JOHN A. REIF, JR. DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING

NJIT
New Jersey Institute of Technology

# ENE 360 Water and Wastewater Engineering - Spring 2018

**INSTRUCTOR:** Dr. Lucia Rodriguez-Freire
Office #: Colton 266
lrfreire@njit.edu
Phone number: 973-596-2448

**OFFICE HOURS:** Wednesday 3 – 6 pm
And by appointment

**REQUIRED TEXT:**
Mihelcic, J.R., Zimmerman, J.B., (2014) Environmental Engineering: Fundamentals, Sustainability, Design, 2nd Edition (ISBN 978-1-118-74149-8) John Wiley and Sons, Inc.

**PREREQUISITES:**
ENE 262: Introduction to Environmental Engineering
Junior standing

**COURSE DESCRIPTION:**
This course provides training in the methods used for water pollution control. Topics include the chemical, physical, and biological processes that occur in waste treatment design and in receiving waters; modeling schemes to determine chemical loadings and removals in various bodies of water; and water and wastewater treatment processes used for water pollution control.

**Course Objectives and Expected Learning Outcomes:**
1. Students will learn to calculate and predict physical, chemical and biological changes that affect water quality and treatment requirements
2. Students will apply fundamentals mechanisms to unit operations and processes in water and wastewater treatment with emphasis on problem interpretation, formulation and solution
3. Students will incorporate engineering tools for problem solving and communication through the application of social, regulatory, and political context to environmental and water quality analysis.

**POLICIES AND PROCEDURES:**
**Lectures:**

- It's important that you read the assignment (text and/or notes) prior to class. We will try to spend class time summarizing important points from the readings, working examples, and getting practice with quizzes
- It is required that students attend class. Information will be provided that will be critical to student performance
- Please be on time for lectures, turn off your cell phone and refrain from talking in class, arriving late, leaving class in the middle of a lecture or doing any other activity that could be disruptive to the class.

**Homework** will be due at the beginning of the class period on the date specified by the instructor. You are strongly encouraged to work in groups and to consult with the instructor if questions arise for homework assignments. However, everyone is required to submit his or her own solutions to the homework. Assignments will not be accepted late under any circumstances, they may however, be turned in early

**Exams** can cover any material presented in the class. Missed exams may not be made up except for special circumstances such as for health reasons, the instructor must be notified of an absence prior to the exam.

**Term paper** Students will team in 3-4 people groups to work together on the project. Each group will prepare a brief literature review report consisting of 5 pages maximum (excluding cover page, abstract, references and tables/figures), single-spaced. The objective of this literature review is to evaluate current and future challenges in a selected topic or topics impacting water quality, water or wastewater treatment, and/or pollution control. Example of topics to consider might include: Emerging contaminants, membrane processes, water reuse, advance oxidation processes….The paper will include the following sections:

1) Project Title
2) Student names
3) Project Abstract (200 word limit)
4) Background and Significance (Introduction) of the Topic you have selected.
5) Objective of your paper.
6) Theoretical Framework
7) Analyses and Discussion (which should include some calculations); this section can be organized in different specific subtopics.
8) Conclusions.
9) References (you will have to cite any references from which you obtained information, data, equations, and other reference material). Students are expected to provide a minimum of 5 citations.
10) An Appendix section should be included that includes figures (e.g., pC-pH diagrams, and others we have seen in class) and tables resulting from the quantitative analyses

**Presentation** Each group will provide a brief presentation on your paper topic of 7 minutes (with the intent to have about 3 minutes for Questions and Answers). Students are encouraged to use slides (e.g. Power Point) as aids to organize and illustrate the presentation.

**NJIT Honor Code** will be upheld, and any violations will be brought to the immediate attention of the Dean of Students. http://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

**GRADING:**

- Homework (20%)
- Quizzes and In-class work (20%)
- Class Projects (20%)
- Midterm Exam (20%)
- Final Exam (20%)

Students need to have a grade in every section to obtain a final grade in the class. Any extenuating circumstances that might prevent the student to complete a task must be discussed with the instructor prior to the deadline.

The following percentages are guarantee to receive at least the indicated grade:

- A: 90-100%
- B+: 85-89.99%
- B: 80-84.99%
- C+: 75-79.99%
- C: 70-74.99%
- D+: 65-69.99%
- D: 60-64.99%
- F: < 60%

The grade of Incomplete ("**I**") may be given in rare instances where a student, and for documented (by the Dean of Students) reasons, could not complete parts of the work of the course.

