

**CWR 5125, U01 (REF.: 89789) – GROUNDWATER HYDROLOGY****Prerequisites: Permission of the Instructor****Department of Civil and Environmental Engineering****Florida International University**

Fall 2021

**Instructor:** Professor Fuentes, Ph.D., P.E., B.C.E.E.

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Office Hours: W &amp; R: 2:00 - 4:00 PM (in-Person, first-come, first-served)

*For an appointment, please email Professor Fuentes at [fuentes@fiu.edu](mailto:fuentes@fiu.edu).***Lecture location and time:** Student Academic Success Center 302

Tuesday: 5:00-7:40 PM

**A. Course Description & Objective**

Quantity and quality of water resources is vital to sustain the survival, health, and welfare of the planet and humankind. 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, well hydraulics, vadose zone characteristics, 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? What is a wellhead protection area and related travel times? How analytical modeling solutions may be used to estimate the movement of an industrial spill in a saturated aquifer?

**B. Textbook & Reading Assignments**Required textbook/material:

1. *Chabernau, R. J., "Groundwater Hydraulic and Pollutant Transport," Prentice-Hall, Inc., Upper Saddle River, NJ, 2000 (reissued 2006).*
2. 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*)
3. USEPA, *Transport and Fate of Contaminants in the Subsurface*, Seminar Publication, EPA/625/4-89/019, Cincinnati, OH, 1969:

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<https://nepis.epa.gov/Exe/ZyPDF.cgi/300048II.PDF?Dockey=300048II.PDF> (supporting reference)

Although the textbook will support learning well during the course program, students should supplement textbook content with their own research notes, posted handouts, and references. Students are also responsible for the timely study of all assigned material, in advance to lectures to enhance their effective retention. Careful study of theory and examples and practice solving problems are 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:

<b><u>Theme/Topic (Reading Assignment)</u></b>	<b>Estimated No. of Lectures (1 lecture = 1.25 minutes) (2 lectures every Thursday)</b>
<b>Part I – Introduction</b>	
1. Introduction	1
2. Groundwater Hydrology (1.1 to 1.5)	1
<b>Part II – Fundamentals</b>	
3. Basic Fluid Mechanics: 2.1	1
4. Darcy's Law: 2.2	2
5. Continuity Principle: 2.3 (2.3.4 excl.)	1
6. Management Models: 2.5	1
<b>Part III – Well Hydraulics</b>	
7. Wells and Placement: 3.1	1
8. Steady Flow: 3.2	1.5
9. Transient Flow: 3.3	1.5
10. Pumping Tests: 3.4	2
11. Well Functions: 3.5	1
12. Slug and Well Tests: 3.6-3.7	1
13. Special Applications: 3.8, 3.10	1
14. Wellhead Protection Areas (with WhAEM2000, 2007)	2
<b>Part IV – Vadose Zone Characteristics</b>	
15. Characteristics and Laws: 4.1-4.3	1
16. Measurements: 4.4	1
<b>Part V – Contaminant Fate &amp; AD Transport</b>	
17. Sources and Processes: 5.1 – 5.6	1
18. Transport by Advection and Diffusion: 6.1, 7.1 – 7.3	1

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19. Advective-Dispersive Transport: 8.1 – 8.9 (8.6 excl.), 8.11 2

#### D. Grading Policies

Homework	10 (TBA)
Exam 1	25 (October 5; 2 <sup>nd</sup> lecture time)
Exam 2	30 (November 9; 2 <sup>nd</sup> lecture time)
Project	30 (Proposal due on October 12; written report due on Friday, December 3; and oral defense held on Tuesday, December 7)
Lecture (MSPP & Handout)	5 (TBD)
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.

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 5 (No. 1) and November 9 (No. 2), 2018.

The written project report is due on Friday December 3 at 6:00 PM (or earlier) and may be dropped at the instructor’s mailbox or slide it under the door of his office. The project oral defense will be held on December 7 from 5:00 to 7:00. The instructor may announce other criteria in advance to any deadlines for either homework, exams, lecture or report.

***ADVICE: 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 November 1. Students will automatically lose 0.45 points per unjustified absence after November 1. No make-ups 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.

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.

In the case of COVID-19 related isolation or quarantine by either instructor or student, the instructor will do the best to ensure the continuity of the program for everyone by either re-scheduling make-ups for either submittal of homework or completion of prep quizzes or exams or both. Re-scheduling may be considered for either the entire class (i.e., in extreme circumstances) or individual cases (this expected to be most possible). After November 14, 2021, there will not be any re-scheduling; the option will be adding any pending grade percentages among all remaining homework prep quizzes and exams. The instructor will address COVID-19 related student absences in reference to the last guidance from the Florida Board of Governors (update of August 24, 2021, FIU Office of the Provost). Please refer to the following link for details and Frequently Asked Questions (FAQs):

[P3 App | Panthers Protecting Panthers | Florida International University \(fiu.edu\)](#)

## F. Days to Remember (refer to the Official FIU Fall 2021 Academic Calendar for details)

[UG Academic Calendar.pdf \(fiu.edu\)](#)

August 23:	Classes begin
September 6:	Labor Day (University Closed)
October 5:	Exam No. 1
October 12:	Project Proposal Due
November 1:	Deadline to drop a course with a DR grade. Last day to withdraw from the University with a WI grade.
November 9:	Exam No. 2
November 11:	Veterans Day (University Closed)
November 25-28:	Thanksgiving Day and Break
November 3:	Written Report Due
December 4:	Classes end
December 7:	Project Oral Defense (5:00 - 7:00 PM) at SACS 302
December 15:	Deadline (by 11:59PM) for faculty to submit grades

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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 be aware of both [Panthers Care](#) and [CAPS](#) services for students, which support their well-being.

## **G. Some Recommended References**

*A good number of relevant references, for your consideration and use, are available at the Steve and Dorothea Green Library. In addition, the items below may be checked out from the instructor, during his scheduled office hours, for up to 48 hours.*

*Aquifer Hydraulics*, V. Batu, John Wiley & Sons, 1998.

*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.

*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:*

[www.epa.gov](http://www.epa.gov), [www.usgs.gov](http://www.usgs.gov), [www.ngwa.org](http://www.ngwa.org), and

[IGWMC Home - Integrated Groundwater Modeling Center \(mines.edu\)](http://IGWMC.Home-IntegratedGroundwaterModelingCenter.mines.edu),

among others.

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