CEE 598 IUW: INTEGRATED URBAN WATER INFRASTRUCTURE

Spring 2024, Class hour and location: 09:00 – 09:50 MWF, 2015 CEE Building

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Office hours: after scheduled class period or by appointment

Course Description: This course examines the interacting subsystems relating to urban water systems. These include the natural hydrologic cycle, the urbanized landscape, the potable-water distribution system, the sanitary sewage collection and treatment system, the storm water collection and drainage system, as well as the interactions between these systems and the electricity production and distribution. These systems are facing daunting challenges including climate change, water scarcity, increasing population, aging infrastructure, energy uncertainty, and dwindling economic resources. Many of the tools used to design these subsystems and analyze their behavior were developed independently of the tools for other subsystems. In the past decade the concept of integrating all components of the *Urban Water Cycle* has moved from the fringes to a growing area of research and development across multiple disciplines.

This course will introduce concepts and tools used for the various subsystems described above and then examine the connections between these subsystems, with emphasis on how resources can be used more efficiently by integrating these systems rather than considering them in isolation.

This course will make use of widely used, public-domain models to facilitate the analysis of these systems and to gain understanding of the connections among the systems. As such, the course will have a quantitative, component with an emphasis on using the tools presented in class to analyze example systems.

At the same time, the course mirrors the subject area in that both the subject matter and the course enrollment are multi-disciplinary. I am thrilled that the enrollment represents a range of disciplines and research interests. This provides a wonderful opportunity to grow in our respective interests by learning from the perspectives of others. Therefore, this course will also have a significant student-directed component, where students will select a topic/article that they will critically review and present to the class.

For online students, the course format will be a mix of synchronous and asynchronous on-line instruction. Feedback from previous semesters and other courses indicates that many students prefer synchronous instruction and the options this provides to ask questions during the lecture. However, many students also have other obligations and may not be able to participate in synchronous on-line discussions. I have scheduled the course from 09:00 – 09:50 AM (Central Time). Links to the Zoom meetings for course lecture/discussion sessions are available in Canvas. These discussions will be recorded and posted to the *Illinois Mediaspace* server and linked from Canvas.

Prerequisites: While it would be helpful for students to have basic background in water resources/hydrology/hydraulics, such as presented in CEE 350, *Water Resources Engineering*, this is not a prerequisite. However, students without some background in water resources are expected to take advantage of background material posted to Compass to become conversant with the language of the discipline and with fundamental analyses used in water resources engineering. [return to top]

Goals: My overall goal for this course is that you learn how to appropriately apply scientific principles—including hydraulics, hydrology, numerical methods, uncertainty analysis—to critically evaluate the tools available to analyze urban water systems. Because of the complexity of urban systems, we often rely on numerical methods to approximate the behavior of these systems under different conditions. I have designed this course to provide you opportunity to get instruction and hands-on experience in applying some of the most commonly used models and methods to realistic engineering problems. In particular, I want you to experience and work through some of the pitfalls associated with these models and methods. The resulting background and experience with these tools will allow you recognize circumstances that violate the assumptions behind the methods you are using and guide you to appropriately select an alternative approach. This is particularly important as you consider design, analysis, and optimization of integrated systems where you often push the tools beyond the bounds for which they were developed [return to top]

Learning Objectives: The primary objective of this course is that the student should be able to

synthesize the knowledge they've acquired in their engineering education and experience and apply that to address complex, often interdisciplinary, real-world urban-water problems. For each major subsystem of urban water infrastructure the student should be able to:

- Identify the appropriate governing equations,
- Describe how these are formulated into existing numerical models,
- Appraise the assumptions in these formulations and corresponding limitations of the models,
- Apply the models to real-world urban water problems.

By the end of the course, students should be able to synthesize modeling tools to examine the interdependencies among the different urban-water subsystems, identify the tradeoffs in the overall system, and identify a Pareto optimal set of solutions that considers the performance objectives of the different water and related energy systems.

Specific learning objectives will be provided at the beginning of each lecture. These will be used in developing the examinations and thus should provide a helpful study tool. [return to top]

Text: We will be using course handouts, Internet sources, and public domain computer programs and associated documentation, available from the Internet. Much of the course material is available on the course web page. [return to top]

Supplemental on–line materials: Course Web site: The Illinois Canvas system will be the course web site. Supplemental instructional materials for this course will be delivered to you via the course website, which contains a variety of different modules, including supplemental references, various design manuals and manuals of practice, commonly used software, links to related web sites, homework assignments and solutions, example problems, etc. Of particular importance, the Bulletin Board (Discussions), Assessments, and Announcements are available only through the website. You are responsible for and expected to regularly check the pilot website for announcements and other important class information. The Uniform Resource Locator (URL) for the course is:

https://canvas.illinois.edu/

When you enter this URL into the Web browser a login box will appear. Follow the instructions on that page to log in. You will be using your campus NetID to login to the pilot website. . [return to top]

Course Outline:

I. Introduction to Urban Water Systems
II. Numerical Modeling Overview
III. Analysis of Water Supply System
    A. Constraints/Demands/Design Criteria

- B. Distribution System
- C. Numerical Modeling (EPANET model)

IV. Analysis of Wastewater System
- A. Constraints/Loads/Design Criteria
- B. Collection System
- C. Numerical Modeling (SWMM model)

V. Analysis of Stormwater System
- A. Constraints/Loads/Design Criteria (Urban Hydrology)
- B. Collection System
- C. Non-point source pollution
- D. Sustainable Urban Drainage Systems
- E. Numerical Modeling (SWMM model)

VI. Analysis of Energy/Water Interactions
- A. Water impacts of Electricity Production
- B. Energy Demands of Water and Wastewater Systems
- C. Evidence of Cascading Failures
- D. Numerical Modeling (PowerWorld and GIS models)

VII. Integration of Urban Water Systems
- A. Stormwater Management
- B. Reclamation/Recycling/Reuse—integration among systems

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Course Expectations

Students are expected to:

1. Arrive on time and contribute actively to classroom discussions
2. Attend each lecture and field session.
3. Contribute actively to your project team. This includes homework and work on your semester project.
4. Refrain from distracting practices, e.g., conversations with classmates, watching movies, working on homework, texting, or browsing on your computer during lectures. These activities hinder your ability learn the material, and impact the learning of your classmates.
5. Communicate ideas, questions, and concerns promptly to the instructor. This will help you as well as other students in the class.

The instructors are committed to:

1. Being well prepared on course subject matters;

2. Provide clear explanations and examples;
3. Help to assess each student's abilities and areas of growth;
4. Provide relevant and challenging homework, exercises, and exams;
5. Maximize the potential for learning by giving useful and timely feedback.
6. Start and finish class on time.
7. Maintain a positive, respectful learning environment.

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Office Hours: I will schedule about 3 hours per week of office hours to meet with students and mentor them on the material and assignments from this course. Mondays and Wednesdays and alternating Fridays I will hold office hours immediately after class in the common area on the 2nd floor of the CEE building. Since this class is has on-line students, I will provide a Zoom link for office hours to allow on-line students opportunity to participate in these. I also anticipate that these times may not work for all students. Therefore, additional office hours can be set by appointment. [return to top]

Evaluation: My goal with the evaluation tools is to facilitate you synthesizing the knowledge you've acquired in your education and applying it to complex, real-world problems. I will use multiple tools to help reach this goal. We will have six larger *Homework* assignments that use public-domain modeling tools. We will have a semester project that will emphasize the synthesis component of this objective to produce a solution to a realistic engineering problem. We will have a *Discovery Assignment* where teams of students examine a contemporary integrated urban water-energy issue from the literature and develop and present a teaching module based on their findings. We will have about six to eight *Breakout Exercises* that are smaller, focused exercises that we will work on in small groups in class. These *Breakout Exercises* provide in-class time to cover the material presented in the recent lecture/discussions. I will provide a short exercise set (think of this as a group quiz) that you are to discuss and work on together and submit one answer for your group. I will coordinate with on-line students to create groups of students that can work together. Asynchronous students will be responsible to establish a meeting and do these exercises before they are due (46 hours from end of lecture).

We will have two *Examinations* over the course of the semester to evaluate your understanding of and ability to apply the material from the readings and discussions. The exams will cover lecture material, content from the on-line course site, handouts, and assigned readings. The format of the exams will be a combination of short answer and worked problems. Any questions regarding your exam score must be discussed with the instructor within two weeks after the exam score is returned to you. Any student registered with the Division of Rehabilitation Services must self identify with the instructor at least one week prior to the first exam.

Exams will be open-book, open-notes, take-home exams provided on-line. **These are to be your work alone—you are not to work with or discuss your work with anyone but the instructor!**

The exams may be a combination of written responses to questions, spreadsheets, and model results. Students will need to convert/scan their final response **to a PDF** and return this to me electronically. Supplemental material (spreadsheets, figures, model results) can be other formats that can be delivered electronically, **provided you clear the format with the instructor in advance**. Please check your submission for completeness and legibility. Electronic exam submissions need to be received no later than the time specified on the due date of the exam. In the unlikely event of problems with the on-line course website system, you can email your submission to me with an explanation of the Compass problem you encountered.

As a graduate-level course I feel that it is essential to provide opportunity for you to grow in your critical thinking skills. As part of this, the exams will be a hybrid of traditional exam and peer evaluation. After each exam, I will assign each student to peer-evaluate selected questions from three class-mates' examinations (I will randomize among questions and students). Your grade for the examination will be 60% based on your original submission, 25% based on your peer evaluation comments/input to your classmates, and 15% based on any revisions you make to your original submission based on peer-review comments. [return to top]

Homework: Over the course of the semester you will have six homework assignments that will help train you in the concepts from that section. These assignments will primarily be application of computer modeling tools to an example urbanizing area. I will modify a proposed urban development to provide a pseudo real-world example that will allow you to develop the skills from this course. As we progress through the course, you will apply commonly used computer models to analyze the subsystem that we are discussing (e.g., EPANET model for water distribution system, SWMM5 for sewage collection system and for stormwater system, etc.). I believe that working in a small team facilitates the learning process, provided that you actually work together. I am pleased to have you work in teams of two to three students on your homework, but please be sure to work together rather than 'divide and conquer' approach where one person is not familiar with what other did. Please Note: most/all of the computer models we use were designed to run under the Microsoft Windows operating system. **For those that use a Mac, you will need to install Bootcamp or Parallels with a Microsoft Windows OS or locate a Windows computer that you can install these models on**. [return to top]

Discovery Assignment: I will ask students to form teams of two to three students to complete a *Discovery Assignment.* This will be a small project that you propose, discuss with me, and present to the class when completed. I would like this to be something that will provide teaching content for your classmates and for future generations of this class. For example, because this is such a rapidly evolving field, you can find dozens of journal papers published in the last few years on topics related to this course. You could do a literature review of a topic related to this course or you could pick an article or two that are closely related and provide an in-depth discussion of the

topic of these articles. For either of these, I would like you to produce teaching slides for this topic. Other potential example projects could include:

- A tutorial on one of the computer models, along with a sample data set and some instructional slides.
- A case study of an integrated urban water project, with teaching slides and references.
- A video—based on one of the above possible topics or a '*virtual field trip*'—that could be used in future classes.

You will self-identify a team, propose a topic, and then mid-semester post a draft presentation to Compass. I will assign each student one project to peer-review. You also will self-select one additional project to peer-review. [return to top]

All About Me Video Introduction: Creating community is a vitally important aspect of meaningful and enjoyable learning. Being a part of a learning community helps students feel more involved and connected, and thus, helps them want to learn the course content more deeply. The goal of the All About Me assignment is to help build community in CEE 598 by sharing a little about yourself with your classmates and the instructor. In this assignment you will produce a short video (2 to 4 minutes) in which you tell us a little bit about yourself. Be sure to include your name, where you are from or where you live, what you are currently doing (e.g., 'I'm a WRES Ph.D. student working with Prof. Valocchi on carbon sequestration', 'I'm a M.S. student in EWES doing research on hydropower', 'I'm an on-line M.S. student and work full time at a water-resources consulting company', etc.,). Also please tell what things you hope to gain from this course, and three things you love to do. You will upload your video to the course Canvas website. You are encouraged to watch the videos posted by the instructor and your classmates. The All About Me assignment is worth 4% of your final grade. [return to top]

Design Project: Near the end of the semester you will form project teams of two to three people to work on a semester project that builds on and integrates the homework you have done earlier in the course. The homework will be based on the various sub-systems (potable water, waste water, storm water, etc.) of our example project area. When done with these homeworks we will have models that describe the key sub-systems (supply, sanitary, storm water, receiving water, and watershed). In last part of the course student teams will incorporate a variety of practices including sustainable urban drainage systems (SUDS), water reuse/recycling, dual distribution systems, etc. and modify all of the models from the previous homeworks to incorporate their proposed changes to the system. The revised models will then be used to look at overall impact of integrating the various conservation/management/recycling practices. [return to top]

Absence Policy: The University requires an absence/attendance policy, so here goes: You are all responsible adults. You are experienced enough to realize that learning is a privilege and that your success in learning is related to your active participation in course discussions and exercises. In addition, your contributions to classroom discussions are important to me and valuable to enhance your classmates learning. As mentioned in the next paragraph, I hope that you will enhance this class by regularly sharing your observations and ideas in course discussions and in working with your classmates on exercises. Hence, I strongly encourage you to attend in-person lectures to the extent it is possible. All lecture slides will be available on Canvas and all lectures are recorded and available in MediaSpace, so if you are unable to attend lecture you can still see the material, although you will miss out on the opportunity for in-class discussion. When possible, please let me know in advance of your missing lecture as this helps me plan in-class activities. [return to top]

Class Participation: I encourage you to pose questions and comments about the class material and relevant water-resources issues before, during, and after class. Various activities will be included during the lecture-discussion time to facilitate discussion with both the instructor and your peers. In addition, you are **strongly encouraged** top use the *Slack Channel* for this course to present your questions or comments to the class as a whole and to respond to the questions and discussions posted by your peers. In particular, the on-line discussion area is on-line student's greatest opportunity for participation. If you directly email questions to the instructor, you will be asked to post these to the *Slack Channel* in order to facilitate interaction with your peers and to allow others to benefit from your questions and discussions. Six percent of your semester grade will reflect your participation in classroom **and on-line** discussions. [return to top]

Grades: The evaluation of your performance in this class is based on the activities outlined in the table below. At the instructor's discretion, opportunities for extra credit may be provided during the course of the semester. These may be problems in addition to the regular homework or supplemental questions on the homework or examinations.

Two hour exams		24%
Homework		18%
Breakout exercises		12%
Discovery Assignment		20%
Project		16%

All About Me Video		4%
Participation		6%
TOTAL		100%

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Student Feedback and Evaluation: A critical part of making this course a valuable and enjoyable learning experience is your feedback. I try to gauge how well you have understood the materials I've presented and adjust in class to clarify any questions. I have found, however, that your feedback throughout the semester is critical to help me adjust what I am doing and thereby meet the goals and learning objectives of the course. In particular, this helps to ensure that neither you nor I have any terrible surprises from the examinations. I encourage you to post your question(s) or comment(s) to the *Slack Channel* so that both you and the other students in the course may benefit from these questions and responses. This will be a key part of your **participation grade**. [return to top]

CEE Honor Code

To foster and promote integrity among students, the CEE Honor Code was developed with input from several CEE undergraduate organizations, the CEE Graduate Student Advisory Committee, and the CEE Graduate Affairs Committee. You (the student) commit to honor the code each time you sign an exam, and implicitly whenever you sign homework or other class assignments.

The CEE Honor Code pledge is the following:

> I pledge to uphold the highest levels of professional and personal integrity in all of my actions, including 1) never assisting or receiving unfair assistance during exams, 2) never assisting or receiving assistance on class assignments beyond that specified by an instructor, and 3) always fully contributing to group activities that are part of a course activity. [return to top]

Statement of Academic Integrity: The *Code of Policies and Regulations Applying to All Students* will be applied in all instances of academic misconduct committed by CEE 598 students. This applies to all exams, assignments, and on-line materials distributed or used in this course. [return to top]

Mental Health

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know

experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

Counseling Center (217) 333-3704

McKinley Health Center (217) 333-2700

National Suicide Prevention Lifeline (800) 273-8255

Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

*This statement is approved by the University of Illinois Counseling Center [return to top]

Students with Disabilities

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor as soon as possible and provide the instructor with a Letter of Academic Accommodations from Disability Resources and Educational Services (DRES). To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class should apply for services with DRES and see the instructor as soon as possible. If you need accommodations for any sort of disability, please speak to me after class, or make an appointment to see me or see me during my office hours. DRES provides students with academic accommodations, access, and support services. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 217-333-1970, e-mail disability@illinois.edu or visit the DRES website at http://www.disability.illinois.edu/. Here is the direct link to apply for services at DRES, https://www.disability.illinois.edu/applying-services.

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