



Course Syllabus
GEL ENV GEG 4250 Hydrogeology
(Groundwater)
Spring 2024

Sec.001 - GEL 33072, ENV 33498, GEG 33707: MW 09:30 - 11:45pm

Course URL: <http://college.earthscienceeducation.net/GW/index.html>

Professor

Uwe Richard Kackstaetter, Ph.D. (Dr. "K")

Office: SI2017

Office Hours

Face-to-Face: M W 11:45-13:00

Virtual or F2F: T R 9:30 - 12:00

Online: By appointment!

Contact

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URL: <http://college.earthscienceeducation.net>

This syllabus may be modified at any time without prior notice.

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Course Description

This course is a practical approach to the study of groundwater with emphasis on water quality, underground flow, pumping, and infiltration / recharge principles in relationship to the geologic environment. The course includes practical methods of water quality evaluation, basic soil science as related to hydrogeology, groundwater flow analysis and experimentation, as well as septic system design and evaluation. Since mathematical models are involved, foundational instruction in graphing and algebraic manipulation are given. Students will also be exposed to foundational knowledge in geology and chemistry pertinent to this course. Self-guided group fieldwork is required.

Credits: 4

Prerequisites: - none - **Highly Recommended:** Basic algebra concepts, some trig, basic chemistry, soil science

Course Outcomes

1. Assess basic water chemical & physical parameters;
2. Distinguish between confined & unconfined aquifers from data;
3. Draw groundwater flownets to scale from provided data;
4. Apply Darcy's Law to groundwater flow and geological material interpretation;
5. Use and interpret pumping data for groundwater flow applications;
6. Use water analytical techniques for reconnaissance water quality analysis.
7. Examine a field site and assess its suitability for installing a septic disposal system.

Outline of Course Content**Major Topics & Subtopics**

- I. Background of geology, math, and chemistry pertinent to this course
- II. Soil & Rock Science of Porosity, Permeability, Density
- III. Groundwater Flow, Darcy' Law
- IV. Pumping Aquifers
- V. Hydrochemical reconnaissance analysis and interpretation
- VII. Groundwater Water Quality

Required Course Materials

1. Open Access Books - FREE to Download
 - a. Freeze, R. A., and J. A. Cherry. Groundwater. New Jersey: Prentice Hall, 1979.
<https://fc79.gw-project.org/english/>
 - b. Kresic, Neven. Hydrogeology 101: Introduction to Groundwater Science and Engineering. Warrenton: Blue Ridge Press, LLC, 2024.
https://karstwaters.org/wp-content/uploads/2023/09/Kresic_Hydrogeology-101_rev-1.pdf
2. Textbook - *Optional, but really, really worth it:* Hölting, B. & Coldewey, W., 2019, Hydrogeology, Springer Textbooks, Berlin, Germany, <https://doi.org/10.1007/978-3-662-56375-5>
 - a. *Note: It is on super sale right now (01/2024) for prices well below any textbook (Just click on the doi.org link above)! This is NOT an ordinary textbook, but a ready reference for everything hydrogeology to keep handy as part of your professional library for use beyond this course!*
3. Graph Paper Collection <https://college.earthscienceeducation.net/GW/Downloads/GWGraphPaper.pdf>
4. Computer! Windows system preferred because some Hydrogeology software not available for Mac
5. Excel Spreadsheet: Be able to use MS Excel or similar for data manipulation and computation. If you need brushing up, there are great tutorials available online. Just "Google" it!
6. Other FREE software as introduced in lectures and labs!