**Tentative Course Schedule**

| Class Date | Topics | Student Learning Outcomes | Reading Assignments |
|---|---|---|---|
| Jan. 22 | • Course Overview<br>• Introduction to Water and Wastewater Engineering<br>• Units/Measurements; Environmental Standards | 1. Describe the water regulatory environment<br>2. Define sustainability, sust. development, and sust. engineering<br>3. Apply Life Cycle Assessment tools for engineering design<br>4. Calculate concentrations in different media/units | Chapters 1 & 2 |
| Jan. 29 | **Chemical Processes 1:** Stoichiometry, Concentrations, Acid-Base Reactions | 1. Balance chemical reactions<br>2. Estimate the pH and speciation in an aqueous solution<br>3. Apply Henry's law for gas-liquid equilibrium<br>4. Predict and quantify solid precipitation | Chapter 3 |
| Feb. 5 | **Chemical Processes 2:** Redox Chemistry and Thermodynamics, Reaction Kinetics, Sorption Processes | 1. Balance redox reactions<br>2. Define and calculate reduction-oxidation potential, and the energy of a reaction<br>3. Calculate reaction kinetics<br>4. Plot and interpret adsorption isotherms | Chapter 3 |
| Feb. 12 | **Physical Processes:** Mass and Energy Balances, Mass Transport, Reactor Design<br><br>**<u>Paper Topic Due</u>** | 1. Effectively apply the law of conservation of mass for mass balances<br>2. Distinguish between different reactors<br>3. Calculate reactor volume and retention time<br>4. Differentiate and employ the mass transport processes<br>5. Define different kind of energies, and apply to energy balances<br>6. Apply Fick's law and Stoke's law to solve environmental engineering problems | Chapter 4 |
| Feb. 19 | **Biological Processes:** Biological Reactions, Kinetics, Biogeochemical Cycles | 1. Describe an ecosystem and its function and structure<br>2. Apply thermodynamics to biological growth<br>3. Describe and apply different biological kinetic models<br>4. Calculate population changes and growth rate<br>5. Define and calculate BOD, COD, and ThOD<br>6. Describe Water, Carbon and Nitrogen biological cycles<br>7. Design of biological reactors | Chapter 5 |
| Feb. 26 | **Environmental Risk Assessment** Relationship between concentration, exposure, dose and risk. Risk minimization | 1. Describe environmental risk<br>2. Distinguish between chemical concentration, exposure, and dose<br>3. Calculate acceptable concentration and acceptable risk<br>4. Describe the relationship between bioaccumulation, bioconcentration, food web cycles, and toxicity<br>5. Learn and evaluate mechanisms for risk minimization | Chapter 6 |

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| Mar. 5 | **Water Quality and Quantity**: Resources, Availability, Usage and Demand Distribution, Collection, Water Quality, Wetlands, Groundwater | 1. Describe the components of the major hydrological cycles<br>2. Delineate a watershed and estimate runoff<br>3. Calculate mass loading of pollutants to a watershed<br>4. Estimate water and wastewater flow rates<br>5. Use mass balances to calculate changes in water quality<br>6. Apply Darcy's law to estimate velocity of groundwater and groundwater pollutants | Chapter 7 |
| Mar. 12 | **SPRING BREAK** | | |
| Mar. 19 | **Midterm Exam** | **Chapters 1 to 6** | |
| Mar. 26 | **Water Treatment 1**: Water Standards, Water Treatment Plant, Coagulation and Flocculation and Hardness Removal | 1. Identify the major physical, chemical and biological constituents and relate them with drinking water quality standards<br>2. Distinguish major components of a water treatment plant<br>3. Define coagulation and hardness removal processes<br>4. Calculate coagulants loads<br>5. Design flocculation and coagulation units | Chapter 8 |
| Apr. 2 | **Water Treatment 2**: Sedimentation, Filtration, Adsorption, Disinfection, Ion Exchange | 1. Apply Stoke and Newton's laws to design a sedimentation basin<br>2. Distinguish between different membrane treatments<br>3. Calculate energy requirement for filtration units<br>4. Define indicator microorganisms<br>5. Calculate disinfection rates using Chick's law<br>6. Define adsorption and ion exchange processes | Chapter 8 |
| Apr. 9 | **Wastewater and Stormwater 1**: Collection Systems, Wastewater Treatment Plants, Preliminary, Primary and Secondary Treatment Biological Processes, Nutrient Removal, | 1. Identify the major physical, chemical and biological constituents and relate them with wastewater quality standards<br>2. Distinguish major components of a wastewater treatment plant<br>3. Apply mass balances to design grit chamber and flow equalization basin<br>4. Calculate organic and nutrients loads and removals<br>5. Integrate mass balances with biological growth kinetics to the design of biological treatment units | Chapter 9 |
| Apr. 16 | **Wastewater and Stormwater 2**: Solid-Waste Management, Alternative Wastewater Treatment Options | 1. Describe and quantify the differences between aerobic, anoxic, and anaerobic biological processes<br>2. Define methanogenesis and calculate methane production in anaerobic processes<br>3. Describe the processes for sludge management<br>4. Differentiate between bio-solids types and their application<br>5. Estimate removal rates in lagoons and wetlands<br>6. Calculate wet-weather flows based on inflow and infiltration | Chapter 9 |

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| Apr. 23 | **New Technologies**: Advance Oxidation Processes, Anaerobic Treatment, Water Reuse<br><br>**Term Paper Due** | 1. Understand state-of-the-art technologies for water and wastewater treatment<br>2. Re-define the major challenges in water quality and supply<br>3. Discuss the needs and requirements for water reuse: public perception | Scientific papers/reviews |
| Apr. 30 | **Project presentations** | | |
| May. | **Final Exam** | **Chapter 7 to 9** | |

**Outcomes Course Matrix – ENE 360 Water and Wastewater Engineering**

| Strategies, Actions and Assignments | ABET Student Outcomes (1-7) | Program Educational Objectives | Assessment Measures |
|---|---|---|---|
| **Student Learning Outcome 1:** | | | |
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**CEE Mission, Program Educational Objectives and Student Outcomes**

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

<u>1 – Engineering Practice:</u> Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

<u>2 – Professional Growth:</u> Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

<u>3 – Service:</u> Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. 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
3. an ability to communicate effectively with a range of audiences
4. 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
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies