Geology 513-001
Hydrogeology
Spring 2024 Syllabus

Meeting Time and Location

Wednesdays 4:30−7:10 pm
Exploratory Hall 1005 (in-person)

Instructor

Dr. Jules Goldspiel
Department of Atmospheric, Oceanic and Earth Sciences (AOES)

Office: Exploratory Hall 3414
Office Hours: Tuesdays 1:30 − 2:30 pm
Other days and times by appointment

e-mail: jgoldspi@gmu.edu (best contact method)

Course Information

3 Credits
Prerequisites: GEOL 101 (Physical Geology) and GEOL 103 (Physical Geology Lab)
or GGS 102 (Physical Geography)
MATH 113 (Analytic Geometry and Calculus I)
CHEM 211 (General Chemistry I)
Or similar lab-science courses in each of Geology, Calculus and Chemistry

This course will focus on the geologic and hydrologic factors that control the occurrence, distribution, movement, quality and development of groundwater. In addition to the general properties that distinguish a groundwater system as an aquifer, this course will cover the physical and chemical properties of groundwater, groundwater interactions with the surface, and how groundwater flow can be calculated and studied analytically, graphically and with computer models. Natural and engineered processes will both be discussed.

The goals of this course are for students to:

- Appreciate the range of physical and chemical properties common in groundwater systems
- Understand how surface conditions affect groundwater systems and vice versa
- Understand the principles of groundwater flow, and how flow is characterized and calculated
- Understand the practical issues related to aquifer development and depletion
- Understand the basic processes of aquifer contamination and remediation
- Gain experience with some of the tools and resources used to monitor, study and understand groundwater systems

Computer modeling will be part of the course. University computers will be available for students to participate in the modeling exercises, but students may also use their own computers. Computers running the Microsoft Windows operating system are best suited for the modeling exercises. Students will also find it helpful to have ready access to a scientific calculator, spreadsheet program or other method for calculations. Please talk to instructor if access to any of these tools may be a problem.

Course Books and Other Materials

Primary Lecture Textbook

Applied Hydrogeology, 5th Edition, 2022, C.W. Fetter and D. Kreamer, Waveland Press (Recommended)

Available in print and electronic formats. See GMU Bookstore or publisher (https://waveland.com) for purchasing and renting options.

Other Useful References

Alley, W. M., et al., 1999, Sustainability of ground-water resources, USGS Circular 1186. (Available at https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf)

Ferris, J. G., et al., 1962, Theory of aquifer tests, USGS Water-Supply Paper 1536-E. (Available at https://pubs.usgs.gov/wsp/wsp1536-E/pdf/wsp_1536-E.pdf)

Hem, J. D., 1985, Study and interpretation of the chemical characteristics of natural water, 3rd Edition, USGS Water-Supply Paper 2254. (Available at https://pubs.usgs.gov/wsp/wsp2254/pdf/wsp2254a.pdf)

Winter, T.C., et al., 1998, Ground water and surface water: A single resource, USGS Circular 1139. (Available at https://pubs.usgs.gov/circ/circ1139/pdf/circ1139.pdf)

Required Coursework & Grading Weights

Weight	GEOL 513 Coursework
10%	Quizzes
10%	Homeworks
15%	Semester Exercise and Abstracts
10%	Numerical Model Inputs Summary
15%	Preliminary Exam I
15%	Preliminary Exam II
25%	Final Exam

The graded coursework for this class and the weight of each component is as listed in the table at left. For the quizzes and homeworks, the indicated weightings are for the combined total of all quizzes and homeworks.

Quizzes will cover facts and concept details from lectures. They are intended to check your understanding of specific information and concept details discussed since the last quiz. Each quiz will consist of no more than 10 questions in multiple choice and/or short answer format.

Homework assignments will cover quantitative aspects of the course. They will generally involve calculations, graphing and graph interpretation, basic computer modeling and/or concept questions. Calculators, spreadsheets or other computational programs may be used, but intermediate steps and calculation methods must be shown.