Grading in GEL4250 Hydrogeology

| | Max. Point |
|---|-------------------|
| 10 ONLINE Lecture Participation Quizzes (10pts ea.) | 100 |
| 4 ONLINE EXAMS: | |
| Hydro Preqs: Geology, Chem, Math | 50 |
| Permeability and Porosity | 50 |
| Aquifer Pumping | 50 |
| Hydrochemistry | 50 |
| 1 In-Class Hands-on Lab Practical Water Quality Exam | 100 |
| 6 LABS (50 pts ea.): | |
| Porosity Lab; Permeability Lab; Flownets Lab; Confined Aquifer Pumping Lab, Unconfined Aquifer Pumping Lab; Water Quality Lab | 300 |
| GROUP PROJECTS | |
| FIELD PROJECT 1 Percolation Assessment and Septic Design | 150 |
| FIELD PROJECT 2 Manitou Springs Water Chemistry assessment & Graphing | 150 |
| TOTAL | 1000 |

Final Grade Distribution Scale by Points

| | | |
|------------------|-------------|--------------|
| A+ > 970 | A = 930-970 | A- = 900-929 |
| B+ = 870-899 | B= 830-869 | B- = 800-829 |
| C+ = 770-799 | C = 730-769 | C- = 700-729 |
| D+ = 670-699 | D = 630-669 | D- = 500-629 |
| F = ≤ 500 points | | |

Checking Your Course Grade

All exercises and grades processed through CANVAS. Please log in to see you grade updates as they become available.

Grading and Assessment Overview

THE FOLLOWING GRADE PENALTY APPLIES FOR LATE WORK -10% Day (autocalculated through CANVAS)

| Assignment / Assessment | Delivery Method | Restrictions / Notices | Total Points |
|---|--|---|---------------------|
| Lecture Participation | Canvas Quizzes pertaining to lecture block. Grade is cumulative throughout the semester. | NO make-up / retake possible. | 100 |
| Online Exams | Canvas Exams covering the topics from book, labs and lectures | Can be retaken ONCE with grades averaged | 200 |
| Hydro Preqs: Geology, Chem, Math | ONLINE | | 50 |
| Permeability and Porosity | ONLINE | | 50 |
| Aquifer Pumping | ONLINE | | 50 |
| Hydrochemistry | ONLINE | | 50 |
| Hydrochemistry in-class Practical Lab Exam | Taken physically in-class covering hydrochemical lab procedures and interpretation | Final Exam - NO retake / make-up possible. | 100 |
| GROUP FIELD PROJECTS | Group field work includes data collection and measurement. | <i>same grade for everyone in group</i> | 150 |
| FIELD PROJECT 1 Percolation Assessment and Septic Design | Compilation of report from data and analysis. | For details exact details see the project assignment packages | 150 |
| FIELD PROJECT 2 Manitou Springs Water Chemistry assessment & Graphing | | | |
| LABS | | | 300 |
| LAB 1 Porosity | | | 50 |
| LAB 2 Permeability | | | 50 |
| LAB 3 Flownets | Hydrogeology Lab Reports | | 50 |
| LAB 4 Confined Aquifer Pumping | NO retake possible. | | 50 |
| LAB 5 Unconfined Aquifer Pumping | | | 50 |
| LAB 6 Water Quality | | | 50 |
| TOTAL POINTS | | | 1000 |

Course Communication & Course Grade:

The official course communication is CANVAS and your **msudenver.edu** email. Make sure you know how to access both. Do NOT ignore any course messages coming through these two official channels. Your grade may depend on it! All exercises and grades processed through CANVAS. Please log in to see you grade updates as they become available.

Course Involvement & Time Commitment

GEL4250 has considerable lab and field involvement that is outside the scope of our scheduled classroom time. It is imperative that you plan accordingly.

Electronic Devices:

This course requires access to a computer, the internet and a printer. If you do not own your personal electronics, our computer labs at MSU Denver can accommodate but you may then need to plan additional time for the course utilizing these resources.

Using AI (Artificial Intelligence):

AI (Artificial Intelligence, such as ChatGPT, etc.) opens a world of opportunities in the geosciences and can alleviate time constraints and stress. Therefore **you are allowed to use AI** for labs, projects or other assignments, with the following addendum:

