

University of Colorado Denver
Department of Civil Engineering
CVEN-5335 Vadose Zone Hydrology

Fall 2023

Class: Mon/Wed 5:00-6:15 pm

Location: Plaza Building M-202

Office Hours: Mon/Wed 3:30-4:45 pm,
and by appointment

Instructor: David C. Mays, P.E., Ph.D.

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<http://engineering.ucdenver.edu/dmays/5335>

Catalog Description: Engineering analysis of the vadose zone, the unsaturated porous media linking the earth surface to groundwater. Darcy's law for flow. Richards equation for moisture content. The advection-dispersion equation for solutes. Analytical solutions and numerical modeling applied to infiltration, evaporation, drainage, and subsurface remediation.

Prerequisites: Graduate standing in civil engineering. Basic proficiency is assumed in fluid mechanics, differential equations, and spreadsheet applications like Microsoft Excel.

Course Objectives: At the end of the semester, you should be able to:

1. Articulate the vadose zone's central role in water resources and environmental engineering.
2. Explain how water flow in porous media depends on gravity, pressure, and capillary effects.
3. Apply soil physics to water resources topics like infiltration, drainage, and field water balance.
4. Extend soil physics to environmental engineering topics like soil remediation.
5. Use the software package HYDRUS-1D for water flow and solute transport modeling.

Required Text: Tindall, J.A. and J.R. Kunkel (1999), *Unsaturated Zone Hydrology for Scientists and Engineers*, Prentice Hall, Upper Saddle River, New Jersey (ISBN 0-13-660713-6).¹

Week	Dates	Topic	Film/Reading Assignment ²
1	8/21, 8/23	Hydrologic Cycle	◆ P-2016, §2.6-2.7, §4.4-4.5, ☼ T-1969
2	8/28, 8/30	Saturated Flow	§4.2-4.3, §4.7, §6.3, §7.0-7.3, §7.5-7.10, ☼ T-1967
3	9/6	Unsaturated Flow	§8.0-8.4
4	9/11, 9/13	Evaporation	§9.0-9.1, §9.3-9.4, §9.7-9.8
5	9/18, 9/20	Flow Modeling	§13.0-13.1, ◆ SVS-2005 (§2.0-2.8, §7.0-7.4, §11.1)
6	9/25, 9/27	HYDRUS-1D (EXAM)	→ <i>same as previous week</i>
7	10/2, 10/4	Infiltration	§11.0-11.8
8	10/9, 10/11	Drainage	§14.0-14.5, ◆ R-1993
9	10/16, 10/18	Field Water	§12.0-12.3
10	10/23, 10/25	Solute Transport	§10.2-10.5, §10.8, §10.13, §10.15
11	10/30, 11/1	Solute Transport (EXAM)	◆ SVS-2005 (§3.0-3.4, §8.0-8.4)
12	11/6, 11/8	HYDRUS-1D for Solutes	→ <i>same as previous week</i>
13	11/13, 11/15	Soil Remediation	§15.0-15.2, Appendix 1
14	11/27, 11/29	Clay Effects	§2.1, §2.4, §7.4, §10.14, ◆ M-2007
15	12/4, 12/6	Summary and Review	→ <i>none</i>

Midterms: Monday 9/25/2023 (weeks 1-4), Monday 10/30/2023 (weeks 1-9).

Final Exam: To be scheduled during exam week Monday 12/11/2023 to Friday 12/15/2023.

Grades: 25% homework, 20% each midterm, and 35% final exam.

¹ Free online. You may print up to eight chapters: http://wwwbr.cr.usgs.gov/projects/GW_Unsat/Unsat_Zone_Book/.

² See the public website <http://engineering.ucdenver.edu/dmays/5335> for film ☼ and reading ◆ assignments: M-2007 is Mays (2007); P-2016 is Perlman (2016); R-1993 is Reisner (1993); SVS-2005 is Šimůnek, van Genuchten, and Šejna (2005); T-1967 is Taylor (1967); and T-1969 is Trefethen (1969).

Homework

Homework will be assigned in class each Monday or through the Assignments and Answers link on the course website, and will be due at the beginning of class on Wednesday of the next week. Engineering paper is strongly encouraged but not required. To clarify the presentation, accelerate the grading, and develop attention to detail, homework must comply with the following specifications:

1. Assignments must be submitted in hard copy, during class or office hours, professionally presented (no wrinkles or ragged edges), and stapled in the upper-left corner.
2. At the top of *each* page, print your name, class number, homework number, due date, and page of total (1 of 5, 2 of 5, etc.). Submitting late? OK, but write the date submitted on the first page.
3. Draw a picture for *each* problem. Use a straight edge for straight lines.
4. Briefly restate *each* problem in your own words. Do not copy the problem statement verbatim.
5. State what you are going to calculate under heading FIND.
6. State any relevant assumptions, including assumed precision of input numbers.
7. Write the units for all numbers, not just final results:
 - a. Use the same units (metric or US) as the problem.
 - b. Write 5 ft rather than 5' and 8 in rather than 8".
 - c. Units like psi are fine for results, but otherwise write lb/in² to show unit cancellation.
8. Write each result, with the correct number of significant digits, on its own line.

Homework will be checked for compliance specifications 1-8, and if more than one specification is overlooked, homework will be returned and considered missing until resubmitted. Homework and exam grades are A (4), B (3), C (2), D (1), and F (0). Final grades, rounded to two decimal places, are $0.00 \leq F < 0.50$, $0.50 \leq D < 1.50$, $1.50 \leq C < 2.50$, $2.50 \leq B < 3.50$, and $3.50 \leq A \leq 4.00$.

- Life happens, so late homework is accepted—no questions asked—with a penalty of one letter grade per class.
- No credit for missing assignments or late assignments after solutions have been posted.
- No credit for missed exams, except (a) when special arrangements have been made ahead of time, or (b) with documentation of an emergency.
- Final grades will not include plus or minus designations.
- Unclaimed exams, assignments, and reports will be destroyed on or after 2/1/2024.

Communication

The business of civil engineering happens by email. Accordingly, I expect you to check your CU Denver email account each and every business day. To sign up, see the university website.³

³ <http://www.ucdenver.edu/email/>

Academic Integrity

Studying with others is useful and encouraged, but you must perform and present your own work, so copied solutions—from artificial intelligence (such as ChatGPT), from an online resource, from a tutor, from other students, or from any other source—violate the expectation for academic integrity stated in the *2023-2024 Academic Catalog*⁴ and our Student Honor Code, attached below. To avoid plagiarism, cite your sources using American Society of Civil Engineers format.⁵ Midterm and final exams will follow an Exam Policy to be distributed separately.

Mental Health

Is your mental health impacted by anxiety, depression, substance use, or loneliness? If so, you are not alone. There is help through Single Stop,⁶ your one-stop-shop for all student support services. You can visit their website below, e-mail them at singlestop@ucdenver.edu, call them at 303-315-WELL, or visit them on the 3rd floor of the Salazar Student Wellness Center (1355 12th Street).

General

- Snow Closure Hotline 877-556-3637. Campus closed? Class on Zoom with video uploaded.
- Need accommodations for homework or exams? Please register with Disability Resources and Services (DRS),⁷ who will evaluate your situation on a case-by-case basis. I am always happy to provide accommodations per your letter from DRS.
- Syllabus subject to revision.
- Students are responsible for all material presented in class, readings, homework, and e-mail.
- We honor and acknowledge that we are on the traditional territories and ancestral homelands of the Cheyenne, Arapaho, and Ute nations.

This semester's Academic Calendar and our Student Honor Code are attached below. If you have not done so already, please print, sign, and scan the Student Honor Code and email back to me.

Welcome to the class!

⁴ <http://catalog.ucdenver.edu/>

⁵ <http://ascelibrary.org/doi/pdf/10.1061/9780784478998.ch17>

⁶ <https://www.ucdenver.edu/wellness/services/basic-needs/single-stop>

⁷ <https://www.ucdenver.edu/offices/disability-resources-and-services>

[UCD Access \(Student Portal\)](#)
[Registrar Forms](#)
[Registration Information](#)

All deadlines are 11:59 PM MT unless otherwise indicated.

Main Session	Date	Important Notes
First day to apply for Fall Graduation via UCDAccess	April 3, 2023	
Registration begins for Fall Semester via UCDAccess	April 3-18, 2023	Check UCDAccess for your specific registration date and time assignment. For best course selection, register as soon as possible after your registration time assignment.
Open enrollment begins for Fall Semester via UCDAccess	April 19, 2023	
First day of Fall semester classes	August 21, 2023	
Last day to waitlist Fall classes using UCDAccess	August 27, 2023	
Last day to drop a Fall class without a \$100 drop charge	August 28, 2023	All waitlists will be eliminated today.
First day instructor approval may be required to add some Fall classes	August 28, 2023	If unable to enroll in UCDAccess because "Instructor Consent is Required", obtain instructor approval on a Schedule Adjustment Form.
Labor Day Holiday	September 4, 2023	No classes. Campus closed.
Census	September 6, 2023	
Last Day to add Fall classes in UCDAccess	September 6, 2023	
Last day to add Fall classes with instructor consent on the Schedule Adjustment form	September 6, 2023	If unable to enroll in UCDAccess because "Instructor Consent is Required", obtain instructor approval on a Schedule Adjustment Form.
Last day to drop Fall classes with a financial adjustment	September 6, 2023	
Fall classes dropped after this date will appear on your transcript with a grade of "W"	September 6, 2023	
Full tuition will be charged for additional Fall classes added after this date	September 6, 2023	College Opportunity Fund hours will not be deducted from eligible student's lifetime hours.

