Physical Science

Course description:

Soil physics develops instruments and analytical methods to improve our fundamental understanding of soil physical properties and processes, and how they interact with other environmental and biogeochemical processes across various spatial and temporal scales. It also applies physical principles to address the practical problems of agriculture, environment, ecology, hydrology, geology, meteorology, and engineering. In this course, we will explore the various physical models developed to characterize the transport of water, heat, gas, and solutes in soils and the spatial and temporal variations in soil properties at various scales. We will also discuss the applications of modern proximal sensing technologies in soil studies.

Three types of lectures will be given in this course, including the theoretical lectures, tutorial classes, and computer-based labs. The theoretical lectures will cover the chapters of Jury and Horton's book with several additional chapters added to introduce proximal soil moisture sensors, digital soil mapping, and spatial and temporal analysis of soil properties.

Tutorial classes will be offered to guide you with the problem sets. You are also required to read the scientific articles and discuss the main contributions and limitations of articles during the tutorial classes. We will demonstrate the use of different proximal soil sensors and remote sensing techniques for measuring and monitoring soil water, heat, gas, and solute transport in soils. Additional tutorial classes will also be provided for the mid-term and final exams.

In terms of the lab classes, you will learn how to model soil water flow using the Hydrus-1D software, use RETC for soil water retention curve fitting and R software for spatial (e.g. kriging) and temporal analysis. Instructions will be given on how to install the software on your own computers before the class. You are expected to discuss the questions provided in the lab notes to help you better understand the soil physical models and spatial and temporal analysis.

The course schedule is provided at the end of this syllabus.

How the credit hours are met:

This class meets for two 75-minute class periods each week and expects that students will work on course learning activities (reading, writing, problem sets, studying, etc.) for about 3 hours out of classroom for every class period.

Learning outcomes:

After this course,

1. You should be able to explain the various physical models governing water, heat, gas and solute transport in soils.
2. You should be able to summarize and compare the principles of various soil sensors used to measure water, heat, gas and solute status and transport in soils.
3. You should be able to use Hydrus software to simulate water, heat, gas and solute transport in soils and use R software for spatial and temporal analysis of soils.
4. You should become familiar with recent advances in soil physics and soil sensing technologies and identify the main research gaps in soil physics.
5. You should become competent in poster presentation.
6. Be able to apply various soil physical models to real-world examples for improved natural resources management.

Exams and Grading Rubric

In this course, you need to complete six tutorial assignments, one three-min poster competition (October 19 Tuesday, 9:30–10:45), one mid-term exam (October 26 Tuesday, 9:30–10:45), and one final exam (December 22 Wednesday, 8:30–9:45).

1. Tutorial assignment (48%):
   Six tutorial assignments will be provided along with the tutorial notes, each of which accounts for 8 points. Each assignment consists of four calculation-based problems (2 points each). You can discuss the assignments with other students. You need to write down your solution process clearly on separate pieces of paper and turn them in at the next tutorial class. A penalty of 10% will be applied for late submission of the assignments.
   You will be marked 75% for the solution process and 25% for the final results. You are allowed to rework on the problem sets and resubmit your assignments within one week when the assignments are returned to you. If the second attempt is correct, you will get 90% of the points for the problems.
2. 3-min poster competition (12%):
   In terms of the 3-min poster competition, it accounts for 12 points and will be held in the class in Room 357, Soil Science Building, in Week 7 (October 19 Tuesday). You need to prepare (electronically) and present a scientific poster using the projector. Topics are related to the proximal soil sensors discussed in the lectures. Templates of the posters will be provided but you are encouraged to design your own poster. After each poster presentation, there is a Q&A session for questions. The others students can ask the presenter one question related to the talk and the presenter will have one minute to respond to the question. Each presenter will be evaluated by other students based on three criteria, namely, the organization of the poster (40%), clarity of the talk (40%), and the response to the questions (20%). The 75th percentile of the scores given by other students will be used as the final score of the presenter.
3. Mid-term (20%) and final (20%) exams:
   The mid-term exam accounts for 20 points and is divided into two halves. The first half includes five two-point multiple-choice questions based on the basic concepts discussed in the lectures. The second half has two calculation-based problems (5 points each). You need to use the models and equations discussed in the lectures and tutorials to solve the problems. The final exam is similar to the mid-term exam.

The final scores will be converted to letter grades by the instructor using the following scales:

A 90–100	B 75–80	D 60–65
AB 80–90	C 65–75	F <60

The instructor reserves the right to adjust the point-to-grade scheme to the advantage of the class and to add fractional points based on extraordinary effort to avoid straddling a grade boundary.

Attendance

If you will miss a class, inform the professor by email in advance, and review the recorded lectures after the class. Lecture slides will be posted online in advance. Furthermore, most of the tips for deriving the physical models and solving the problem sets will be taught in the tutorial classes and labs, which will be made available online. Whenever you have a conflict with an exam day, let the professor know more than one week before, and we will arrange for you to take the exam early.

Academic integrity

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/.

Accommodations for students with disabilities

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA."
http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

Diversity & inclusion

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/

Course Schedule

Week	Dates	Tuesday	Thursday
1	9-Sep		Lecture 1 Introduction
2	14-Sep & 16-Sep	Lecture 2 Ch1 Soil Solid Phase	Lecture 3 Ch2 Water Retention in Soil
3	21-Sep & 23-Sep	D1 (demo of SWRC measurements)	Lab 1 (Hydrus-1D & RETC)
4	28-Sep & 30-Sep	Lecture 4 Ch3 Water Movement in Soil	Lecture 5 Soil Moisture Sensors
5	5-Oct & 7-Oct	D2 (demo of soil water content/potential measurements)	Lecture 6 Ch4 Water Flow under Natural Conditions
6	12-Oct & 14-Oct	D3 (demo of infiltration measurements)	Lab 2 (Hydrus-1D)
7	19-Oct & 21-Oct	3 min Poster Presentation	Mid-term Exam Review
8	26-Oct & 28-Oct	Mid-Term Exam	Lecture 7 Ch5.1-5.2 Soil Thermal Regime
9	2-Nov & 4-Nov	Lecture 8 Ch5.3.1-5.3.3 Heat Flow in Soils	D4 (demo of soil temperature measurements)
10	9-Nov & 11-Nov	Lecture 9 Ch6 Soil Aeration (recorded lecture)	D5 (demo of soil gas measurements)
11	16-Nov & 18-Nov	Lecture 10 Ch7.1-7.2 Chemical Transport in Soil	Lecture 11 Ch7.3.1-7.3.4 Chemical Transport in Soil
12	23-Nov & 25-Nov	D6 (demo of soil nitrate measurements)	Thanks Giving
13	30-Nov & 2-Dec	Lecture 12 Ch8 Spatial and Temporal Variations of Soil Properties	Lab 3 (R: gstat)
14	7-Dec & 9-Dec	Lecture 13 Digital Soil Mapping (demo of soil moisture mapping)	Exam Review
15	14-Dec & 16-Dec		
16	22-Dec	Final Exam (Wednesday)	

Note: black (non-bold), theoretical lecture classes; yellow, computer-based lab classes; green, tutorial classes (sample problems, literature discussion, demo of soil sensors, and exam reviews); blue, poster presentation competition and mid-term/final exams.