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GEO 420.01: Hydrogeology

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**SYLLABUS – GEO 420
HYDROGEOLOGY
Spring 2022**

Schedule: T, Th 8:00-9:50, ISB 110

Instructor: W. Payton Gardner, CCHB 353

Office hours: T: 10:00-11:00 or by appt.

TA: Andrew Norberg (MS Student)

Office Hours: T:2-5pm or by appt.

Office: CHCB 113A

Email: andrew.norberg@umconnect.umt.edu

Course Description: Fundamental physics of groundwater flow and applications in hydrogeology and earth sciences. Topics include: Darcy's law, groundwater flow equation, storage, hydrogeologic investigation, aquifer characterization and evaluation. This course will help students develop the skills to understand the movement and occurrence of groundwater and its role in the hydrologic system. The focus is on developing the skills and background needed to quantitatively analyze applied hydrogeologic problems.

Learning Outcomes:

- Students will be able describe the fundamental subsurface properties which control the occurrence, storage and movement of groundwater.
- Students will be able to manipulate Darcy's law to calculate groundwater flux, discharge and velocity.
- Students will be able to derive the groundwater flow equation for a variety of aquifer types and configurations.
- Student will be able to apply Darcy's law and solutions of the groundwater flow equation to quantitatively solve applied hydrogeologic problems including: aquifer characterization, groundwater storage and supply evaluation, contaminant migration.
- Students will be able to quantitatively calculate the interaction of groundwater with surface systems.
- Students will understand the role of groundwater in Montana water resources.

Course Text:

We will utilize a variety of online material including Open Educational Text books from The Groundwater Project, and additional reading. Reading is MANDATORY. Assigned readings should be completed by Tuesday morning of the week they are assigned except for week 1. There will be pop quizzes and/or reading summary assignments in class to assure that you are reading. All of this is free and on the web, so there are no excuses for not reading.

Texts:

[Poeter et al., Groundwater in Our Water Cycle](#)

[Woessner and Poeter, Hydrogeologic Properties of Earth Materials and Principles of Groundwater Flow](#)
[Poeter and Hsieh, Graphical Construction of Flownets](#)

Course Materials:

Required materials for every class – engineering graph paper. Mechanical pencil (back up pencils), large eraser, scientific calculator.

Suggested materials for class – Nice pen for taking notes – we’ll take a lot. Three-ring notebook with engineering paper, folders for containing printed materials. Colored pencils and or pens.

Grading: 100-90 A, 89-80 B, 79-70 C, 69-60 D, 59 or less F

Weighting:

Lab/Class Participation:	10%
Assignments:	40%
Midterms:	20%
Final Project:	15%
Final Exam:	15%

Students will be evaluated on their ability to master the topics covered, with specific focus on the stated learning outcomes, and their participation in class. The ability of students to learn and apply the concepts will be evaluated by testing as well as assignments. This is a fast-paced, quantitative class, each day of lecture is very important. Don’t miss class, and stay up on your reading.

Homework

Homework assignments are work intensive. **Don’t expect to be able to finish the homework the night before its due** - start working on it as soon as you get it. Assignments should be turned in at the start of class the day they are due. Assignments and answers will follow a specific format that will be demonstrated in class. Messy, unclear assignments that do not follow the specified format will not be graded.

Late Policy:

Late homework will be docked 5% of the maximum points allowed per day past the due date for two additional days. Late assignments will not be accepted after two days.

In-Class Participation:

In class participation will be quantified by in class lab exercises and occasional quizzes. Classes and in-class assignments missed that were not excused beforehand will not be accepted.

Field Trip:

There is a required Saturday field trip. In this field trip, we will gather field data that will be utilized for your final projects. The field trip will tentatively be on 4/2/2021.

Final Project:

The final project will be a Montana water resources characterization that utilizes skills gain in class. The objective is for students to get experience amalgamating different hydrogeologic datasets and writing an applied water resources evaluation.

Course website:

Please check the course website (Moodle) regularly, especially before class, for announcements, notes, readings, assignments, and schedule updates.

Email:

Feel free to communicate with me by email, but please ask homework questions in class or via the Moodle questions forum (others likely have similar questions).

Student Conduct Code:

The Student Conduct Code at the University of Montana embodies and promotes honesty, integrity, accountability, rights, and responsibilities associated with constructive citizenship in our academic community. This Code describes expected standards of behavior for all students, including academic conduct and general conduct, and it outlines students' rights, responsibilities, and the campus processes for adjudicating alleged violations. [Full student conduct code.](#)

Course Withdrawal:

Students may use Cyberbear to drop courses through the first 15 instructional days of the semester. Beginning the 16th instructional day of the semester through the 45th instructional day, students use paper forms to drop, add and make changes of section, grading option or credit. GEO420 may not be taken as credit/no-credit.

Disability Modifications:

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and [Disability Services for Students](#). If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or call 406.243.2243. We will work with you and Disability Services to provide an appropriate modification.

Schedule of Topics:

Note: The schedule below represents the best intentions.

Week	Date	Topic	Reading	Assignment
1	01/18/22	Introduction to groundwater,		
	01/20/22	Groundwater in the hydrologic cycle - Recharge and Discharge	Poeter Chapter 1-3, Poeter	
2	01/25/22	Groundwater in the hydrologic cycle - Hydrograph separation	Chapter 4; Fan, 2013 Woessner	
	01/27/22	Wells and drilling	Chapter 4	
3	02/01/22	Basic fluid mechanics, fluid potential		
	02/03/22	Darcy's law, Discharge and Flux		
4	02/08/22	Porosity and Permeability Permeability & Hydraulic Conductivity	Woessner Chapter 2,3	HW1
	02/10/22			
5	02/15/22	Heterogeneity and anisotropy	Woessner Chapter 5	
	02/17/22	Storage	Woessner Chapter 6	
6	02/22/22	Geology and Groundwater - groundwater system architecture	Toth 1963	
	02/24/22	MIDTERM1		HW2
7	03/01/22	Groundwater flow equation - confined aquifers	Woessner 7,8 Poeter (Flownets)	
	03/03/22	Boundary Conditions, The Boundary Value Problem, Flownets	1,2; Freeze, 1967	
8	03/08/22	Groundwater flow equation - unconfined aquifers and unsaturated flow		
	03/10/22	Variable saturated flow - Richards equation	Mualem ,1976; van Genuchten, 1980 Witherspoon, 1980	
9	03/15/22	Fracture flow and Variable Density Flow	1980 HW3 due 3/23	
	03/17/22	Surface water and groundwater interactions	Woessner GW-SW 1-6	HW3

10	03/22/22	SPRING BREAK		
	03/24/22	SPRING BREAK		
		Seasonality of groundwater, Groundwater hydrographs,		
11	03/29/22	Estimating Recharge and Discharge		
		Groundwater response to pumping,	BWHB 5-11 –	
	03/31/22	theis equation, superposition	5-13; 9-1 – 9-	
		Pump tests - Theis curve	5	
12	04/05/22	characterization		
		Groundwater response of other		
	04/07/22	aquifers		
		Slug tests and slug test	BWHB 9-5 -	
13	04/12/22	interpretation	9-13; 10-5	
	01/14/22	MIDTERM2		HW4
14	04/19/22	Artificial recharge		
	04/21/22	Irrigation and Groundwater Storage		
15	04/26/22	Conjunctive management		
	04/29/22	Groundwater mining		Final Project
		FINAL EXAM - Tuesday May 10th 8-		
	5/10/22	10		