Last updated 3/7/2023

Last day to apply for Fall graduation via UCDAccess	September 6, 2023	After this date, contact your advisor.
Last day to request or cancel Grade Forgiveness for Fall Semester	September 6, 2023	Refer to the Grade Forgiveness form for restrictions.
Last day to request No Credit or Pass/Fail grade for a Fall class	October 29, 2023	Graduate degree students can exercise the P+/P/F option for undergraduate courses only. Graduate students should consult their school or college regarding the P+/P/F option. A grade of P+/P/S will not be acceptable for graduate credit to satisfy any graduate education requirement.
Last day to withdraw from a Fall class via UCDAccess	October 29, 2023	
First day to withdraw from a Fall class with a Late Withdraw Petition form	October 30, 2023	
Registration begins for Spring Semester via UCDAccess	Nov. 1, 2023 - Nov. 16, 2023	Check UCDAccess for your specific registration date and time assignment. For best course selection, register as soon as possible after your registration time assignment.
Open enrollment begins for Spring Semester via UCDAccess	November 17, 2023	
Fall Break	November 20 - 26, 2023	No classes. Campus open.
Thanksgiving Day	November 23, 2023	No classes. Campus closed.
Last day to withdraw from a Fall class with a Late Withdraw Petition form	December 6, 2023	
Fall Finals week	December 11 - 16, 2023	
End of Fall semester - Commencement	December 16, 2023	
Final Fall Semester grades available on UCDAccess and transcripts (tentative)	December 21, 2023	
Winter Break	Dec. 25, 2023 - Jan. 1, 2024	No classes. Campus closed.
Fall degrees posted on UCDAccess and transcripts (tentative)	January 12, 2024	This is the date your degree will be recorded on your transcript; diplomas begin mailing on January 1st.

Important Information

Last updated 3/7/2023

Student Honor Code

(Revised 12/1/2022)

The Honor Code outlined below is the College of Engineering, Design and Computing statement on academic integrity. The Code articulates the College's expectations of its students and faculty in establishing and maintaining the highest standards in academic work.

Honor Code Text

The Honor Code of the College of Engineering, Design and Computing is a statement of its students, individually and collectively:

- Students will not give or receive aid during examinations.
- Students will not use any prohibited electronic devices during examinations.
- Students will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading.
- Students will uphold the spirit and letter of the Honor Code and they will take an active role to ensure that others uphold the Honor Code and if they observe violations of the Honor Code they must report violations to their Department Chair.
- The Faculty of the College will do its part to ensure its confidence in the honor of its students. Faculty must ensure that precautions are in place to prevent the forms of dishonesty mentioned above. Faculty will also avoid, as far as practical, academic procedures that create temptations to violate the Honor Code. Faculty alone has the right and obligation to set academic requirements. However, the students and faculty will work together to establish optimal conditions for honorable academic work.

Violations of the Honor Code

Examples of conduct that will be regarded as being in violation of the Honor Code include:

- Copying from another's examination paper or allowing another to copy from one's own paper.
- Plagiarism in any shape or form. Plagiarism is defined as the use, without giving reasonable and appropriate credit to or acknowledging the author or source, of another person's original work, whether such work is made up of code, formulas, ideas, language, research, strategies, writing or other form(s).
- Giving or receiving unpermitted aid either in person or via electronic devices.
- Engaging in unauthorized collaboration on academic assignments or examinations.
- Representing as one's own work the work of another.

Penalties for Violating the Honor Code

Most student disciplinary cases have involved Honor Code violations. Of these, most cases arise when a student submits another's work as his or her own, gives or receives unpermitted aid, or engages in unauthorized collaboration. If a violation occurs during a quiz or on a homework assignment, the student will receive a zero for that quiz or assignment. If a violation occurs on an examination or a final project that compromises at least 15% of the final grade, the student will receive a failing grade for the course. The standard penalty for a first offense may include suspension from the College of Engineering, Design and Computing for a severe infraction of the Honor Code. The penalty for a second violation will be expulsion from the College of Engineering, Design and Computing. An instructor who notices a violation should report it to the Department Chair. The Department Chair makes a confirming determination if a violation has occurred and writes a formal letter to the student describing the penalty that will be imposed.

It is the responsibility of the student to seek clarification from the instructor when in doubt about these guidelines.

By signing below, I affirm that I have read and understood the Student Honor code and will abide by its provisions.

Student Name (*printed*): _____

Student ID: _____

Student Signature: _____

Date: _____