THE UNIVERSITY OF UTAH™
University of Utah
Salt Lake City, Utah 84112 Phone 801.585.7961

SYLLABUS
(version as of 12 December 2022)
CVEEN 5920 – Groundwater Hydraulics
Spring 2023

Course Scope and Objectives

The primary goal of this course is to introduce and review the fundamentals of groundwater flow and associated coupled processes, mathematical constructs of groundwater flow processes in geological strata, and the coupling between groundwater and surface water. Topics include Darcy's equation, mass conservation, the groundwater flow equation, solutions to the groundwater flow equation, heterogeneity and anisotropy of hydrologic properties, heat transport, multiphase flow of gases and liquids (e.g., CO_2 sequestration, oil production, etc.), and solute and contaminant transport at multiple scales. These fundamentals will culminate in a survey of subsurface hydraulics with analysis via groundwater model simulation.

Of particular emphasis will be "induced" hydraulics resulting from wells drilled for energy extraction and other purposes. This will include development and simulation of groundwater models, including simplified generic models, actual groundwater well fields, geothermal energy well fields, and groundwater contamination case studies. Specific modeling studies may include simulation of the Blundell geothermal energy field associated with Roosevelt Hot Springs in central Utah, an oilfield in the Uinta basin, Utah, and the Woburn Massachusetts groundwater contamination site, featured in the best-selling non-fiction book "A Civil Action" by Jonathan Harr.

Instructor:

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Class Meeting Times:

Mondays and Wednesdays, 11:50 am – 1:10 pm, GC 1790 (tentative shift to CME 100)

Office Hours:
Mondays and Wednesdays 1:30 pm CME 100 (tentative, but likely)

Required Textbook:

***Fundamentals of Groundwater*, Schwartz and Zhang (2003)**
Amazon: http://www.amazon.com/Fundamentals-Ground-Water-Franklin-Schwartz/dp/0471137855
Wiley: http://bcs.wiley.com/he-bcs/Books?action=index&bcsId=1316&itemId=0471137855
You may either buy the full textbook now; I did order the textbook at the Campus Store, if you prefer to purchase immediately. Or, you may borrow a copy of the textbook from me for the semester (over the years I've purchased a stack for this purpose) and wait to purchase later in (or after) the semester, when prices drop.

Class Website:

Canvas – http://utah.instructure.com

Course and Grade Components

25% - Midterm Test
50% - Homework (a mix of textbook homework and model simulation problems)
25% - Final Exam

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Schedule

Tabulated below are the TENTATIVE topics we will cover this semester. The class period sequence (class #'s) are only approximate. Note that the topics or sequence of topics may be adjusted, as appropriate, during the course of the semester. This syllabus will be updated with any adjustments, and the online version of this syllabus supersedes any printed versions.

Class Period #	Topic	Reading Assignment
Review at Home	History of Hydrology and the Water Cycle	SZ Ch. 1
1	Groundwater Flow and Darcy's Law	SZ Ch. 3
2	Components of Darcy's Law	SZ Ch. 3
3	Hydraulic Conductivity and Heterogeneity: Averages	SZ Ch. 3
4	Transmissivity and Storativity	SZ Ch. 4.1-4.2
5	Continuity Equation and the Groundwater Flow Equation	SZ Ch. 5.1-5.3
6	Flow Nets (graphical solution to GWFE)	SZ Ch. 5.4-5.5
7	Regional Flow, Flow Divides and Toth Analysis (solution to GWFE)	SZ Ch. 5.4-5.5
	Pressure Length (online only)	webcast on Canvas
8	Modeling Concepts and Finite Difference Method for Solving GWFE	SZ 15
9	Finite Difference Method (FDM) and the Taylor Series Expansion	SZ 15
10	FDM Implementation of 2-D Regional-Scale Flow Model in Spreadsheet	
11	Development of 3-D Regional-Scale Flow Model with Commercial Software	
12	Steady-State Well Hydraulics: Confined (Thiem)	SZ 9.1 – 9.2
13	Development of Steady-State Well Hydraulics Model with Commercial Software	
14	Midterm Test	
15	Transient Well Hydraulics: confined isotropic (Theis and Jacob Cooper)	SZ 9.3-9.8
16	Development of Transient Well Hydraulics Model with Commercial Software	
Spring Break		
17	Aqueous Geochemistry Overview	SZ 16
18	Solute (Contaminant) Transport: Advection-Dispersion Equation	SZ 16 and 19
19	Simulation of Contaminated Groundwater Site (Woburn)	
20	Simulation of Contaminated Groundwater Site (Woburn)	
21	Fundamental Groundwater/Heat Flow	
22	Simulation of Regional Scale Groundwater/Heat Flow	
23	Simulation of Geothermal Energy System (Blundell Power Plant and its wellfield)	
24	Overview of Petroleum Systems (oil/gas generation and its relationship to thermal history)	
25	Overview of Multiphase Flow in oil/gas fields and in CO_2 sequestration fields	
26	Simulation of Oil Generation and Migration	
27	Simulation of Geologic Carbon Storage	
	Final Exam: Thursday, April 27, 2023 - 10:30 am – 12:30 pm	