NORTHWESTERN UNIVERSITY
CIV_ENV 364 Syllabus
Sustainable Water Systems
Winter 2023

MWF 9-9:50 am, Tech A110
W, 2-2:50 pm (Discussion/ Office Hours), Tech A110
Zoom Meeting ID for Office Hours: 935 5746 7595

Instructor: Professor George Wells
Department of Civil and Environmental Engineering
Office – Tech A318
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Grader: McKenna Farmer
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COURSE DESCRIPTION:
This course is designed to provide students with an overview of the engineered water cycle, an underappreciated yet critically important foundation for modern society that is in need of both immense investments to shore up existing infrastructure and innovative solutions to emerging problems. The emphasis in this course is on urban water infrastructure in industrialized countries, but we will also touch on the enormous challenges presented by the lack of sanitation and drinking water in developing countries. We will cover fundamental principles as well as design and assessment methods for physical, chemical and biological treatment unit processes for drinking water treatment, wastewater ("used water") treatment and reuse, and water resource engineering. Regulatory drivers of water management will also be reviewed. Special attention will be paid to emerging issues, the energy-water nexus, and technological advances in the evolving engineered water cycle.

PREREQUISITES*: MECH_ENG 241 (Fluid Mechanics I) and CIV_ENV 260 (Environmental Systems and Processes)

REQUIRED TEXTS (Available in the NU bookstore):

Davis, Mackenzie L. (2019) *Water and Wastewater Engineering: Design Principles and Practice, 2nd edition.* McGraw-Hill, New York, NY.
WEBSITE: http://www.mhprofessional.com/wwe2e
→The first edition of this book (published in 2011) is also acceptable. Note that both a student edition and a professional edition of Davis 2011 are available. Only the student edition is necessary for the course.

Fishman, Charles. (2011) *The Big Thirst: The Secret Life and Turbulent Future of Water.* Free Press, New York, NY.

These texts will be supplemented with in class handouts and online resources.

** Prerequisites for undergraduate students. Graduate student admission is subject to instructor permission.*

OTHER REFERENCES:

Crittenden, J. C., Trussel, R. R., Hand, D. W., Howe, K. J., & Tschobanoglous, G. (2012) *MWH's Water Treatment: Principles and Design, 3rd Edition.* John Wiley & Sons, Hoboken, NJ.
Available to NU affiliates online at:
https://onlinelibrary-wiley-com.turing.library.northwestern.edu/doi/book/10.1002/9781118131473

Tschobanoglous, G., Stensel, H. D., Tsuchihashi, R., & Burton, F. L. (2013) *Wastewater Engineering: Treatment and Resource Recovery, 5th edition*. McGraw-Hill, New York, NY. (Also known simply as Metcalf & Eddy)

Rittmann, B. E. & McCarty, P. L. (2020) *Environmental Biotechnology: Principles and Applications, 2nd Edition.* McGraw-Hill, New York, NY.

EVALUATION:

- Six homework assignments – 30%
- Two exams - 40%
- Group project that will involve the conceptual design and/or analysis of a water resources solution - 25%: 15% report + 7.5% presentation + 2.5% teamwork (peer evaluation)
- Participation (class attendance and discussion) - 5%

OBJECTIVES:

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

Magnitude of the Problem

1. Explain current water resources issues and potential solutions
2. Identify typical and emerging water and wastewater contaminants
3. Describe the difficulties utilities face in eliminating combined sewer overflows

Regulations

4. Recognize what the regulations cover and where to find them
5. Indicate what performance characteristics are required
6. Interpret regulatory trends

The Major Technologies

7. Illustrate when and where they are used
8. Describe how the processes work and what performance can be achieved
9. Determine design parameters needed for conceptual and quantitative design

Innovative Technologies

10. Describe new and emerging technologies
11. Illustrate where they can be used and why they are improvements over older methods

How to Approach a Problem/Case Studies

12. Interpret the logic involved and decision processes commonly used

Resources

13. Locate and apply important information resources, including major professional journals, institutional websites, and professional organizations

