CWR 5125, U01 (REF.: 89376) – GROUNDWATER HYDROLOGY
Prerequisites: Permission of the Instructor
Department of Civil and Environmental Engineering
Florida International University
Fall 2023

Instructor: Professor Fuentes, Ph.D., P.E., B.C.E.E.
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Office Hours: W & R: 2:00 - 4:00 PM (in-Person, first-come, first-served)
For an appointment, please email Professor Fuentes at fuentes@fiu.edu.

Lecture location and time: EC-1114
Tuesday: 5:00-7:40 PM

A. Course Description & Objective

Quantity and quality of water resources is vital to sustain the health and welfare of ecosystems and human communities. Their protection requires understanding theory and methods that are needed to use it, sustainably, while securing its quantity and protecting its quality. The *overall learning objective* of the course is to provide civil engineers and environmental engineers with working knowledge of the principles, processes, and methodologies to characterize and solve groundwater flow problems, including an introduction to the concepts that are needed to estimate contaminant transport in groundwater environs. Contents will then focus on the following themes: groundwater occurrence, fundamental laws and principles, aquifers and well hydraulics, and an introduction to contaminant fate and transport under advective-dispersive flow conditions. Some relevant questions are, for instance: What models are used to predict pumping effects in a well field? How much drawdown can well pumping cause in a confined aquifer? How analytical modeling solutions be used to estimate the movement of an industrial spill in a saturated aquifer?

B. Textbook & Study Assignments

Recommended Textbook:
Chaberneau, R. J., *"Groundwater Hydraulics and Pollutant Transport,"* Prentice-Hall, Inc., Upper Saddle River, NJ, 2000 (reissued 2006).
Guidance Technical Reports:
USCOE, *Groundwater Hydrology: Engineering & Design*, Department of the Army, EM 1110-2-1421, Washington, DC 20314-1000.
Heath, R. C., *Basic Ground-Water Hydrology*, Water-Supply Paper 2220, U.S. Department of the Interior, U.S. Geological Survey, 1983: https://pubs.er.usgs.gov/publication/wsp2220 (*supporting reference*)
USEPA, *Transport and Fate of Contaminants in the Subsurface*, Seminar Publication,

EPA/625/4-89/019, Cincinnati, OH, 1969:
https://nepis.epa.gov/Exe/ZyPDF.cgi/300048II.PDF?Dockey=300048II.PDF

Although the recommended textbook and reference technical reports will support learning well during the course program, students should supplement textbook content with their own notes, posted handouts, and other references. Students are responsible for the timely study of all assigned material, in parallel (best in advance) to lectures thus enhancing their learning. Careful study of theory and examples and practice solving problems are quite critical to achieve the learning objective.

C. Use & Management of Class Time

Class time is used to highlight and discuss theory and examples. Lectures will follow the following list of topics:

Topic	**Estimated Lectures**
Module 1 – Basic Groundwater Hydraulics (USCOE)	
Introduction: Chapter 1 (1.1 to 1.8)	2
Occurrence and Flow: Chapter 2 (2.1 to 2-20):	2
Well Field Tests and Equations: Chapter 4 (4.1 to 4.9. Appendix D)	2
Infiltration: Chapter 6 (6.3)	1
Module 2 – Practical Applications (USGS-WS Paper 2220: **pages**)	
Unsaturated Flow Basics: 16, 18	2
Pumping Equations: 34, 36, 38, 40, 44, 46, 48, and 50	2
Well Design: 52, 54, 56, 58, 60, 62	2
Water Quality: 66, 68, 70, 72, 74, 76, 78	2
Module 3 – Contaminant Fate & Transport (USEPA)	
Introduction: Chapter 1	2
Physical Processes in Contaminant Transport: Chapter 2	2
Parameters of Physical Transport: Chapter 4	2
Subsurface Chemical Processes: Chapter 5	2
Microbial Processes: Chapter 7	2
Module 4 – Modeling Process (special sessions)	
USCOE: Chapter 5: Computer Modeling	1.5
USAEPA: Chapter 9: Modeling Subsurface Contaminant Transport and Fate	1.5

This course completes the program of study in a 16-week schedule. Professor Fuentes expects each student to commit time, dedication, and discipline to each learning module, as follows:

a) Timely study of assigned material (i.e., textbook and handouts, as it may apply).

b) Thorough mastering of example problems beyond lecture presentation.

c) Timely consultation with students' selected references *or with the instructor or both, as needed, on the application of theory and methods to solving problems.*

D. Grading Policies

Homework	15 (TBA)
Exam 1	25 (October 3, 2nd lecture time)
Exam 2	25 (November 7, 2nd lecture time)
Final Exam	25 (December 5)
Research Activity	10 (due on the last term lectures
Total Maximum	*100*

Homework: a) will be collected a number of times during the term, at the discretion of the instructor; b) will be collected, at least, one class after completion of relevant lectures; c) must comply with requested format in engineering paper or equivalent (if approved); d) if late, will not be accepted, receiving "zero" points; and e) its completion or graded return does not condition, in any way, the content of exams.

All exams are open book (i.e., access to the Recommended Textbook and the Guidance Technical Reports, only). Questions and problems in exams will be based on all assigned and covered material up to the last lecture before the scheduled day of the exam. Exams will be held on October 3 (No. 1), November 7 (No. 2) and December 5 (Final Exam), 2023. The lowest score in Exams 1 and 2 will be replaced by the score of the Final Exam if the latter helps to raise the overall grade.

The Research Activity and Presentation will consist of a long abstract and a presentation in MSPowerPoint. They will be held on the 28th of November during the last week. The written short-paper and MSPowerPoint file will be due at the end of each presentation.

The instructor may announce other criteria in advance to any deadlines for either homework, exams, or research activity. Unless it is directed by Professor Fuentes, with specific guidelines and conditions, the use of AI is not acceptable in the completion of homework and exams. If a student wishes to use AI in support of the Research Activity, he/she must timely discuss the planned use with Professor Fuentes.

Students should always carry their *FIU One Card* for official identification purposes and be

ready to present it if requested by the Instructor or Teaching Assistant during any scheduled activity, but most especially during quizzes and exams.

<u>ADVICE</u>: BEGIN YOUR STUDY, HOMEWORK AND PROJECT PROMPTLY. ALL YOUR WORK MUST BE AN INDIVIDUAL EFFORT, UNLESS APPROVED BY THE INSTRUCTOR. ANY QUESTIONS ON GRADES WILL ONLY BE CONSIDERED WITHIN THE FIVE (5) WORKING DAYS FOLLOWING THEIR OFFICIAL ANNOUNCEMENT.

Final grade is a function of the total number of points accumulated by the student at the end of the course, as follows:

93.3	≤ A	≤ 100.0	70.0	≤ C	< 76.7
90.0	≤ A-	< 93.3	60.0	≤ D	< 70.0
86.7	≤ B+	< 90.0		F	< 60.0
83.3	≤ B	< 86.7			
80.0	≤ B-	< 83.3			
76.7	≤ C+	< 80.0			

E. Other Performance Policies

Class attendance is required and documented by signing the class roll; late arrival or early departures are considered absences. A student with three unjustified absences will be dropped from the course with a DR on October 30th. Students will automatically lose 0.45 points per unjustified absence after October 30th. No make-up or incomplete grades will be considered, unless properly justified and documented emergencies. Please be in time for all classes and keep any unauthorized e-devices off during all lectures and exams.

F. Days to Remember (refer to the Official FIU Fall 2023-2024 Academic Calendar for details)

GD_Academic_Calendar.pdf (fiu.edu)

August 21:	Classes begin.
September 4:	Labor Day (University Closed)
October 3:	Exam No. 1 (2nd lecture)
October 30:	Deadline to drop a course with a DR grade. Last day to withdraw from the University with a WI grade.
November 7:	Exam No. 2 (2nd lecture)
November 11:	Veterans Day (University Closed)
November 23-25:	Thanksgiving Day and Break
December 2:	Classes end
December 5:	Final Exam (5:00 PM) at EC 1114
December 13:	Deadline (by 11:59PM) for faculty to submit grades.

The instructor will comply and enforce all applicable FIU's Policies and Regulations. It is the students' responsibility to know all applicable policies and requirements. All students should refer, for details, to the *FIU Student Handbook* (which includes the Student Code of Conduct) at

https://studentaffairs.fiu.edu/about/student-handbook/index.php

Students are deemed by the university to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the FIU Student Handbook. Misconduct includes, among other, *cheating, plagiarism, misrepresentation misuse of computer services, bribery, conspiracy and collusion, falsification of records and academic dishonesty* (please visit http://integrity.fiu.edu).

Students should know of both Panthers Care and CAPS services, which support their well-being.

G. Some Recommended References

A good number of relevant references are available at the Steve and Dorothea Green Library. Some items may be checked out checked out from the instructor:

Aquifer Hydraulics, V. Batu, John Wiley & Sons, 1998.
Applied Groundwater Hydrology and Well Hydraulics, M. Kasenow, 3rd Edition, Water Resources Publications, *LLC, 2010*
Applied Hydrogeology, C. W. Fetter, Prentice-Hall, 2001.
Groundwater, R. A. Freeze and J. A. Cherry, Prentice-Hall, 1979
Ground Water Contamination Transport and Remediation,* P. B. Bedient, H. S. Rifai, and C. J. Newell, Prentice-Hall PTR, 1999 (*Recommended if available*)
Groundwater Hydrology, H. Bouwer, McGraw-Hill, 1978
Groundwater Hydrology & Hydraulics, D. B. McWhorter & D. K. Sunada, Water Resources Publications, 1977
Hydraulics of Groundwater, J. Bear, McGraw-Hill, 1979
Subsurface Hydrology, G. F. Pinder and M. A. Celia, Wiley Interscience, 2006.

Important websites for computer models for groundwater flow and transport applications:

https://water.usgs.gov/software/lists/groundwater

https://www.epa.gov/land-research/ground-water-modeling-research

https://www.epa.gov/ceam/groundwater-models-assess-exposures

Important federal agency and other websites Among others):

www.epa.gov, www.usgs.gov, www.ngwa.org, and
IGWMC – Integrated Groundwater Modeling Center (princeton.edu)

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