1. **Remember GIGO** (garbage in - garbage out) from the early days of computing. AI is not infallible and I have seen it make mistakes or missing the point. Therefore, don't trust AI blindly to do a good job. You must still carefully proof-read and edit your work. You are ultimately responsible for correct content, so be careful!!!!
2. **Cite any AI work:** If you use AI, the segments produced by it in your work must be cited, same as you would when including another author's work. You will NOT lose points if AI is used extensively in your work as long as it is properly cited. Beware, that you can lose significant points if you try to hide that fact.
3. Be aware, that when using examples of your course work in portfolios **for future employment or graduate school, AI work may NOT be accepted.** Do NOT try to hide it. The same AI that generates your work is used in academia and employment offices to spot AI generated work with a high degree of accuracy. Note that AI generated resumes, for example, especially the electronic ones, may now be auto-rejected by the AI HR software of your anticipated employer / graduate school admissions. For reasons like this it might be best NOT to use AI for every work project. Be selective where to employ AI in your schoolwork.
4. AI and Exams: **I do NOT allow AI as a source for taking open book online exams, obviously!** As for now, I use the honor system, but reserve the right for occasional spot checks. If abuse is detected, you are in danger of being charged with academic misconduct, which is a "can of worms" you do NOT want to open.

Absences:

Frankly, registering enrolling in this course is a serious commitment on your part akin to you taking employment. I expect from you the same professional courtesies that you would extend toward any employer.

Absences that affect any course assessments (e.g. quizzes, exams, labs, Participation scores, etc.) and permit you to make-up missed work without penalty REQUIRES an external written 3rd party documentation (e.g. Doctor's Notes, hospital forms, therapist affidavit, accident report, etc.) that would verify the legitimacy of your extraneous circumstances, uniquely qualifying you for a personal due-date extension. It is vital that these documents show the EXACT dates. Without such documentation, late penalties or ZEROs will apply to your missed work.

Question: What about family celebrations, weddings, reunions, work conflicts or similar events? Since these events are usually known long in advance, you will need to let me know AT THE BEGINNING OF THE SEMESTER. I will still need an acceptable 3rd party verification, such as booking tickets, wedding announcements, employer's note, etc. showing your name and the date(s) of your anticipated absences.

Important Note: Since ALL assignments are available at the beginning of the semester and can be submitted ANY time BEFORE the listed due dates, a last minute or after-the-fact "oh, I missed the due date" excuse is definitely NOT going to be accepted.

Note: Nothing in this policy shall require the instructor to reschedule classes, repeat lectures or other ungraded activities or provide ungraded individualized instruction solely for the benefit of students who are unable to attend regularly scheduled classes or activities. For F2F classes, recorded lectures may be available if you missed an in-class lecture.

Late Work / Missing Assignments:

Late Work grace period is 10 days beyond the assignment due date with a Late Penalty of -10% / day (which is automatically processed through the CANVAS grading system). After 10 days beyond the due date, late work will no longer be accepted and your assignment grade will drop to a PERMANENT “missing” or ZERO. Be intimately familiar with the CANVAS course calendar which lists due dates for your convenience thus being able to avoid late submittals. YOU DO NOT HAVE TO WAIT FOR THE DEADLINE TO TURN IN YOUR ASSIGNMENTS!!! *Hint: Turn your work in early and there will be NO problems!*

Exceptions to Late Work Penalties - Occasionally students will asked if I can make an exception to the late work policy for a variety of reasons. Common ones are sudden work conflicts, uncooperative electronics or the internet, traveling, etc. In order to be true to "fairness for all" in the course, the only way I could grant such a request would be an external written 3rd party documentation that would verify the legitimacy of extraneous circumstances, uniquely qualifying you for a personal due-date extension. In short, if I grant you a due date exemption, I must necessarily grant the same privilege to every other student in the class. Without an external written documentation (e.g. Doctor's Notes, hospital forms, therapist affidavit, accident report, etc.) there is not much I can do without violating fairness and impartiality for all students.

For the occasional late work there is a generous 10-day grace period beyond the submittal deadline. While there is a late penalty, it usually does not affect the grade that much if the work is turned in ASAP after the deadline and the late submittals do NOT become a pattern. Think about it this way: Rushing an assessment, throwing it haphazardly together to turn in mediocre work by the deadline may give you a “D”. Taking an extra day, doing a much better job and getting a 90% with a 10% late penalty for being a day late, will give you a final score of 80%, or a B-. Yes, and even if you are two days late your grade might still be higher than in the rushed and mediocre scenario by ONE WHOLE GRADE!!!!

Note: Since everything is posted and available since day 1 of the semester, I usually recommend not to wait until the deadline for submittals but to turn work in early. This will most likely alleviate tons of stress and mitigate uncooperative electronics, sudden work / family conflicts, or similar consternation.

Incomplete (I) for the course:

Because of an extremely poor track record of students keeping their “I” or incomplete commitments, I will no longer give an “I” or incomplete. Facilitating an “I” contract is a substantial time commitment for faculty that spills over into the following semesters. And when students take an “I” lightly and do not complete the work, then facilitating the “I” contract with its tracking requirements is a total waste of my time. To put my decision against “I”s into perspective, only about 1% of my students that have requested and were granted an “I” have ever made an effort and completed the required work. I literally wasted countless hours for them in my misguided decision to help.

Therefore, please do NOT request an “I” unless there are indeed extraordinary, verifiable circumstances completely in line with the university ruling governing the “I” grade. Failing a class or poor performance because of missing assignments are definitely NOT university approved qualifiers for requesting an “I”.

FIELD TRIPS (Group Projects):

This course requires two field exercises, one for percolation testing and septic design, the other for water sampling and analysis.

The field location for the percolation test will be on Dr.K’s property. Students are required to create test holes, execute the percolation test with all necessary field preps, collect data as prescribed, and then analyze the data using Excel or similar spreadsheet software. A final report is required (ONE PER GROUP). Keep all health safety measures when doing your field work. If you do not have a car or feel unsafe doing the field work, talk with your group so they can secure a sample for you and let the instructor know. [See assignment packet for details.](#)

Field location for the water sampling and graphing project will be the easily accessible public mineral water springs in the quaint town of Manitou Springs, CO. You will need to bring field equipment to Manitou Springs and follow sampling and measurement procedures. [See assignment packet for details.](#)

EXTRA CREDIT:

If you do an excellent, top-notch job, some extra credit (up to 10%) is build into assignments, labs, quizzes, and exams at the discretion of the instructor.

GRADES & GRADING - Be aware of the following:

EXAMS: Exams are timed, usually open notes and can be retaken once with your scores being averaged. You will get EXACTLY the same exam for the retake. Just copy the correct answers and focus on questions you did get wrong. Unfortunately, some students guess widely on the first take and receive a low grade, hoping now to pull an incredible grade like an A the second time around. This philosophy is fundamentally flawed which can be shown by the following example:

You get a 28% [F] on the first take of the exam. Now you retake the test and pull an 82% [B]. Take the average $(28\% + 82\%) \div 2 = 55\%$, you still have an F average on the exam.

Therefore, invest time and study. A higher score the first time around means less wrong questions to make up and a greater probability of a much higher score during the retake. Which means a better chance of a passing grade in the course at the end.

A LOWER GRADE ON EXAM RETAKES: A few students have managed to get a lower score on a retake. While rare, it does happen. How is this possible since you know which questions you got wrong? The answer is relatively simple and here are the possibilities:

1. You inadvertently copy the correct answers to the wrong question (e.g. question 2 to question 3, question 3 to question 4, and so forth) on the retake. Double check to make certain that you copy your correct answers to the right question.
2. Exams with "Multiple Response" questions can be tricky. In "Multiple Response" questions one or multiple responses could be correct. The computer gives you partial credit for correct responses mixed with missed or wrong responses. If you get more "Multiple Response" selections wrong on a retake than you did on the first take, your grade will be lower. Here is in example:

On a "Multiple Response" question worth 2 points the correct answer choices would be A, C, D and F. During your first take you answered A, D and F, which would be 3 correct but one wrong, because you omitted it. The computer will give you credit for the correct responses (0.5 pts ea) but will subtract -0.5pts for the omitted correct response. Total credit for this answer would be $(3 \times 0.5 \text{pts}) - 0.5 \text{pts} = 1$ out of 2pts. During the retake you answer the same question with choices B, D, E and F. Now you got 2 correct $(2 \times +0.5 \text{pts})$, 2 incorrect $(2 \times -0.5 \text{pts})$ and 2 missing $(2 \times -0.5 \text{pts})$ responses for a total of -1pt, which defaults to NO points received on your retake for this particular question.

Lab Liability Waiver

1. All students participating in lab activities taught by the Department of Earth and Atmospheric Sciences should be aware that there is always an element of risk involved when working with equipment, machinery and/or chemicals. These risks involve serious injury or death, especially if safety protocols are not followed and/or equipment, machinery, and chemicals are misused. Instructors and/or Lab Personnel will use all reasonable precautions and students need to exercise prudent behavior during such activities, but even then there exists the possibility of an accident or injury. Since many of these activities are to be undertaken in the field and outside of the classroom without the direct supervision of an instructor, students must be alert and aware of possible risks and dangers when using chemicals, equipment, and/ or machinery with or without supervision.
2. Neither the University, nor the instructor, nor any assigned Lab Personnel shall be liable for any damages, including but not limited to injuries, death, loss of property or profits, or incidental, consequential, exemplary, special or other damages that may result from use of chemical, equipment, and/or machinery used in conjunction with or outside the framework of this college course. This condition also expands to the use of procedures and formulations given in LAB texts.
3. The associated LAB instructions and described analytical procedures are intended for use by mature persons

following the safety instructions precisely. Neither the author, nor the instructor, nor the University does accept liability or responsibility for any injury or damage to persons or property incurred by performing the experiments described in the LAB texts, nor for the content of any outside material referred to in class or manual, including linked websites.

4. EXPLICIT SAFETY RULES & REGULATIONS:
 - a. You MUST wear Safety Goggles when working with chemicals or using equipment or machinery.
 - b. You MUST read and follow instructions precisely.
 - c. Do NOT misappropriate chemicals, equipment or machinery other than its intended and prescribed use.
 - d. You must take care not to ingest, inhale, taste or otherwise orally contact chemicals or reactive products. NO FOOD / DRINK IN LAB AREA! You MUST wash hands after each experiment.
 - e. Some tests may include open flames. You MUST take precautions in hair and clothing to avoid accidental or intentional contact of persons and property with flames and fire.
 - f. You MUST take care when transporting equipment to avoid spillage and unintended contact with property and persons.
 - g. Students who violate any of the above rules, policies and stipulations which are written in this document or implied through instruction and professional laboratory behavior or who fail to conform to directives from the instructor or lab personnel **may be immediately dismissed from the course.** They may also be subject to a failing grade, be required to withdraw from the course, and be subject to disciplinary action by the University.
 - h. All participants MUST SIGN the following LIABILITY WAIVER.

In consideration of my being permitted to participate in this activity, I, by enrolling in GEL3050 hereby release and hold harmless: the Trustees of the Metropolitan State Universities of Denver, the Earth and Atmospheric Sciences Department, and respective employees, from all claims, losses, damages, or expenses because of property damage or personal or bodily injury incurred or caused by me during or in conjunction with the above mentioned activity or activities. By enrolling in GEL3050, I acknowledge that I fully understand the risk that is inherent with on and off campus laboratory procedures and/or equipment and/or machinery use. I also indicate by enrolling in the course that I will follow appropriate safety rules and regulations. Furthermore, I have fully read and understand the department policies and my liability and do accept the restrictions.

General Knowledge Prerequisites!

I require the following from students in GEL4250

It is assumed that you have acquired the following general knowledge skills in the sciences, language, and math through your education up to this point. It is the students FULL responsibility to make-up ANY deficiencies in these areas, preferably before enrolling in the course. I will NOT teach, lecture, or tutor any student in these basic High School skills and general knowledge subjects and no further instruction on the topics listed below will be given.

Basic Office Software

Know how to properly use and command MS Word, MS Powerpoint, MS Excel. Graphing with Excel, putting figures / pictures into Word documents, compiling a short presentation using PowerPoint are expected skills in my course.

English Language

Students should be able to write in short, clear, concise sentences when answering questions. Proper syntax becoming to a college student is expected. In many instances you will also be graded on professionalism which includes expressing yourself accordingly in writing. Unless otherwise instructed, always use third person when writing for the sciences. Usage of "I", "we", "my", "mine", "our", is uncommon in technical writing and needs to be avoided.

Basic Mathematical Operations

Students should be able to do the following mathematical operations without any further instructions:

- Round answer to significant digits. (*If you have problems with this, watch the [video](#)*)
- Doing unit conversions (e.g.; continental drift happens at about 5.5cm/yr. How fast would this be in mph?)
- Percent calculations (e.g.; you measure 2.58g/cm³. The actual density is 2.65g/cm³. What is your percent error?)
- Using units in ALL your operations (*I am real stickler about that!*)
- Solving equations for an unknown value; manipulating equations (basic Algebra)
- Basic Geometry: surface areas, volumes, circumferences, areas, angles
- Scientific notations (e.g.; 1.8×10⁻⁹m/s) & scientific prefixes (milli-, mega-, terra-, micro-, etc.)
- Metric system & conversions within (µg, mg, g, kg, t, µm, mm, cm, m, km, m², km², cm³, m³, km³)
- Weights & Measurements (Both American and Metric)
- Operating a scientific calculator (e.g.; know how to switch between degrees and radians, know how to use the arctangent function) $\theta^\circ = \arctan(\text{rise/run})$

Graphing

You are required to be able to differentiate between bar, line and scatter graphs and know how and when each one needs to be constructed. Students should be able to hand-draw curved graphs without being sloppy. Be able to extrapolate values from any graph given, no matter the scale and type.

Physics

Students should be familiar with basic Newtonian laws of motion and understand terms such as velocity, acceleration, inertia, mass vs. weight, force, gravitational constants, kinetic energy, potential energy. Being able to work with the following basic physics equations is a must (Middle School Physics!):

$$v=d/t \quad a=d/t^2 \quad a=(v_f-v_i)/t \quad F=ma \quad I=mv \quad KE=1/2mv^2 \quad PE=ma_g\Delta h \quad a_g=9.8m/s^2 \text{ or } 30ft/s^2$$

Chemistry

Background in basic High School chemistry is essential. Students should know element names and associated symbols, how to read atomic weight and atomic mass from the periodic table, difference between covalent, ionic, metallic and hydrogen bonding, meaning of chemical formulas and subscripts. Students also need to understand pH and the difference between oxidizing and reducing environments. Furthermore, a working knowledge of solutions, solubility, mixtures, homogenous and heterogenous systems, and precipitation is a must.

Geography

Students should know basic physical geography, which includes the location of countries, major mountain ranges, and major rivers.

Drawing & Drafting

While the world is moving rapidly to electronic PC drafting, sketching results by hand is a essential skill in geology. Students must be able to use a drawing compass and a protractor. Sketching curves through data points is another required skill.

Citations

Students should know how to properly format and include citations in their work. I highly recommend the FREE citation tracker and database [ZOTERO](#). It will automatically incorporate into your search engine and MSWord, can grab sources from the web at the click of a button and will make citing and creating correctly formatted references a breeze.

COLLEGE OF LETTERS, ARTS, AND SCIENCES SYLLABUS STATEMENTS

A syllabus is a binding contractual document for any course and becomes the guiding legal document when enrolling in a course. Many policies, procedures and resources are university, college and / or department wide and thus are automatically an integral part of THIS SYLLABUS.

To read these additional policies, procedures and resources, log in to your course in CANVAS and look at the always up-to-date material listed under the

University Policies and Resources Module

for further information.

In case of disagreements between the student and the university faculty and staff, students are responsible for full knowledge of the provisions and regulations pertaining to all aspects of their attendance at MSU Denver, and should familiarize themselves with the policies found in the

University Policies and Resources Course Module

FYI:

*For this course you are part of the
COLLEGE OF LETTERS, ARTS, AND SCIENCES (CLAS)
and the
DEPARTMENT OF EARTH & ATMOSPHERIC SCIENCES (EAS)*