The Semester Exercise will involve collecting and summarizing groundwater data. The data will be gathered from publicly available U.S. Geological Survey (USGS) websites. GEOL 513 students are further required to formalize the data summaries in the form of short abstracts.

The Numerical Model Inputs Summary assignment will involve collecting and summarizing the geologic and hydrogeologic properties for a specific region of the U.S. The end result is to be a summary table that contains all the basic information necessary to permit realistic modeling of groundwater flow in the region. The modeling itself is not required for this assignment.

Grade Scale

Grade	Coursework %
A	≥ 90%
B	80 – 89%
C	65 – 79%
D	50 – 64%
F	< 50%

Letter grades will be determined by the weighted percentage of total points possible. The standard grade scale ranges are as indicated in the table at left. The grade scale is subject to change, but if any change is made, it will be favorable to students (i.e., if the scale is changed, the cutoffs for each grade would be at lower percentages than indicated, not higher).

+/- qualifiers will be used for grades near the letter grade limits

Tentative Course Schedule

Week	Date	Topic (and corresponding textbook sections)	Quiz	HW
1	01/17	Course Information & Hydrogeology Overview (Fetter and Kreamer: Chapters 1, 2.1-2.7)		
2	01/24	Physical Properties and Physical Environments of Groundwater (Fetter and Kreamer: Chapters 3, 12.1–12.2)	#1	
3	01/31	Chemical Properties and Chemical Environments of Groundwater (Fetter and Kreamer: Chapter 9)		#1
4	02/07	Hydrologic Connections Between Groundwater and Surface Water (Fetter and Kreamer: Chapters 2.8-2.14, 6)		#2
5	02/14	Geologic Controls and Geologic Impacts of Groundwater Flow and Storage (Fetter and Kreamer: Chapter 8)	#2	
6	02/21	*Preliminary Exam I*		
7	02/28	Groundwater Flow: Governing Equations and Approximations (Fetter and Kreamer: Chapter 4)	#3	
8	03/06	*Spring Break – No Class*		
9	03/13	Groundwater Flow: Wells (Fetter and Kreamer: Chapter 5)		#3
10	03/20	❖ Groundwater Flow: Regional Systems (Fetter and Kreamer: Chapter 7)	#4	
11	03/27	Aquifer Protection, Contamination and Restoration (Fetter and Kreamer: Chapters 10, 11.7-11.8)		#4
12	04/03	■ Hydrogeology in Especially Wet, Dry and/or Cold Environments (Fetter and Kreamer: Chapters 7.7, 8.5-8.6)	#5	
13	04/10	*Preliminary Exam II*		
14	04/17	Numerical Modeling: General Principles, Mechanics & Applications (Fetter and Kreamer: Chapter 13)		#5
15	04/24	To Be Determined (Possible options: Course Review, Groundwater Rights, Hydrogeology in Planetary Environments, expansion of previous topic and/or other topics)		
16	05/01	*Final Exam* (4:30-7:15 pm)		

❖ Numerical Model Inputs Summary due

■ Semester Exercise and associated Abstracts due

Quiz and Homework (HW) numbers in the schedule are the weeks these items will be assigned.

Note: Course content and schedule may be modified by the instructor as the semester progresses.

Other Important Dates

Jan 23 Last day to add classes
Jan 30 1st Drop deadline (full tuition refund, no record on transcript)
Feb 06 2nd Drop deadline (50% tuition refund, no record on transcript)

After the 2nd Drop deadline, Withdrawals for graduate students require academic dean approval.

Course Policies

Electronic Devices: The use of electronic devices (computer, tablet, phone and the like) is permitted during class. While in class, your phone ringer and any other audible alerts on your devices must be off. Be respectful of your peers and instructor and do not use your electronic devices to engage in activities that are unrelated to the class while class is in session. The instructor reserves the right to prohibit the use of electronic devices by any student whose use of a device is unrelated and/or disruptive to the class.

Calculators are the only aid that may be used during exams. If you plan to use a calculator function on a phone, tablet or other electronic device during an exam, you may only use the calculator function. Except for taking online exams themselves in the event the class transitions to online, no other use of electronic devices is allowed during exams, i.e., you may not use electronic devices to access notes or any other information during exams.

All standard University policies apply to the use of University computers and University computer systems for this course. Please see the GMU policies website for a summary of the University computer policies (https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).

Course Materials and Presentations: All course materials and presentations (e.g., lecture outlines, lecture slides, assignments, quizzes, exams, demonstrations) are for course use only. ***These materials may not be shared, posted or in any way redistributed outside of the course, either electronically or as hardcopy.*** Sharing or redistribution of these materials is a violation of the GMU Honor Code.

Recording of Lectures: Lectures and demonstrations may *not* be electronically recorded in any format without prior permission of the instructor and completion of a recording agreement form. Acceptable agreement forms are the Disability Services Recording (Audio/Video) and Copies of Class Presentations Acknowledgement form, or a similar form provided by the instructor. In all cases, the opinions, questions and comments of other class members may not be played back at any point to anyone outside of the class.

Attendance: Students are expected to attend class regularly, but attendance is not strictly required.

Exams: The Preliminary Exams will be taken during the class meeting time on the dates listed in the course schedule. The time and date for the Final Exam is as listed on the course schedule. If GMU is closed on the scheduled date of the Final Exam, the make-up date and time for the Final Exam will be announced through the class Blackboard site and GMU e-mail.

All exams will be taken in person unless the class transitions to online, in which case exams will be online.

All exams are closed book and closed notes. Use of these materials, or any other source of information, is prohibited during all exams.

Homeworks and Quizzes: Homework assignments and quizzes will be posted on Blackboard on the dates listed in the course schedule. Except when specifically noted otherwise, quizzes and homework assignments are due by the start of class (4:30 pm) one week after they are issued. Quizzes must be completed within Blackboard. Assignments may be given to instructor directly, e-mailed to the instructor, or submitted through Blackboard if that option is enabled. *Please do not leave assignments in the instructor's office mailbox or in the instructor's office if the instructor is not present at the time.*

Late or Missed Coursework: Reasonable accommodations will be made for late homeworks and quizzes, and for exams missed due to sickness, religious observance and other unavoidable schedule conflicts if the instructor is notified prior to the date the homework or quiz is due or date the exam is given. Unusual situations that prevent advance notice to the instructor will be handled on a case-by-case basis. In any event, homeworks, quizzes and exams that are not turned in, are not made up, or remain unexcused one week after the scheduled due date or exam date are subject to a grade of zero.

Grade Postings on Blackboard: All course scores will be posted on Blackboard unless otherwise requested.

Collaboration: Students are encouraged to study together and discuss with each other the information and concepts covered in the lectures and course readings. Collaboration on homeworks, quizzes, the Semester Exercise and the Model Inputs Summary is permitted so long as all students in the collaboration fully participate in the discussion of all questions and do a fair share of the collaborative work. For the Semester Exercise and Model Inputs Summary, collaborating students must also use different data sets and do their own write-ups. Simple division of labor (i.e., dividing questions within the group) is not consistent with this collaboration policy and is not permitted.

Collaboration of any sort is not permitted during exams.

Unscheduled University Closure: In the event of an unscheduled University closure or access limitation due to weather or other reasons, check Blackboard and your GMU e-mail for any class announcements. If class cannot meet because of a closure or access limitations, supplementary activities may be assigned.

Extended Emergency Adaptation: All classes are scheduled to be conducted in person. If an extended emergency situation prevents in-person classes, classes may be shifted to a synchronous online mode (i.e., live online) and conducted through Blackboard. You will be told if classes are being shifted to online mode and given instructions on how to access the online system.

University Policies

General University Policies: The University Catalog is the central resource for GMU policies affecting student, faculty and staff conduct in university academic affairs. Please see the catalog (https://catalog.gmu.edu) or the University Policy web site (https://universitypolicy.gmu.edu) for information on academic and non-academic policies not explicitly specified in the syllabus.

