

**NORTHWESTERN UNIVERSITY**  
**CIV\_ENV 364 Syllabus**  
**Sustainable Water Systems**  
**Winter 2022**

MWF 9-9:50 am, Tech LR5  
*Zoom Meeting ID: 990 9148 7910*  
W, 2-2:50 pm (Discussion/ Office Hours), Tech M177  
*Zoom Meeting ID: 943 2493 9191*

Instructor: Professor George Wells  
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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, 2<sup>nd</sup> 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, 3<sup>rd</sup> Edition*. John Wiley & Sons, Hoboken, NJ.

Available to NU affiliates online at:

<http://site.ebrary.com/turing.library.northwestern.edu/lib/northwestern/docDetail.action?docID=10558088>

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

Rittmann, B. E. & McCarty, P. L. (2020) *Environmental Biotechnology: Principles and Applications, 2<sup>nd</sup> 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
<b>1</b>	Jan 3		Introduction			
	Jan 5		Water Quality Standards and Regulations	Chp 1.5, Chp 2		
	Jan 7					
<b>2</b>	Jan 10	Physical-chemical treatment processes	Water Resources and Supply, Water-Energy Nexus			
	Jan 12		Particles in Water and Coagulation	Chp 6		
	Jan 14		Coagulation/ Flocculation, Part I			HW1
<b>3</b>	Jan 17		<b>MLK Day- no class</b>			
	Jan 19		Coagulation/ Flocculation, Part II	Chp 6	Chps. 2 and 3	
	Jan 21		Hardness and Softening	Chp 7		
<b>4</b>	Jan 24		Sedimentation	Chp 10		
	Jan 26					
	Jan 28		Filtration	Chp 11		HW2
<b>5</b>	Jan 31		Disinfection	Chp 13	Chps 5 and 7	
	Feb 2					
	Feb 4		Emerging Issues (Tentative)			
<b>6</b>	Feb 7		Review			
	Feb 9					
	Feb 11		<b>EXAM 1: Drinking Water Treatment*</b>			HW3
<b>7</b>	Feb 14	Biological Treatment Processes	General Wastewater Treatment Design Considerations	Chp 18	Chp 6	
	Feb 16					
	Feb 18		Wastewater Microbiology: microbial kinetics, molecular processes, and the activated sludge microbiome	Chp 22	Chp 8	
<b>8</b>	Feb 21		Secondary Treatment: Activated Sludge	Chp 23		
	Feb 23					
	Feb 25					HW4
<b>9</b>	Feb 28		Tertiary Treatment	Chp 26		
	Mar 2					
	Mar 4					HW5
<b>10</b>	Mar 7		Student presentations, review			
	Mar 9					
	Mar 11					HW6
<b>Final</b>	Mar 18, 9-11 am		<b>EXAM 2: Wastewater Treatment</b>			

Davis chapters are for the 2<sup>nd</sup> edition **OR** the 1<sup>st</sup> 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 19, February 2, February 16, and February 23 from 2-2:50 pm.
- We will not have a formal discussion section on January 5, January 12, January 26, February 9, or March 1 and 9. 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). For periods with remote teaching, live-streamed lectures will be available through the Zoom integration with Canvas. If at all possible, please join for synchronous classes and course discussions. **To join synchronous class activities (classes, discussions, or office hours), please go to the calendar in Canvas and click on appropriate class, 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.** When you have a question or comment during lectures, please either use the "raise your hand" feature in the participant list, or alternatively type your question in the chat window. All classes will also be recorded and available on Canvas for later viewing.

Some of you are in very different time zones or may have personal circumstances that make it difficult to participate synchronously in class activities. I empathize with the unique nature of our current situation, and will be as flexible as possible to accommodate your unique needs or circumstances. **If you are not able to attend lectures or discussions synchronously, please contact me to make alternate arrangements.**

**RECORDING OF SYNCHRONOUS CLASS SESSIONS:** This class or portions of this class will be recorded by the instructor for educational purposes and available to the class during the quarter. You will be able to access these recordings through the course Canvas site. Portions of the course that contain images, questions or commentary/ discussion by students will be edited out of any recordings that are saved beyond the current term. Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

**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](mailto: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](http://northwestern.edu/asla) or [asla@northwestern.edu](mailto: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)