SCHEDULE ***(subject to change):***

Wk	Date*	Theme	Topic	Davis Reading	Fishman Reading	Due
1	Jan 3		Introduction			
	Jan 4		Water Quality Standards and Regulations	Chp 1.5, Chp 2		
	Jan 6					
2	Jan 9	Physical-chemical treatment processes	Water Resources and Supply, Water-Energy Nexus			
	Jan 11		Particles in Water and Coagulation	Chp 6		
	Jan 13		Coagulation/ Flocculation, Part I			HW1
3	Jan 16		**MLK Day- no class**			
	Jan 18		Coagulation/ Flocculation, Part II	Chp 6	Chps. 2 and 3	
	Jan 20		Hardness and Softening	Chp 7		
4	Jan 23					
	Jan 25		Sedimentation	Chp 10		
	Jan 27					HW2
5	Jan 30		Filtration	Chp 11	Chps 5 and 7	
	Feb 1					
	Feb 3		Disinfection	Chp 13		
6	Feb 6					
	Feb 8		Review			
	Feb 10		**EXAM 1: Drinking Water Treatment***			HW3
7	Feb 13	Biological Treatment Processes	General Wastewater Treatment Design Considerations	Chp 18	Chp 6	
	Feb 15					
	Feb 17		Wastewater Microbiology: microbial kinetics, molecular processes, and the activated sludge microbiome	Chp 22		
8	Feb 20				Chp 8	
	Feb 22		Secondary Treatment: Activated Sludge	Chp 23		
	Feb 24					HW4
9	Feb 27					
	Mar 1		Tertiary Treatment	Chp 26		
	Mar 3					HW5
10	Mar 6		Student presentations, review			
	Mar 8					
	Mar 10					HW6
Final	Mar 13, 12-2 pm		**EXAM 2: Wastewater Treatment**			

Davis chapters are for the 2nd edition *OR* the 1st edition, professional version.

* Tentative; subject to rescheduling.

OFFICE HOURS AND DISCUSSION SECTION:

- We will have 4 discussions about chapters from "The Big Thirst" (more information about this soon); these discussions will occur on January 18, February 1, February 15, and February 22 from 2-2:50 pm.
- We will not have a formal discussion section on January 4, January 11, January 25, February 8, or March 1 and 8. On these days, I will hold office hours at this time (Wednesday, 2-2:50 pm). Office hours will be by Zoom.

Chapter Conversion Chart between Student and Professional Editions in the first edition of Davis *Water and Wastewater Treatment*

Topic	**Chapter in Student Ed.**	**Chapter in Prof. Ed.**
The Design and Construction Process	1	1
General Water Supply Design Considerations	2	2
Coagulation and Flocculation	3	6
Lime-Soda Softening	4	7
Ion Exchange	5	8
Reverse Osmosis and Nanofiltration	6	9
Sedimentation	7	10
Granular Filtration	8	11
Disinfection	10	13
General Wastewater Treatment Design Consideration	12	18
Wastewater Microbiology	15	22
Secondary Treatment	16	23
Tertiary Treatment	19	26
Wastewater Treatment Plant Residuals	20	27

FORMAT AND PLATFORMS: I will use Canvas to distribute lecture slides, homeworks, readings outside of your textbook, grades, and supplemental articles/ readings. Lecture slides will be available through Canvas prior to each class. I'd encourage you to download these, and either annotate electronically or print and take notes during courses. In some classes, I will include whiteboard work (e.g. solving example problems). To provide flexibility to students, my office hours will be held via Zoom, or in person by appointment. To join Zoom office hours, please go to the calendar in Canvas, or go to the Canvas course homepage and scroll down to the appropriate date. You will need to be logged in to Zoom via your authenticated Northwestern account.

ACADEMIC INTEGRITY AT NORTHWESTERN: Students are required to comply with University regulations regarding academic integrity. If you are in doubt about what constitutes academic dishonesty, speak with your instructor or graduate coordinator before the assignment is due and/or examine the University website. Academic dishonesty includes, but is not limited to, cheating on an exam, obtaining an unfair advantage, and plagiarism (e.g., using material from readings without citing or copying another student's paper). Failure to maintain academic integrity will result in a grade sanction, possibly as severe as failing and being required to retake the course, and could lead to a suspension or expulsion from the program. Further penalties may apply. For more information, visit The Office of the Provost's Academic Integrity and McCormick School of Engineering Academic Integrity websites.

DIVERSITY STATEMENT: As educators and learners, we must share a commitment to diversity and equity, removing barriers to education so that everyone may participate fully in the community. In this course, we respect and embrace the unique experiences that brought each person here, including backgrounds, identities, learning styles, ways of expression, and academic interests. The broad spectrum of perspectives represented by our students enrich everyone's experiences, and we strive to meet each perspective with openness and respect.

ACCESSIBILITY: Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact **AccessibleNU** to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations as part of a student's educational record, is confidential under FERPA regulations.

ACADEMIC SUPPORT AND LEARNING ADVANCEMENT (ASLA): If you are looking for help with a course or academic challenge, or if you would simply like to sharpen your study strategies and stay on track, check out Academic Support & Learning Advancement. They offer drop-in tutoring, study groups, academic coaching, and individual consultations for all undergraduates. For more information: northwestern.edu/asla or asla@northwestern.edu.
For assistance in writing for the group project, I would also encourage you to explore consultations through The Writing Place.

The following ABET learning outcomes will be addressed in this course:

O1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(Course Objectives 2, 8, 9)

O2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(Course Objectives 5, 7, 10, 11, 12)

O4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(Course Objectives 1, 3, 4, 6, 13)