GEOL 435-001 GROUNDWATER

INSTRUCTOR: Dr. Antonia Sebastian (she/her/hers), asebastian@unc.edu, Mitchell Hall 324

SYNCHRONOUS LECTURES:

TR 9:45 to 11:00 am; Knapp Building Rm 2601

Zoom Link and Meeting ID: 916 3243 6147; Password: GEOL435

CREDIT HOURS 3.0

PREREQUISITS

CHEM 102; MATH 231; PHYS 104 or 114 or 116; exceptions may be made on a case-by-case basis

COURSE DESCRIPTION

Water is an essential resource for all life, and the availability of clean water will become one of the most important socio-political and economic discussions over the coming decades. This course covers fundamentals of groundwater storage, subsurface flow and contaminant transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater and drinking water resources.

LEARNING OBJECTIVES

By the end of this course, you should be able to:

1. Describe the importance of groundwater in the hydrologic cycle and the hydraulic properties of aquifers
2. Understand the basic equations of groundwater flow and demonstrate their application to real-world problems
3. Apply simple models of groundwater flow to wells and calculate the impact of pumping on drawdown and aquifer yield
4. Characterize the physical, chemical, and biological processes which affect the fate of groundwater as it is transported through the environment
5. Discuss how humans have influenced groundwater resources at local and regional scales

COURSE MATERIALS

Required Textbook

- Fetter, C. W. (2001). *Applied hydrogeology*. 4th Ed., Prentice Hall, Upper Saddle River, NJ.[1]

Useful References (not required)

- Charbeneau, R.J. (2006). *Groundwater Hydraulics and Pollutant Transport*, Waveland Press, Inc.
- Freeze, R.A. and Cherry, J.A. (1979). *Groundwater*. Prentice Hall, Englewood Cliffs, NJ.

[1] The text is available for rent or purchase from Amazon as hardcover, paperback, or e-book. You may also find it elsewhere (e.g., Scribd). Please be sure to obtain the 4th edition, including the Appendices, since many of the homework assignments will come from this book.

- Ingebritsen, S.E., Sanford, W.E., Neuzil, C.E. (2006). *Groundwater in Geologic Processes*. Cambridge University Press.
- Bedient, P.B., H.S. Rifai, and C.J. Newell. (1999). *Groundwater Contamination, Transport and Remediation*, 2nd Ed., Prentice Hall, Upper Saddle River, NJ.

UNC HONOR CODE

In this course, all students will be held to the standards of the UNC honor code in which students are expected to refrain from "lying, cheating, or stealing" in the academic context. If you are unfamiliar with the details of this code or how it is administered, please see me, or consult the Instrument of Student Judicial Governance at honor.unc.edu.

In addition, do not upload any content from this course to the web in any form. If you post my course content, you may be violating my intellectual property rights. If you post your own work from this course, you are allowing sites to profit from your intellectual property. In utilizing web sources to upload or download course content, you risk violating the University's Honor Code.

Note: You are encouraged to work and discuss homework and projects with your peers, so long as the final product is your own.

RESOURCES

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability, or pregnancy complications resulting in difficulties with accessing learning opportunities. All accommodations are coordinated through the Accessibility Resources and Service Office. See the ARS Website for contact information: https://ars.unc.edu or email ars@unc.edu.

The University of North Carolina at Chapel Hill Counseling and Psychological Services (CAPS) is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: https://caps.unc.edu/ to learn more.

INCLUSIVITY STATEMENT

All students are welcome in the course regardless of their race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. I value the perspectives of individuals from all backgrounds that reflect diversity on UNC's campus, and I strive to make the classroom, whether in-person or virtual, an inclusive space for all students. Please let me know if there are ways I can improve. I appreciate feedback.

COVID-19 AND MASKS

This fall semester all UNC students are required to wear a mask covering their nose and mouth in the classroom. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from the course for the protection of the UNC community. Students who have an authorized accommodation from Accessibility Resources and Service have an exception to this policy.

GRADING

Homework (40%)

Typically, homework will be due by 6pm on the date that is listed at the top of the assignment in order to provide me with enough time to look over your work and provide feedback on the assignment prior to the next class period. There will be approximately five homework assignments during the course. You may work together on homework and/or consult me, but each student must complete their own assignment with all work shown.

Given the uncertainty surrounding COVID-19, please plan to upload a copy of your homework in Sakai in the form of either a legible photograph or scanned copy (if you have access to a scanner). If you choose to work a homework problem using excel and/or Python/R please upload a copy of your excel sheet or annotated code to Sakai. Coding proficiency is not required for this course.

Short Learning Assessments (15%)

There will be three short in-class learning assessments related to the objectives of the course (listed above). Each assessment is intended to serve as a check-point for both you and for me to gauge our collective progress in understanding the major concepts and material covered up until that point in the course.

Paper and Presentation (35%)

The paper will cover a topic of your choice that relates to the subjects covered in this class. This paper can address an advancement in groundwater modeling or review the current literature on a groundwater topic that interests you (e.g., GenX contaminants, Phytoremediation). The paper topic must be approved by the instructor. We will discuss our paper topics at several points throughout the semester so pick something that you are excited about and willing to share with the class. Additional information regarding the paper and presentation, and the intermediary deadlines will be handed out separately.

Participation (10%)

There will be several low-stakes assignments or in-class activities that you are required to take part in. Any and all low-stakes assignments and in-class activities will be graded based on completion.

Bonus

Bonus points (0.5% per item to a max of 3%) will be given to students who post recent news articles pertaining to pertinent water topics. To obtain the bonus points, you must write a short description of the news article (<half a page) highlighting the premise of the article, the current understanding (both by society and science) of the topic, and how it relates to the content of the course.

ATTENDANCE

Attendance and participation in class discussions and activities is mandatory unless prior arrangements have been made. Excused absences (e.g., university approved absences) must be reported at least one week in advance. Unexcused absences will be handled individually, and you should discuss them with the instructor. You must complete all assignments (oral and written) to pass the course.

LATE POLICY

Late assignments will be penalized at 10% per day.

COURSE TOPICS

Below is a list of the topics I plan to cover this semester. A more detailed course schedule can be found on Sakai. We may discover that we want to spend more time on certain topics if there is special interest and less time on others. I may consider changing the schedule if this would benefit most students in the course and will notify you if there are any changes in the course schedule.

- Elements of the Hydrologic Cycle (Ch. 1-2)
- Properties of Aquifers (Ch. 3)
- Principles of Groundwater Flow (Ch. 4)
- Groundwater Flow to Wells (Ch. 5)
- Soil Moisture and Groundwater Recharge (Ch. 6)
- Water Quality and Groundwater Contamination (Ch. 10)