Academic Integrity: GMU is an Honor Code university. The Honor Code establishes the principles of academic integrity at GMU and explicitly defines cheating, plagiarism, stealing and lying in the academic context. See the Office for Academic Integrity (https://oai.gmu.edu) for a full description of the code and the honor committee process.

Academic integrity is taken seriously and violations are treated gravely. Three fundamental principles to follow at all times are: (1) collaboration on coursework may or may not be permitted (see policies for specific courses), but either way all work submitted must be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules for collaboration on a particular assignment, ask for clarification.

Another element of academic integrity is the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives and traditions.

Electronic Communications: The instructor will only use the GMU e-mail or Blackboard systems for electronic communications with students. All student electronic communications to the instructor should be sent through your GMU e-mail account or Blackboard. Please do not use personal e-mail accounts. For more information about student e-mail accounts, see the GMU mail website (https://mail.gmu.edu).

Disability Accommodations: All academic accommodations for classes at GMU must be arranged through Disability Services. Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at GMU.

If you are seeking accommodations, please visit https://ds.gmu.edu for detailed information about the Disability Services registration process. Disability Services may also be contacted directly at ods@gmu.edu and 703-993-2474. Disability Services offices are located in Student Union Building I (SUB I), Suite 2500.

Diversity: Through its curriculum, programs, policies, procedures, services and resources, GMU strives to maintain a quality environment for work, study and personal growth. An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals.

Diversity is broadly defined to include such characteristics as, but not limited to, race, color, ethnicity, national origin, religion, age, disability, gender identity and expression, pregnancy status, sex and sexual orientation. Diversity also entails different viewpoints, philosophies and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

Students, instructors and staff are all expected to uphold GMU's commitment to equitable access and meaningful inclusiveness for all within the GMU community.

Sexual Misconduct and Interpersonal Violence: GMU is committed to providing a safe learning, living and working environment. Your experience at Mason is meant to be vibrant and dynamic, and one that includes ample opportunities for exploration of self, identity and independence. Sexual misconduct and incidents of interpersonal violence deeply interrupt that experience, and GMU is committed to maintaining a campus that is free of such incidents.

GMU encourages individuals who have been sexually harassed, assaulted or subjected to sexual misconduct to seek assistance and support. Confidential resources that are available on campus include: University Title IX Coordinator, Counseling and Psychological Services (CAPS), Student Support and Advocacy Center (SSAC) and Student Health Services (SHS). Please note that most all other members of the University community are not considered confidential resources and are required to report incidents of sexual misconduct or other prohibited conduct to the University Title IX Coordinator.

Title IX

Title IX is a federal civil rights law that was passed as part of the Education Amendments of 1972. It prohibits discrimination on the basis of sex under any education program or activity receiving federal funding. GMU receives federal funds in many forms and so is required to comply with Title IX.

Sexual assault and sexual harassment are forms of sex discrimination prohibited by Title IX. Other issues that are investigated under Title IX include stalking, intimate partner violence, gender-based harassment, sexual exploitation, complicity in the commission of any act prohibited by this policy, and retaliation for good faith reporting of any of these forms of conduct or participation in any investigation or proceeding.

For more information see https://diversity.gmu.edu/title-ix/what-title-ix/university-title-ix-statement and https://www2.ed.gov/about/offices/list/ocr/docs/tix_dis.html .

Student Support Resources

GMU has several support resources available to all students. Potentially useful starting points include:

- Learning Services: https://learningservices.gmu.edu
- Student Health Services: https://shs.gmu.edu
- Counseling and Psychological Services: https://caps.gmu.edu
- Student Support and Advocacy Center: https://ssac.gmu.edu
- Diversity, Equity and Inclusion: https://diversity.gmu.edu
- Sexual Misconduct, Harassment and Discrimination resources: https://diversity.gmu.edu/equity-access-services/title-ix
- Title IX Contacts: https://diversity.gmu.edu/equity-access-services/title-ix/who-can-i-speak
- University Career Services: https://careers.gmu.edu

Many other resources are listed under Student Life: https://www.gmu.edu/student-life